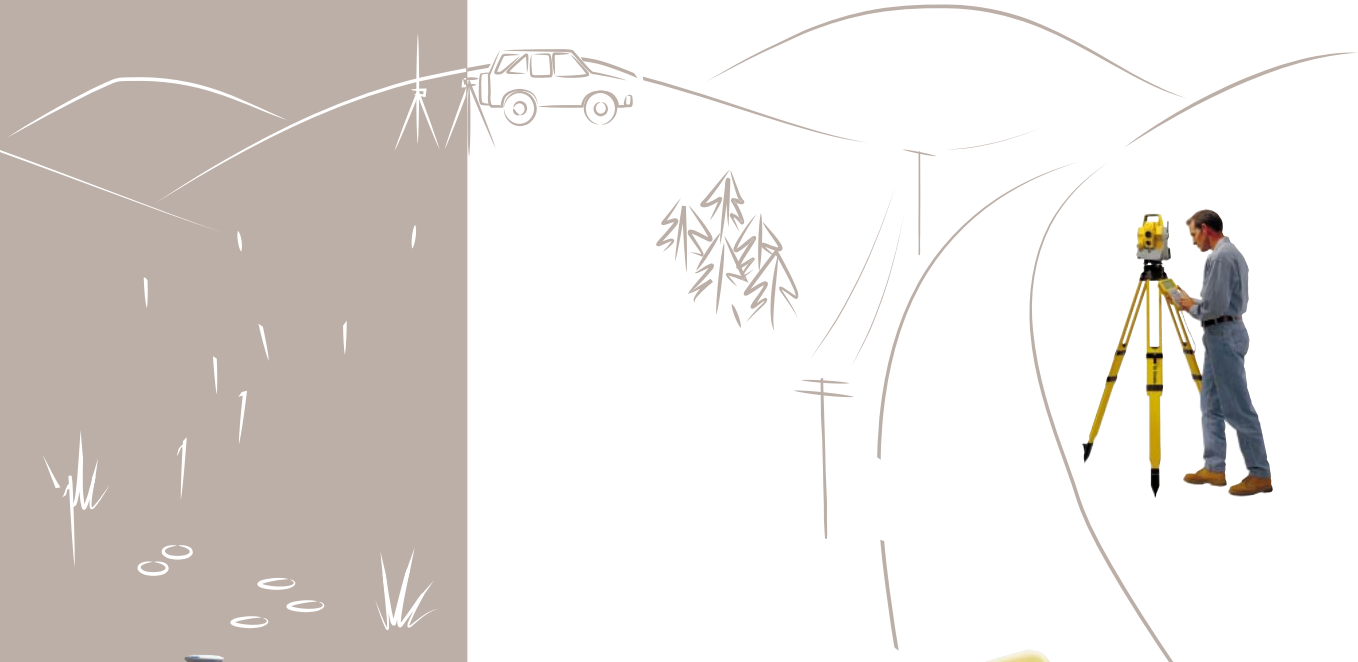
Trimble Survey Controller
Reference Manual



Trimble™

Trimble Survey Controller

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for Chapters 10-23 and Appendixes D-G

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About This Manual

Welcome to the world of surveying with Trimble's handheld Trimble Survey Controller™ system. This system is a result of Trimble's continued commitment to manufacturing the very best survey products. The Trimble Survey Controller version 7.7 software operates on the Trimble System Controller platform, the TSC1™ data collector. Together they make it possible for you to survey more efficiently than ever before.

Scope and Audience

This manual is a complete reference guide, providing operating instructions for all Trimble Survey Controller software functionality.

If you have had little or no exposure to surveying using Global Positioning System (GPS) products, the explanation of fundamental concepts is invaluable for learning and appreciating the issues that are important to conducting successful GPS surveys.

If you are not familiar with GPS, we recommend the booklet *GPS, A Guide to the Next Utility* that is available from Trimble Navigation Limited.

If you use conventional surveying instruments as well, the Trimble Survey Controller software lets you combine conventional observations with GPS observations in the same job. The Trimble Survey Controller software interfaces with all major brands of conventional instruments, including Trimble's own conventional total station.

Related Information

Other documentation for the Trimble Survey Controller software includes:

- Online Help

  The TSC1 data collector has an online Help system that makes it easy to find the information you need. To access the Help system, press the HELP button. For more information see Help Key, page 3-38.

- *Trimble Survey Controller Field Guide*

  The *Trimble Survey Controller Field Guide* is a handy volume that gets you surveying in the field as quickly as possible. For more detailed information refer to the two-volume *Trimble Survey Controller Software Reference Manual* (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. They are provided as a PDF file on the CD. Use Adobe Acrobat Reader to view the contents of the release notes.

Other sources of related information are:

- Update Notes

  Contact your local Trimble dealer for more information about the support agreement contracts for software and firmware, and extended warranty programs for hardware.

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

- Trimble training courses – consider a training course to help you use your GPS system to its fullest potential. For more information, visit the Trimble web site at www.trimble.com/support/training.htm.

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Your feedback about the supporting documentation helps us to improve it with each revision. To forward your comments, do one of the following:

- Send an e-mail to ReaderFeedback@trimble.com.
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If the reader comment form is not available, send comments and suggestions to the address in the front of this manual. Please mark it *Attention: Technical Publications Group*.

Document Conventions

The document conventions are as follows:

Convention	Definition
Italics	Identifies software menus, menu commands, dialog boxes, and the dialog box fields.
Helvetica Narrow	Represents messages printed on the screen.
Helvetica Bold	Identifies a software command button, or represents information that you must type in a software screen or window.
“Select *Italics* / *Italics*”	Identifies the sequence of menus, commands, or dialog boxes that you must choose in order to reach a given screen.
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.

CHAPTER

1

Surveying with GPS

In this chapter:

- Introduction
- Advantages
- Overview of the Global Positioning System
- Satellite signals and GPS receivers
- GPS surveying concepts
- GPS surveying techniques
- Techniques for survey tasks

Introduction

This chapter introduces you to the Global Positioning System (GPS) and the concepts related to surveying with GPS.

Advantages

Surveying with GPS increases productivity. You can achieve real-time centimeter-level precision while surveying faster than is possible with conventional survey methods.

GPS makes it possible to survey 24 hours a day in all weather conditions, and eliminates the need for mutually visible survey stations. GPS surveys are also easy to do.

Overview of the Global Positioning System

The Global Positioning System is a satellite-based positioning system operated and controlled by the U.S. Department of Defense for the benefit of both military and civilian users.

Satellites in Space

There are 27 operational NAVSTAR satellites (SVs) in space. They orbit the earth every twelve hours at an altitude of about 12,600 miles (20,200 km). The satellites are grouped into six orbits, each inclined at 55 degrees to the equator.

Each satellite transmits radio signals that are marked with unique identifying codes. High-precision atomic clocks aboard the satellites control the generation of these signals and codes.

Controlling the GPS

The U.S. Department of Defense controls the system using four ground-based monitor stations, a master station, and three upload stations:

- The monitor stations continuously track the satellites and provide this data to the master station.
- The master station calculates corrections to synchronize the atomic clocks aboard the satellites. It also revises orbital information. The master station forwards these results to the upload stations.
- The upload stations update each individual satellite using the information provided by the master station.

Users of GPS

GPS signals are used by civilians as well as by the military. Anyone who has a GPS receiver can use GPS.

Initially, GPS receivers were used mainly for position determination and navigation. GPS receivers are now being used for an unprecedented range of precise survey tasks on land, on sea, and in the air.

Satellite Signals and GPS Receivers

Each satellite transmits two unique codes. The first and more simple code is called the C/A (coarse acquisition) code. The second code is called the P (precise) code. These codes are modulated onto two carrier waves, L1 and L2. The L1 wave carries both the C/A and the P-code, while the L2 wave carries only the P-code.

GPS receivers are categorized as being single-frequency or dual-frequency. Single-frequency receivers observe the L1 carrier wave, while dual-frequency receivers observe both the L1 and L2 carrier waves.

Code and Phase Measurements

Positions are resolved by trilateration after determining the range to each visible satellite. Ranges are measured using the code or the phase of the carrier wave.

There is a time difference between when the code is generated in the satellite and when it is received at the GPS antenna. Code measurements make it possible to record this time difference. The measurements are multiplied by the speed of light, making it possible to determine the range.

Survey-grade GPS receivers measure the phase difference of the carrier wave. The wavelengths of the L1 and L2 waves are known, so ranges are determined by adding the phase difference to the total number of waves that occur between each satellite and the antenna.

Determining the full number of cycles between the antenna and the satellite is referred to as the integer ambiguity search. For postprocessed surveys that require centimeter-level precision, the integer is determined during postprocessing. For real-time surveys that require centimeter-level precision, the integer is determined during initialization.

GPS Surveying Concepts

GPS surveying requires the simultaneous observation of the same four (or more) satellites by at least two GPS receivers. Although you can use more than two receivers for some surveys, this manual limits discussion to the use of two: the base receiver and a rover receiver.

The base receiver is located over a known control point for the duration of the survey. The rover receiver is moved to the points that are to be surveyed or staked out. When the data from these two receivers is combined, the result is a three-dimensional vector between the base and the rover. This vector is called a baseline.

You can use different observation techniques to determine the position of the rover receiver relative to the base. These techniques are categorized according to the time at which a solution is made available:

- Real-time techniques use a radio to transmit base observations to the rover for the duration of the survey. As each measurement is completed, the solution is resolved.
- Postprocessed techniques require data to be stored and resolved some time after the survey has been completed.

Generally, the technique you choose depends on factors such as the receiver configuration, the accuracy required, time constraints, and whether or not you need real-time results.

Note – *If you are using postprocessed techniques, you must have the appropriate module of the Trimble Geomatics Office™ software installed before you can process the data.*

GPS Surveying Techniques

The Trimble Survey Controller software from Trimble Navigation Limited lets you survey using the kinematic, differential, or FastStatic™ survey techniques. Kinematic and differential techniques are suitable for real-time or postprocessed surveys. The FastStatic technique is suitable for postprocessed surveys only.

Kinematic

Kinematic (Stop and Go) surveying uses phase measurements from four or more satellites common to the base and rover receivers. To achieve centimeter-level precision, the survey must first be initialized.

Initialization can be achieved in different ways:

- If using single-frequency receivers, initialize a survey by setting the rover over a known point or a new point, or by using an initializer bar. The initializer bar creates an artificial known baseline.
- If using dual-frequency receivers for a real-time survey, set the rover over a new point or a known point. If the rover has the On-The-Fly (OTF) option installed and there are at least five common satellites, initialization can be achieved while the rover is moving.

  If you are using dual-frequency receivers for postprocessed surveys, OTF initializations are attempted whether or not the receiver has the OTF option installed.

If the number of common satellites falls below four while you are surveying, the survey must be reinitialized when four or more satellites are again being tracked.

Differential

Differential survey techniques use GPS code (C/A-code) measurements to determine position. Differential surveys do not require initialization or the continuous tracking of satellites. Results typically achieve submeter precision.

You can use single-frequency or dual-frequency receivers for differential surveys.

Wide Area Augmentation System (WAAS)

GPS surveying using the broadcast message from the Wide Area Augmentation System (WAAS) satellites is similar to differential surveying, except that you do not need a radio to track the WAAS signals—the GPS receiver tracks them. WAAS signals can be used to provide real-time, differentially-corrected positions in any survey, when the radio link is down.

The availability of WAAS signals depends on your location in the world. Please contact you local Trimble dealer for details.

You must use a receiver that is capable of tracking WAAS satellites for WAAS surveys.

Note – *The US term WAAS describes a satellite-based delivery system for differential positions. It is synonymous with EGNOS, which is used in Europe.*

FastStatic

FastStatic surveying is a postprocessed survey method that provides centimeter-level precision. It uses carrier phase measurements to measure baselines in as little as eight minutes (8–30+ minutes). The time required depends on the receiver type, the baseline length, the number of satellites available, and the satellite geometry.

Static surveying is used for surveys of the highest precision, but it requires occupation times of one hour or longer. FastStatic surveying is a derivative of static surveying, and is the result of advances in both hardware and software development.

You can use single-frequency or dual-frequency receivers for FastStatic surveys.

Techniques for Survey Tasks

Surveyors use GPS for control surveys, topographic surveys, and stakeout.

Control Surveys

Control surveys establish control points in a region of interest. Vectors are measured using careful observation techniques. These vectors form tightly braced networks, and precise coordinates result from the rigorous adjustment of the networks.

Static and FastStatic observation techniques, combined with a network adjustment, are best suited to control work.

Topographic Surveys

Topographic surveys determine the coordinates of significant points in a region of interest. These surveys usually result in the production of a map.

Kinematic techniques (real-time or postprocessed) are best suited to topographic surveys because of the short occupation time required for each point.

Stakeout

Stakeout is the procedure whereby predefined points are located and marked. To stake out a point, you need results in real time.

Real-time kinematic (RTK) is the only technique that provides centimeter-level, real-time solutions.

Table 1.1 summarizes the different survey techniques.

Table 1.1 Characteristics of GPS survey techniques

Procedure	Minimum number of SVs	Minimum observation time	Typical horizontal precisions	Other characteristics
Static	4	1 hour	Single-frequency: ±5 mm + 1 ppm Dual-frequency: ±5 mm + 0.5 ppm	For single-frequency receivers, best precision is on baselines of ≤10 km. For dual-frequency receivers, there is no maximum baseline length.
FastStatic	4	8–30 minutes	Varies between static and kinematic precisions, depending on occupation time.	Procedure is the same as for Static, but observation times are shorter.
Postprocessed kinematic	4	2 epochs	±1 cm + 1 ppm	Baseline limit is approximately 50 km. Receiver needs five satellites to initialize on the fly. Rover must be initialized for centimeter-level precisions.
Real-time kinematic (RTK)	4	1 epoch	±1 cm + 1 ppm	Radio link is required. Baseline limit is approximately 10 km. Receiver needs five satellites to initialize on the fly. Rover must be initialized for centimeter-level precisions.

Table 1.1 Characteristics of GPS survey techniques (Continued)

Procedure	Minimum number of SVs	Minimum observation time	Typical horizontal precisions	Other characteristics
Postprocessed differential	4	2 epochs	Everest / Maxwell receivers: <0.5 m RMS with 5 SVs, PDOP <4 Other receivers: 1–3 m in same conditions.	Satellites do not have to be tracked continuously.
Real-time differential	4	1 epoch	Everest / Maxwell receivers: 0.2 m + 1 ppm RMS with 5 SVs, PDOP <4 Other receivers: 1–3 m in same conditions.	Radio link is required. Satellites do not have to be tracked continuously.

Values in this table assume a low multipath environment and low ionospheric activity. They are based on results obtained using the latest Trimble equipment.

CHAPTER

2

The TSC1 Data Collector

In this chapter:

- Introduction
- Turning the TSC1 data collector on and off
- Screen
- Rebooting
- Data capacity (memory)
- Operating temperature and humidity ranges
- Power sources
- Recharging the TSC1 battery
- Using the 9 V TSC1 battery adaptor
- Ports
- Maintenance
- Upgrading the Trimble Survey Controller software

Introduction

The Trimble Survey Controller field computer consists of Trimble Survey Controller version 7.7 software running on the Trimble System Controller (TSC1™) data collector. This chapter introduces the hardware and describes how to use it. For information about how to use the Trimble Survey Controller software, see Chapter 3, General Operation.

Figure 2.1 and Figure 2.2 show different views of the TSC1 data collector. They will help you to become familiar with the terms used in this manual.

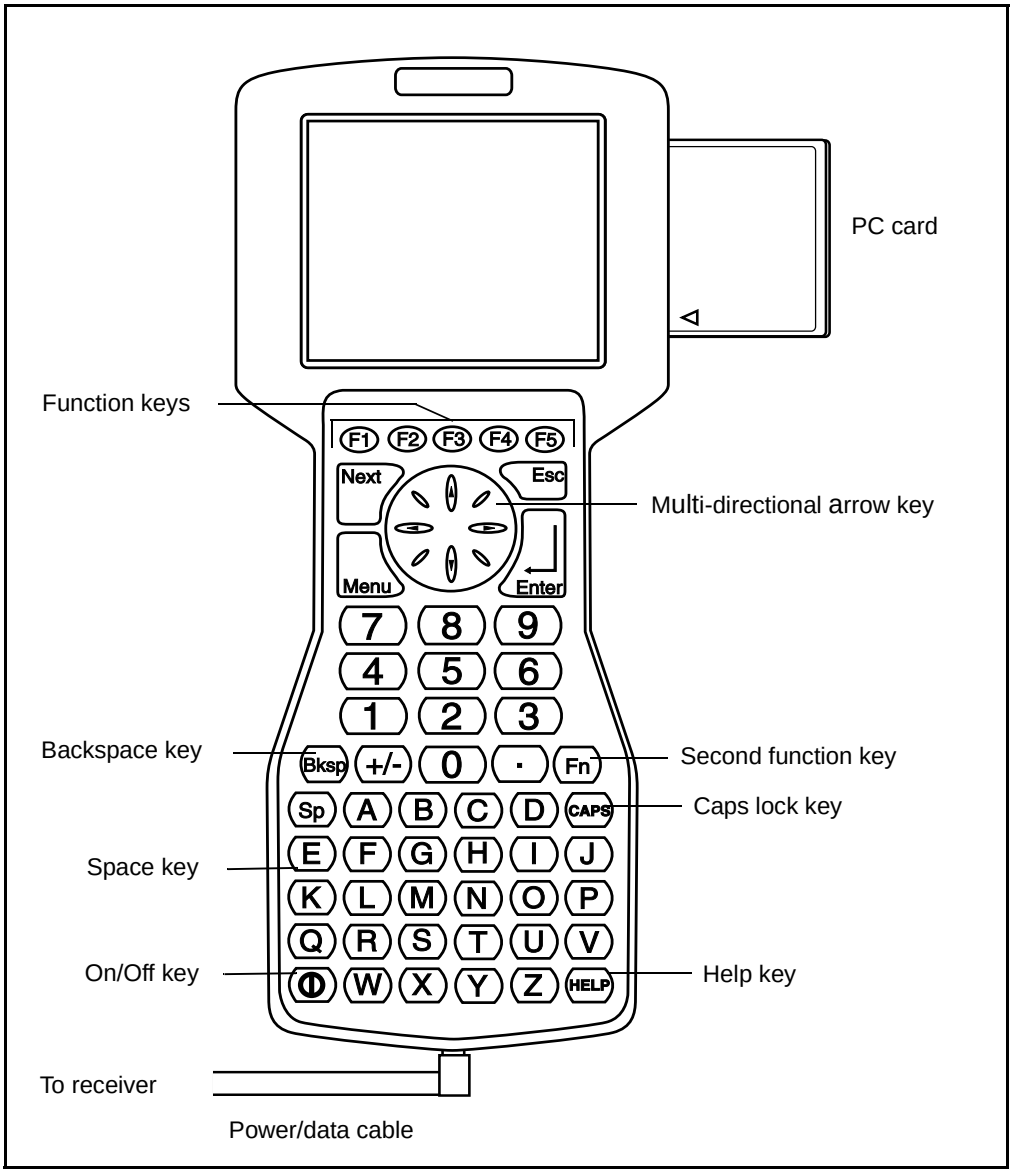


Figure 2.1 Front view of the TSC1 data collector

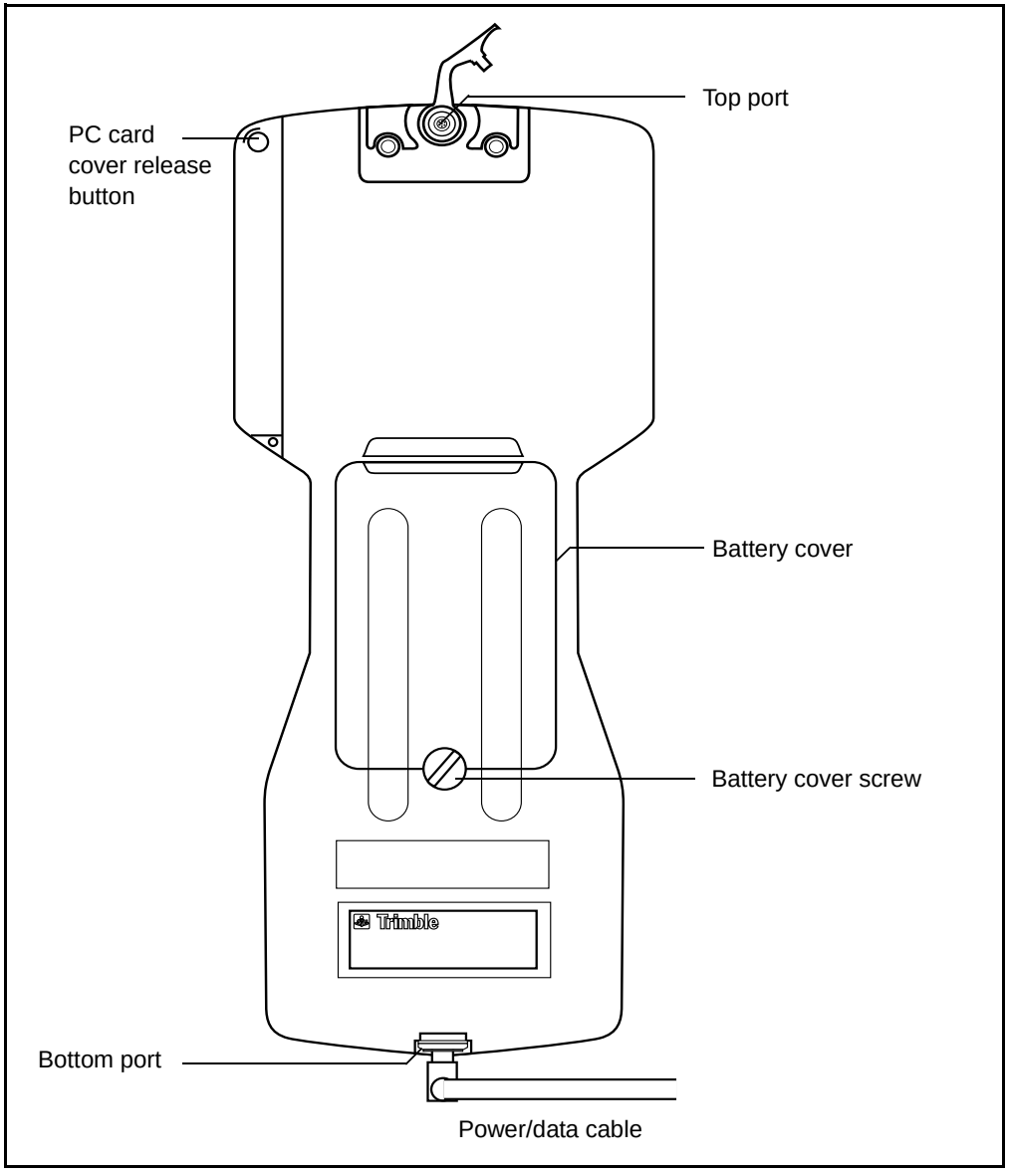


Figure 2.2 Back view of the TSC1 data collector

Turning the TSC1 Data Collector On and Off

To turn on the TSC1 data collector, make sure that power is supplied (see Power Sources, page 21). Then press the green on/off key marked ⏻.

To turn off the TSC1, hold down ⏻ for one second.

Tip – For the location of this key and other keys on the TSC1 data collector keypad, see Figure 2.1.

Screen

The TSC1 has an LCD screen. This screen responds to heat, and prolonged exposure to full sunlight can cause it to darken. If the screen does darken, turn it away from direct sunlight to get it to return to normal.

Warning – Repeated exposure to direct sunlight causes the screen to degrade.

Contrast

To increase the screen contrast, press Fn E.

To decrease the screen contrast, press Fn F.

The TSC1 can automatically set the screen contrast. See Hardware, page 55.

Backlight

To toggle the screen backlight on and off, press Fn L.

Rebooting

If the Trimble Survey Controller software fails to respond to keystrokes, you might have to reboot the system. Turn off the TSC1 and turn it back on again.

If this does not work, hold down the ⏻ key for five seconds, then release it. Press it again to turn on the Trimble Survey Controller software.

If this does not work, perform a warm boot.

Note – *If the software fails to respond to keystrokes, first check that the TSC1 data collector is receiving power.*

Warm Boot

A warm boot shuts down the hardware and restarts the Trimble Survey Controller software.

Note – *You do not lose data when you perform a warm boot.*

To perform a warm boot:

1. Turn off the TSC1 data collector. It may be necessary to hold down ⏻ for five seconds.
2. Hold down Bksp while you press and release ⏻. This turns on the TSC1.
3. When you hear three beeps, release Bksp. The TSC1 data collector restarts and, a few seconds later, runs the Trimble Survey Controller software.

   Note – *A warm boot restores the Trimble default settings.*

If the warm boot fails, perform a cold boot.

Cold Boot

A cold boot ***erases the internal memory*** and restarts the Trimble Survey Controller software. It does not affect data stored on the PC card.

Warning – A cold boot causes you to lose all data in the internal memory. Only perform one if a warm boot fails.

To perform a cold boot:

1. Turn off the TSC1 data collector. It may be necessary to hold down ⏻ for five seconds.
2. Hold down Fn and F5 together while you press and release ⏻. This turns on the TSC1. After a few seconds a message appears:

   Force Reformat Internal Media Please Wait.....

3. Release Fn and F5. After a few minutes, the Trimble Survey Controller software starts.

Data Capacity (Memory)

The TSC1 data collector is supplied with 2 MB of internal memory for data storage. Although the TSC1 can hold a large volume of data, Trimble recommends that you transfer data files to an office computer daily.

Note – *If you are in a survey and the main memory of the TSC1 data collector is nearly full, the Trimble Survey Controller software ends the survey. To create more memory space, download the data and purge some files.*

While some data collectors use battery-backed static memory, the TSC1 uses flash memory. With flash memory, there is no need for a backup battery to preserve data when the system is turned off. This means that the TSC1 data collector provides exceptionally secure data storage.

To increase the memory available for data storage, insert a PC card into the side of the TSC1. PC cards supplement the internal flash memory and are available in various sizes (for example, 4 MB, 10 MB, and up to 85 MB). For more information see Chapter 8, PC Cards.

Real-Time Surveys

Table 2.1 shows the maximum amount of free space that is available for data storage during a real-time survey, as well as the estimated number of positions that can be stored. It shows values for standard RTK positions with QC1 records, and for RTK positions with QC1 and QC2 / QC3 records. For more information, see Quality Control Records, page 379.

Table 2.1 Position storage capacity

Memory	Available memory	RTK + QC1 Number of positions	RTK + QC1 + QC2 / QC3 Number of positions
2 MB	1.795 MB	5,800	4,600

Postprocessed Surveys

Postprocessed surveys continuously log raw GPS observation data. The number of points that can be stored in the TSC1 data collector depends on the logging/epoch rate and the number of satellites tracked.

Table 2.2 shows the estimated time available when using a dual-frequency receiver to track six satellites with a logging/epoch interval of five seconds.

Table 2.2 Data logging time available

Memory	Available memory	Time available
2 MB	1.795 MB	8 h 34 m

To calculate the time available, first calculate the number of bytes required to store one record:

33 + (*n* x 30) for a single-frequency (L1) receiver

33 + (*n* x 43) for a dual-frequency (L1/L2) receiver

where *n* is the number of satellites available.

To see how many bytes are left in the TSC1 memory, select *Configuration* / *Controller* / *Hardware*. Look at the value in the *Memory free* field to see how much memory is left.

To calculate the time remaining, use the formula:

$$\text{Time} = \frac{\text{Bytes free}}{\text{Bytes stored per epoch}} \times \text{logging interval}$$

For example, if a TSC1 with 1.795 MB free is logging L1/L2 data with a logging interval of fifteen seconds, and tracking six satellites, the time remaining is:

Number of bytes per record = 33 + (6 x 43) = 291

$$\text{Time} = \frac{1{,}795{,}000}{291} \times 15 \text{ sec} = 92{,}526 \text{ seconds} = 25 \text{ h } 42 \text{ min}$$

Tip – To log data for longer periods than this, increase the GPS logging intervals or use a PC card to increase the TSC1 memory capacity. For more information about changing the logging interval, see Logging device, page 128.

Operating Temperature and Humidity Ranges

The TSC1 data collector operates in temperatures of between –30°C (–22°F) and +65°C (149°F) and in environments of up to 100% non-condensing humidity.

To store the TSC1, transfer any data and remove the battery. Store at a temperature of between –30°C (–22°F) and +80°C (+176°F).

The data collector withstands wind-driven rain and dust.

Table 2.3 lists the specifications of the TSC1 data collector.

Table 2.3 TSC1 physical specifications

Property	Specification
Size	266 mm x 116 mm x 42 mm
Weight	800 g (28 oz)
Power	<1 W
Operating temperature	from –30°C to +65°C
Storage temperature	from –30°C to +80°C
Humidity	100 % non-condensing
Casing	UV-resistant plastic, fully sealed and buoyant
Memory	2 MB internal flash memory with PC card expansion capacity
Communications	2 x RS232 serial ports
Display	240 x 200 graphics LCD display with backlight

Power Sources

The TSC1 data collector is supplied with a Lithium-ion battery (part number 29518). This is a 7.4 V 1.3 AH rechargeable battery.

The TSC1 is also supplied with a 9 V battery adaptor. Use this if you want to use a 9 V battery to power the unit. The operation time of a standard 9 V battery is approximately two to three hours. For more information, see Using the 9 V TSC1 Battery Adaptor, page 30.

Warning – If using Lithium-ion batteries, only insert a Trimble-approved Lithium-ion battery into the TSC1 internal battery compartment. A Lithium-ion battery not approved by Trimble can damage the unit.

The TSC1 relies on the internal battery when it is not connected to a receiver supplying power or to any other power source.

Battery Status

The status line displays the status of both the TSC1 battery and of any external power source. For a list of items that appear in the status line, see Table 3.3 on page 42.

You can also view the TSC1 data collector power status by selecting *Configuration* / *Controller* / *Hardware*. The *Internal battery* field shows how much power remains, and indicates whether the internal battery is:

- being used
- not being used
- charging

Note – *For information about the receiver power status, see Receiver Status, page 354.*

Low Battery Warnings

When the Trimble Survey Controller software detects that the internal battery voltage is low, the following message flashes in the status line:

Low Controller battery

This usually appears when the voltage level has dropped to about 10%. You can continue to use the TSC1 data collector for a short period, but replace or recharge the battery as soon as possible.

When the Trimble Survey Controller software detects that the main battery voltage is so low that it cannot function, the following message flashes in the status line:

Controller battery is dead

The TSC1 turns off, and you must replace or recharge the battery.

Note – *The TSC1 data collector can work without a charged internal battery if it is connected to another power source.*

Even when the internal battery can no longer function, no data is lost. This is because data in the TSC1 is stored in flash memory (see page 17). The only item that may change is the *Time*/*date* setting. The Trimble Survey Controller software automatically corrects this when you start the next GPS survey. If the TSC1 receives power from another source within 30 seconds the *Time*/*date* setting is not affected.

Recharging the TSC1 Battery

To recharge the Lithium-ion battery of the TSC1data collector, do one of the following:

- Connect the TSC1 to the AC adaptor.
- Connect the TSC1 to an Office Support Module charger.
- Remove the battery and charge it in the (optional) battery charger.
- Connect the TSC1 to a receiver with an external power source, or directly to a camcorder battery, and change the *Low voltage charging enabled* setting to Yes.

The battery recharges fully in approximately three hours.

Note – *Recharge Lithium-ion batteries at a temperature of between 0°C and 50°C.*
If the temperature exceeds this range while the battery is being charged, a red temperature warning light (labeled TEMP) comes on. Charging stops until the temperature returns to the required range.

Using the AC Adaptor

To recharge the TSC1 battery using the AC adaptor:

1. Connect the TSC1 data collector to the AC adaptor using the TSC1 to DB9/power supply Y-cable (part number 32345).
2. Insert the jack plug on the AC adaptor into the socket on the Y-cable, and the Lemo connector into the TSC1.
3. Plug the AC adaptor into the main power.

For more information about the AC adaptor, see page 28.

Using the Office Support Module II Charger

To recharge the TSC1 battery using the Office Support Module II (OSM II) charger:

1. Connect the TSC1 to the OSM II using the TSC1 to 5-pin Lemo cable (part number 32959). Connect this cable to the TSC1 and the 5-pin Lemo cable that comes out of the OSM II.
2. Plug the OSM II into the main power.

Using the Battery Charger

To recharge the TSC1 battery using the (optional) battery charger:

1. Remove the Lithium-ion battery from the TSC1 data collector. To do this, turn off the TSC1, unscrew the battery cover screw (see Figure 2.3) and take out the battery.

   Note – *No data is lost when you remove the TSC1 battery.*
2. Connect the output plug of the AC adaptor (part number 30413) to the input power port of the battery charger.
3. Connect the AC power plug of the adaptor to an AC power source that provides 90–264 V of 50/60 Hz single-phase power.

Figure 2.3 shows the location of the internal battery in a TSC1 data collector.

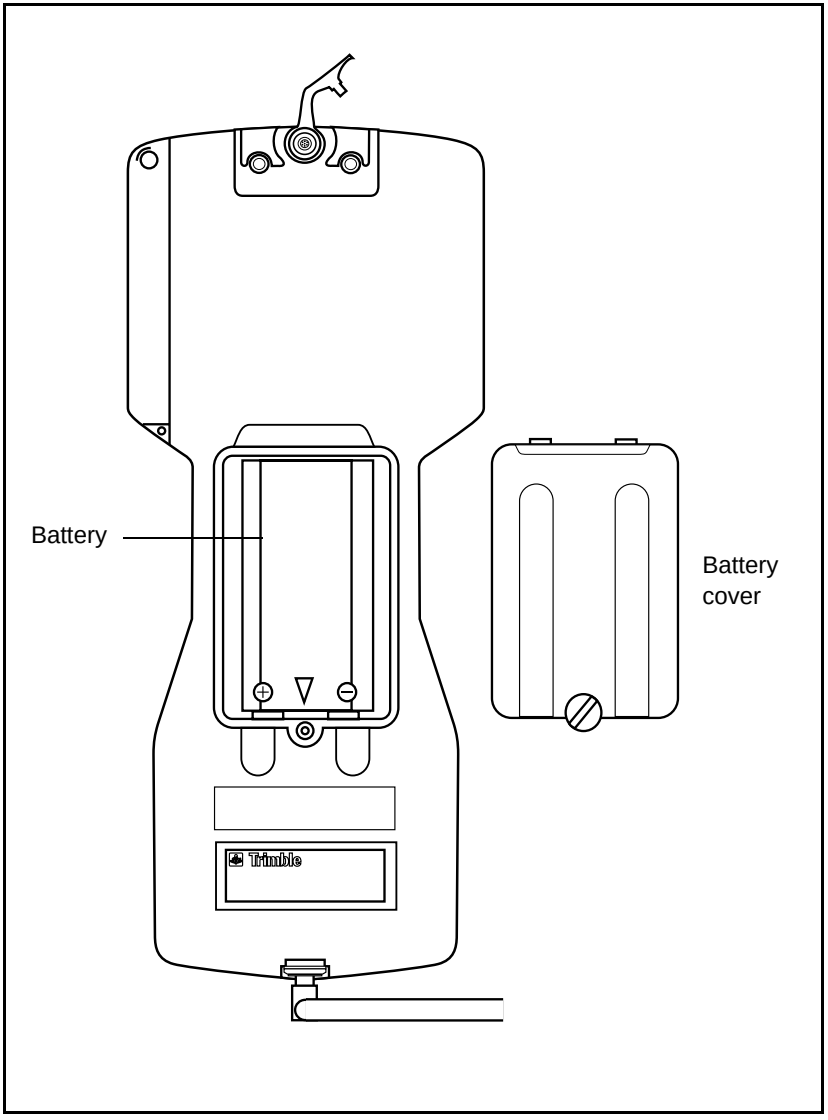


Figure 2.3 Location of the TSC1 internal battery

4. Connect the battery charger as shown in Figure 2.4, and insert the batteries.

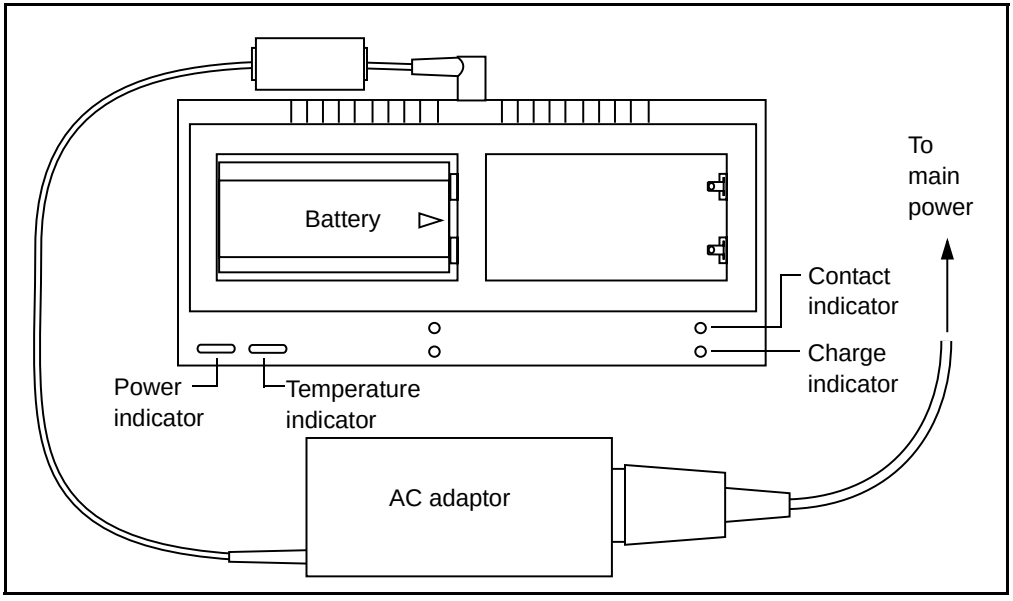


Figure 2.4 TSC1 battery charger

When the battery charger is properly connected, the green Power indicator light comes on. When you insert a battery into the battery charger, the battery status indicators show the status of the battery in each slot. These indicators are described in the following section.

Charge status

An orange light labeled CONTACT and a green light labeled CHARGE are located next to each battery slot. They indicate the charge status of the battery in that slot.

When you insert a battery into the charger, the orange Contact light next to the battery slot comes on and the green Charge indicator light starts flashing.

Only one Charge indicator light flashes, even if you insert two batteries; the other one stays off. This indicates that the charger is charging one battery while the other battery is in standby mode. The second green indicator only lights up when the first battery is fully charged.

When a battery is fully charged, the Charge indicator light changes from flashing to continuous. The Charge light for the next battery slot then starts to flash, indicating that the battery has started to charge.

When the Charge indicator stays on continuously, remove the fully-charged battery from the slot and insert another battery that requires charging.

Table 2.4 summarizes the Contact indicator light displays.

Table 2.4 Contact indicator

Orange light status	Meaning
Off	No battery is in the slot, or the terminal contact is poor
On	A battery is in the slot

Table 2.5 summarizes the Charge indicator light displays.

Table 2.5 Charge indicator

Green light status	Meaning
Off and the orange Contact indicator is on	Charging is required but has not yet started
Flashing on and off	Charging is in progress
On continuously	The battery is fully charged

If you leave both batteries fully charged in the slots, the charger automatically checks the condition of each battery periodically. If either battery requires more charge, the corresponding green light starts to flash again as that battery is charged. The other slot still displays a continuous green light.

Other indicators

The battery charger has a temperature warning indicator (labeled TEMP) next to the Power indicator. The Lithium-ion battery must be charged in an environment where the temperature is between 0^{o} and $+50^{o}$C. If the charger is operated at a temperature outside of this range, the green Charge indicators go off and a red temperature warning light comes on. This indicates that the charger has stopped charging and is in sleep mode, where it takes minimal power from the AC power source.

When the environment returns to the required temperature range, the charger begins charging automatically and the red temperature warning light turns off.

AC adaptor

The AC adaptor (part number 30413) supplied with the battery charger can deliver a maximum output of +18 V DC at 1.66 A. It has built-in overload and short circuit protections. The AC adaptor provides enough output to drive one dual battery charger (part number 33282-00) and one TSC1 data collector simultaneously.

When the batteries are fully charged (or when there are no batteries in the slots), the charger uses very little power from the AC source. Because the charger is so efficient, you can leave it on at all times.

Using a Low Voltage Power Supply

To recharge the TSC1 battery using a power source of less than 15 V:

1. Connect the TSC1 data collector to a receiver with an external power source, or directly to a camcorder battery.
2. Make sure that the TSC1 cannot turn itself off while the battery is being charged:
   a. Select *Configuration* / *Controller* / *Time*/*date*.
   b. Access the *Timeout* field and press Never.

3. Select *Configuration* / *Controller* / *Hardware* and set the *Low voltage charging enabled* field to Yes. This field defaults back to No when the TSC1 is turned off.

   A charge icon appears in the status line until the battery is fully charged. See Table 3.3 on page 42.

   Note – *Do not start a survey while charging the battery of the TSC1 data collector in this way.*

Using the 9 V TSC1 Battery Adaptor

The TSC1 is usually powered by a rechargeable Lithium-ion battery that is supplied with the unit. However, a 9 V battery adaptor is available if you want to use a 9 V battery to power the unit.

Insert a 9 V battery into the adaptor, and insert the adaptor into the TSC1 as shown in Figure 2.5.

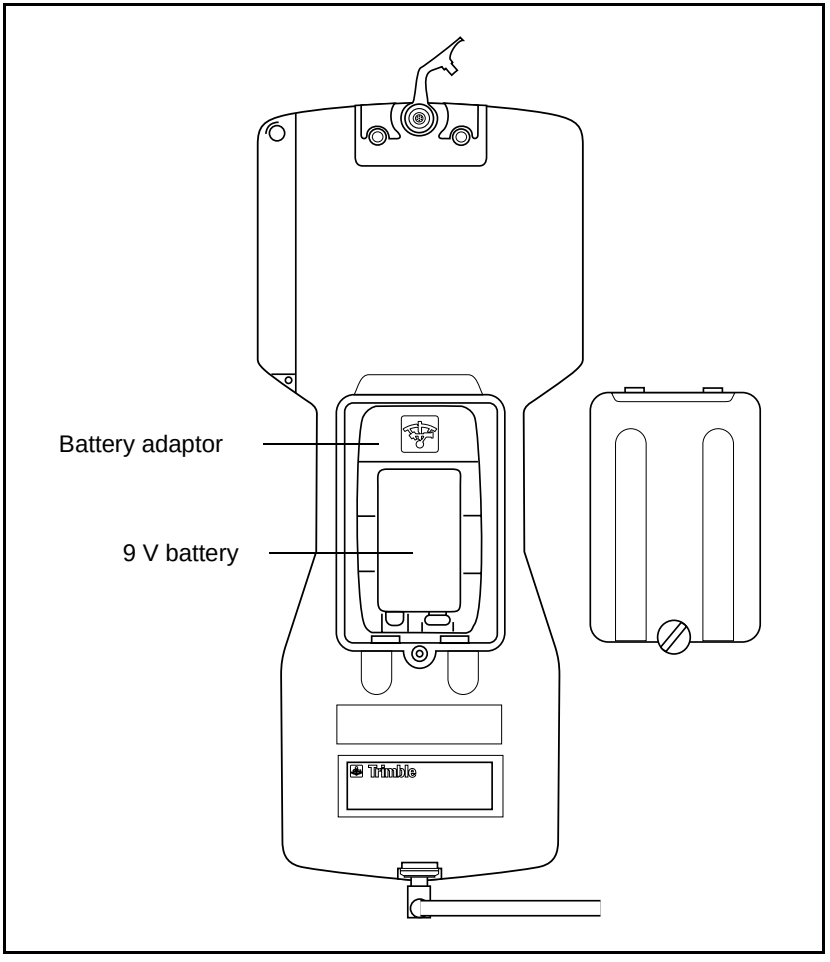


Figure 2.5 9 V battery adaptor inserted into the TSC1

Ports

The TSC1 data collector has two data/power ports. One port is at the bottom of the unit, the other is at the top on the back. Both ports function in the same way. Figure 2.2 shows where these ports are located on the TSC1.

The Trimble Survey Controller software automatically detects which port is connected to an external device.

Each port takes a 7 pin 0-shell Lemo plug. Figure 2.6 shows the position of the sockets.

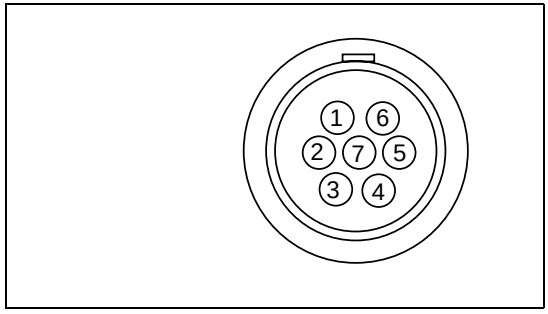


Figure 2.6 Pinout diagram of the TSC1 port

Table 2.6 describes the function of each socket.

Table 2.6 Pinout functions – TSC1 data collector ports

Socket number	Top port function	Bottom port function
1	Signal ground	Signal ground
2	Power 1 in return (–)	Power 2 in return (–)
3	Transmit data (TXD1)	Transmit data (TXD2)
4	Request to send (RTS1)	Request to send (RTS2)
5	Clear to send (CTS1)	Clear to send (CTS2)
6	Power 1 in (+)	Power 2 in (+)
7	Receive data (RXD1)	Receive data (RXD2)

Maintenance

The TSC1 data collector does not need to be serviced.

To clean it, use a soft cloth moistened with water and a mild soap.

If the TSC1 develops a fault, transfer any data to an office computer and reset the TSC1 with a cold boot as described on page 17. If you cannot transfer the data, do ***not*** perform a cold boot. Contact your local dealer for advice.

Contact your local Trimble dealer for repairs, replacement parts, service information, and technical assistance.

Upgrading the Trimble Survey Controller Software

Use the WinFLASH™ software to upgrade the software and/or options on the TSC1 data collector. WinFLASH comes with full instructions on how to carry out the upgrade. First download all files that you want to keep, then connect the equipment as described in Connecting the TSC1 Data Collector, page 160. Run WinFLASH on the office computer and follow the instructions on the screen.

Note – *Depending on the number of Survey Styles you have defined, you may need to use the* Upgrade *softkey. If WinFLASH does not connect to the TSC1 data collector, use the TSC1 to select Configuration / Controller / Hardware. Press* Upgrade*. A message appears on the TSC1 screen:*

Please confirm. Upgrade will delete all of your data and then reboot. Do you want to continue?

Press Yes *and run WinFLASH again.*

CHAPTER

3

General Operation

In this chapter:

- Introduction
- The TSC1 keypad
- Sample screen displays
- Menus
- Data fields
- Entering data
- TSC1 controller settings
- Reviewing the database
- Responding to messages
- Auto-connecting to an instrument

Introduction

The Trimble Survey Controller software simplifies surveying by configuring and controlling receivers for GPS surveys, and by communicating with conventional instruments for conventional surveys. The Trimble Survey Controller software:

- stores points
- controls stakeout tasks
- performs numerous calculations, including Cogo functions
- permits two-way data transfer operations

For GPS surveys it also:

- configures the necessary receiver parameters
- monitors receiver and radio status

The Trimble Survey Controller software makes surveying a faster and more efficient process. The best way to learn to use it is to take it out into the field and become familiar with the keypad, press various keys, look through the menus, and use the online Help.

This chapter describes how to operate the Trimble Survey Controller software using the TSC1 data collector as a platform.

The TSC1 Keypad

Figure 3.1 shows the TSC1 keypad.

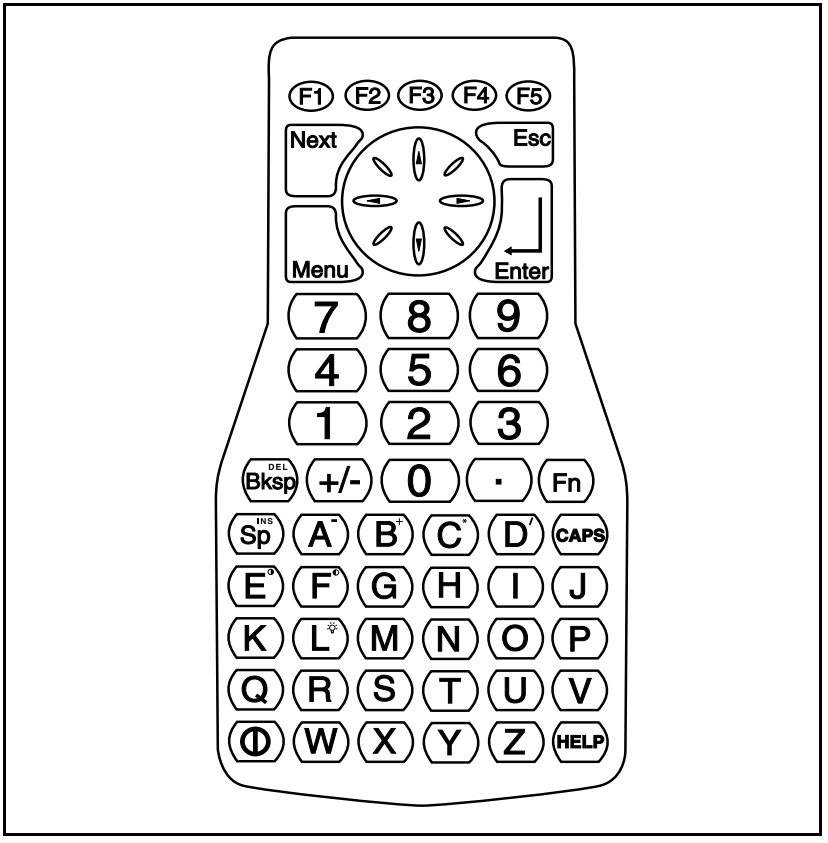


Figure 3.1 Keypad of the TSC1 data collector

To turn on the TSC1 data collector, make sure that power is supplied (see Power Sources, page 21). Then press the green on/off key marked ⏻.

To turn off the TSC1, hold down ⏻ for one second.

To operate the software, use the keys on the TSC1 keypad.

Hard Keys

Hard keys are the physical keys on the TSC1 keypad, such as 1, 2, 3, A, B, C, Enter, ►, ▼, and Esc. Use these keys to enter data and to access different screens.

When a field is highlighted, access it at the beginning by pressing ► or access it at the end by pressing ◄.

Alternate Keys

Alternate keys give some hard keys a second function. Some of the second functions are shown on the hard keys in small yellow print. To use a second function, press the Fn hard key and then press the alternate hard key.

Table 3.1 shows some of the functions accessed using alternate keys.

Table 3.1 Useful second functions of the TSC1 keys

Key combination	Function
Fn ▼	Page down
Fn ▲	Page up
Fn ◄	Home
Fn ►	End
Fn Next	Previous
Fn E	Contrast up
Fn F	Contrast down
Fn t	Turn instrument

For a full list of second functions see Appendix B, Alternate Keys.

Softkeys

Softkeys are displayed on the bottom line of the TSC1 screen. A softkey on the screen corresponds to an adjacent hard key on the keypad: F1, F2, F3, F4, or F5. Press this hard key to activate the softkey. To activate the Options softkey, for example, press F5.

Softkeys relate to particular fields and only appear when these fields are accessed. For example, the Units softkey appears when the *Antenna height* field is accessed, as it relates to this field.

Note – *The → softkey appears if there are more than five softkeys associated with a screen. Press it to see the others.*

Menu Key

Return to the main menu at any time by pressing Menu. Use this key with the Next key to move quickly between Trimble Survey Controller software screens. For more details see the next section.

Next Key

The Next hard key provides quick access to previously viewed screens (windows). For example:

1. From the main menu select *Files* / *Review current job*.
2. Press Menu to return to the main menu, and select *Key in* / *Points*.
3. Press Menu again to return to the main menu, then select *Configuration* / *Controller* / *Hardware*.

   Now the three windows (*Review*, *Key in* / *Point*, and *Hardware*) are open. To view them quickly, press Next repeatedly.

Note – *Menus cannot be included in the cycle of windows.*

To remove a window from a cycle:

- View the window and then press Esc to return to the main menu.

Note – *There is a maximum number of windows that you can open at any one time. This number depends on which windows are open. A warning message appears if too many are open.*

Help Key

Press the HELP key at any time to obtain more information about a topic. When you press it, an alphabetic list of Help topics appears. To exit Help, press Esc from the Help listing screen.

To access information on a certain topic, press Page↓ or ▼ to highlight the required topic, then press Enter. Otherwise type the first few letters until the required topic is highlighted, then press Enter.

Use the key combinations shown in Table 3.2 to navigate the Help system.

Table 3.2 Navigating Help

Key combination	Function
Fn ►	Go to the end of the list
Fn ◄	Go to the beginning of the list
Fn ▼	Page down
Fn ▲	Page up

Some Help topics have more than one screen of information. This is indicated by a small arrow in the top right corner of the screen. Press ▼ to see the next screen.

Figure 3.2 shows two typical Help screens.

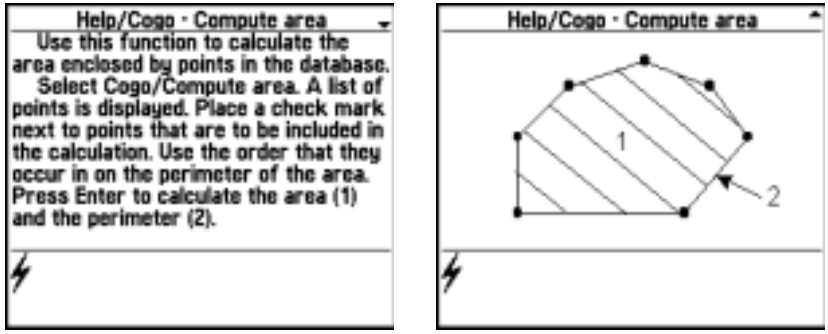


Figure 3.2 Online Help screens

Sample Screen Displays

This section shows a number of screen displays similar to those on the TSC1 data collector. Labels are added to clarify the symbols and the layout used.

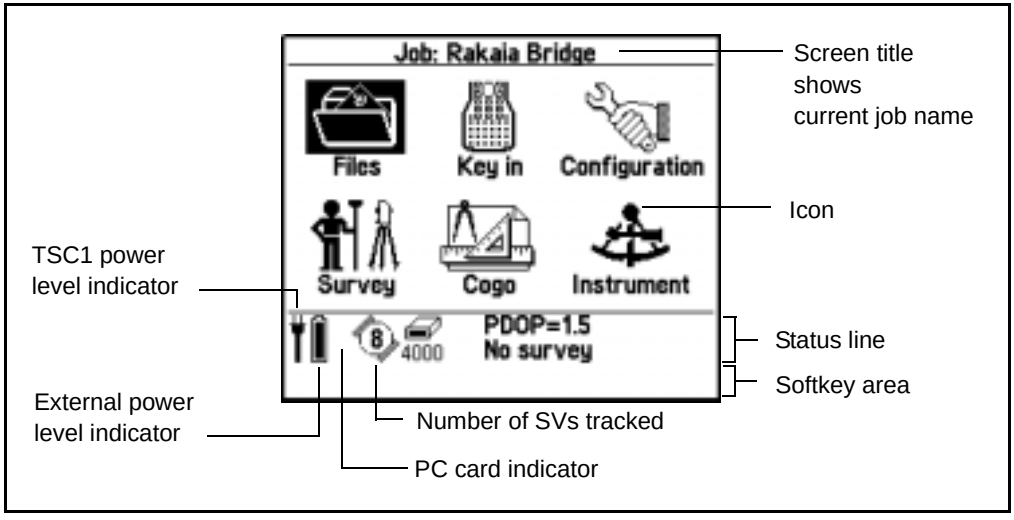


Figure 3.3 Main Menu – TSC1 connected to GPS receiver

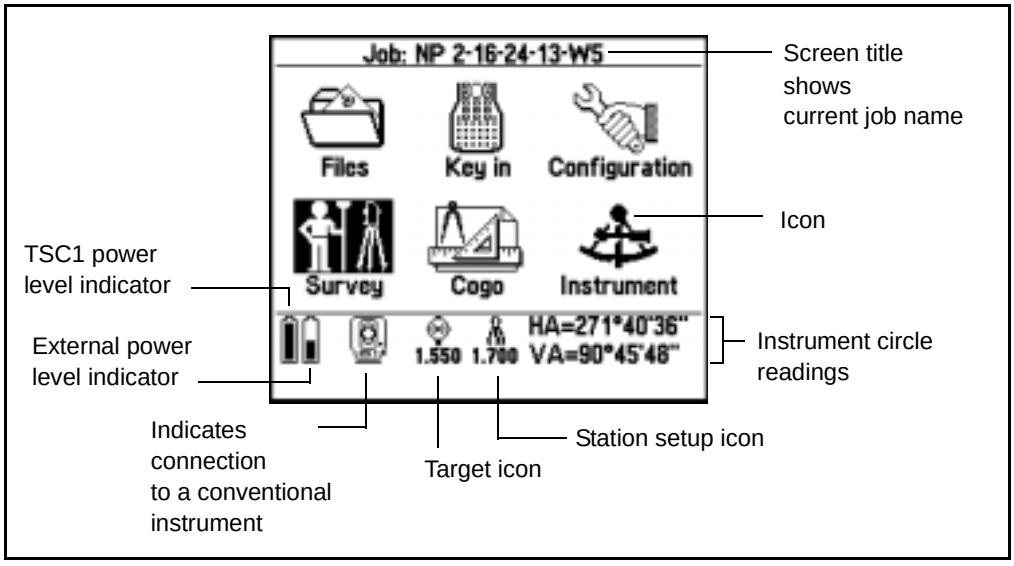


Figure 3.4 Main Menu – TSC1 connected to conventional instrument

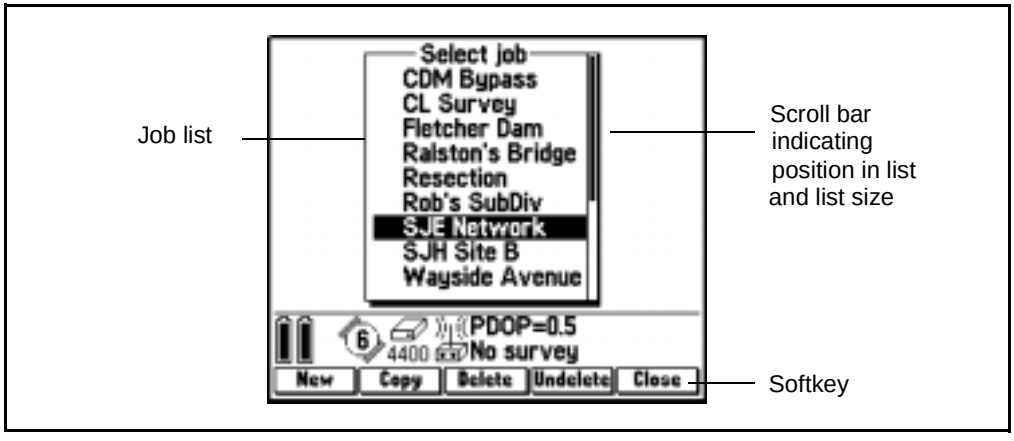


Figure 3.5 Typical list with scroll bar

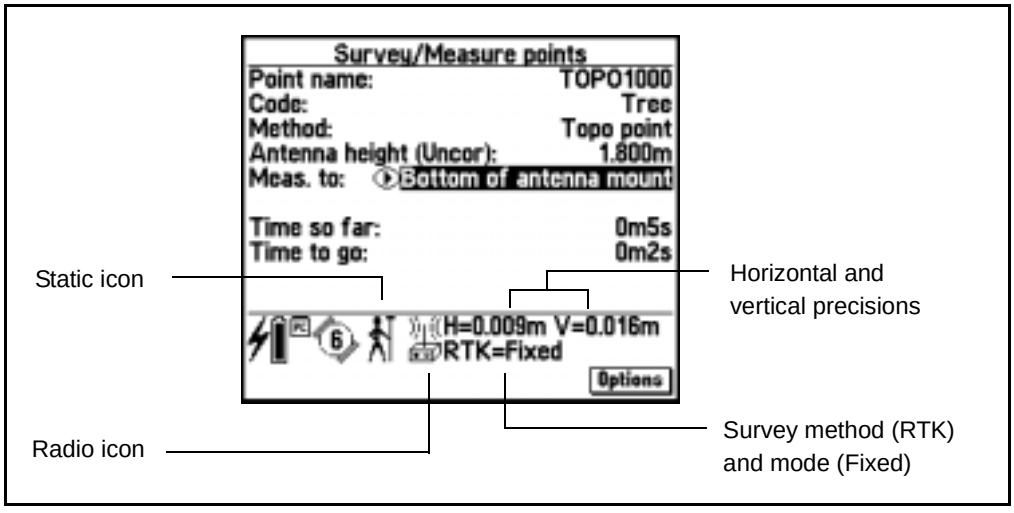


Figure 3.6 Typical status line display

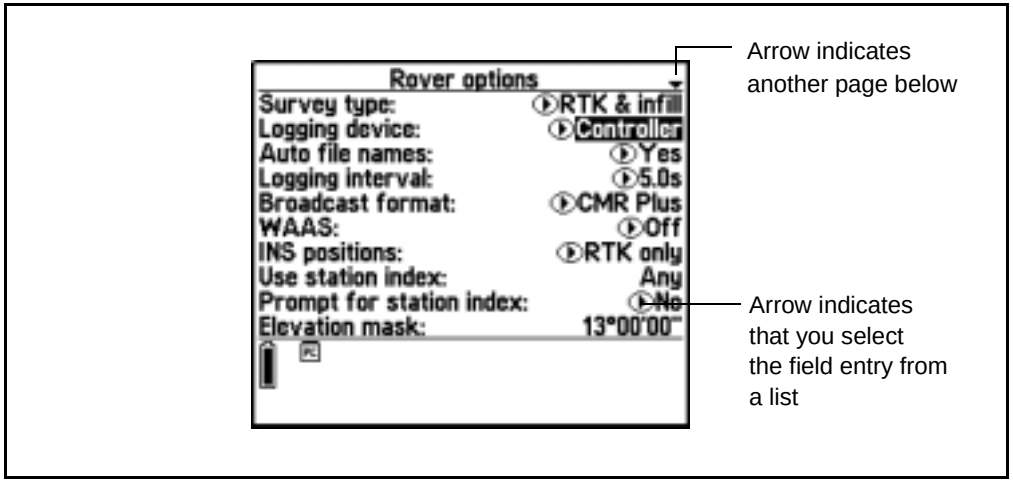


Figure 3.7 Meaning of arrows

Status Line Display

When you turn on the TSC1 data collector, various icons appear in the status line. The icons that appear depend on the equipment that is connected to the TSC1. Table 3.3 lists and explains these icons.

Table 3.3 Status line icons

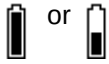
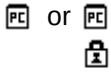
Icon	What it shows
(extreme left)	TSC1 data collector is connected to and drawing power from an external supply
(extreme left)	TSC1 is connected to an external power supply and is recharging the internal battery
	Power level is 100% (first icon) or Power level is 50% If this icon is on the extreme left, it refers to the TSC1 internal battery. If it is indented from the left, it refers to an external power source.
	A PC card is inserted (first icon) or a PC card is inserted and should not be removed
	A GPS Total Station® 4800 receiver is in use
	A GPS Total Station 4700 receiver is in use
	An MS750™ receiver is in use
	A Series 4000™ receiver is in use

Table 3.3 Status line icons (Continued)

Icon	What it shows
	A Trimble Site Surveyor™ 4400 receiver is in use
	A Trimble 4600LS™ receiver is in use
	A GPS Total Station 4800 receiver is in use, and the antenna height is 1.800 (the units are the system height units)
	An external antenna is in use, and the antenna height is 1.800 (the units are the system height units)
	A conventional instrument is in use
	A conventional instrument is being used to measure a point
	The height of a conventional target is 2.000 (the units are the system height units)
	A conventional instrument station setup has been completed and the instrument height is 1.725 (the units are the system height units)
	A static point is being measured
	Radio signals are being received
	Cellular modem signals are being received

Table 3.3 Status line icons (Continued)

Icon	What it shows
	WAAS signals are being received
	Continuous points are being measured
(number varies)	If no survey is running: the number of satellites being tracked If a survey is running: the number of satellites in the solution

The information provided by the satellite icon, the last icon in Table 3.3, depends on the type of survey you are doing and the receiver type:

- If using a single-frequency receiver see Table 3.4.
- If using a dual-frequency receiver see Table 3.5.

Table 3.4 Single-frequency satellite icon information

Survey type	What icon shows
No survey	Number of satellites tracked on L1
Uninitialized RTK	Number of common satellites on L1
Initialized RTK	
Uninitialized postprocessed kinematic or FastStatic	Number of satellites tracked on L1 for more than one epoch
Initialized postprocessed kinematic	
Real-time differential	Number of common satellites on L1
Postprocessed differential	Number of satellites tracked on L1 for more than one epoch

Table 3.5 Dual-frequency satellite icon information

Survey type	What icon shows
No survey	Number of satellites tracked on L1
Uninitialized RTK	Number of common satellites on L2
Initialized RTK	Number of common satellites on L1
Uninitialized postprocessed kinematic or FastStatic	Number of satellites tracked on L2 for more than one epoch
Initialized postprocessed kinematic	Number of satellites tracked on L1 for more than one epoch
Real-time differential	Number of common satellites on L1
Postprocessed differential	Number of satellites tracked on L1 for more than one epoch

For more information about the satellites tracked by the receiver, see Satellites, page 348.

When the TSC1 data collector is connected to a receiver, the status line displays the current survey mode. Table 3.6 explains these modes.

Table 3.6 GPS status line mode display

Survey mode	Explanation
No Survey	Receiver is connected but a survey has not been started
RTK=Fixed	Current RTK survey is initialized and the solution type is L1 fixed (centimeter-level)
RTK=Float	Current RTK survey is not initialized and the solution type is L1 float
RTK=Check	Current RTK survey is verifying the initialization
RTK=Auto	Radio link is down in the current RTK survey and the solution is an autonomous position
RTK=WAAS	Radio link is down in the current RTK survey and the solution is a WAAS position
FastStatic	Current survey type is FastStatic

Table 3.6 GPS status line mode display (Continued)

Survey mode	Explanation
PPK=Fixed	Current postprocessed kinematic survey is initialized and, when postprocessed, should yield an L1 fixed or an iono-free (centimeter-level) solution
PPK=Float	Current postprocessed kinematic survey is not initialized and, when postprocessed, should yield an L1 float solution
PP differential	Current survey type is postprocessed differential
RT differential	Current survey type is real-time differential
Infill=Fixed	Current kinematic infill survey is initialized and, when postprocessed, should yield an L1 fixed or an iono-free (centimeter-level) solution
Infill=Float	Current kinematic infill survey is not initialized and, when postprocessed, should yield an L1 float solution
Infill	Current survey type is differential and you are doing an infill session
WAAS	Current survey type is differential and using signals from WAAS satellites

The Horizontal Angle (HA) and Vertical Angle (VA) appear in the status line when you use conventional instruments. The Root Mean Square (RMS) indicator is displayed when you are in Fine mode in a real-time kinematic survey. It shows the RMS of the current position, expressed in millicycles.

Menus

Menus list the Trimble Survey Controller software functions. When you turn on the TSC1 data collector, the main menu appears after the Trimble logo screen. To return to the main menu at any time, press the Menu key.

To select a menu item, highlight the required option using the arrow keys or by typing the first letter, and press Enter. Other menus, such as the *Files* menu or the *Instrument* menu, appear when you select these items from the main menu.

Figure 3.8 shows a two-page summary of the menu structure.

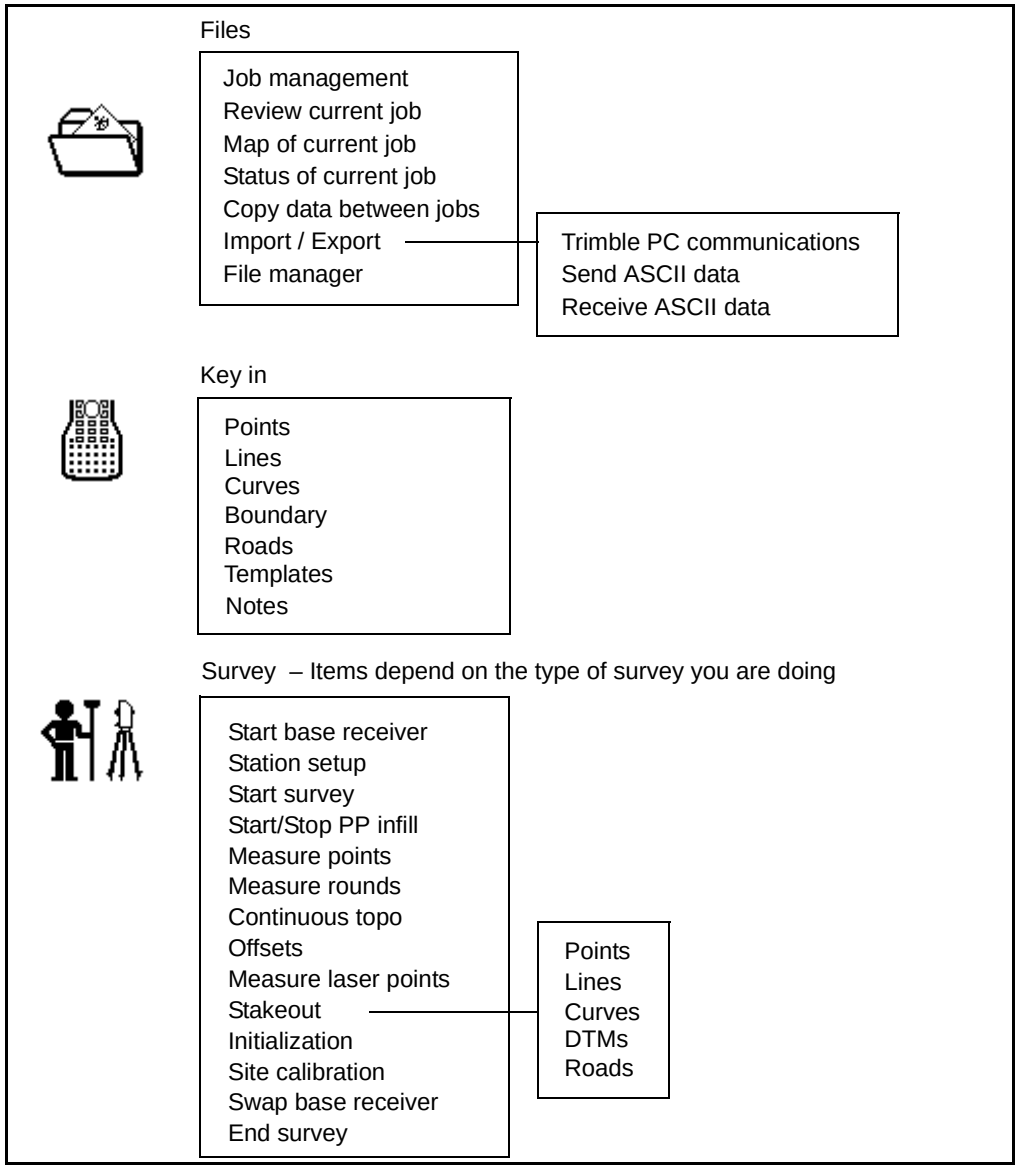
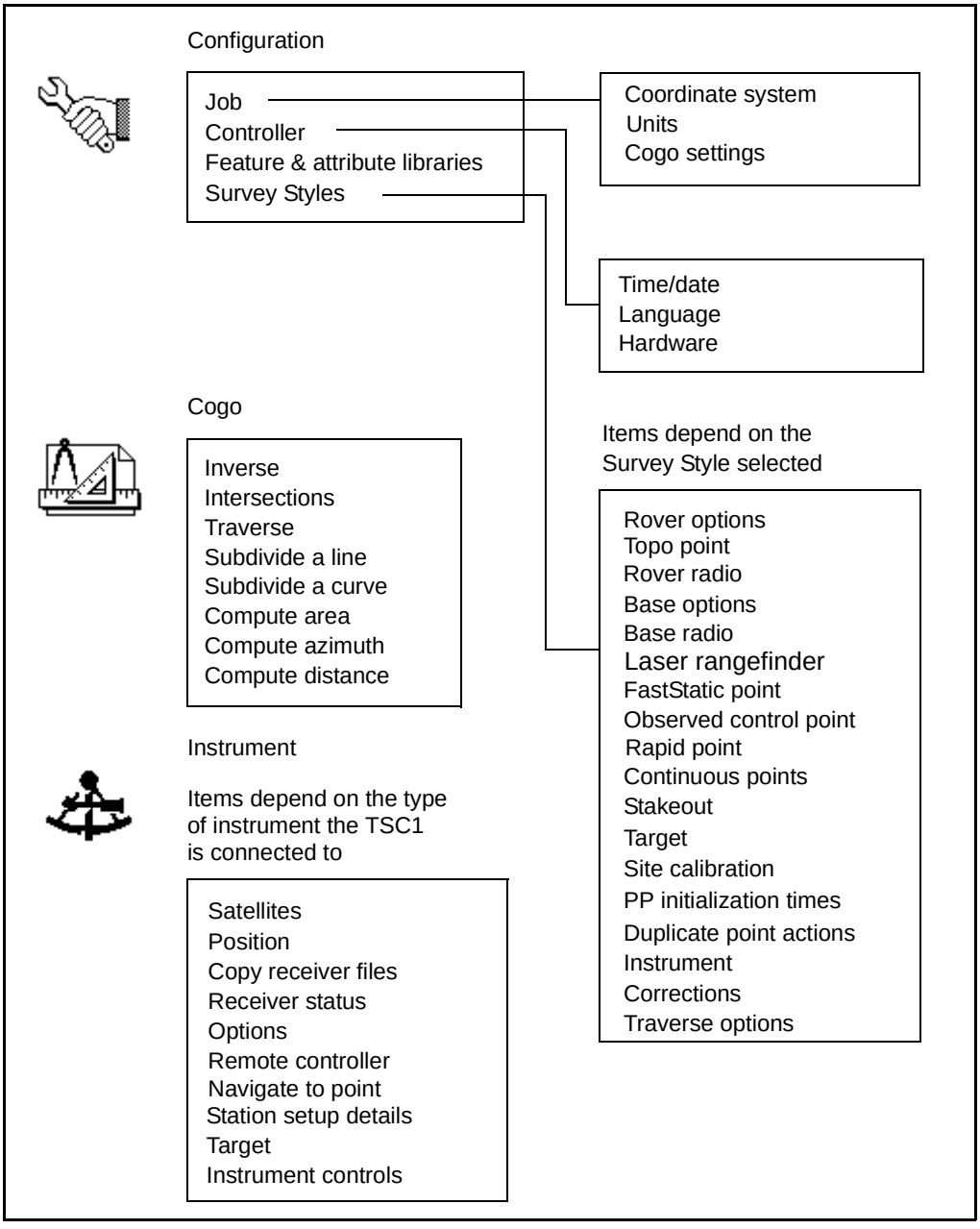


Figure 3.8 Trimble Survey Controller software menu structure

This figure continues on page 48.


Configuration
Job
Controller
Feature & attribute libraries
Survey Styles
Coordinate system
Units
Cogo settings
Time/date
Language
Hardware
Cogo
Inverse
Intersections
Traverse
Subdivide a line
Subdivide a curve
Compute area
Compute azimuth
Compute distance
Items depend on the
Survey Style selected
Rover options
Topo point
Rover radio
Base options
Base radio
Laser rangefinder
FastStatic point
Observed control point
Rapid point
Continuous points
Stakeout
Target
Site calibration
PP initialization times
Duplicate point actions
Instrument
Corrections
Traverse options
Instrument
Items depend on the type
of instrument the TSC1
is connected to
Satellites
Position
Copy receiver files
Receiver status
Options
Remote controller
Navigate to point
Station setup details
Target
Instrument controls

Data Fields

Fields generally require you to input data. Field titles are on the left side of the screen display. Select options from a list or use the keypad to type in details. If a field has a list of options, this is indicated by a ⊙ symbol to the left of the field. Press the ⊙ key to display the list, or the ⊙ key to cycle through the list.

Entering Data

When a field is highlighted, press the ⊙ key to access the field. Then do one of the following:

- Type the numeric or alphanumeric details, depending on the field.
- Select an item from a list of options. To do this, highlight the required option and press Enter.
- Select an item from a list of relevant records in the database. Press List to see the list of available records, then place a check mark beside the required item(s) and press Enter. (The List softkey only appears when you edit certain fields.)
- To enter a symbol, press Symbol to see the list of available symbols. Highlight the required symbol and press Enter to insert it in the field. For a list of symbols see Table B.3 on page 185.
- To enter a value in different units, type in the value and press Units. Select the units to be used and press Enter. The value is converted to the system units and the result is inserted in the field. For more information, see Using different units, page 53.

When the field is complete, press Enter or ⊙ to save any changes and move to the next field.

Press Enter to accept the screen when all fields are complete. Some screens cannot be accepted unless certain fields have been completed. For example, in the *Survey*/*Measure points* screen, you cannot measure a point unless the *Point name* and *Antenna height* fields have values in them. If you press Enter before completing these fields, a warning message appears.

Editing Details in a Field

When a field is highlighted, press ⊙ to access the beginning of the field. Press ⊙ to access the end of the field. If already in the field, press Fn ⊙ to go to the beginning of it, Fn ⊙ to go to the end.

Use the left and right arrow keys to move around inside the field. To insert a character press Fn Sp. To delete a character press Fn Bksp.

Note – *Sometimes a field cannot be changed. When you try to access it, the highlight remains on the field title. For example, when you select Files / Current job status, it is not possible to change the fields in the screen that appears.*

Using Quadrant Bearings

To enter quadrant bearings:

1. Make sure the system units are Quadrant bearings.
   For more information, see System Units, page 101.
2. Enter the bearing in any *Bearing* field.
3. Press NE, NW, SE, or SW.

   The quadrant bearing is inserted in the field.

Example

To enter the quadrant bearing N25° 30' 30"E in a bearing field:

- Key in **25.3030.**
- Press NE.

Using the In-Field Calculator

Use the Trimble Survey Controller software's in-field calculator to calculate values in the following fields:

- Northing
- Easting
- Elevation
- Antenna height
- Azimuth
- Dist
- H.Dist
- V.Dist

If the Operator softkey appears when you access a field, the in-field calculator is available.

In the *Cogo* / *Intersections* screen, for example, use it to sum two distances or to calculate the distance between two points in a *H.Dist* field.

Tip – When calculating a distance between two points, press List to select the points from the Trimble Survey Controller software database.

Note – *When keying in a point name that includes spaces, put double quotes around it. To save time, use the* List *softkey to select the point.*

The Trimble Survey Controller software checks the syntax of the formula when you press Enter. If it is incorrect, the Trimble Survey Controller software warns you and you can edit the formula.

Note – *When you enter an equation with two or more operators, use parentheses.*

When you enter addition and subtraction equations in angle-, azimuth-, or quadrant-bearing fields, use consistent units for all values. Do not give units to some values but not others. For example, with the system units set to Quadrant bearings, to add N40°20'20"E and the angle 10°15'15", key in:

=N40°20'20"E+10°15'15"

or (even quicker):

=N40°20'20"E+N10.1515

For information about using different units, see Using different units, page 53.

Table 3.7 shows operators for the in-field calculator.

Table 3.7 Symbols used by the in-field calculator

Symbol	Alternate keys	Function	Example	Result
=	Fn Q	Starting an equation	=3+4	7
+	Fn A	Adding	=3+2+5	10
-	Fn B	Subtracting	=5-3	2
*	Fn C	Multiplying	=2*4	8
/	Fn D	Dividing	=10/2	5
(	Fn H	Inserting parentheses	=2*(5+3)	16
)	Fn I			
▷↗	Fn 6	Calculating the azimuth between two points	=1000▷↗1001	Azimuth between Point 1000 and Point 1001 **Note**: The arrow symbol only appears in the list for an azimuth field.

Table 3.7 Symbols used by the in-field calculator (Continued)

Symbol	Alternate keys	Function	Example	Result
◿	Fn 7	Calculating the slope distance between two points	=1000◿1001	Slope distance between Point 1000 and Point 1001
⊿	Fn 8	Calculating the horizontal distance between two points	=1000⊿1001	Horizontal distance between Point 1000 and Point 1001
◿	Fn 9	Calculating the vertical distance between two points	=1000◿1001	Vertical distance between Point 1000 and Point 1001 ***Note***: The triangle symbols only appear in the list for a distance field.

Note – *When you enter equations using the in-field calculator, enter the '=' symbol first.*

Using different units

You can use values with different units in the Trimble Survey Controller software in-field calculator. For example, if the system units are US feet, it is possible to add a value in meters to a value in feet. The answer will be in the system units.

For example, to add 20 m to 10 USft when the system units are US survey feet:

1. Key in **=20**
2. Do one of the following:
   - Press Units. Then select Meters (m) and press Enter.
   - Press M.
3. Key in **+10** and press Enter.

   The value 75.617 USft is inserted in the field.

TSC1 Controller Settings

To review the Trimble Survey Controller software settings at any time, select *Configuration* / *Controller* from the main menu. The *Controller settings* menu appears.

Time/Date

The *Time*/*date* screen displays the time and date settings for the Trimble Survey Controller software. Use it to set the following:

- Timeout – after this fixed period of inactivity, the TSC1 data collector turns itself off.
- The fixed interval after which the Trimble Survey Controller software automatically records the current time (set the *Timestamp* field to the required interval between records) in the current job.
- Your offset from UTC – so that you can display local time. When the TSC1 is not connected to a GPS receiver, edit the *Local time* and *Local time offset* fields. When the TSC1 is connected to a receiver but no survey is running, you can only edit the *Local time offset* field.

  You can enter positive and negative values in the *Local time offset* field.
- Formats in which time and date are displayed.
- The GPS time display. Set this to Date/time if you want to display the GPS time (in the QC records for example) as a local date and time instead of GPS weeks and seconds. The values are always stored as GPS weeks and seconds—this setting only configures the display.

Every time the TSC1 data collector is connected to a GPS receiver, the UTC time is automatically updated.

Language

The *Language* screen contains a list of the language files uploaded into the Trimble Survey Controller. From the list, select a language.

If an online Help file in another language is present, the Trimble Survey Controller software automatically uses that file when you select the corresponding language in the *Language* screen. If not, the online Help is in English.

For information about transferring files, see Chapter 9, Data Transfer.

Hardware

The *Hardware* screen displays information about the Trimble Survey Controller hardware. See Figure 3.9.

Figure 3.9 Hardware screen

To turn the screen backlight on, set the *Backlight enabled* field to Yes. This field resets to No every time the TSC1 data collector is turned off.

Set the *Beeper volume* field to Off, Low, or High.

For the Trimble Survey Controller software to automatically adjust the screen contrast, set the *Automatic contrast adjustment* field to Yes.

To charge the internal battery off a low-voltage (less than 15 V) external power source, set the *Low voltage charging enabled* field to Yes. Then see Using a Low Voltage Power Supply, page 28.

Table 3.8 shows the options in the *Internal battery* field.

Table 3.8 Internal battery options

Option	Description
Internal battery (being used)	TSC1 data collector is using the internal battery
Internal battery (not being used)	TSC1 is using an external power source
Internal battery (charging)	TSC1 is using an external power source and being recharged from that source

The *Memory free* field appears if no PCMCIA (PC) card is inserted. It shows the free space in the main memory. If a PC card is inserted, the *Main memory free space* and the *PC card free space* fields appear.

The *Version* and *Build number* fields provide information about the version of the software that is running.

The *Serial number* field displays the serial number of the TSC1 data collector.

Press Options to display the *Installed application options* screen. This screen shows what software options you can install in the TSC1, and shows if they are enabled. It also shows the software support expiry date.

Press Upgrade to put the Trimble Survey Controller software into Upgrade mode. For more information, see Upgrading the Trimble Survey Controller Software, page 32.

Reviewing the Database

From the main menu select *Files* / *Review current job*.

Records are stored in chronological order. When you first access the database, the last page is displayed first.

To move around the database, use one of the following:

- Page↑ and Page↓ softkeys
- arrow keys
- second function keys Fn ⓥ, Fn ⓐ, Fn ◄, and Fn ►

To search for a particular item:

1. Press Search, and select an option:
   - Current record type
   - Point by name—enter the point name to search for
   - Point by code—enter the code to search for
   - Point by class—enter the class to search for
2. To start the search, press Search↑ or Search↓:
   - Search↑ causes the Trimble Survey Controller software to search up the database from the current position.
   - Search↓ causes it to search downwards.

For more information about a record, highlight the record and press Enter. The Next and Prev softkeys show the next record and the previous record respectively. Press Esc to return to the database listing.

Note – *If point coordinates appear as '?' see Coordinate View Setting, page 58.*

It is possible to edit certain records, for example *Code* and *Antenna*.

Note – *When you change an antenna height record in the database, the coordinates of some offset points (those stored as coordinates) are not updated.*

Also, the change in antenna height does not affect any postprocessed points that will be processed using the Trimble Geomatics Office™, Trimble Survey Office™ or GPSurvey™ software. Verify the antenna height information when you transfer the data to the office computer. Do the same if you download postprocessed points directly from the receiver to the office software.

You can store a note at any position in the database. To do this:

1. Highlight a record.
2. Press Note. The *Note* screen appears.
3. Enter the note and press Enter. The note is stored immediately before the record you highlighted in step 1.

   The *Note* screen remains open until you press Esc. Alternatively, press Enter when there is no text on the screen.

For details of the road information that is stored in a job, see Chapter 18, Roading.

Coordinate View Setting

The setting in the *Coordinate view* field (WGS-84, Local, Grid, or HA VA SD, for example) determines what values are visible in the point record. It is possible to change the coordinate view setting for the job or just when viewing a point.

To change the coordinate view setting for the job see System Units, page 101.

To change the *Coordinate view* setting for a point that you want to view:

1. When reviewing the database, highlight the point record and press Enter.
2. Press Options and set the *Coordinate view* field as required.

   The options are listed in Table 6.2 on page 101.

If the coordinate value for a point is '?', the following situations may have occurred:

- The point may be stored as a GPS point but with the *Coordinate view* field set to Local or Grid and a datum transformation and projection not defined. Change the *Coordinate view* setting to WGS-84, define a datum transformation and/or projection, or calibrate the job.
- The point may be stored as a polar vector from a point which has been deleted. Undelete the point.
- In a 2D survey, a projection may have been defined with the Default elevation at null. Set the default elevation to approximate the elevation of the site.

Deleting and Undeleting Points, Lines, or Curves

To delete a point, line, or curve in the Trimble Survey Controller software database:

1. From the main menu select *Files* / *Review current job*.
2. Highlight the point/line/curve to be deleted and press Enter.
3. Press Delete.

   For points, the Search class changes to Deleted (normal), Deleted (control), Deleted (staked), Deleted (backsight), or Deleted (check), depending on the original search classification.
4. Press Enter.

The Trimble Survey Controller software records a note after the original point/line/curve record, showing the time it was deleted.

Note – *When you delete a point/line/curve, the point symbol changes. For a topo point, for example, the* ⊘ *symbol replaces the* × *symbol.*

Note – *When you delete a Face 1 or Face 2 observation that contributes to a matched pair record, the matched pair record is also deleted. The same applies to mean turned angle records.*

To undelete a point, line, or curve in the Trimble Survey Controller software database:

1. From the main menu select *Files* / *Review current job*.
2. Highlight the point/line/curve to be undeleted and press Enter.
3. Press Undelete.

Deleted points

A deleted point, line, or curve is not used in calculations, but it is still in the database. Deleting points, lines, or curves does not make a job file smaller.

When you download a file that contains deleted points, the deleted points are not transferred to the office software. If you download a file using Data Transfer, GPLoad™ or TRIMMAP™ software, however, the deleted points are recorded in the Data Collector (.dc) file. They have a classification of Deleted.

Some points, such as continuous offset points and some intersection and offset points, are stored as vectors from a source point. If you delete a source point, any point stored as a vector from that point has null (?) coordinates when you review the database point record.

Tip – To see how a point is stored, select *Files* / *Review current job*. Then highlight the point, press Enter, and view the *Stored as* field. For more information, see Table 15.2 on page 375.

Responding to Messages

If the Trimble Survey Controller software cannot operate normally, it displays an error message or a warning at the top of the screen, or a flashing message in the status line.

For a list of Trimble Survey Controller software messages, see Appendix G, Messages, at the back of Volume 2.

Warnings and Error Messages

You can usually continue working after acknowledging a warning, but you have to correct an error before normal operations can be resumed:

- To acknowledge a warning, press Esc or OK.
- To continue after an error message, press Esc or OK and correct the mistake.

Status Line Messages

A status line message is generally displayed when the Trimble Survey Controller software cannot start or continue with its present function for some reason. For example, a message appears if there is no radio link or if the battery is low.

A status line message generally remains on the screen until you (or the Trimble Survey Controller software) resolve the situation.

Auto-Connecting to an Instrument

As soon as you turn on the TSC1 data collector, it tries to auto-connect to any device that it could be connected to. It first tries to connect to the device specified in the last Survey Style used. If this is unsuccessful, it uses the information contained in all available Survey Styles to determine what instrument it may be connected to. Working through the list, it checks its top and bottom ports for each instrument specified in the Survey Styles. The more Survey Styles there are stored, the longer this auto-connect process takes.

Note – *If many Survey Styles are defined, the auto-connect process may fail. When you start a survey, however, the Trimble Survey Controller software will connect to the device specified in the Survey Style.*

When connection is achieved, the appropriate icon appears in the status line. Table 3.3 on page 42 lists the icons that can appear.

Note – *If the TSC1 data collector is plugged into a GPS Total Station 4800 or 4700 receiver, a 4600LS receiver, or a Trimble conventional instrument and then turned on, the Trimble Survey Controller software automatically turns on that receiver or instrument.*

CHAPTER

4

GPS Survey Preparations

In this chapter:

- Introduction
- Coordinate systems
- Field reconnaissance
- Choosing a GPS survey type
- Planning field observations
- Satellite availability

Introduction

Before taking the equipment into the field, there are a number of things to consider.

Coordinate Systems

GPS measurements are referenced to the 1984 World Geodetic System reference ellipsoid, known as WGS-84. For most survey tasks, however, results in terms of WGS-84 have little value.

It is best to display and store results in terms of a local coordinate system. Before starting a survey, choose a coordinate system. Depending on the requirements of the survey, you can choose to give the results in the national coordinate system, a local coordinate grid system, or as local geodetic coordinates.

When you have chosen a coordinate system, search your survey archives for any horizontal and vertical control points in that coordinate system that are in the area to be surveyed. You can use these to calibrate a GPS survey. For more information, see Chapter 5, Coordinate Systems.

Field Reconnaissance

Visit the region to be surveyed before starting the observations. Record the location (azimuth and elevation) of any objects that may obstruct the path of the GPS satellite signals to the points to be measured. Be aware of objects that may reflect or distort the GPS signals, an effect known as ‘multipath’.

Identify a suitable location for the base station. This should be a position that is free of multipath and that has a clear and uninterrupted view of the sky. Accurate WGS-84 coordinates should be available for the base station mark (see Base Station Coordinates, page 280).

For all surveys, make sure the longest baseline does not exceed the limit defined by the survey technique you are using. For real-time surveys, make sure all marks are within range of the base radio. If they are not, decide where to place radio repeaters to gain full site coverage. Alternatively, use a sequence of multiple locations for the base station or postprocessed infill survey techniques to survey in areas where the radio does not provide coverage.

Choosing a GPS Survey Type

The Trimble Survey Controller software offers you a choice of kinematic, differential, or FastStatic survey techniques (see page 7). It lets you choose any one of nine different survey types based on these three techniques.

Before starting a GPS survey, decide which survey type is best suited to the project:

- What level of precision is required?

  For centimeter-level precision, use kinematic or FastStatic techniques. If submeter precision is sufficient, differential methods are satisfactory.

- Do you require real-time results?

  For real-time results, use a radio system and select the appropriate real-time technique (kinematic or differential, depending on the precision required). Stakeout and centimeter-level navigation are two activities that require real-time solutions.

- Do you need to log raw data?

  With the postprocessing techniques (FastStatic, PP kinematic, PP infill, and PP differential), raw data must be logged at the base and at the rover for the duration of the survey.

To continue the real-time survey by using postprocessed techniques during periods of radio failure, use the RTK & infill or RT differential & infill survey types. These survey types log data at the base for the duration of the survey. Data is only logged at the rover when infill is started.

Note – *If your receiver supports the use of signals from the Wide Area Augmentation System (WAAS), you can use these signals to provide differentially-corrected positions in a real-time survey when the radio link is down.*

For 'pure' real-time methods (RTK and RT differential) it is not generally necessary to store raw data. However, some contracts may include a quality control clause that stipulates that raw data be collected for the entire survey period. If this is the case, create a new Survey Style: set the survey type to *RTK & data logging* or to *RT differential & data logging*, depending on the precision required.

Raw data must be collected simultaneously at both the base and rover. It is necessary to consider the memory capacity of both the base and the rover receivers:

- Trimble's 4600LS receivers, GPS Total Station 4800 receivers, and GPS Total Station 4700 receivers all have built-in memory. You only need one TSC1 data collector.
- To collect raw data using Trimble's Site Surveyor 4400 receivers, you need two TSC1 data collectors—one at the rover and one at the base.
- It is possible to buy a Trimble Series 4000 receiver with or without memory. What you use determines how many TSC1s are needed.

Consider these points, then use the flow chart in Figure 4.1 to select an appropriate survey type.

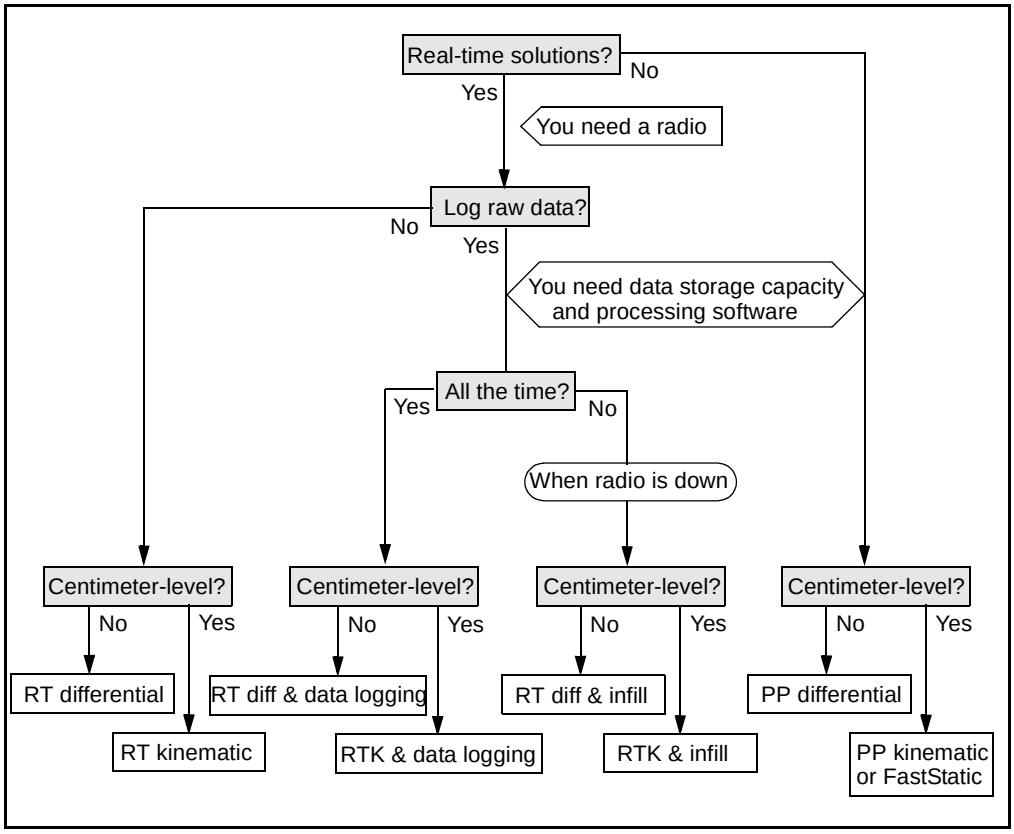


Figure 4.1 Choosing an appropriate survey type

Planning Field Observations

Planning is important to a successful survey.

Before conducting any field work, plan a field method that lets you comfortably achieve the goals of the survey. Consider how observations should be processed, and how results will be combined.

Start the base receiver ***before*** the rover receiver. If different field parties set up the base and rover receivers, the rover party must be satisfied that the base has been started before they start to measure, because:

- the radio corrections needed during a real-time survey are not available until the base is started
- for postprocessed surveys, the base and rover receivers must store data simultaneously

Schedule the day's work before leaving the office, and have the base and rover parties communicate using walkie-talkie radios or mobile phones.

Satellite Availability

To survey using GPS, the base and rover receivers must track a minimum of four common satellites. For On-The-Fly (OTF) initializations, five common satellites are required.

Plan the survey using a product such as Trimble's QuickPlan™ software. Specify the approximate latitude and longitude of the project site, the proposed survey date and time, the time zone, the elevation mask, and the location of any obstructions that will reduce the view of the satellites.

Obtain a recent satellite Ephemeris file and place it in the appropriate software directory. If using QuickPlan, overwrite the Current.eph file in the ...Trimble Geomatics Office\Projects folder with the more recent Ephemeris file.

Warning – If you copy raw GPS data files from a receiver to the Trimble Survey Controller software, you cannot use the Ephemeris file in QuickPlan.

You can generate a graph that indicates the number of available satellites and PDOP information. Use this information to determine the best time to perform the survey. Trimble recommends that you conduct surveys during periods when the PDOP is less than 6.

Figure 4.2 shows a sample graph generated by Trimble's QuickPlan software. It shows satellite availability and PDOP values throughout the day.

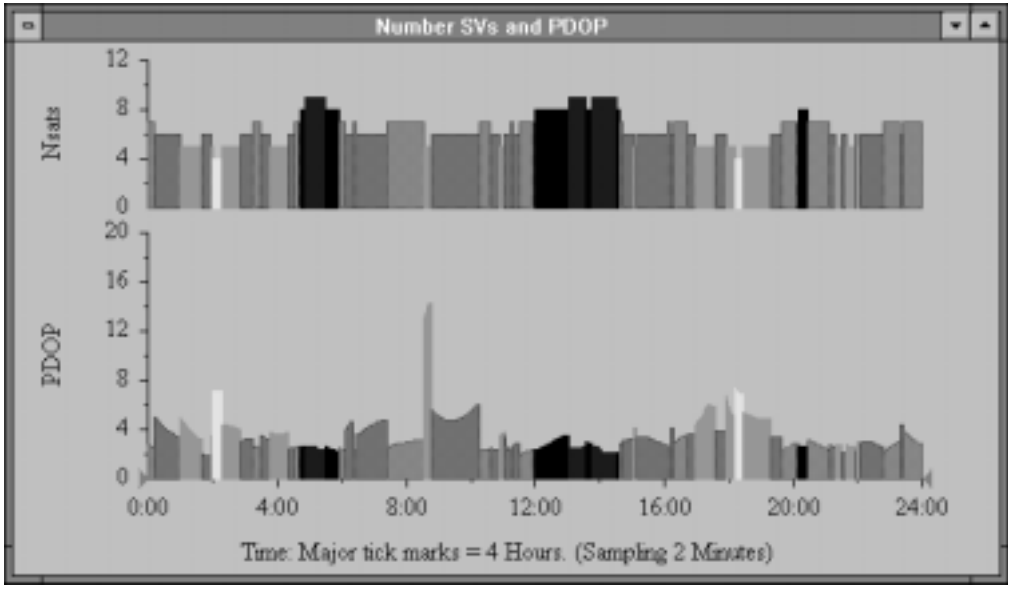


Figure 4.2 Graph showing satellite availability and PDOP values

CHAPTER

5

Coordinate Systems

In this chapter:

- Introduction
- Local coordinate systems
- Calibration
- Using a datum grid file
- Using a geoid model
- Choosing a coordinate system for a GPS survey
- Choosing a coordinate system for a conventional survey

Introduction

Before starting a GPS survey, decide which coordinate system to use. This chapter discusses some things to consider when making this decision.

Tip – For information about the GPS coordinate system, WGS-84, see page 64.

If you intend to combine conventional observations with GPS measurements, read the whole of this chapter. To make only conventional observations see Choosing a Coordinate System for a Conventional Survey, page 85.

Local Coordinate Systems

A local coordinate system simply transforms measurements from a curved surface (the earth) onto a flat surface (a map or plan). Four important elements constitute a local coordinate system:

- Local datum
- Datum transformation
- Map projection
- Calibration (Horizontal and Vertical adjustments)

When you survey using GPS, consider each of these.

Local Datum

Because an exact model of the earth's surface cannot be created mathematically, localized ellipsoids (mathematical surfaces) have been derived to best represent specific areas. These ellipsoids are sometimes referred to as local datums. NAD83, GRS80, and AGD66 are examples of local datums.

Datum Transformation

GPS is based on the WGS-84 ellipsoid. The WGS-84 ellipsoid has been sized and positioned to best represent the entire earth.

To survey in a local coordinate system, the WGS-84 GPS positions must first be transformed onto the local ellipsoid using a datum transformation. Four types of datum transformation are commonly used:

- No transformation
- Three-parameter
- Seven-parameter
- Datum grid

A three-parameter datum transformation assumes that the rotational axis of the local datum is parallel with the rotational axis of WGS-84. The three-parameter transformation involves three simple translations in X, Y, and Z. The three-parameter transformation that the Trimble Survey Controller software uses is a Molodensky transformation, so there may also be a change in ellipsoid radius and flattening.

Note – *Positions on a local datum are commonly called 'local geodetic coordinates'. The Trimble Survey Controller software abbreviates this to 'Local'.*

A seven-parameter datum transformation is the most complex transformation. It applies translations ***and*** rotations in X, Y, and Z as well as a scale factor.

A datum grid transformation uses a gridded data set of standard datum shifts. By interpolation, it provides an estimated value for a datum transformation at any point on that grid. The accuracy of a datum grid depends on the accuracy of the gridded data set it uses. For more information, see Using a Datum Grid File, page 79.

Map Projection

Local geodetic coordinates are transformed into local grid coordinates using a map projection (a mathematical model). Transverse Mercator, and Lambert are examples of common map projections.

Note – *Positions on a map projection are commonly called 'local grid coordinates'. The Trimble Survey Controller software abbreviates this to 'Grid'.*

Horizontal and Vertical Adjustments

If published datum transformation parameters are used, slight discrepancies can exist between local control and GPS-derived coordinates. These discrepancies can be reduced using minor adjustments. The Trimble Survey Controller software calculates these adjustments when you use the *Site calibration* function. They are called horizontal and vertical adjustments.

Calibration

Calibration is the process of adjusting projected (grid) coordinates to fit the local control.

Key in a calibration, or let the Trimble Survey Controller software calculate it.

You should calculate and apply a calibration before:

- staking out points
- computing offset or intersection points

The rest of this section describes how to perform a calibration using the Trimble Survey Controller software. To key in a calibration see Creating a Job, page 88.

Calibration Calculations

Use the Trimble Survey Controller software system to perform a calibration in one of two ways. Each method results in the computation of different components, but the overall result is the same if enough reliable control points (coordinates in your local system) are used. The two methods are:

- If you use published datum transformation parameters and map projection details when creating a job, and if you provide enough control points, the Trimble Survey Controller software performs a calibration that computes horizontal and vertical adjustments. Horizontal control points allow scale error anomalies in the map projection to be removed. Vertical control allows local ellipsoid heights to be transformed into useful orthometric heights.

Tip – Always use published parameters if they exist.

- If you do not know the map projection and datum transformation parameters when creating the job and defining the local coordinate system, specify *No projection*/*no datum*.

  Then specify whether *Grid* or *Ground* coordinates are required after a site calibration. When ground coordinates are required, you must specify the *Reference elevation*. In this case, the Trimble Survey Controller software performs a calibration that calculates a Transverse Mercator projection and a Molodensky three-parameter datum transformation using the supplied control points. The reference elevation is used to compute a scale factor for the projection so that ground coordinates are computed at that elevation.

For information about the formulas used by the Trimble Survey Controller software to calculate a calibration, see Appendix C, Calculations and Search Rules.

Table 5.1 shows the output of a calibration when various data is supplied.

Table 5.1 Calibration output

Projection	Datum transformation	Calibration output
Yes	Yes	Horizontal and vertical adjustment
Yes	No	Datum transformation, horizontal and vertical adjustment
No	Yes	Transverse Mercator projection, horizontal and vertical adjustment
No	No	Transverse Mercator projection, zero datum transformation, horizontal and vertical adjustment

Local Control for Calibration

Trimble recommends that you observe and use a minimum of four local control points for the calibration calculation.

For best results, local control points should be evenly distributed over the job area as well as extending beyond the perimeter of the site (assuming that the control is free of errors).

Tip – Apply the same rule of thumb as you would when placing control for photogrammetric jobs. Make sure that the local control points are evenly distributed to the extent of the job area.

Why Calibrations Are Needed

If you calibrate a project and then survey in real time, the Trimble Survey Controller software gives real-time solutions in terms of the local coordinate system and control points.

Operations That Require Calibration

Warning – Perform a calibration at any time, but always complete the calibration ***before*** staking out any points, or computing offset or intersection points.

If no datum and no projection are defined, you can only stake out lines and points that have WGS-84 coordinates. Displayed bearings and distances are in terms of WGS-84.

Specify a projection before staking out curves, roads, and DTMs and when computing intersections and offsets. The Trimble Survey Controller software does not assume that WGS-84 is the local ellipsoid, so you must also define a datum.

Without a datum transformation, you can only start a real-time base survey with a WGS-84 point.

For information on how to perform a calibration, see Chapter 13, Calibration.

Figure 5.1 shows the order of calculations performed when a calibration is calculated.

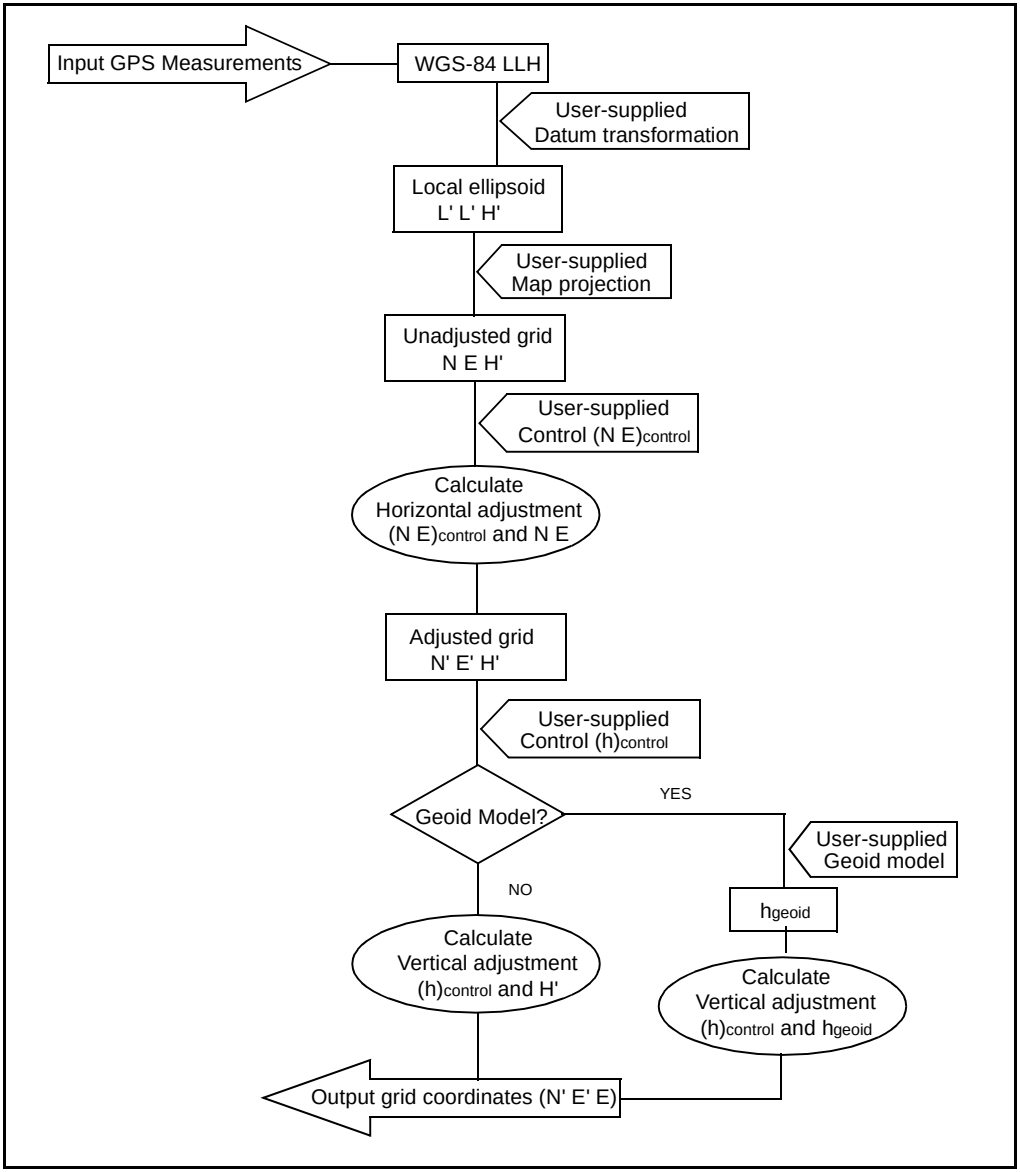


Figure 5.1 Calibration calculation process

Copying Calibrations

You can copy a calibration from a previous job if the new job is completely encompassed by that initial calibration. If a portion of the new job lies outside the initial project area, introduce additional control to cover the unknown area. Survey these new points and compute a new calibration. Use this as the calibration for the job.

Using a Datum Grid File

A datum grid transformation uses interpolative methods to estimate the value of the datum transformation at any point in the area covered by the datum grid files. Two gridded datum files are required for this interpolation—a latitude datum grid file and a longitude datum grid file. When you export a datum grid using the Trimble Geomatics Office or Trimble Survey Office software, the two datum grid files associated with the current project are combined into a single file for use in the Trimble Survey Controller software.

Note – *A datum grid transformation is only used to calculate the horizontal datum shift. For a vertical adjustment, specify an inclined plane or a geoid model.*

Uploading a Datum Grid File

The Trimble Survey Controller software uses a Combined Datum Grid (.cdg) file. This file is created in the Trimble Geomatics Office or Trimble Survey Office software. For more information, refer to the section on exporting projects in the office software documentation.

To upload a .cdg file to a PCMCIA card or to the TSC1 data collector, use Trimble's Data Transfer or GPLoad™ software. For more information on transferring files, see Data Transfer Between the TSC1 and the Office Computer, page 156.

Selecting a Datum Grid File When Creating a Job

When you create a job, the Trimble Survey Controller software prompts you to define a coordinate system.

Note – *The U.S. State Plane 1927 and the U.S. State Plane 1983 coordinate systems in the Trimble Survey Controller software use three-parameter transformations.*

To select a datum grid file when creating a job, do one of the following:

- Select a coordinate system from the library provided in the Trimble Survey Controller software. Set the *Use datum grid* field to Yes. In the *Datum grid* field, select the file that you want to use.
- Key in the coordinate system parameters. Select *Datum transformation* and set the *Type* field to Datum grid. In the *Datum grid* field, select the file that you want to use.

Selecting a Datum Grid File for the Current Job

First upload a datum grid file to the TSC1 data collector (see page 79) then select it.

To select the datum grid file for use in the current job:

1. From the main menu select *Configuration* / *Job* / *Coordinate system*.
2. Do one of the following:
   – If the *Key in parameters* screen appears, select *Datum transformation*.
   – If the *Select coordinate system* screen appears, press Key in. From the *Key in parameters* screen, select *Datum transformation*.

   The *Datum transformation* screen appears.
3. In the *Type* field, choose Datum grid.

4. In the *Datum grid* field, choose the name of the datum grid file.

   The semi-major axis and flattening values for the selected datum grid file are displayed. These details overwrite any already provided by a specified projection.

Using a Geoid Model

The geoid is a surface of constant gravitational potential that approximates mean sea level. A geoid model or Geoid Grid file (a .ggf file) is a table of geoid-ellipsoid separations that is used with the GPS ellipsoid height observations to provide an estimate of elevation.

The geoid-ellipsoid separation value (N) is obtained from the geoid model and is subtracted from the ellipsoid height (H) for a particular point. The elevation (h) of the point above mean sea level (the geoid) is the result. This is illustrated in Figure 5.2.

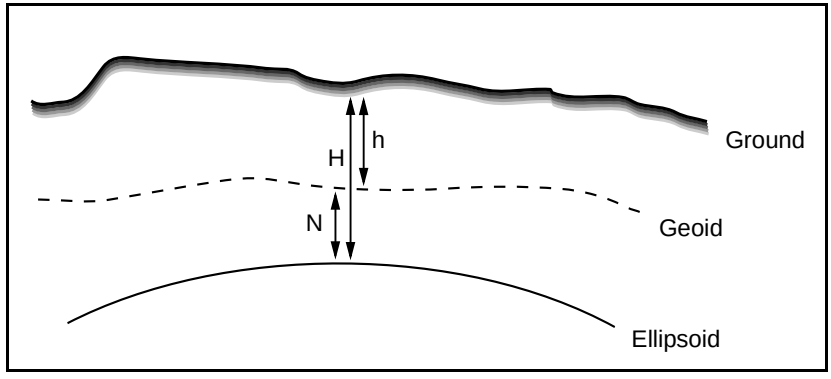


Figure 5.2 Geoid – ellipsoid separation

Note – *For correct results, the ellipsoid height (H) must be based on the WGS-84 ellipsoid.*

When you select Geoid model as the vertical adjustment type, the Trimble Survey Controller software takes the geoid-ellipsoid separations from the geoid file chosen, and uses them to display elevations on the screen.

The benefit of this function is that you can display elevations (which are only as accurate as the geoid model) without having to calibrate on elevation benchmarks. This is useful when local control or benchmarks are not available, as it makes it possible to work 'on the ground' rather than on the ellipsoid.

Note – *Elevations derived from a geoid model are only as accurate as the geoid model and ellipsoid height used to determine them.*

For more information, see Geoid Model, page 197.

Note – *If using a geoid model in a Trimble Geomatics Office project or a Trimble Survey Office project, be sure to upload that geoid file (or the relevant part of it) when uploading the job into the TSC1 data collector.*

Uploading a Geoid File

A folder containing geoid model files is supplied as part of the Trimble Geomatics Office or Trimble Survey Office software. You can copy a whole file (approximately 8 MB) to a PC card and use it in the TSC1 data collector. Alternatively, Trimble recommends that you create a subgrid of the geoid file when you use the office software to upload it to the TSC1 data collector. This gives a smaller file for use in your local area. (A 20 KB geoid file, for example, can cover an area of approximately 100 km by 100 km.) For instructions on subgridding a geoid file, refer to the office software documentation.

To upload a geoid file to the TSC1 data collector use the Trimble Geomatics Office, Trimble Survey Office, GPSurvey™, or TRIMMAP™ software.

Note – *If the geoid file that you upload has the same name as a geoid file already in the TSC1 data collector, the uploaded file overwrites the existing file.*

For more information about transferring files from the office computer, see Data Transfer Between the TSC1 and the Office Computer, page 156.

Selecting a Geoid File When Creating a Job

When creating a job, you are prompted to define a coordinate system. Do one of the following:

- Select a coordinate system from the library provided in the Trimble Survey Controller software. Set the *Use geoid model* field to Yes. In the *Geoid model* field, select the file to be used.
- Key in the coordinate system parameters. Select *Vertical adjustment* and set the *Type* field to Geoid model or Geoid/Inclined plane as required. (Select Geoid/Inclined plane if you intend to key in the inclined plane adjustment parameters.) For more information, see Geoid Model, page 197.

Selecting a Geoid File for the Current Job

When you upload a geoid file into the TSC1 data collector, select it for use in the current job. To do this:

1. From the main menu select *Configuration* / *Job* / *Coordinate system*.
2. Do one of the following:
   - If the *Key in parameters* screen is displayed, select *Vertical adjustment* and set the *Type* field to Geoid model or Geoid/Inclined plane as required. (Select Geoid/Inclined plane if you intend to key in the inclined plane adjustment parameters.)
   - If the *Select coordinate system* screen is displayed, set the *Use geoid model* field to Yes. In the *Geoid model* field, select the file to be used.

Choosing a Coordinate System for a GPS Survey

When you create a new job, the Trimble Survey Controller software prompts you to define what coordinate system you are using. The *Select coordinate system* menu appears. Select a system from the library, key in the parameters, select *Scale factor only*, copy a system from another job, or select no projection and no datum transformation. For more information, see Creating a Job, page 88.

The most rigorous coordinate system consists of four parts:

- Datum transformation
- Map projection
- Horizontal adjustment
- Vertical adjustment

Note – *To conduct a real-time survey in terms of local grid coordinates, define the datum transformation and map projection before starting the survey.*

Tip – In the *Coordinate view* field, select Local to display local geodetic coordinates. Select Grid to display local grid coordinates.

When WGS-84 coordinates are transformed onto the local ellipsoid using a datum transformation, local geodetic coordinates result. Local geodetic coordinates are transformed into local grid coordinates using the map projection. The result is Northing and Easting coordinates on the local grid. If a horizontal adjustment is defined, it is applied next, followed by the vertical adjustment.

Choosing a Coordinate System for a Conventional Survey

When surveying using conventional equipment, it is important to choose a suitable coordinate system.

If a job is to combine GPS measurements with conventional observations, for example, choose a coordinate system that lets you view GPS observations as grid points. This means that you must define a projection and a datum transformation. For more information, see Creating a Job, page 88.

Note – *It is possible to complete the field work for a combined survey without defining a projection and a datum transformation, but you will not be able to view the GPS observations as grid coordinates.*

If you want to combine GPS measurements with two-dimensional conventional observations, specify a default elevation for the job. For more information, see Default Elevation, page 109.

If a job is to contain conventional observations only, select one of the following when you create the job:

- A typical coordinate system and zone that provide mapping plane coordinates. For example, State Plane coordinates.
- *Scale factor only.*

  In a conventional survey, measurements are made at ground level. To compute coordinates for these measurements, observations are reduced to grid level. The specified scale factor is applied to measured distances to reduce them from ground to grid.

  The *Scale factor only* option is useful for areas that use a local scale factor to reduce distances to grid.

Tip – If you are not sure what coordinate system to use, select the *Scale factor only* projection and enter a scale factor of 1.000.

CHAPTER

6

Job Operations

In this chapter:

- Introduction
- Job management
- Reviewing the job database
- Status of current job
- Map of current job
- File manager
- System units
- System settings and corrections

Introduction

Before starting a survey, select or create a job. All subsequent settings and data are stored in this job.

Note – *In the Trimble Survey Controller software, GPS and conventional data can be combined in a single job.*

You can change certain settings (such as the units and distance display) at any time. Trimble recommends that you set these before creating a job, as this reduces the number of records in the job database. For more information, see System Settings and Corrections, page 103.

Job Management

You can create, open, copy, delete, and close jobs in the Trimble Survey Controller software database. The current job name is displayed at the top of the main menu.

Note – *If a job is stored on a PCMCIA (PC) card, always close the job before removing the PC card from the TSC1 data collector.*

To perform most job operations, select *Files* from the main menu. Then select *Job management*.

Creating a Job

To create a job:

1. Press New and enter the job name. Press Enter to accept the job name.
2. To record data on a PC card, change the *File location* field to PC card. This field only appears if a PC card is inserted.
3. Press Enter again to create and open the job.

4. The *Select coordinate system* menu appears. Do one of the following:

   – Select a system from the list provided by the Trimble Survey Controller software.

     To do this, choose *Select from library.* Select a coordinate system from the list, then select a zone for the area.

     To use a geoid file from the database, set the *Use geoid model* field to Yes and set the *Geoid model* field to the geoid file name. For more information, see Using a Geoid Model, page 81.

   – Key in the projection and datum transformation parameters for the site.

     To do this, select *Key in parameters / Projection*. Enter the details for the site. Select *Datum transformation* and enter the details.

     In the *Datum transformation* screen, the *Scale* field displays a parts per million (ppm) value.

     Note – *When keying in the coordinate system parameters, define the local ellipsoid in either the Projection screen or the Datum transformation screen. If the values change in one of these screens, the Trimble Survey Controller software automatically changes them in the other.*

     The source ellipsoid is always WGS-84. The parameters do not appear here and there is no need to edit them.

   – Select *Scale factor only* and enter a value in the *Scale* field. All ground distances will be scaled by this value.

   – Copy a coordinate system from another job in the database.

     To do this, select *Copy from other job*. Select the job name that you want to copy from.

   – Select *No projection/no datum*.

Set the *Coordinates* field to Ground and enter a value (average site elevation) in the *Reference elevation* field to use ground coordinates after a site calibration. Alternatively, set the *Coordinate* field to Grid.

Set the *Use geoid model* field to Yes and select a geoid model to calculate a Geoid/Inclined plane vertical adjustment after a site calibration.

If a survey is to contain conventional observations only, select *Scale factor only.* If conventional observations are to be combined with GPS measurements, choose a coordinate system now. For more information, see Choosing a Coordinate System for a Conventional Survey, page 85.

Note – *If you are not sure of the coordinate system, select No projection/no datum. Set the Coordinates field to Ground and enter the average site elevation in the Reference elevation field. Define the values later in the job and all points will be updated. (To do this, select Configuration / Job / Coordinate system. Press* Key in *or* Select *and enter the parameters or select a coordinate system.)*

If no datum transformation and no projection are defined, any points measured using GPS are displayed only as WGS-84 coordinates. Any points measured using a conventional instrument are displayed with null (?) coordinates.

Warning – If using GPS, define the coordinate system and/or calibration for the job ***before*** computing offsets and/or intersection points, or staking out points.

If you later change the coordinate system or calibration, any of the above points already computed, measured, or staked out will not be in terms of the new coordinate system. They will be inconsistent with points computed or staked out after the change.

5. Press OK or Enter to create the job.

Opening a Job

To open a job, highlight the name of the required job and press Enter.

Copying a Job

To copy a job:

1. Highlight the name of the job to be copied and press Copy.
2. Enter a name for the new job in the *To name* field and press Enter.

   The complete job is copied.

Tip – Use this function to rename a file.

Deleting a Job

To delete a job:

1. Make sure the job is closed.
2. Highlight the name of the job to be deleted and press Delete.

   The Trimble Survey Controller software warns you if the job has not yet been transferred to an office computer.

3. Press Yes to continue the deletion process, or No to keep the job and download it later.

   If you press Yes to confirm the deletion, all raw files associated with the job are also deleted.

If you make a mistake when deleting a job, undo the deletion. See Undeleting a Job.

Undeleting a Job

To see a list of recently deleted files, press Undelete.

To undelete a file, highlight the name of the job to be undeleted and press Enter.

A deleted file remains on the Undelete list as long as there is memory space. When the TSC1 memory starts to get full, the oldest deleted file is purged from memory.

Copying Data Between Jobs

Use this option to copy data between jobs. You can copy the following data:

- Calibration
- All control points
- Calibration and control points
- Roads
- Points

To copy data from another job:

1. From the main menu select *Files* / *Copy data between jobs.*
2. Highlight the *Job to copy from* field and press ⊙. Select the name of the job that contains the data you want to copy and press Enter.
3. Highlight the *Job to copy to* field and press ⊙. Select the name of the job that you want to copy the data into and press Enter.
4. In the *Copy* field, select the appropriate option according to the data that you want to copy.
5. Set the *Copy duplicate points* field to Yes if you want to copy a point—even if it already exists in the job you are copying to.

If you set the *Copy duplicate points* field to Yes, the *Overwrite* field appears. Set it to Yes if you want the duplicate points you copy to overwrite (delete) the points in the job you are copying to.

6. Press OK.

   When copying points, the message:

   Calibration differs from current job. Copy calibration also?

   appears if the two jobs have different calibrations. Press Yes or No as appropriate. If you press Yes the calibration is also copied.

   If duplicate points were copied, a warning message appears and shows how many duplicates were copied.

Closing a Job

To close the current job press Close. Then delete or copy the job as required.

If the job is stored on the PC card, close the job before removing the PC card from the TSC1 data collector.

Reviewing the Job Database

To review the database for the current job, see Reviewing the Database, page 57.

Status of Current Job

From the main menu select *Files / Status of current job*. A screen appears, showing details of the job status. See Figure 6.1.

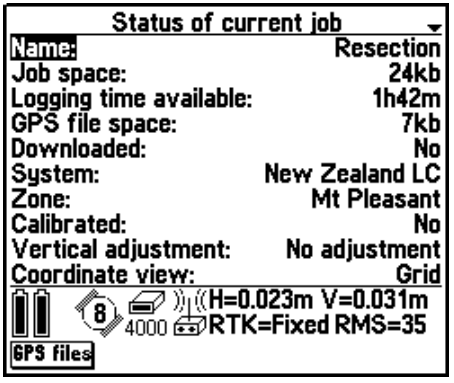


Figure 6.1 Status of Current Job screen

If a PC card is inserted, an extra field called *File location* appears. It shows where the file is stored—on the PC card or in main memory.

The *Job space* field shows the memory taken up by data such as job records, RTK points, and coordinate system details. It does not include the memory used by the raw GPS files.

The *Logging time available* field appears when the current survey is logging data. It shows how much memory is left in the receiver or TSC1 if logging continues at the current logging interval and with the current number of satellites.

The *GPS file space* field shows the memory taken up by the raw GPS files when GPS data is logged to the TSC1 data collector for postprocessing.

The *Downloaded* field shows whether or not the job has been downloaded.

The *Projection* field (or *System* or *Zone* field, depending on the options set) shows the coordinate system for the current job.

The *Calibrated* field shows whether or not the job has been calibrated.

The *Vertical adjustment* field shows the type of adjustment used for the current job.

The *Coordinate view* and *Distances* fields show the settings for the current job.

Press GPS Files to see a list of the files containing the raw GPS data used for postprocessing. A new file is created each time you start a datalogging or infill survey.

Map of Current Job

The *Map of current job* screen is a graphical representation of all grid points in the job database. To display it, select *Files / Map of current job*. A screen similar to Figure 6.2 appears.

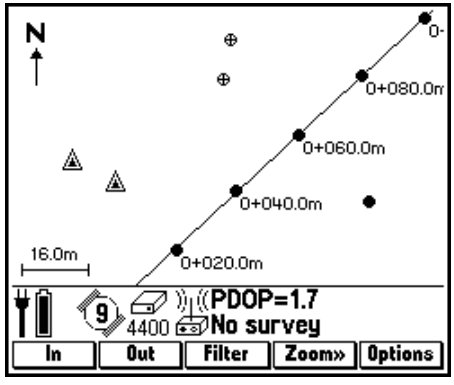


Figure 6.2 Map of Current Job screen

Different symbols identify different point types. The current position of the GPS antenna is shown as a vertical/horizontal cross (+).

Note – *Only grid coordinates are displayed. If you have not defined a projection, only points stored as grid coordinates appear.*

Note – *If the Grid coords field in the Cogo settings screen is set to Increase South-West or Increase South-East, this screen is rotated by 180° N on the north arrow denotes Grid 0°.*

Use the softkeys as described in Table 6.1.

Table 6.1 Softkeys in Map of Current Job screen

Softkey	Function
In	Zooms in
Out	Zooms out
Filter	Shows a legend for the point symbols and lets you choose which points are displayed. Place a check mark against the points you want displayed.
Zoom>>	Displays a list of more advanced zooming features. Choose from the following: • Here – zooms to current position of GPS antenna (this option only appears when the TSC1 data collector is connected to a GPS receiver) • Extents – shows all points on the screen • Select – displays a zoom window that you can move • Pan – displays crosshairs that you can move • To point – displays the Zoom to point screen so enter a point name and scale value
Options	Changes the labels that are displayed next to the points. (The names of continuous points are not displayed.) Choose from Name, Code, or None. You can also choose whether to display the point symbols and coded features for each point. If *Display coded features* is set to Yes, the Trimble Survey Controller software draws lines between points if their feature codes have certain display properties. When you create or edit a feature code, use the Display softkey to specify the feature code's display properties. To display the points in the stakeout list, set the *Display stakeout list points* field to Yes. The points are displayed with a hollow flag icon next to them (⚐). **Warning:** If you set the *Display stakeout list points* field to Yes, the map display takes longer to update.

Press ◀, ▶, ▼, or ▲ to pan across the screen.

Figure 6.3 shows the screens that appear when the Filter softkey is pressed. The screen that appears depends on your position in the list.

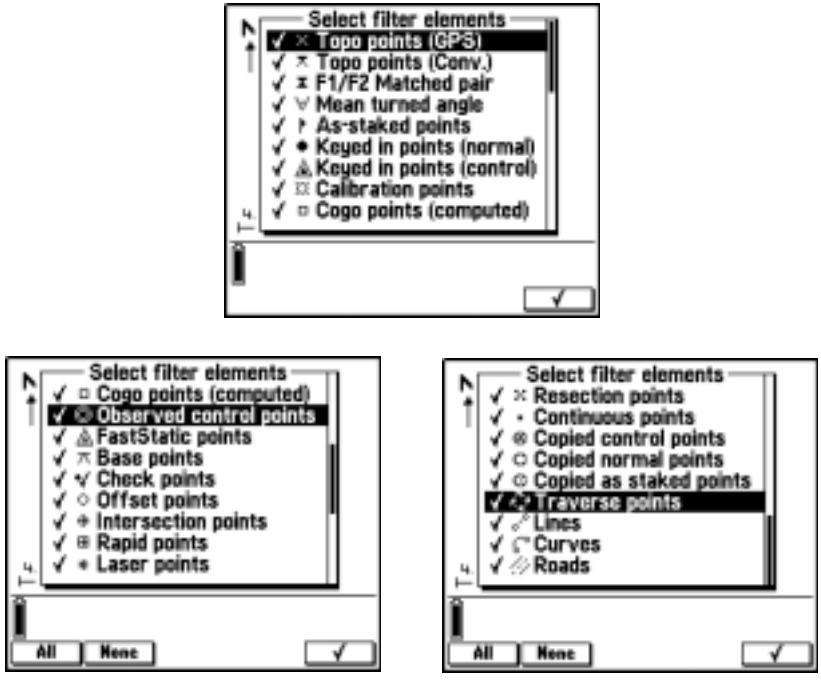


Figure 6.3 Point symbols

File Manager

Use the Trimble Survey Controller file manager to manage the files stored in the TSC1 data collector. With the file manager, it is easy to copy and delete multiple files.

To access the file manager:

- From the main menu, select *Files* / *File manager*.

Tip – You can also select *Job management* to do some of these tasks with job files.

Changing the Type of File Displayed in the List

When you select *File manager*, the Trimble Survey Controller software displays a list of files of the type that was used last. There is a separate list for each type of file.

To change the type of file displayed in the list:

1. Press Type and choose one of the following:
   - All files
   - Job (*.job) files
   - GPS (*.raw) files
   - Grid DTM (*.dtm) files
   - TIN DTM (*.ttm) files
   - Geoid (*.ggf) files
   - Feature & attribute libraries (*.fal)
   - Survey Style (*.sty) files
   - Combined datum grid (*.cdg) files
   - Antenna files (Antenna.dat)
   - Language (*.lng) files

- Help (*.hlp) files
- Copied receiver (*.r00) files
- DC (*.dc) files
- ASCII (CSV) files (*.csv)
- UK national grid files

Note – *If a file is stored on a PC card, the PC card icon (PC) appears to the left of the file name.*

Note – *The All files option displays all files in the main memory and all recognizable files on the PC card; including deleted and system files. The deleted files have a small deleted icon (PC or ⊘) to the left of the file name. The system files have a small Trimble sextant icon (⛵) next to them and you cannot purge them.*

2. Press Enter.

   A new list of files appears.

Getting Information About a File

To see information about a file, highlight the file name and press Enter. This displays the source file name, file type, the size of the file, and the date when it was last modified.

Copying a File to or from a PC Card

It is possible to copy one file at a time or several files at once. A file stored in the main memory is copied to the PC card; a file stored on a PC card is copied to the main memory. Chapter 8, PC Cards, describes how to use a PC card with the TSC1 data collector.

Note – *You cannot copy GPS files. They are part of a job and are only copied when the job is copied.*

Warning – If you copy one of the following file types, and a file of that name already exists, the existing file is overwritten: Geoid file, Combined datum grid file, Antenna file, Language file, Help file, CSV file, Copied receiver file.
For other file types a new file is created with the same name, and the source file name is incremented.

To copy a file to or from a PC card:

1. Make sure the list is showing the file type that you want to copy.
2. Highlight the file to be copied and press ✓.
3. Repeat Step 2 for each file that you want to copy.
4. Press Copy.

Tip – To copy a single file, highlight it and press Copy.

To select all files, press All. A check mark appears next to each file, and the All softkey changes to None. To clear all check marks, press None.

Purging/Deleting a File

For files stored in the main memory or on a PC card, you can delete one file at a time or several files at once.

Warning – If you use the file manager to delete a file, you cannot undelete it later.

To purge/delete a file:

1. Make sure the list is showing the file type of the file to be purged.
2. Highlight the file to be purged and press ✓.
3. Repeat Step 2 for each file that you want to purge.

4. Press Purge.
5. Press Yes to delete the files.

Tip – To delete a single file, highlight it and press Purge.

To select all files, press All. A check mark appears next to each file, and the All softkey changes to None. To clear all check marks press None.

System Units

Set the units and the preferred format of the units at any time. The job database is immediately updated. A job retains the settings assigned to it, even if the units or format change in a subsequent job.

To change the units or format:

1. Select *Configuration / Job / Units*.
2. Highlight a field, for example *Angles*, and press ⊙. A list of formats for the angle display appears. Select a format from this list.
3. Change the other fields as required:
   – The setting for the *Coordinate view* field determines what is displayed when you review the database. Table 6.2 describes the options.

Table 6.2 Coordinate View Options

Option	Description
WGS84	View as WGS-84 Latitude, Longitude, and Height
Local	View as local ellipsoidal Latitude, Longitude, and Height
Grid	View as Northing, Easting, and Elevation
ECEF (WGS84)	View as Earth-Centered-Earth-Fixed WGS-84 X, Y, Z coordinates

Table 6.2 Coordinate View Options (Continued)

Option	Description
Az VA SD	View as azimuth, vertical angle, and slope distance
HA VA SD (raw)	View as horizontal angle, vertical angle, and slope distance
Az HD VD	View as azimuth, horizontal distance, and vertical distance
HA HD VD	View as horizontal angle, horizontal distance, and vertical distance
Δ Grid	View as differences in Northing, Easting, and Elevation from the instrument point

Note – *If the coordinate value for a point is '?', it is possible that the point is stored as a GPS point but the Coordinate view field is set to Local or Grid, and you have not defined a datum transformation and projection. Change the Coordinate view setting to WGS-84, define a datum transformation and/or projection, or calibrate the job.*

Alternatively, it is possible that the point is stored as a polar vector from another point but that source point is deleted. Undelete it.

– The grade of a slope can be displayed in one of the following formats: angle, percent, or ratio.

The ratio display can be in one of two formats, Rise:Run or Run:Rise. Figure 6.4 shows the difference between these.

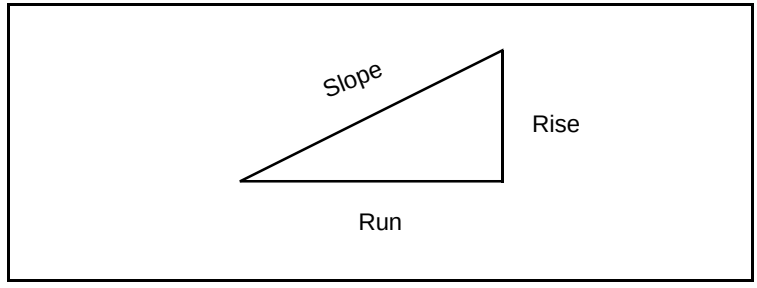


Figure 6.4 Rise and run in the grade display

The setting in the *Laser VA display* field determines whether the laser measurements are displayed as vertical angles measured from the zenith, or inclinations measured from horizontal.

Use the *HA VA angle display* field to specify how horizontal and vertical angles are displayed.

4. Press Enter to accept the settings and return to the *Job* menu.

System Settings and Corrections

Various settings and corrections affect how data and results are displayed on the TSC1 data collector. It is important to understand the effects of the settings used.

Note – *If you change the settings in a subsequent job, the original job retains its settings.*

When you change a setting, a Note is recorded in the job database.

Corrections applied to measurements made using conventional instruments are stored in the Conventional Survey Style.

Cogo Settings Screen

To access the list of settings and corrections, select *Configuration* from the main menu. Then select *Job* / *Cogo settings*. Figure 6.5 shows the *Cogo settings* screen that appears.

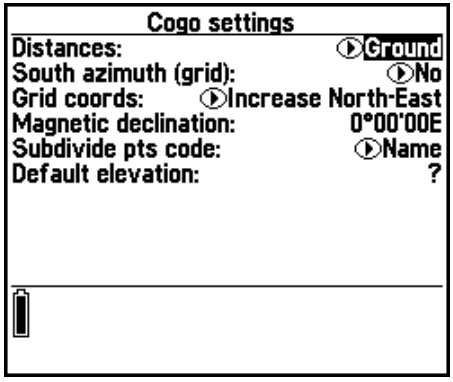


Figure 6.5 Cogo Settings screen

Change these settings as required. They are applied to the current job (if one is open) or to the next job you create.

Options Softkey

An Options softkey appears in some of the screens that you reach by selecting *Cogo* from the main menu. Press it to change some settings and corrections (for example, *Distances*).

Note – *Parameters set in the Options screen only apply to the current job. Different jobs can have different settings.*

Distance Display

The *Distances* field defines how distances are displayed and which distances are used for calculations in the Trimble Survey Controller software. Select one of the following options:

- Ground (the default setting)
- Ellipsoid
- Grid

Figure 6.6 shows these options between the points A and B.

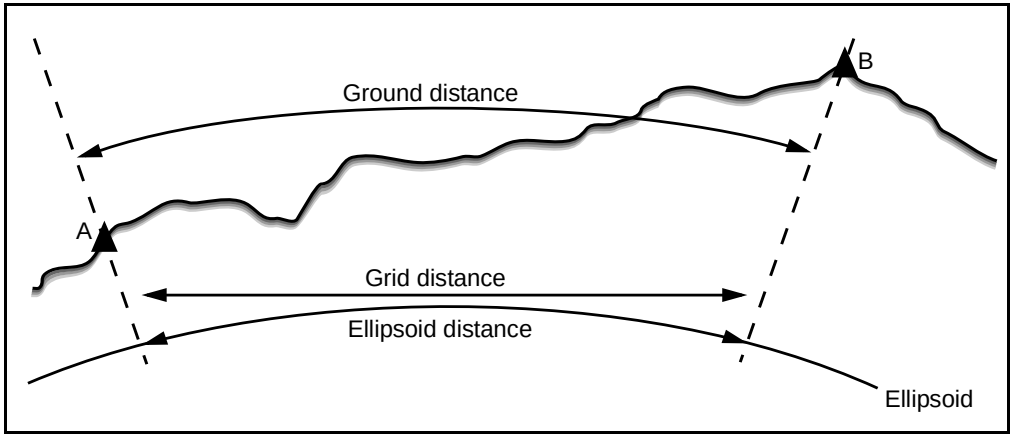


Figure 6.6 Distances used by the Trimble Survey Controller software between points A and B

Note – *Distance and height/elevation fields have the suffix (grid), (grnd), or (ell), depending on the value in the Distances field.*

Ground distance

A ground distance is the horizontal distance calculated between the two points at the mean elevation parallel to the chosen ellipsoid.

If an ellipsoid has been defined in the job and the *Distances* field is set to Ground distance, the distance is calculated parallel to that. If no ellipsoid has been defined, the WGS-84 ellipsoid is used.

Ellipsoid distance

If the *Distances* field is set to Ellipsoid then a correction is applied and all distances are calculated as if on the local ellipsoid, which usually approximates to sea level. If no ellipsoid has been specified, the WGS-84 ellipsoid is used.

Note – *If the coordinate system for a job is defined as Scale factor only, ellipsoid distances cannot be displayed.*

Grid distance

If the *Distances* field is set to Grid, the grid distance between two points is displayed. This is the simple trigonometrical distance between the two sets of two-dimensional coordinates. If the coordinate system for the job is defined as Scale factor only, and the *Distances* field is set to Grid, the Trimble Survey Controller software displays ground distances multiplied by the scale factor.

Note – *A grid distance between two measured GPS points cannot be displayed unless you have specified a datum transformation and a projection, or performed a site calibration.*

Curvature Correction

In the Trimble Survey Controller software system, all ellipsoid and ground distances are parallel to the ellipsoid. See Ellipsoid Calculations, page 200.

Azimuth Display

The azimuth displayed and used by the Trimble Survey Controller software depends on the coordinate system that you defined for the current job:

- If you defined both a datum transformation and a projection, or if you selected Scale factor only, the grid azimuth is displayed.

- If you defined no datum transformation and/or no projection, the best available azimuth is displayed. A grid azimuth is the first choice, then a local ellipsoidal azimuth, then the WGS-84 ellipsoid azimuth.
- If you are using a laser rangefinder, the magnetic azimuth is displayed.

In the *Survey / Offsets* screen you can select which azimuth is used. For more information, see Azimuths/Angles, page 596.

Note – *The azimuth that the Trimble Survey Controller software is using, is identified by the suffix (grid), (local), (WGS84), or (mag).*

South Azimuth

If a south azimuth display is required, set the *South azimuth* field to Yes. All azimuths still increase clockwise. Figure 6.7 shows the effect of setting the *South azimuth* field to No or Yes.

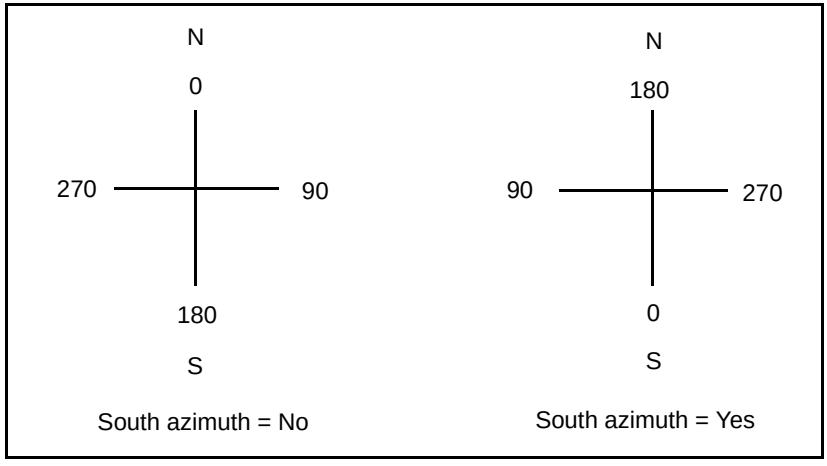


Figure 6.7 South azimuth setting

Grid Coordinates

Use the *Grid coords* field to set the grid coordinates to increase in one of the following sets of directions:

- North and East
- North and West
- South and West
- South and East

Figure 6.8 shows the effect of each setting.

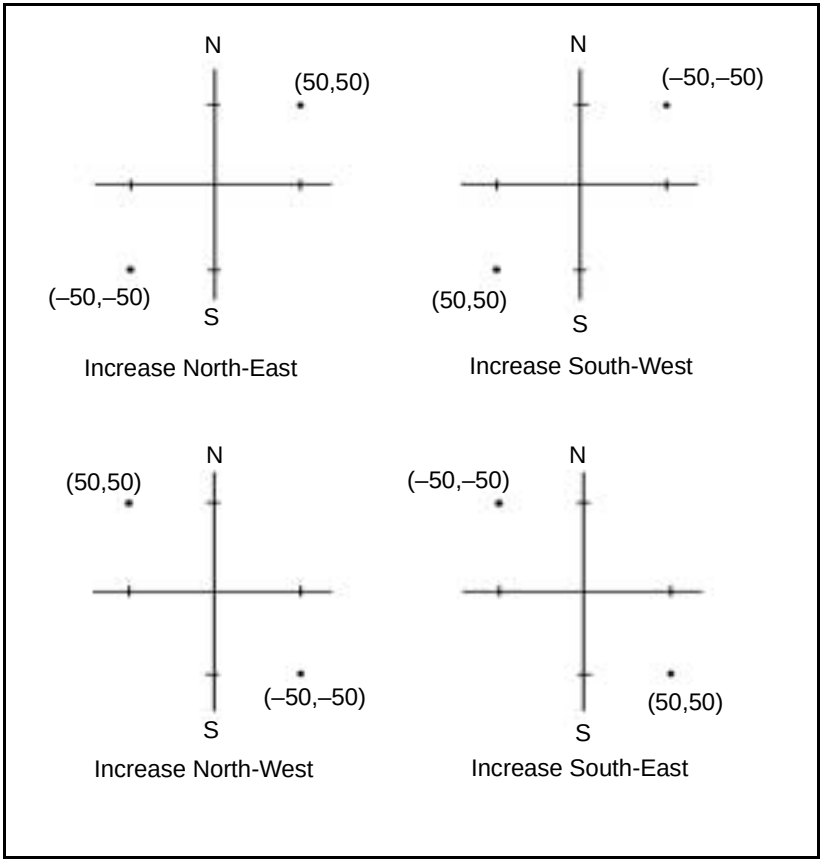


Figure 6.8 Grid coordinates setting

Magnetic Declination

Set the magnetic declination for the local area if magnetic bearings are being used in the Trimble Survey Controller software. You can use magnetic bearings if you choose the Brng-dist from a point method in the *Survey/Offsets* screen.

Enter a negative value if magnetic north is west of true north. Enter a positive value if magnetic north is east of true north. For example, if the compass needle points 7° to the east of grid north, the declination is +7° or 7°E.

Note – *Use the published declination values if available.*

Subdivide Pts Code

When you subdivide a line or curve, a number of points are created. Use the *Subdivide pts code* field to specify what code the new points will get. Choose from the name or the code of the line or curve that is to be subdivided.

Default Elevation

If a point has no elevation, the Trimble Survey Controller software uses the default elevation for Cogo calculations. If you combine GPS and two-dimensional conventional observations, set the *Default elevation* field to approximate the elevation of the site. The default value is null (?). This elevation is used with 2-D points to calculate grid and ellipsoid distances from measured ground distances.

If you have defined a projection and you intend to do a 2-D survey, you must enter a value for the default elevation. This reduces measured ground distances to ellipsoid distances.

CHAPTER

7

Survey Styles

In this chapter:

- Introduction
- The concept of survey styles
- Trimble GPS survey styles
- Using the style wizard to customize a Trimble GPS survey style
- Creating a new GPS survey style
- Copying and editing a survey style
- Differential survey styles

Introduction

There are two kinds of Survey Style, GPS and Conventional. They appear together in the *Select Survey Style* list. This chapter describes the GPS Survey Styles. For information on Conventional Survey Styles, see Configuring the Trimble Survey Controller software, page 452.

When using the Trimble Survey Controller software for a GPS survey, choose from one of nine survey types. These types are based on the kinematic, differential, and FastStatic techniques (see GPS Surveying Techniques, page 5). To select the survey type you need, select an appropriate Survey Style.

This chapter shows how to use Survey Styles and introduces the Style wizard.

The Concept of Survey Styles

Survey Styles make the Trimble Survey Controller software easier to use. Use them to change the configuration of the Trimble Survey Controller software quickly and easily for different types of survey.

In a GPS survey, the Survey Style instructs the base and rover receivers to perform the functions required for a specific survey type. It also defines the parameters for measuring and storing points. This whole set of information is stored as a template that can be called up and re-used when necessary.

A GPS Survey Style defines the survey type, antenna information, elevation mask, PDOP mask, and point occupation times. If applicable, it also defines:

- logging intervals
- initialization times
- Site calibration defaults
- GPS file storage location

- real-time broadcast message format
- radio communication parameters

Choosing a Survey Style

Trimble provides four GPS Survey Styles that cover four of the nine possible survey types. (For information about survey types, see Choosing a GPS Survey Type, page 65.) To use any survey type not covered by the Trimble Survey Styles, you must create your own Survey Style. This is described in Creating a New GPS Survey Style, page 122.

Entering the equipment details

The first time each Survey Style is used to start a survey, the Style wizard prompts you to select the type of antenna and the radio (if applicable) you are using. For more information, see Using the Style Wizard to Customize a Trimble GPS Survey Style, page 119.

Setting the options

Before starting a survey, you can edit many of the options in the Survey Style that you intend to use. For more information, see Copying and Editing a Survey Style, page 142.

Generating a Survey Menu

When you choose the *Survey* icon from the main menu, the *Select Survey Style* screen appears. It displays a list of available Survey Styles. Until you create your own Styles, this list contains the four Trimble GPS Survey Styles (see below) and the Trimble Conventional Survey Style.

When you select a Survey Style from the list, the Trimble Survey Controller software generates a menu specific to that Style, and displays it on the screen as the *Survey* menu. The options that appear in this *Survey* menu depend on what ***type*** of survey you chose (by selecting that Survey Style). A PP kinematic *Survey* menu, for example, never includes *Stakeout* and *Site calibration*, which are items specific to real-time survey types.

Trimble GPS Survey Styles

The four standard Trimble GPS Survey Styles supplied with the Trimble Survey Controller software system are:

- Trimble RTK
- Trimble RTK & infill
- Trimble PP Kinematic
- Trimble FastStatic

These Styles cover the four most popular centimeter-level survey types. To use the default settings for a survey type, select the appropriate Style and use it as it is. For more information about survey types, see Choosing a GPS Survey Type, page 65.

It is not possible to delete a Trimble Survey Style, but you can copy one and edit some of the fields in the copy that you make. This is described in Copying and Editing a Survey Style, page 142.

Using a Trimble GPS Survey Style

To conduct a GPS survey using a Trimble Survey Style:

1. Make sure that a job is open. Look at the title of the main menu. It should be the job name.
2. From the main menu, choose the *Survey* icon. From the *Select Survey Style* menu, select one of the following Survey Styles:
   - Trimble RTK
   - Trimble RTK & infill
   - Trimble PP Kinematic
   - Trimble FastStatic

Tip – To avoid confusion, do not use the word 'Trimble' when choosing names for your own Survey Styles.

3. If this is the first time this Survey Style is being used, the Style wizard prompts you to select the type of antenna and, if applicable, the type of radio. For more information, see Using the Style Wizard to Customize a Trimble GPS Survey Style, page 119.

4. The *Survey* menu appears. It displays the items appropriate to the type of survey associated with the Survey Style selected. Figure 7.1 shows the screen that appears if *Trimble RTK* is selected, for example.

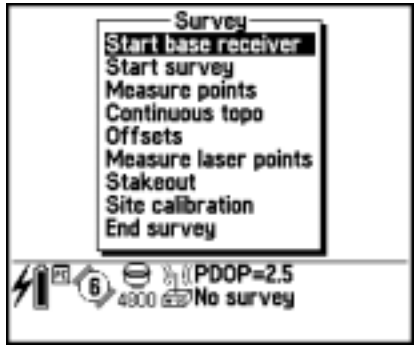


Figure 7.1 Trimble RTK Survey menu

5. Start the base receiver. See Chapter 11, Starting the Base Receiver.
6. Start the rover receiver. See Chapter 12, Starting the Rover Receiver.

Options in a Trimble GPS Survey Style

A group of options is associated with each survey type. The selected GPS Survey Style determines which survey type is used, and which options are available. Once you are familiar with the use of Survey Styles, you can edit many of the options to further customize individual surveys. For example, you can edit the default setting for the minimum occupation time of a topo point.

Table 7.1 shows the options associated with each Trimble GPS Survey Style.

Table 7.1 Options in Trimble GPS survey styles

	Trimble GPS Survey Styles			
Option	**Trimble RTK**	**Trimble RTK & infill**	**Trimble PP kinematic**	**Trimble FastStatic**
Rover options	✓	✓	✓	✓
Rover radio	✓	✓		
Base options	✓	✓	✓	✓
Base radio	✓	✓		
Laser rangefinder	✓	✓	✓	✓
FastStatic point				✓
Topo point	✓	✓	✓	
Observed control point	✓	✓	✓	
Rapid point	✓	✓		
Continuous points	✓	✓		
Stakeout	✓	✓		
Site calibration	✓	✓		
PP initialization times		✓	✓	
Duplicate point actions	✓	✓	✓	✓

Default settings

The default elevation mask for the base receiver and the rover receiver is 13°. The default PDOP mask setting is 6. Other default settings define how point measurements are made.

To edit the options for a Survey Style see Copying and Editing a Survey Style, page 142.

Note – *When editing an option, you cannot access every field in the screen that appears. The setting in the Survey type field, for example, is fixed for each Trimble Survey Style.*

Trimble RTK Survey Style

The *Trimble RTK* Survey Style prepares the Trimble Survey Controller software for a real-time kinematic (RTK) survey. Use this Style for centimeter-level stakeout as well as topographic and control surveying.

Note – *Survey Styles (such as Trimble RTK) that employ the real-time kinematic survey type rely on a trouble-free radio solution.*

By default, the base receiver is instructed to generate real-time kinematic corrections at one second intervals.

Trimble RTK & Infill Survey Style

The *Trimble RTK & infill* Survey Style prepares the Trimble Survey Controller software for a real-time kinematic (RTK) survey, with postprocessed support when base radio corrections are not available.

Use this Style for real-time topographic or control surveys if there is a risk of radio link outage. Use it if obstructions or interference are a problem, or if the operational range of the radio could be exceeded.

By default, the base receiver is instructed to generate real-time kinematic corrections at one second intervals and to simultaneously log raw data at five second intervals for the duration of the base survey.

Trimble PP Kinematic Survey Style

The *Trimble PP Kinematic* Survey Style prepares the Trimble Survey Controller software for a postprocessed kinematic survey. No radio is required for a postprocessed kinematic survey.

Use this Style for topographic or control surveys when no radio is available.

By default, the base receiver is instructed to log raw data at five second intervals for the duration of the survey.

Trimble FastStatic Survey Style

The *Trimble FastStatic* Survey Style prepares the Trimble Survey Controller software for a FastStatic survey.

Use this Style for control surveys when no radio is available.

By default, the base receiver is instructed to log raw data at five second intervals for the duration of the survey.

Using the Style Wizard to Customize a Trimble GPS Survey Style

The first time you start a base or rover survey in a Trimble GPS Survey Style, the Style wizard prompts you to define the details of the equipment. Select an item from a list displayed (the antenna type, for example).

The Style wizard customizes the chosen Trimble Survey Style, setting any parameters specific to the hardware.

Tip – To correct a mistake when customizing a Survey Style, first complete the process and then edit the Style. For more information, see Copying and Editing a Survey Style, page 142.

Antenna Type

When you start the base or the rover receiver for the first time, you must select the type of antenna that you are using from a list. Table 7.2 shows some common choices.

Table 7.2 Typical antenna configurations

Receiver and station	GPS Total Station 4800 receiver	GPS Total Station 4700 receiver	4600LS receiver	Trimble Series 4000 or Site Surveyor 4400 receiver
Base receiver	4800 Internal	Micro-centered L1/L2 w/GP	4600LS Internal	Micro-centered L1/L2 w/GP or Compact L1/L2
Rover receiver		Micro-centered L1/L2		Micro-centered L1/L2 or Compact L1/L2

Radio Type

With a real-time system, define the radio solution that you intend to use. The options are: TRIMTALK™ 450, TRIMTALK 900, TRIMTALK 450S, TRIMMARK™, TRIMMARK Rover, TRIMCOMM™, Trimble internal, Pacific Crest, Satel, Clarion, Custom radio, and Cellular modem.

Note – *With the GPS Total Station™ 4800 receiver or 4700 receiver, use an external radio at the base even if using the internal radio at the rover.*

GPS File Storage

If a Trimble Survey Style needs raw GPS data to be logged during a survey, the Trimble Survey Controller software asks if you want to store data in the memory of the TSC1 data collector. If you choose not to, it stores the data in the receiver.

Table 7.3 summarizes where the Trimble Survey Controller software can store GPS files.

Table 7.3 GPS file storage

Receiver	RTK & infill	PP kinematic	FastStatic
GPS Total Station 4800	Receiver or TSC1		
GPS Total Station 4700			
4600LS			
Site Surveyor 4400	TSC1 only		
Series 4000	Receiver or TSC1	Receiver or TSC1	Rover: TSC1 only Base: TSC1 or receiver

Site Surveyor 4400 receiver

A Site Surveyor 4400 receiver has no memory, so you need two TSC1 data collectors if the survey type requires raw data logging. One data collector stays with the base receiver, the other with the rover receiver.

Series 4000 receiver

If the rover in a FastStatic survey is a Series 4000 receiver, use the TSC1 data collector to store the GPS data logged by the receiver. To store this data in the receiver, use the front panel of the receiver to control the rover survey.

If the base receiver in a FastStatic survey is a Series 4000 receiver, use either the TSC1 data collector or the base receiver to store the GPS data logged by the receiver.

Creating a New GPS Survey Style

The Trimble Survey Controller software provides Trimble Survey Styles that configure the hardware for four of the nine possible GPS survey types—RTK, RTK & infill, FastStatic, and PP Kinematic.

The other available survey types are:

- RTK & data logging
- RT differential
- RT diff & infill
- RT diff & data logging
- PP differential

The RTK & data logging survey type is similar to RTK except that raw GPS data is recorded for the entire survey. This method is useful if raw data is required for quality assurance purposes.

For information about the differential Survey Styles, see page 143. To survey using any of these types, first create a new Survey Style.

To create a new GPS Survey Style:

1. From the main menu select *Survey.* The *Select Survey Style* screen appears.
2. Press New.
3. Enter a name in the *Style name* field and press Enter.
4. In the *Style type* field choose GPS.
5. If a PC card is inserted, set the *File location* field as required.
6. Press Enter.

Note – *When you create a new GPS Survey Style, it is configured as an RTK survey that you must edit.*

The items that appear at first are: *Rover options*, *Rover radio*, *Base options*, *Base radio*, *Laser rangefinder*, *Topo point*, *Observed control point*, *Rapid point*, *Continuous points*, *Stakeout*, *Site calibration*, and *Duplicate point actions*. Some of these are shown in Figure 7.2.

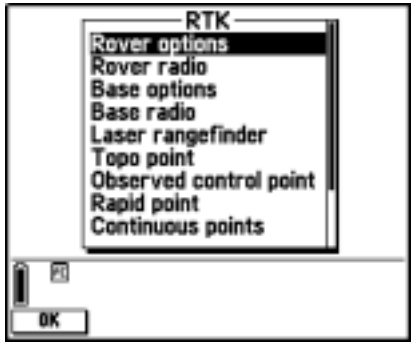


Figure 7.2 Trimble RTK Survey Style menu

If you select *Rover options* or *Base options* and change the setting in the *Type* field, the list of Survey Style options is rebuilt so that it is appropriate to that survey type. For example, if the survey type is changed to FastStatic, the list shown in Figure 7.3 appears.

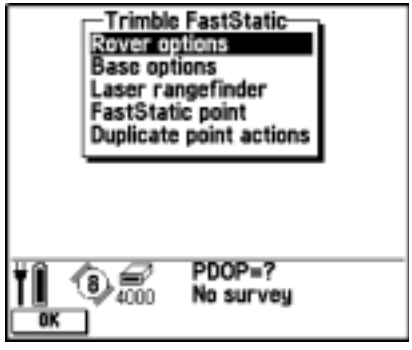


Figure 7.3 Trimble FastStatic Survey Style menu

Select each menu item in turn. In the screen that appears, set the fields to specify your equipment and preferences. For more information about each menu item, see the following sections.

Note – *Another way to create a new Survey Style is to copy a Trimble Survey Style, although this limits you to the four popular survey types. For more information, see Copying and Editing a Survey Style, page 142.*

Rover Options and Base Options

There are nine survey types to choose from. Generally when a GPS total station consists of one base and one rover, the survey type selected in the *Rover options* field and that selected in the *Base options* field is the same. When there are multiple rovers, however, various configurations are possible. Table 7.4 shows the rover survey types possible when the base survey type is RTK & infill or PP kinematic.

Table 7.4 Base support for rover survey types

Base survey type	Possible rover survey types
RTK & infill or RTK & data logging	RTK RTK & infill PP kinematic FastStatic PP differential
PP Kinematic	PP kinematic FastStatic PP differential

Tip – As a rule of thumb, if there is only one rover, make sure that the base and rover survey type are the same.

The fields that can appear when you select *Rover options* or *Base options* are described below.

When the rover options are set and accepted, the list of items in the Survey Style is rebuilt. The new list includes only those items that are relevant to the chosen rover survey type. For example, set the *Rover survey type* field to FastStatic and press Enter. The menu is rebuilt. Select the *Rover options* field again and change the survey type to RTK. Press Enter to see the menu being rebuilt again.

Broadcast format

For real-time kinematic surveys, the format of the broadcast message can be CMR™, CMR Plus™, or RTCM RTK 2.x (where CMR stands for Compact Measurement Record and RTCM stands for Radio Technical Commission for Maritime Services).

The default is CMR Plus. CMR Plus is a type of format used by the modern Trimble receivers. It is a modified type of CMR record that improves the efficiency of a low bandwidth radio link in real-time surveys. Only use CMR Plus if all the receivers have the CMR Plus option installed. To check if this option is installed in the receiver, select *Instrument* / *Options* on a TSC1 data collector that is connected to a receiver.

Note – *If you want to operate several base stations on one frequency, use CMR Plus. For more information, see Operating Several Base Stations on One Radio Frequency, page 290.*

The rover selection should always correspond to the broadcast message format generated by the base.

Output additional code RTCM

For real-time surveys the base receiver can broadcast the RTK message and the RTCM differential message at the same time. Set the *Output additional code RTCM* field to Yes to do this. The RTCM output option must be installed in your receiver.

Note – *When RTCM code and CMR messages are being broadcast, the behavior of rover GPS receivers varies according to type. When you are broadcasting CMR with Output additional code RTCM enabled, only use Series 4000 receivers, GPS Total Station 4700, or 4800 receivers with firmware later than v1.2. Not all receivers will function correctly in this environment, the behavior is receiver and manufacture dependent. Most RTCM only receivers will work correctly. Contact your local Trimble dealer for more details.*

Warning – Do not use this option when time delays are being used for sharing the radio frequency.

WAAS

When the radio link is down in a real-time survey, the receiver can track and use signals from the Wide Area Augmentation System (WAAS). This provides WAAS positions instead of autonomous GPS positions. WAAS positions can also be used for more accurate navigation when the radio link is down. Set the *WAAS* field to On if you want to do this.

When using WAAS signals, only Rapid points or postprocessed points can be measured.

Note – *You must use a receiver that can track WAAS satellites for WAAS surveys.*

INS Positions

For real-time surveys configure the GPS Total Station 4700 receiver for use with an Inertial Navigation System (INS). Use INS positions in areas where the receiver cannot track a sufficient number of satellites.

For more information, refer to the GPS/INS Surveyor system manuals and release notes.

Station index

In real-time surveys the base receiver broadcasts the station index number as part of the broadcast message. You set the station index number in the *Start base* screen. Set the default station index number for the *Start base* screen in the *Station index* field in the *Base options* of the Survey Style.

Use station index

If you want to use multiple base stations on one radio frequency, in the *Use station index* field, enter the station index number that you want to use first.

If you do not want to use multiple base stations on one frequency, enter the same station index number that you enter in the *Base options* screen.

To use any base station operating on the frequency set in the rover radio, press Any.

Warning – If you press Any and there are other base stations operating on the frequency, you could use corrections from the wrong base in the rover survey.

For information about using multiple bases, see Operating Several Base Stations on One Radio Frequency, page 290.

Prompt for station index

When you use a receiver that supports multiple base stations on one radio frequency, the Trimble Survey Controller asks you which base to use when you start the rover survey. You can stop this question from appearing by setting the *Prompt for station index* field to No. The station index number in the *Use station index* field is used.

Elevation mask

It is necessary to define an elevation mask above which satellites are considered. For kinematic applications, the default of 13° is ideal for both the base and rover.

For differential surveys where the base and rover are separated by more than 100 kilometers, Trimble recommends that the base elevation mask be lower than the rover setting by 1° per 100 kilometers of separation between the base and rover. Generally, the base elevation mask should be no lower than 10°.

PDOP mask

For the rover option, define a PDOP mask. The Trimble Survey Controller software issues High PDOP warnings when the satellite geometry goes above this threshold. The default is 6.

Logging device

With survey types that involve postprocessing, set the datalogging device to be either the receiver or 'Controller' (the TSC1 data collector).

To define the logging interval, enter a value in the *Logging interval* field. The base and rover logging intervals must correspond to (or be multiples of) each other.

Antenna type

To set the default antenna height, enter a value in the *Antenna height* field.

To define the antenna details, access the *Type* field and select the correct antenna from the list of antennas. Access the *Meas. to* field and select the correct measurement method for the equipment and type of survey. The field that displays the part number is automatically filled. Use the keypad to enter the serial number.

Radios

If you are using an RTK survey type to provide real-time positions, you need to specify the type of radios used to provide the radio link between the base station and the rover. Specify the type of radio in use at both the base and rover receivers.

For information about configuring a Survey Style to use real-time corrections provided by WAAS instead of a radio, see Differential Survey Styles, page 143.

To specify the radio used:

1. Select *Rover radio*.
2. In the *Type* field, select your radio from the list.
   The options are TRIMTALK 450, TRIMTALK 900, TRIMTALK 450S, TRIMMARK Rover, TRIMCOMM, Trimble internal, Pacific Crest, Satel, Clarion or Cellular modem.

   Note – *If your radio does not appear on the list, select Custom radio and define the receiver port, the baud rate, and the parity.*

   If you select Cellular modem, do the following:

   – In the *Init string* field, enter the command that the Trimble Survey Controller software sends to the modem to instruct it to start communication. This step is optional.

Tip – For some cellular modems you must enter a Personal Identification Number (PIN). Usually the command is as follows:
AT+CPIN=**** (where ******** is the PIN)
If using a PIN, add the command to the end of the value in the *Init string* field.

   – In the *Hang up* field, enter the command that the Trimble Survey Controller software sends to the modem to instruct it to end communication.

- In the *Dial prefix* field, enter the command that the Trimble Survey Controller software sends to the modem to instruct it to dial a number.
- In the *Number to dial* field, enter the phone number of the base station modem.

  Note – *In the Number to dial field, use the character "," to send a short delay. You can use this to separate the area code from the phone number.*
- In the *Dial suffix* field, enter the command that the Trimble Survey Controller software sends to the modem after it has dialled the number. This step is optional.

  The Dial prefix, Number to dial, and Dial suffix are concatenated and sent to the modem.
- In the *Post connect* field, enter the information that the rover modem provides to the base system when connection has been made. For example, a log-in name and password. This step is optional.

  Note – *In the Post connect field, use the character "," to send a carriage return and a short delay (3 seconds) to the base system. You can use this to separate a log-in name and password.*

3. Select *Base radio*.
4. In the *Type* field, select your radio from the list.
   The options are TRIMTALK 450, TRIMTALK 900, TRIMTALK 450S, TRIMMARK, TRIMCOMM, Pacific Crest, Satel, Clarion, Custom radio and Cellular modem.

   If you select Cellular modem, do the following:

   - In the *Init string* field, enter the command that the Trimble Survey Controller software sends to the modem to instruct it to start communication. For the base, this command must leave the modem in auto-answer mode. Alternatively, you can set the auto-answer mode separately.

– In the *Hang up* field, enter the command that the Trimble Survey Controller software sends to the modem to instruct it to end communication.

If you are using a cellular modem, CTS is always enabled for the base modem. For more information about CTS, see the next section.

For more information about radios, see Radio Solutions, page 288.

Ready To Send (RTS) and Clear To Send (CTS)

If you select *Base radio* and set the *Type* field to Custom radio you can also do the following:

- enable Clear To Send (CTS)
- set the CTS delay

Warning – Do not enable CTS unless the receiver is connected to a radio that supports CTS.

The GPS Total Station 4700 and 4800 receivers support RTS/CTS flow control when you enable CTS. If you are using a GPS Total Station 4700 or 4800 receiver, use receiver firmware version 1.20 or later.

Only use the *CTS delay* field if you are using a Series 4000 receiver.

Table 7.5 shows which receiver port the radio must be connected to when the *CTS enabled* field is set to Yes.

Table 7.5 Receiver port – CTS enabled

Receiver	Receiver port
GPS Total Station 4800	Port 1 **Note**: Connect the TSC1 to Port 2
GPS Total Station 4700	Port 1 or Port 3 **Note**: Connect the TSC1 to Port 2
Series 4000	Port 2 or Port 4

Topo Point

Select the *Topo point* menu item to set the parameters associated with observing topographic points.

The *Auto point step size* field defines the increment size for automatic point numbering. The default is 1, but you can use larger step sizes as well as negative steps.

It is possible to store quality control information with each point measurement. The default is QC1. For real-time surveys other options are QC1 & QC2 and QC1 & QC3. For more information, see Quality Control Records, page 379.

Note – *If you intend to use topo point data with TRIMNET™ software, record QC1 & QC2 records for each point.*

The Trimble Survey Controller software can terminate a topo point measurement and store the result automatically if the *Auto end point* field is set to Yes. When the number of measurements, the occupation time, and the horizontal and vertical precisions are satisfied, the point is measured and the result stored.

Observed Control Point

Select the *Observed control point* menu item for another way to observe points in the field. This option lets you set different observational criteria from those used for topo point measurements.

The Trimble Survey Controller software can terminate observed control point measurement and store the results automatically if the *Auto end point* field is set to Yes and the occupation times are satisfied. For RTK surveys, the number of measurements and the horizontal and vertical precisions must also be satisfied. The default setting for the *Number of measurements* field is 180. The extended occupation time suggests that this measurement type is ideally suited to points that will be used for control purposes.

Quality control information is automatically stored with each point:

- Real-time observed control points can store QC1, QC1 & QC2, or QC1 & QC3 records.
- Postprocessed observed control points only store QC1 records.

For more information, see Quality Control Records, page 379.

If the *Topo point* option is configured to perform 180 measurements, the positional result is similar to a point measured using the observed control point measurement type.

Differences are:

- the default value in the *Quality control* field
- the observation class given by the office software when the point is downloaded

FastStatic Point

You can measure a FastStatic™ point in a FastStatic survey.

The Trimble Survey Controller software terminates a FastStatic occupation automatically if the *Auto end point* field is set to Yes and the specified occupation time is satisfied.

The default occupation times are satisfactory for most users. If you change an occupation time, choose a setting according to the number of satellites being tracked by that receiver. Remember that both receivers must track the same satellite at the same time for the data to be useful.

Tip – Use a mobile phone or a walkie-talkie radio to verify that both receivers are tracking the same satellites.

Changing the occupation times directly affects the outcome of a FastStatic survey. Any changes should increase this time rather than decrease it.

Rapid Point

Select the *Rapid point* menu item to configure a Rapid point™ observation. This is useful for in-field calculations where precision is not vitally important. Use the Rapid point observation method to quickly measure the position of the center line on a busy road, for example.

Rapid points are automatically saved if the horizontal and vertical precisions are satisfied. The Trimble Survey Controller software collects just one epoch of data when the preset precisions are reached, so the default precision values should ideally be higher than for other point measurement types. The Trimble Survey Controller software uses this single epoch of data to define the point, making Rapid point the least precise measurement method.

You can store quality control information with each Rapid point. The options are QC 1, QC1 & QC2, or QC1 & QC3. For more information, see Quality Control Records, page 379.

Continuous Points

Continuous points use one epoch of data or one real-time measurement to create a point.

In a real-time survey, the Trimble Survey Controller software automatically saves continuous points if the horizontal and vertical precisions are satisfied. In a postprocessed survey, it stores continuous points at the time interval specified in the Survey Style. Set this interval in the *Logging interval* field of the *Rover options* screen.

Stakeout

To set the as-staked point details:

1. Set the *View deltas before storage* field to Yes to view the differences between the design point and the measured as-staked point before storing the result.

   If you set this field to Yes, enter a value in the *Horizontal tolerance* field. The Trimble Survey Controller software displays the deltas if the tolerance is exceeded. The default is 0.000. With the default setting, the deltas are always displayed.

   Note – *The Stake delta values are reported as differences* ***from*** *the measured/as-staked point* ***to*** *the design point.*

2. Set the name of the as-staked point to be the next auto point name or a point name that is equivalent to its design name.

3. Set the code of the as-staked point to be the design point name or the design point code.

To set the display:

1. Set the *Display mode* field. The options are:

   – Surveyor centered – the cross that represents your current position stays in the center of the screen and the target moves as you change position.

   – Target centered – the target stays in the center of the screen and the cross moves as you change position.

2. You can enter a value in the *Zoom factor* field. This is the amount that the display zooms in when you switch from Coarse mode to Fine mode while navigating to a point. The default value is 4.0. When you zoom in by this amount, the width of the graphical display corresponds to approximately one meter (or three feet).

3. Set the *Display grid deltas* field. The options are:

   – Yes – the change in Northing and Easting is displayed during stakeout.

   – No – a bearing and distance is displayed. See Figure 17.8 on page 406.

   Note – *When you stake out a point, the elevation of the current position is also displayed.*

4. If required, define a DTM and set the *Display cut/fill to DTM* field to Yes. The cut or fill relative to the DTM can be displayed.

   To use the DTM, select the name of the appropriate file in the *DTM* field.

   Note – *You can create a DTM file from an ASCII file. Use the Trimble Geomatics Office or Trimble Survey Office software to do this. Full documentation is provided with that software.*

5. If required, choose a setting for the *External display* (NMEA) output) field. Do this if you need to:

   – navigate using an external display (such as Trimble's NavTracXL™ or NT200 display) and a Series 4000 receiver

   – output NMEA strings from a Site Surveyor 4400, 7400MSi™, GPS Total Station 4800, or GPS Total Station 4700 receiver

   when staking out a point or navigating to a point.

   To set the receiver to output NMEA strings, set the *Enabled* field to Yes. Set the other fields according to the equipment.

   Note – *The External display (NMEA output) field is only available if the NMEA option is installed in the receiver. To check this see Options, page 354.*

Table 7.6 summarizes the types of NMEA string that are output when the external display option is enabled.

Table 7.6 NMEA output strings

Receiver	NMEA output strings
Series 4000	BWC, GGA, GLL, GSA, VTG, WPL, XTE, ZDA, GGK
Site Surveyor 4400	GGK at 1 Hz
7400MSi	GGK at 1 Hz
GPS Total Station 4800	GGK at 1 Hz
GPS Total Station 4700	GGK at 1 Hz

Note – *With a GPS Total Station 4800 or 4700 receiver, the NMEA strings are output on Port 2 only.*

For more information about NMEA strings, refer to the receiver manual.

You cannot start a survey if the *External display* (NMEA output) *Enabled* field is set to Yes, but the receiver does not support NMEA output.

When you end a survey that outputs NMEA strings, the same NMEA strings are disabled in the receiver.

Site Calibration

To set the parameters for computing a calibration, select the *Site calibration* menu item and do the following:

1. The *Fix H. scale field to 1.0:* field details whether the calibration computation should compute a horizontal scale factor or not:
   - To compute the horizontal scale factor, select No.
   - To fix the horizontal scale factor to 1.0, select Yes.

Only select No if GPS measurements should be scaled to fit the local control. (GPS measurements are usually more precise.) Select Yes to avoid distorting the geometry of the GPS network, but note that the calibration residuals will be higher.

2. Select an observation type appropriate to a calibration point. The options for a calibration point are Topo point or Observed control point.

3. For the Trimble Survey Controller software to automatically perform a calibration when you measure a calibration point, set the *Auto calibrate* field to Yes. To switch automatic calibration off, set it to No.

4. If necessary, set the tolerances for maximum horizontal and vertical residuals, and maximum and minimum horizontal scale settings. These settings only apply to automatic calibration and do not affect manual calibration.

   You can also specify the maximum slope of the vertical adjustment plane. The Trimble Survey Controller warns you if the slope in the north direction or the slope in the east direction exceeds this. Generally the default settings are appropriate.

5. Specify how the calibration points you measure will be named:

   a. In the *Method* field, choose one of the following options: Same, Add prefix, Add suffix, or Add constant.

   b. In the *Add* field, enter the prefix, suffix, or constant.

Table 7.7 shows the different options and gives an example of each.

Table 7.7 Calibration point name options

Option	What the software does	Example value in Add field	Grid point name	Calibration point name
Same	Gives the calibration point the same name as the grid point	n/a	100	100
Add prefix	Inserts a prefix before the grid point name	GPS_	100	GPS_100
Add suffix	Inserts a suffix after the grid point name	_GPS	100	100_GPS
Add constant	Adds a value to the grid point name	10	100	110

PP Initialization Times

Select the *PP initialization times* menu item to define initialization times. Generally the default settings are appropriate.

Warning – Reducing any of these times can affect the outcome of a postprocessed survey. Any changes should increase these times rather than decrease them.

Duplicate Point Actions

When you enter the name of a new point, the Trimble Survey Controller software warns if a point of the same name already exists.

In a real-time GPS survey, set the tolerances for a duplicate point warning—specify the maximum distance that the new point can be from the existing point. A duplicate point warning appears when you try to store the new point, but only if it is outside the tolerance set. This warning also appears when you key in a duplicate point. If a survey is not running, the tolerances in the last real-time survey are used to perform the check.

Duplicate point : Out of tolerance screen

If the new point has the same name as an existing point and is closer to the existing point than the tolerance specified (the new point is 'within tolerance'), the new point is stored (the Store another option).

If the new point is further from the original point than the tolerance specified (the new point is 'out of tolerance'), the *Duplicate point : Out of tolerance* screen appears when you store the point. Choose what to do with the new point.

The options are Discard, Rename, Store as a check, Store another, or Overwrite. If you select Overwrite, the existing point and all other points of the same name are deleted if they have the same (or a lower) Search class.

For information about how the Trimble Survey Controller software uses Search classes, see Database Search Rules, page 211.

Specify horizontal and vertical tolerances in the *Duplicate point actions* screen. The default is 0.000. With the default setting, a warning is always given. For no warning to be displayed, enter high values in the *Horizontal* and *Vertical* fields. The range for these settings is 0.000 m to 1000.000 m.

When you enter a duplicate point name, a warning appears:

Point name already exists

If you continue to measure the point, a screen similar to the one shown in Figure 7.4 appears when you end or store the point.

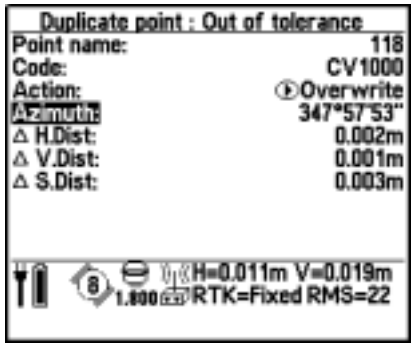


Figure 7.4 Duplicate point : Out of Tolerance screen

Set the *Action* field to one of the options listed in Table 7.8.

Table 7.8 Duplicate point action options

Option	Effect on the point just measured or computed
Discard	It is discarded
Rename	It is renamed (to the name at the top of this screen)
Overwrite	It overwrites and deletes the original point, and all other points of the same name and the same (or lower) Search class
Store as a check	It is stored with the lower classification of 'Check'
Store another	It is stored and can be averaged in the office software. The original point is used in preference to this point.
Store and reorient	It is stored and used as the backsight observation for subsequent measurements.

For more information about point classification, see Database Search Rules, page 211.

Copying and Editing a Survey Style

Edit a Survey Style to define new field observation procedures or to set options for new hardware, such as radios and receivers.

Trimble Survey Styles can be edited, but the survey type (RTK, RTK & infill, PP Kinematic, and FastStatic) is fixed and cannot be changed.

Any Survey Style that you create by copying an original or edited Trimble Survey Style is also locked in this way. If you create your own Survey Styles, however, you can copy and edit them without limitation. See Creating a New GPS Survey Style, page 122.

Copying a Survey Style

To copy a Survey Style:

1. End the current survey.
2. From the main menu select *Survey.* A list of Survey Styles appears. Highlight the name of the Style to be copied and press Copy.
3. Enter the name of the new Style in the *To name* field and press Enter twice.

Editing a Survey Style

To edit a Survey Style:

1. End the current survey.
2. From the main menu select *Survey.* The list of Survey Styles appears. Highlight the name of the Style to be edited and press Edit. The list of options for that Survey Style appears.
3. Change the settings in each option as required. For more information about these options, see Creating a New GPS Survey Style, page 122.

Differential Survey Styles

This section describes the differential Survey Styles that you can use with the Trimble Survey Controller software and shows how to create a differential Survey Style.

Differential Survey Types

Differential GPS surveys can be real-time, postprocessed, or a combination of both. For real-time differential surveys the GPS receiver can track and process signals from the Wide Area Augmentation System (WAAS). This is instead of using a ground-based RTCM broadcast message. You do not need to use a radio.

Note – *You must use a receiver that is capable of tracking WAAS satellites for WAAS surveys.*

When using WAAS signals, only Rapid points or postprocessed points can be measured.

To conduct a differential survey, first create a Survey Style that uses a differential survey type. (See Creating a Differential Survey Style, page 144.) There are four differential survey types:

- RT differential
- RT diff & infill
- RT diff & data logging
- PP differential

For the first three, a radio solution is required. If no radio is available, use the postprocessed option, PP differential.

RT differential

A real-time differential survey using the RTCM broadcast message relies on a reliable radio for the duration of the survey. Alternatively, do not use a radio and use WAAS signals to provide real-time positions.

RT diff & infill

A real-time differential & infill survey provides the option to switch to raw data collection if the radio link fails. Observations during this time may only be resolved by postprocessing. When radio transmissions are again received, you can stop data logging and continue the real-time survey.

RT diff & data logging

A real-time differential & data logging survey works in the same way as an RT differential survey, except data is recorded for the entire survey both at the base and at the rover receivers.

This method is useful if raw data is required for quality assurance purposes.

PP differential

A postprocessed differential survey does not require a radio solution. As a result, the coordinates of a point are not available in real time. Data is collected both at the base and at the rover. When the survey is completed, the data is processed and results obtained.

Creating a Differential Survey Style

To create a differential Survey Style:

1. From the main menu select *Configuration* / *Survey Styles*.
2. Press New or copy an existing Survey Style (not a Trimble Survey Style).

3. Choose *Rover options* or *Base options* and make the appropriate changes to the *Type* field.

   In this case, change it to the differential method that you want to use. The survey type you select depends on whether the technique you choose is real-time or postprocessed.

   Note – *You cannot edit the survey type of a Trimble Survey Style.*

4. For both real-time and postprocessed techniques, define an elevation mask and antenna for the base and the rover. For the rover options, define Broadcast format, the PDOP mask, and the RTCM age limit. In a differential survey you can choose to set the *Broadcast format* field to RTCM or WAAS.

5. For methods that involve datalogging, specify whether the data is to be logged in the receiver or in the Trimble Survey Controller software, and define the interval.

   For real-time techniques, the RTCM-SC104 version 2 broadcast message format is used. Real-time signals are generated at 1 second intervals.

For more information about options in a Survey Style, see Creating a New GPS Survey Style, page 122.

Field Techniques for Differential Surveying

Differential surveys require four satellites that are common to the base and the rover receivers. Differential surveys do not require initialization.

The success of a real-time differential survey, like that of an RTK survey, depends on the radio solution that you are using. Assuming a trouble-free radio solution, two fixes per second are possible.

Note – *For postprocessed surveys, always collect enough data at each station.*

CHAPTER

8

PC Cards

In this chapter:

- Introduction
- Advantages
- Choosing a PC card
- Inserting and removing a PC card
- Storing data on a PC card
- PC card status
- Copying files to and from a PC card
- Transferring PC card data to the office computer

Introduction

To expand the memory of the Trimble Survey Controller software system, insert a PCMCIA (PC) card into the back of the TSC1 data collector. PC cards have different memory capacities, for example 4 MB, 10 MB, or 85 MB.

Advantages

A PC card:

- provides efficient data management
- increases the memory capacity of the Trimble Survey Controller software
- speeds up data transfer

Because data is stored on the card, only the card needs to be returned to the office for downloading. This means that the TSC1 data collector is free for continued work in the field.

If the office computer is PCMCIA-compatible, you can insert the PC card directly into it and retrieve the data using Trimble's Data Transfer or GPLoad™ software. If the office computer is not PCMCIA-compatible, leave the PC card in the TSC1 data collector and use the Trimble Survey Controller software to download the file as usual.

You can store various types of file on a PC card. These include:

- Jobs
- DTMs
- Geoid models
- Combined datum grids
- Languages
- Feature codes
- Survey Styles

- Data Collector (*.dc) files
- Comma Separated Value (*.csv) files

Files on the PC card can be copied to and from the main memory of the TSC1, and to and from the office computer.

Choosing a PC Card

Only Type I or Type II ATA format PC cards are supported by the Trimble Survey Controller software at present. Trimble supplies a 4 MB card (part number 33050-04) and a 10 MB card (part number 33050-10).

In addition to the cards supplied by Trimble, PC cards from the following manufacturers have been tested successfully in the TSC1 data collector:

- Epson
- IBM
- SanDisk
- Viking

Inserting and Removing a PC Card

You can insert a PC card into the TSC1 data collector at any time.

To insert a PC card:

- Make sure that the card has the correct side facing up and is in the correct location for insertion. Looking at the front of the TSC1, the small arrow on the PC card is to the bottom left corner as the card is inserted. See Figure 2.1 on page 13.

Note – *Do not force the card into the slot. The card cannot be fully inserted if it is upside down.*

When a PC card is inserted, the PC card icon (PC) appears in the status line.

To remove a PC card:

1. If the current job is stored on the PC card, close the job.
2. Press the PC card release button, and remove the card. See Figure 8.1 on page 150.

Warning – Only remove a PC card when the TSC1 is turned off or when the lock icon is not displayed. (When a file is open on the PC card, a small icon appears below the PC icon.) If you remove the card while this lock icon is present, the Trimble Survey Controller software shuts down with a fatal error because it cannot access the files it needs. Data can be lost.

Figure 8.1 shows how to remove a PC card from the TSC1 data collector.

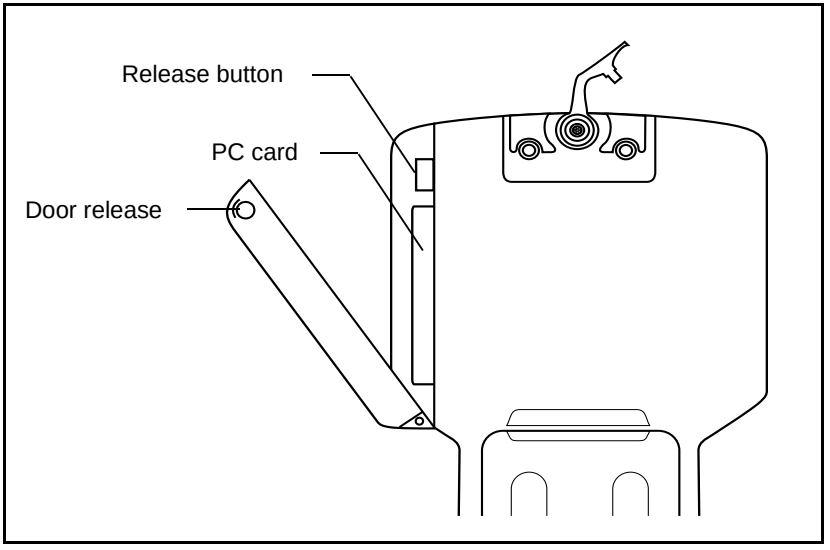


Figure 8.1 Removing a PC card

Storing Data on a PC Card

To store a new job on the PC card, select *Files* / *Job management* and press the New softkey. Enter a name for the new job, and set the *File location* field to PC card.

If you store data in the main memory and decide later to store it on the PC card, copy the data to the PC card. See Copying a File to or from a PC Card, page 99.

PC Card Status

When a PC card is inserted, the Trimble Survey Controller software automatically detects it. The following message appears:

Initializing PC card.....

Press OK to acknowledge the message.

The PC card icon (PC) appears in the status line. If a padlock symbol ( ) appears below this, the PC card is in use and should not be removed.

To see how much memory remains on a PC card:

1. From the main menu choose *Configuration*.
2. Select *Controller* / *Hardware*.

   The *PC card free space* field displays how much memory remains on the PC card.

To see where a job is being stored (in main memory or on the PC card), do one of the following:

- From the main menu select *Files* / *Current job status*. The *File location* field displays where the current job is stored.
- From the main menu select *Files* / *Job management* (this lets you inspect the list of jobs). A *Select job* list appears. If a job is stored on the PC card, the PC icon appears to the left of the job name.

Copying Files to and from a PC Card

For information on how to copy a Trimble Survey Controller software file to or from a PC card see Copying a File to or from a PC Card, page 99.

Transferring PC Card Data to the Office Computer

Download files stored on the PC card to the office computer in one of the following ways:

- directly – by inserting the PC card into the office computer
- indirectly – using the Trimble Survey Controller software

Use the same methods to upload files from the office computer to the PC card.

Note – *The Trimble Survey Controller software does not support subdirectories on a PC card. Use subdirectories on the office PC, but not on a PC card.*

By Direct Transfer

This is the fastest way to download data. The office computer must have a PC card reader.

Remove the PC card from the TSC1 data collector and insert it in the PC card reader on the office computer.

The rest of the operation is controlled by the Trimble Geomatics Office, Trimble Survey Office or GPLoad software that is running on the office computer. For more information, refer to the documentation for that software.

Using the Trimble Survey Controller Software

With the PC card in the TSC1 data collector, transfer data from the Trimble Survey Controller software to the office computer as described in Chapter 9, Data Transfer.

CHAPTER

9

Data Transfer

In this chapter:

- Introduction
- Data transfer between the TSC1 and the office computer
- Data transfer between the TSC1 data collector and another device

Introduction

This chapter describes how to transfer data between the TSC1 data collector and an office computer. It lists the types of file that can be transferred, and shows how to connect the equipment for transfer. It then shows how to transfer point names, point codes, and grid coordinates in ASCII format between the TSC1 data collector and a variety of conventional instruments, data collectors, and office computers.

Data Transfer Between the TSC1 and the Office Computer

It is possible to transfer various types of files between the TSC1 data collector and the office computer, including data collector (.dc) files, feature code files, DTMs, and language files. The data transfer process on the TSC1 data collector is controlled by the office computer software when you connect the TSC1 data collector to the office computer and select the appropriate options.

Use one of the following software packages to transfer data to and from the TSC1 data collector:

- Trimble Geomatics Office
- Data Transfer
- Trimble Survey Office
- GPSurvey
- TRIMMAP
- Autodesk's AutoCAD Land Development Desktop

Warning – Update all Trimble software programs that communicate with the TSC1 data collector ***before*** transferring files to or from the TSC1. Use the WinFLASH™ upgrade software to do this. For more information, see Upgrading the Trimble Survey Controller Software, page 32.

You can transfer files from the Trimble Survey Controller software directly to and from third-party software (other than the AutoCAD Land Development Desktop software) without using one of the above-mentioned software packages. For information about how to do this, see Data Transfer Between the TSC1 Data Collector and Another Device, page 163.

File formats

When job data is transferred from the Trimble Survey Controller software to Trimble office software, a .dc file is created. Information about the .dc file format is available from the Trimble web site (www.trimble.com). For more information, contact your local Trimble dealer.

Geoid models and Datum grid files

If a job uses a geoid model or a datum grid, do not use:

- Trimble .dc version 3.0 format to download points that are stored as grid coordinates
- SDR33 format to download points that are stored as WGS-84, local geodetic, or ECEF coordinates

Trimble Survey Office software

To transfer data between the Trimble Survey Controller software and the Trimble Survey Office software, use the Data Transfer version 1.01 software.

To transfer a job file from the Trimble Survey Controller software to the Trimble Survey Office software:

1. Connect the TSC1 data collector to the office computer.
2. Use the Data Transfer software to transfer the Trimble Survey Controller job file as a version 7.00 .dc file to your project's Checkin folder on your office computer.

In the Trimble Survey Office software, import the files into the current project using the *Survey Controller* / *SDR file (*.dc, *.sdr) option*.

Note – *Do not use the Survey Controller / GPS Receiver option.*

To transfer a job file to the Trimble Survey Controller software from the Trimble Survey Office software:

In the Trimble Survey Office software, use the *Export* / *Survey Controller* / *SDR file (*.dc,*.sdr)* option to export the files to a folder on the office computer.

3. Connect the TSC1 data collector to the office computer.
4. Use the Data Transfer software to transfer files from the folder on your office computer to the Trimble Survey Controller software.

TRIMMAP office software

To transfer data from the Trimble Survey Controller software to the TRIMMAP™ software:

1. Download and transfer the GPS part of the job using the *DC v6.5 GPS* option.
2. Download and transfer the conventional part of the job using the *SDR 33 Conv* option.

TRIMNET office software

If you download a file in SDR33 or DC7 format and the file has conventional observations in it, a Data Collector Observation (.dco) file is also created. Use the .dco file with TRIMNET™ office software.

Roads

Use DC7.5 or SDR33 format to upload a road, and DC7.5 format to download it.

Note – *You cannot download a road in SDR33 format, and DC6.5 format does not support all roading records.*

For more information about the data transfer process, refer to the documentation for the office software you use.

AutoCAD Land Development Desktop software

Use the Trimble Link™ software to transfer data between the Trimble Survey Controller software version 7.01 or later and Autodesk's AutoCAD Land Development Desktop software.

Connecting the TSC1 Data Collector

To transfer data between the TSC1 data collector and the office computer, connect the equipment as shown in Figure 9.1 (or Figure 9.2, depending on the equipment).

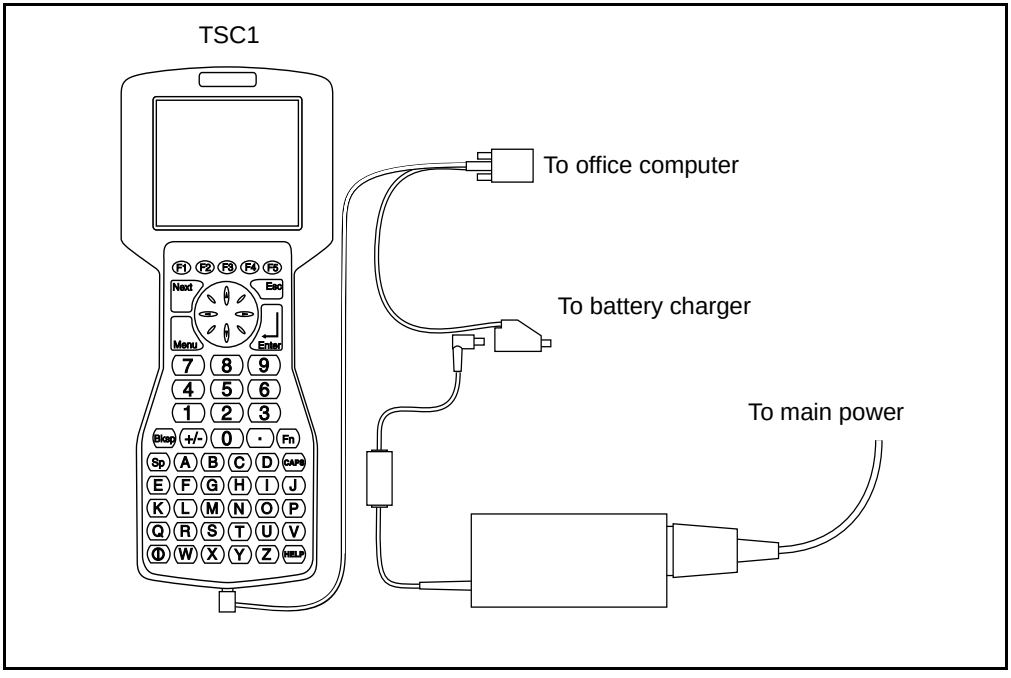


Figure 9.1 Download connection

Connect the TSC1 to the office computer, the battery charger, and the AC adaptor using the TSC1 to DB9/power supply Y-cable, part number 32345.

Alternative connection

If you are using an Office Support Module charger (OSM II charger, part number 20669-40), connect the TSC1 data collector to the office computer using the cable attached to the OSM II charger. With some equipment you may need to use the adaptor cable, part number 32959, to do this.

1. Connect the TSC1 data collector to the OSM II charger using the cable attached to the OSM II.
2. Connect the OSM II charger to the office computer using an RS232 cable. Insert one end into the OSM II DATA I/O port, the other into the office computer port.

Figure 9.2 shows how to connect the equipment using this method.

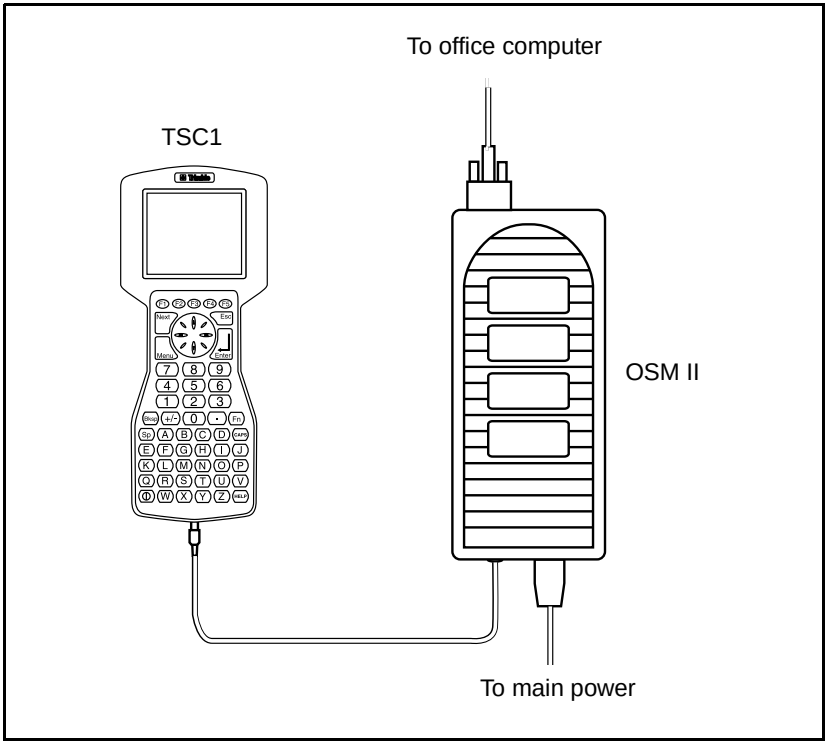


Figure 9.2 Alternative download connection

Transferring the Data

To download files from the TSC1 data collector to the office computer or upload files from the office computer to the TSC1:

1. From the main menu on the TSC1 data collector select *Files* / *Import/Export*.
2. Select *Trimble PC communications*.

   A message appears:

   Trimble PC communications. Waiting for PC connection.

3. The rest of the procedure is controlled by the office computer. To continue, follow the instructions in the appropriate software documentation.

Note – *There are no communication parameters to set up, as the Trimble Survey Controller software and the office computer software negotiate the maximum speed at which they can work together.*

To abandon the data transfer at any time, press the Esc key on the TSC1 data collector or the Esc key on the office computer.

When a .dc file is transferred to the Trimble Geomatics Office, the Trimble Survey Office or GPSurvey software, any GPS data files associated with that file are also transferred. These GPS data files cannot be transferred separately.

Note – *It is possible to upload to the Trimble Survey Controller software a job or file that has the same name as an existing file. The existing file is not overwritten, and it could be confusing to have two files with the same name.*

Note – *If a Trimble Geomatics Office or Trimble Survey Office project uses a geoid model, remember to upload the geoid file (or the subgridded part of it) as well when uploading the job into the Trimble Survey Controller software.*

Data Transfer Between the TSC1 Data Collector and Another Device

This section shows how to use the ASCII data transfer function in the Trimble Survey Controller software. Use this function to transfer point names, point codes, and grid coordinates in ASCII format between the TSC1 data collector and a variety of conventional instruments, data collectors, and office computers.

If you have a PC card, you can also convert job files to Trimble DC v3 and SDR33 format Data Collector (.dc) files and store them on the PC card. In addition, job files can be transferred directly to the office computer as DC v3 and SDR33 format .dc files using third-party download software, such as HyperTerminal.

This section also shows how to transfer data between the Trimble Survey Controller software and a Leica instrument by using the PC card.

Note – *Only points with grid coordinates are transferred when you use the ASCII data transfer function. If the job does not have a projection and datum transformation specified, GPS points cannot be transferred.*

Deleted points, and any points stored as polar vectors from a deleted point, cannot be transferred either.

Transferring ASCII Data to and from the PC Card

You can transfer job files to and from the PC card in the following ASCII formats:

- Trimble DC v3
- SDR33 DC
- Generic (CSV)

Note – *The Trimble Survey Controller software only recognizes CSV files on the PC card if they have the extension .CSV.*

When you select a job to transfer to the PC card, the Trimble Survey Controller software can convert it to one of the above formats and store it on the PC card.

If you have a Trimble DC v3, SDR33 DC, or CSV file on the PC card, the Trimble Survey Controller software can convert it to a job file and store it on the PC card or in the main memory.

Note – *You can also copy these files from the main memory to the PC card and from the PC card to the main memory. Use File manager to do this.*

Transferring a file to the PC card

To transfer a job to the PC card as an ASCII format file, do the following:

1. Select *Files* /*Import*/*Export* / *Send ASCII data*. Figure 9.3 shows the screen that appears.

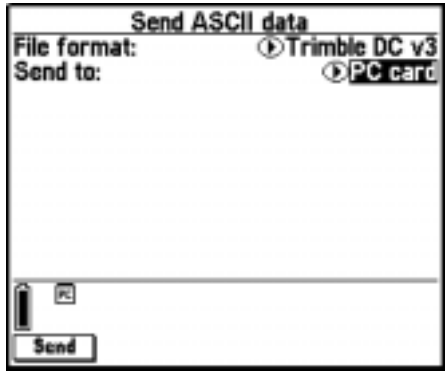


Figure 9.3 Send ASCII Data (to PC card) screen

2. In the *File format* field choose Trimble DC v3, SDR33 DC or Generic (CSV).
3. Set the *Send to* field to PC card.

   Note – *The PC card option only appears if you have a PC card inserted.*

4. If the *File format* field is set to Generic (CSV), you can specify the format of the data to be output. (CSV stands for Comma Separated Values.) Five fields appear: *Point name*, *Point code*, *Northing*, *Easting*, and *Elevation*. Using the options provided, select a position for each field. Select Unused if you do not want to send a particular value.

5. For example, if the fields are set as follows:

Point name	Field 1
Point code	Unused
Northing	Field 2
Easting	Field 3
Elevation	Field 4

   the Trimble Survey Controller software will output a file containing data in the format: Point name, Northing, Easting, Elevation.

6. Press Send. One of the following happens:

   – If the *File format* field is set to Trimble DC v3 or SDR33 DC, the *Select job to send* list appears. Select the job you want to send and press Enter.

   The Trimble Survey Controller software prompts you to enter an eight character file name for the new file. Enter a file name and press Enter.

   The file is converted to an ASCII file and stored on the PC card.

   – If the *File format* field is set to Generic (CSV), the *Select job to send* list appears. Select the job to send and press Enter.

   The Trimble Survey Controller software prompts you to enter an eight character file name for the new file. Enter a file name and press Enter.

The *Select points* list appears. Select the points you want to send. The procedure is similar to that used to create a *Stakeout/Points* list (see Staking Out a Point, page 402).

Note – *Only points with grid coordinates can be selected and transferred. If the job does not have a projection and datum transformation specified, GPS points cannot be transferred.*

Deleted points, and any points stored as polar vectors from a deleted point, cannot be transferred either.

The points are transferred into a .csv file and the file is stored on the PC card.

To transfer a file from the PC card

To convert an ASCII file stored on the PC card to a job file, do the following:

1. Select *Files* /*Import*/*Export* / *Receive ASCII data*. Figure 9.4 shows the screen that appears.

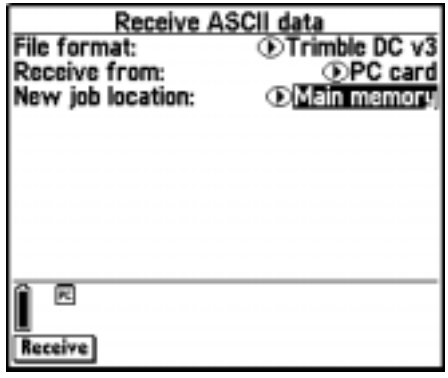


Figure 9.4 Receive ASCII Data (from PC card) screen

2. In the *File format* field choose Trimble DC v3, SDR33 DC, or Generic (CSV).

3. Set the *Receive from* field to PC card.

   Note – *The PC card option only appears if you have a PC card inserted.*

4. If the *File format* field is set to Trimble DC v3 or SDR33 DC, set the *New job location* field. Choose where to store the new job that will be created.

5. If the *File format* field is set to Generic (CSV), specify the format of the data that is received. Five fields appear: *Point name, Point code, Northing, Easting,* and *Elevation*.

   Using the options provided, select a position for each field. Select the Unused option if a particular value is not present in the file being received. If you set the fields as follows, for example:

Point name	Field 1
Point code	Unused
Northing	Field 2
Easting	Field 3
Elevation	Field 4

   the Trimble Survey Controller software receives a file containing data in the format: Point name, Northing, Easting, Elevation.

6. Press Receive. One of the following happens:

   – If the *File format* field is set to Trimble DC v3 or SDR33 DC the *Select file to import* list appears. Select the file to import and press Enter.

   The file is converted to a job and stored on the PC card or in the main memory depending on what you specified in the *New job location* field.

– If the *File format* field is set to Generic (CSV) the *Select job to receive into* list appears. Select the job that the data is to be stored in.

The coordinates are transferred into the job you selected.

Transferring ASCII Data to and from an External Device

You can transfer ASCII data to and from an external device or office computer in the following formats:

- Geodimeter (Area)
- Generic (CSV)
- SDR33 coordinates
- SDR33 DC
- TDS
- Topcon (GTS-7)
- Topcon (FC-5)
- Trimble DC v3
- Zeiss (R5)
- Zeiss (Rec E/M5)
- Zeiss (Rec500)

The next sections describe how to connect the TSC1, and how to send and receive data to and from the Trimble Survey Controller software.

Connecting the TSC1

To connect the TSC1 data collector to the office computer, use the standard Trimble download cable. See Figure 9.1 on page 160.

To connect any other device, use the 0-shell to DB9 cable to connect the TSC1 data collector to the other device. See Figure 9.5.

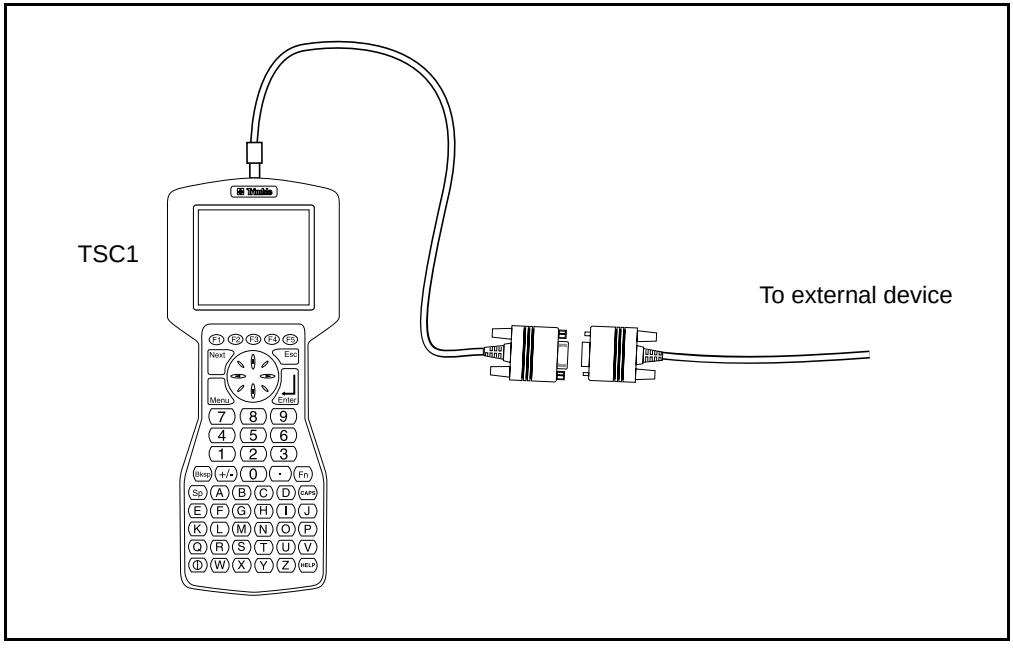


Figure 9.5 External device connection

Sending ASCII Data to an External Device

To send ASCII data to an external device:

1. Select *Files* /*Import*/*Export* / *Send ASCII data*. Figure 9.6 shows the screen that appears.

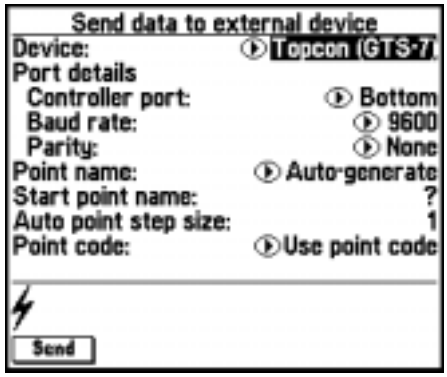


Figure 9.6 Send ASCII Data (to external device) screen

2. Use the *File format* field to specify the type of file that you want to send.
3. If the *File format* field is set to Generic (CSV), Trimble DC v3, or SDR33 DC, the *Send to* field appears. Set the field to External device.
4. Set the *Port details*/*Controller port* field to Top or Bottom, depending on which TSC1 port you are using for the transfer.
5. Set the *Baud rate* and *Parity* fields to match the corresponding parameters on the device that you are communicating with.

   Note – *If the File format field is set to Generic (CSV), set the baud rate correctly on the external device. If appropriate, set the flow control (xon/xoff) as well.*

   If you are transferring a .dc file, the *Checksum* field appears. Set it to On if you want the Trimble Survey Controller software to include a checksum when the file is transferred.

For the Geodimeter (Area), SDR33, TDS, Topcon (GTS-7), Topcon (FC-5), Zeiss (R5), Zeiss (Rec E/M5), and Zeiss (Rec500) output options, the format is controlled by the external device.

Warning – When sending data to a device that does not include a units setting as part of its file, make sure that the Trimble Survey Controller software file uses the units setting of that device.

If you are not sure whether the device file includes a units setting, set the Trimble Survey Controller software file to the same units as the device.

6. If the *File format* field is set to SDR33 coordinates or TDS, the *Job name* field appears. Enter a name for the file that is created when the data is transferred.
7. Set the *Point name* field to Unchanged or Auto-generate. Unchanged sends the point names as they appear on the TSC1 data collector. Auto-generate adds two extra fields:
   - Use the *Start point name* field to specify the name of the first point to be transferred.
   - Use the *Auto point step size* field to define the amount by which the Start point value is incremented or decremented when the Trimble Survey Controller software generates point names for subsequently transferred points.

     Note – *If the File format field is set to TDS and the Point name field is set to Unchanged, a point will only be transferred if the point name is less than eight characters long and contains numeric characters only.*
8. Use the *Point code* field to specify what is sent to the external device specified in the *Code* field:
   - Select Use point code to send the point code.
   - Select Use point name to send the point name.

Note – *If you have used long codes (up to 42 characters) in the Trimble Survey Controller software, and the file format you are transferring to does not support long codes, the codes will be shortened.*

9. If the *File format* field is set to SDR33 coordinates there is an *Output notes* field. Set this to Yes to output all user-entered notes with the point data. The notes are output in SDR33 record 13NM format.

10. If the *File format* field is set to Generic (CSV), you can specify the format of the data to be output. (CSV stands for Comma Separated Values.) Five fields appear: *Point name*, *Point code*, *Northing*, *Easting*, and *Elevation*. Using the options provided, select a position for each field. Select Unused if you do not want to send a particular value.

    For example, if the fields are set as follows:

Point name	Field 1
Point code	Unused
Northing	Field 3
Easting	Field 2
Elevation	Field 4

    the Trimble Survey Controller software will output a file containing data in the format: Point name, Easting, Northing, Elevation.

11. When the format details are complete, press Send.

12. The *Select job to send* list appears. Select the job to send and press Enter.

13. If you are sending points (not a .dc file), the *Select points* screen appears. Select the points to send.

    The procedure is similar to that used to create a *Stakeout/Points* list (see Staking Out a Point, page 402). You can transfer up to 3,500 points.

Note – *Only points with grid coordinates can be selected and transferred. If the job does not have a projection and datum transformation specified, then GPS points cannot be transferred.*

Deleted points, and any points stored as polar vectors from a deleted point, cannot be transferred either.

14. You are prompted to initiate receiving on the instrument that you are sending data to. For more information about receiving data, refer to the manual for the receiving device.

    When the other device is ready to receive, press Yes to send the data. The data is transferred.

Receiving ASCII Data from an External Device

To receive ASCII data from an external device:

1. Select *Files*/*Import*/*Export* / *Receive ASCII data*. Figure 9.7 shows the screen that appears.

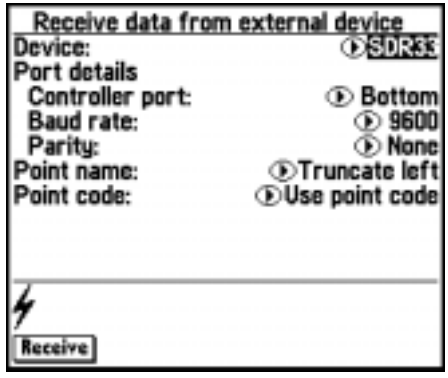


Figure 9.7 Receive ASCII Data screen

2. Use the *File format* field to specify the device that you want to receive data from.

3. If the *File format* field is set to Generic (CSV), Trimble DC v3, or SDR33 DC, the *Receive from* field appears. Set the field to PC card or External device depending on where you want the file to be sent. If you choose PC card, the *Port details* fields disappear.

   Note – *The PC card option only appears if you have a PC card inserted.*

4. Set the *Port details*/*Controller port* field to Top or Bottom depending on which TSC1 port is to be used for the transfer.

5. Set the *Baud rate* and *Parity* fields to match the corresponding parameters on the device that the Trimble Survey Controller software is communicating with.

   Note – *If the File format field is set to Generic (CSV), set the baud rate correctly on the external device. If appropriate, set the flow control (xon/xoff) as well.*

   If you are transferring a .dc file, the *Checksum* field appears. Set it to On if you want the Trimble Survey Controller software to validate the checksum when the file is transferred.

   You have no control over the file format when transferring the following formats: Geodimeter (Area), SDR33, TDS, Topcon (GTS-7), Topcon (FC-5), Zeiss (R5), Zeiss (Rec E/M5), or Zeiss (Rec500).

   The fields used for receiving from these devices are described below.

Warning – When receiving data from a device that does not include a units setting as part of its file, make sure that the Trimble Survey Controller software file uses the units setting of that device.
If you are not sure whether the device file includes a units setting, set the Trimble Survey Controller software file to the same units as the device.

The *Point name* field has four possible settings depending on the file format you are using:

– Unchanged—uses the point names in the data that is being received.

– Truncate left—shortens point names to 16 characters, starting from the left.

– Truncate right—shortens point names to 16 characters, starting from the right.

Trimble Survey Controller software point names have a maximum of sixteen characters, but some points received from other devices can exceed this. If point names have 16 characters or more, choose either Truncate left or Truncate right—the names are not affected.

– Auto-generate causes two extra fields to appear:

Use *Start point name* to specify a name for the first point received.

Use *Auto point step size* to define the increment or decrement value applied to the Start point value to generate point names for subsequently transferred points.

Use the *Point code* field to specify the data that is used in the *Code* field for a point when it is transferred to the Trimble Survey Controller software:

– Select Use point code to use the point code provided in the data being transferred.

– Select Use point name to use the point name provided in the data being transferred.

6. The setting in the *File Format* field (see Step 2) determines what you do next.

– If the *File format* field is set to Generic (CSV), for example, you can specify the format of the data that is received. Five fields appear: *Point name, Point code, Northing, Easting,* and *Elevation.*

Using the options provided, select a position for each field. Select the Unused option if a particular value is not present in the file being received. If you set the fields as follows, for example:

Point name	Field 1
Point code	Unused
Northing	Field 2
Easting	Field 3
Elevation	Field 4

the Trimble Survey Controller software inputs a file containing data in the format: Point name, Northing, Easting, Elevation.

– If the *File format* field is set to Trimble DC v3 or SDR33 DC and you have a PC card inserted, the *New job location* field appears. Select PC card or Main memory.

7. When the format details are complete, press **Receive**.

   If you are transferring points (not a .dc file), the *Select job to receive into* list appears. Select the job that the data is to be stored in.

8. The Trimble Survey Controller software prompts you to initiate sending on the external device. For more information about sending data, refer to the manual for the sending device.

   When sending is initiated, the Trimble Survey Controller software starts to receive data and a progress bar appears.

   When the transfer is complete, the Trimble Survey Controller software automatically terminates the operation and saves the received data.

   If it is clear that the transfer is complete but the operation has not been terminated, press Esc.

The following message appears:

Transmission interrupted. What would you like to do now?

Do one of the following:

– Press Continue to return the Trimble Survey Controller software to receive mode.

– Press Finish to terminate the operation and save any received data to the current job.

– Press Abort to terminate the operation and discard any received data.

Transferring Data to and from a Leica Instrument Using the PC Card

You can transfer data between the Trimble Survey Controller software and Leica instruments that use PC cards (the Leica TC 1100, for example). The PC card must be a Type I or Type II ATA format PC card.

Transferring data to a Leica instrument using the PC card

To transfer data to a Leica instrument, do the following:

1. Create a CSV file on the PC card. For information about how to do this, see Transferring ASCII Data to and from the PC Card, page 163. This file is stored in the root directory on the PC card.
2. Remove the PC card from the TSC1 and insert it into the Leica instrument.
3. From the main menu on the Leica instrument, select *Data conversion*.
4. Press the CONF softkey and configure the output file settings. Use the same settings as in the Trimble Survey Controller software.

Note – *Set the Search extens. field to CSV. If you do not, the CSV files will not be available for selection in the Source File field.*
Also, set the Separator field to Comma.

Press OK.

5. Set *Source Path* to A:\.
6. In the *Source File* field, select the CSV file on the PC card.
7. Set the *Output Path* to A:\GSI. For the Leica instrument to read the file it must be in the GSI directory.
8. Key in the output file name. (Make sure that the file extension is GSI,)
9. Set the *Format* to GSI 16.
10. Press the *Go* softkey.

The CSV file is then converted to a GSI file and stored in the GSI directory on the PC card.

Transferring data from a Leica instrument using the PC card

To transfer data from a Leica instrument do the following:

1. Check that the Leica instrument has a PC card inserted.
2. From the main menu on the Leica instrument, select *Data conversion*.
3. Press the CONF softkey and configure the output file format. Use the same settings as in the Trimble Survey Controller software.

   Note – *Set the Search extens. field to GSI. If you do not, the GSI files will not be available for selection in the Source File field.*
   Also, set the Separator field to Comma.

4. Press OK.
5. Set *Source Path* to A:\GSI

6. In the *Source File* field select the job to export coordinates from.
7. Set the *Output Path* field to A:\ . The Trimble Survey Controller software only reads CSV files that are in the root directory.
8. Key in the output file name. Make sure that it has the extension CSV.
9. Set the *Format* field to ASCII.
10. Press the GO softkey (F1).

    The GSI file is converted to a ASCII CSV file and is stored in the root directory on the PC card.

    Note – *The Leica instrument does not transfer point codes when it converts a GSI file to an ASCII file.*
11. Remove the PC card from the Leica instrument and insert it into the TSC1.
12. Transfer the coordinates into a job on the Trimble Survey Controller software. For information about how to do this, see To transfer a file from the PC card, page 166.

APPENDIX

A

Serial Number Form

Introduction

This appendix provides a serial number form that you can use to record the part numbers, serial numbers, and version numbers of equipment used with the Trimble Survey Controller software.

Use Table A.1 to record these details.

Table A.1 Equipment Details

	Type	Part number	Serial number	Software version	Firmware version
Receiver					
Antenna (optional)					
TSC1					

Tip – There is a copy of this form in the *Trimble Survey Controller Field Guide*. Store one of them in a safe place. You will need it if the equipment is ever lost, stolen, or damaged.

APPENDIX

B

Alternate Keys

In this chapter:

- Introduction
- Controlling the backlight
- Navigating the screen
- Creating symbols
- Operating the in-field calculator

Introduction

This appendix provides a list of key combinations that simplify control of the TSC1 data collector.

Press the Fn key and then press an alternate key (see page 35) to access the second function associated with the alternate key.

Use second function keys to:

- control the backlight (see Table B.1)
- navigate the TSC1 screen (see Table B.2)
- create special symbols (see Table B.3)
- use the in-field calculator (see Table B.4)

Controlling the Backlight

Table B.1 shows the second function keys used to control the backlight.

Table B.1 Controlling the backlight

Function	Keys
Toggle the backlight on/off	Fn L
Increase the screen contrast	Fn E
Decrease the screen contrast	Fn F

Navigating the Screen

Table B.2 shows the second function keys used to navigate the TSC1 screen.

Table B.2 Navigating the screen

Function	Keys
Insert characters	Fn Sp
Delete characters	Fn Bksp
Page up	Fn ▲
Page down	Fn ▼
Home	Fn ◄
End	Fn ►
Go to previous ...	Fn Next

Creating Symbols

Table B.3 shows the second function keys used to create symbols on the TSC1 screen.

Table B.3 Creating symbols

Symbol	Keys
-	Fn A
+	Fn B
*	Fn C
/	Fn D
?	Fn G
(	Fn H
)	Fn I
,	Fn J

Symbol	Keys
:	Fn P
=	Fn Q
\	Fn R
"	Fn S
[	Fn T
;	Fn V
@	Fn W
#	Fn X

Table B.3 Creating symbols (Continued)

Symbol	Keys	Symbol	Keys
%	Fn K	&	Fn Y
<	Fn N	!	Fn Z
>	Fn O		

Operating the In-Field Calculator

Table B.4 shows the second function keys used to operate the in-field calculator.

Table B.4 Using the in-field calculator

Function	Keys	Function	Keys
=	Fn Q	)	Fn I
-	Fn A	“	Fn S
+	Fn B		Fn 6
*	Fn C		Fn 7
/	Fn D		Fn 8
(	Fn H		Fn 9

APPENDIX

C

Calculations and Search Rules

In this chapter:

- Introduction
- Transforming between coordinate systems
- Geoid model
- Trimble Survey Controller software measurement precision
- Area calculations
- Ellipsoid calculations
- Conventional instrument calculations
- The Trimble Survey Controller software database
- Database search rules

Introduction

This appendix outlines some of the calculations performed by the Trimble Survey Controller software, and discusses the database search rules that are used.

For more information on the concepts associated with Trimble Survey Controller software calculations, see Chapter 5, Coordinate Systems.

Transforming Between Coordinate Systems

Coordinate transformation provides parameters so that one set of coordinates can be represented in terms of another.

Figure 5.1 on page 78 shows a typical route for the conversion of measurements to grid coordinates using the Trimble Survey Controller software.

This section provides an overview of the management and application of coordinate transformations using the Trimble Survey Controller software. It describes how to apply a datum transformation and map projection, and horizontal and vertical adjustments. It also describes the plane projection.

With the Trimble Survey Controller software, an ***infield*** calibration process defines transformation parameters derived from a set of points. This set of points is coordinated in terms of two systems:

- WGS-84 Latitude, Longitude, Height (LLH) geodetic coordinates
- a local system with project-specific Northing, Easting, Elevation (NEE) grid coordinates

The Trimble Survey Controller software accepts measured WGS-84 Cartesian coordinates and converts them to a local planar grid system. Alternatively, key in local planar grid coordinates or upload them from an office product. The Trimble Survey Controller software converts these to WGS-84 Cartesian coordinates for stakeout purposes.

For more information on the creation of a user-defined plane projection, see page 192. For more information on Geoid models, see page 197.

Transforming WGS-84 ECEF to WGS-84 LLH

When GPS signals are processed by a receiver, they yield Earth-Centered-Earth-Fixed (*X, Y, Z*) coordinates. It is then necessary to transform these coordinates to more meaningful geodetic coordinates (ϕ , λ , *H*).

Here ϕ represents the geodetic latitude, λ is the longitude, and *H* is the perpendicular height above the WGS-84 ellipsoid.

First we define:

$$e^2 = 2f - f^2 \quad (1)$$

$$N = \frac{r}{\sqrt{1 - e^2 \sin^2(\phi)}} \quad (2)$$

where *f* is the flattening value for the source ellipse and *r* is the semi-major axis.

The values of the ECEF coordinates are:

$$X = (N + H).\cos(\phi).\cos(\lambda) \quad (3)$$

$$Y = (N + H).\cos(\phi).\sin(\lambda) \quad (4)$$

$$Z = [N(1 - e^2) + H].\sin(\phi) \quad (5)$$

The inverse problem (that of transforming ECEF coordinates to ϕ , λ , and *H*) is solved by using an iterative procedure. The values of e^2 and *N* now use the destination ellipsoid flattening and semi-major axis values:

$$\phi = \tan^{-1}\left(\frac{Z}{\sqrt{X^2 + Y^2}}(1 - e^2)\right) \quad (6)$$

then iterate

$$\phi = \tan^{-1}\left(\frac{Z + e^2 N \sin(\phi)}{\sqrt{X^2 + Y^2}}\right) \quad (7)$$

$$\lambda = \tan^{-1}\left(\frac{Y}{X}\right) \quad (8)$$

if 45°S < ϕ < 45°N

$$H = \frac{\sqrt{X^2 - Y^2}}{\cos(\phi)} - N \quad (9)$$

or if ϕ > 45°N or ϕ < 45°S

$$H = \frac{Z}{\sin(\phi)} - N(1 + e^2) \quad (10)$$

Datum Transformation

A datum transformation provides the necessary parameters for converting from one geodetic coordinate system to another.

The Trimble Survey Controller software can apply a predefined three- or seven-parameter datum transformation. It can also calculate a three-parameter datum transformation given points coordinated in WGS-84 and local L'L'H'.

$$X = T + kRX' \quad (11)$$

where X' is a matrix of 3-D Cartesian ECEF coordinates or Cartesian local coordinates, T is a matrix of translation parameters, k is a scalar, and R is a rotation matrix. In most cases, X' is measured and T, k, and R are user-specified.

To calculate a three-parameter datum transformation, pairs of WGS-84 LLH and local L'L'H' coordinates are needed.

In the trivial one point case, the three translation parameters are just the vector components of the ECEF vector that connect the ECEF pair derived from the WGS-84 LLH and the local L'L'H'.

In the non-trivial case, the translation parameters are the vector components of the average vector. This is represented as:

$$AX + W = 0 \tag{12}$$

where the solution

$$X = \begin{bmatrix} \Delta X \\ \Delta Y \\ \Delta Z \end{bmatrix} \tag{13}$$

and

$$W = \begin{bmatrix} X_1 - X'_1 \\ Y_1 - Y'_1 \\ Z_1 - Z'_1 \\ X_2 - X'_2 \\ Y_2 - Y'_2 \\ Z_2 - Z'_2 \\ \vdots \end{bmatrix} \tag{14}$$

where X_n is the value of the ECEF coordinate derived from the local L'L'H' of the *n*th 3-D point in the list, and X'_n is the X value of the ECEF coordinate derived from the WGS-84 LLH of the *n*th 3-D point and

$$A = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \\ 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \\ \vdots & & \end{bmatrix} \tag{15}$$

is called the Molodensky matrix.

For more information, refer to *GPS Satellite Surveying* by A. Leick (John Wiley & Sons, 1995).

Map Projection

A map projection defines the relationship between the local ellipsoidal surface (L'L'H') and a plane. Generally, map projection parameters are based on a local conformal mapping model.

For more information about map projections, please refer to *Map Projections—A Working Manual* by J.P. Snyder (U.S. Geological Survey Professional Paper 1295, U.S. Government Printing Office, Washington, 1987).

For nearly all projection types used in the Trimble Survey Controller software, the height component of a projected coordinate is just the height above or below the datum at that point. For a plane projection, however, the definition includes an ellipsoidal height and a projected surface elevation at the origin point.

Plane projection

In the Trimble Survey Controller software, the definition of a plane projection consists of the following parameters:

- Origin point Latitude, Longitude, and Height
- Origin point Northing, Easting, and Elevation
- Scale factor
- Rotation
- Projection ellipsoid radius
- Projection ellipsoid flattening

Before the transformation from ellipsoidal coordinates to plane coordinates starts, the ellipsoidal height at the origin point is substituted for the point's height. The conversion of the ellipsoid coordinates into ECEF coordinates can then take place.

The origin point is also coordinated in terms of the ECEF reference frame, so an ECEF vector can be computed between the origin point and the point in question. A projection scale and rotation relative to the origin point are applied to the dX,dY,dZ vector. This results in transformed dX',dY',dZ' values. This new vector is added to the NEE of the origin point. The elevation of the resultant NEE is adjusted by the residual between the point's LLH height and the origin's LLH height.

Note – *When the Trimble Survey Controller software uses a geoid model based on the WGS-84 ellipsoid, it does not use the local height to grid elevation separation value that is defined in some projections.*

Horizontal Adjustment

It may be necessary to minimize the discrepancy between local fixed control coordinates ($NE_{control}$) and projected grid coordinates (N'E'). The horizontal adjustment solves parameter translations in north and east (ΔN, ΔE), a rotation ϕ, and a scale factor k using two different sets of plane coordinates—one converted from measurements in the field, and the other from a control list. Where the Trimble Survey Controller software generates its own three-parameter datum transformation, it is necessary to provide for scaling and rotation. This is done by a horizontal adjustment.

Figure C.1 shows the transformation between two coordinate systems.

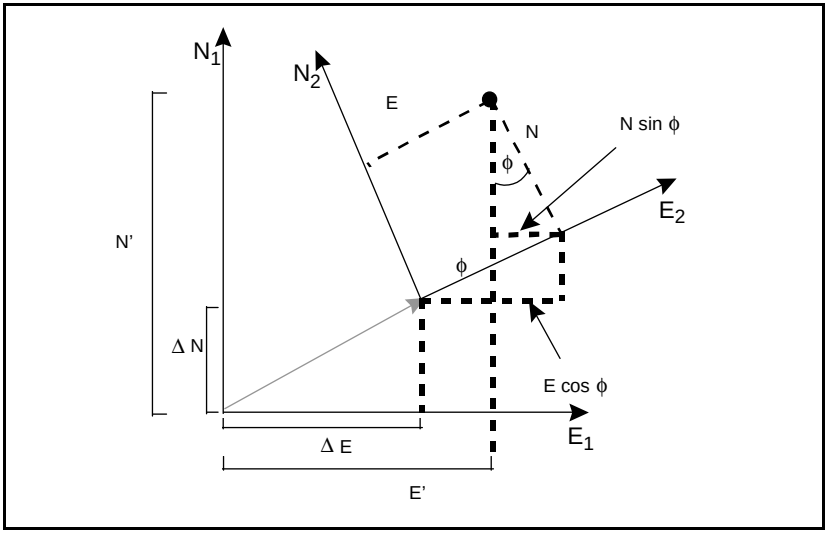


Figure C.1 Coordinate systems for a horizontal adjustment

The Trimble Survey Controller software minimizes the discrepancy between local NE control and NE values derived using GPS observations and a datum transformation and map projection. It does this by performing a plane horizontal least-squares adjustment with no weighting.

In the trivial one point case, the translation parameters are just the Northing and Easting components of the vector between the two coordinated values. The scale factor is one, and the rotation value is zero.

For two or more points, calculation of horizontal adjustment uses a simple four-parameter transformation. This solves for two translations (ΔN, ΔE), a rotation (ϕ), and a scale factor (k) between coordinate pairs.

The geometry between the two coordinate systems results in two transformation equations:

$$N' = aN + bE + \Delta N \qquad (16)$$

$$E' = -bN + aE + \Delta E \quad (17)$$

where $a = k \cos \phi$ and $b = k \sin \phi$ are used to simplify the matrix representation, and ΔN and ΔE represent the shifts of the N and E axis in the N' and E' system.

Common points in both coordinate systems are used in a least-squares adjustment to solve the four unknown parameters (a, b, ΔE, and ΔN).

Once estimates of a and b are determined, the rotation and scale between the two systems is calculated by:

$$\phi = \tan^{-1}\left(\frac{a}{b}\right) \text{ and } k = \sqrt{a^2 + b^2} \quad (18)$$

For more information about horizontal adjustment, please refer to *Observations and Least Squares* by E. Mikhail (John Wiley & Sons, 1982).

Vertical Adjustment

The Trimble Survey Controller software determines a vertical adjustment using least-squares with no weighting. This adjustment requires measured WGS-84 heights and control elevations.

In the trivial one-point case, the adjustment consists of a constant height shift only. For two or more points, a tilt in north and east are also computed.

The inclined plane parameters are determined by solving the matrix equation:

$$AX = B \quad (19)$$

where the solution

$$X = \begin{bmatrix} \Delta H \\ \Delta E \\ \Delta N \end{bmatrix} \quad (20)$$

the components being the constant height shift and tilt east and north (in terms of a height shift per unit distance east or north), and the design matrix

$$A = \begin{bmatrix} 1 & E_1 - E_1 & N_1 - N_1 \\ 1 & E_2 - E_1 & N_2 - N_1 \\ & \vdots & \\ 1 & E_n - E_1 & N_n - N_1 \end{bmatrix} \quad (21)$$

where $E_n\ N_n$ are the coordinates of the *n*th point as derived from the WGS-84 data set.

$E_1\ N_1$ are the coordinates of the origin point of the adjustment. (The origin point can be any one of the *n* points.)

$$B = \begin{bmatrix} H'_1 - H_1 \\ H'_2 - H_2 \\ \vdots \\ H'_n - H_n \end{bmatrix} \quad (22)$$

where $H'_n - H_n$ is the difference in elevation between the keyed in value for the *n*th point and the value derived from the WGS-84 data set.

Projection Scale Factor

In the Trimble Survey Controller software, you can define a *Reference elevation* when you are creating a no projection/no datum job. The reference elevation is used after you perform a site calibration to compute a scale factor for the projection, so that ground coordinates are computed at elevation.

The projection scale factor is calculated as follows:

$$SF = \frac{R + h}{R}$$

and

$$R = \frac{a}{\sqrt{1 - e^2 \sin^2(\phi)}}$$

where:

SF = scale factor of projection

R = ellipsoidal radius

h = average elevation (reference elevation)

a = semimajor axis

e^2 = eccentricity^2

ϕ = origin latitude of projection

Geoid Model

The Trimble Survey Controller software can use a geoid model to provide orthometric heights from measured (by GPS) WGS-84 heights.

Geoid model is one of the options in the *Vertical adjustment* field. (The other options in this field are No adjustment, Inclined plane, Geoid model/Inclined plane.) For information on how to select a Geoid model, see Using a Geoid Model, page 81.

In-Field Calibration

If you select Geoid model and you do not perform an in-field calibration, the elevation values displayed by the Trimble Survey Controller software represent the unadjusted elevation above the defined geoid using the relationship:

$$h_{geoid} = H - N \qquad (23)$$

where:

h_{geoid} = the unadjusted elevation above the geoid

H = the measured GPS height above the ellipsoid

N = the geoid ellipsoidal separation, derived from a geoid model

If you select Geoid model and perform an in-field calibration, the Trimble Survey Controller software computes the calibration parameters using $h_{control}$ and h_{geoid} as inputs, so that the geoid model is inclined to fit the local control elevations. The method of vertical adjustment becomes Geoid/Inclined plane.

Trimble Survey Controller Software Measurement Precision

Precision values are not displayed for autonomous GPS positions (points that will be postprocessed).

For real-time kinematic and differential surveys, the precision values displayed reflect the GPS instrument precisions. These are similar to the day-to-day repeatability of survey observations except they do not take into account multipath, other environmental noise, and incorrect reference station coordinates.

The precision values are determined from the following:

$$\text{horizontal precision} = \text{HDOP} * \text{RMS} * 3.0 \quad (24)$$

$$\text{vertical precision} = \text{VDOP} * \text{RMS} * 3.0 \quad (25)$$

where HDOP and VDOP are the horizontal and vertical dilution of precision respectively. RMS (Root Mean Square) is the solution RMS for the L1 phase observation in meters, and is the radius of the error ellipse within which approximately 70% of position fixes will be found. The precision values are scaled to ~ 99% confidence level by multiplying by a factor of three.

Both float and fixed solutions use the same formula. The loss of precision indicated in float solutions is due to an increase in the RMS value where the integer ambiguities are not fixed. Real-time precision statistics cannot be displayed while a receiver is roving (moving), if there are less than five satellites being tracked.

Area Calculations

When we calculate the area in *Cogo* / *Compute area*, it is calculated at the average elevation of all the points when the *Distances* field is set to Ground. Average elevation is calculated as follows:

calculate

$$\bar{h} = \frac{\sum h_i}{N} \qquad (26)$$

then

$$\left(\frac{\bar{h} + R}{R}\right)^2 \text{ X area at sea level} \qquad (27)$$

where:

N = number of stations

$\bar{h}$ = average elevation

R = ellipsoidal radius

Ellipsoid Calculations

The ground and ellipsoid distances in the Trimble Survey Controller software are calculated parallel to the ellipsoid. The equations used for these calculations are based on the Robbins ellipsoid geometry formulas. These formulas (by Dr A.R. Robbins) are in the *Empire Survey Review* No. 125, 1962. They are accurate to better than 20 mm over distances of 1,500 km. The errors can reach 16 meters at 4,500 km and more than 2,000 meters at 9,000 km.

Conventional Instrument Calculations

Figure C.2 shows the position of the corrections applied when you use the Trimble Survey Controller software with a conventional instrument.

Note – *Interim corrections are not shown in the figure. They are enclosed in square brackets in the text that follows.*

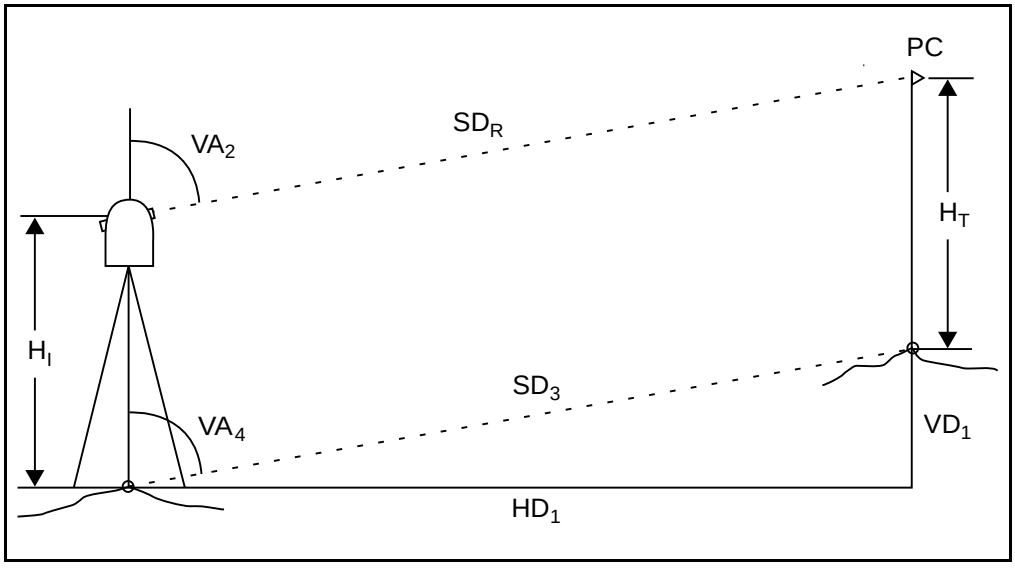


Figure C.2 Correction variables used in conventional instrument calculations

Where:

VA_2 = Vertical angle from conventional instrument

Note – *The Trimble Survey Controller software assumes that the conventional instrument applies any corrections for collimation and tilt. [VA_1 is the vertical angle before these corrections are applied.]*

[VA_3 = Vertical angle corrected for curvature and refraction]
VA_4 = Vertical angle corrected for curvature and refraction, instrument and target heights
SD_R = Slope distance from EDM
[SD_1 = Slope distance corrected for prism constant (PC)]
[SD_2 = Slope distance corrected for prism constant and PPM]
SD_3 = Slope distance corrected for prism constant, PPM, instrument and target heights

HD_1 = Horizontal distance between instrument point and target point

VD_1 = Vertical distance between instrument point and target point

H_I = Height of instrument

H_T = Height of target

PC = Prism constant

Prism Constant Correction

The prism constant is applied to all slope distances. It is usually negative, but can be positive.

$$SD_1 = SD_R + PC \quad (28)$$

where:

SD_R= measured (raw) slope distance

SD_1= resultant slope distance

PC= prism constant

PPM Correction

The parts per million (PPM) correction is applied to the slope distance after being corrected for the prism constant (see above). PPM depends on pressure and temperature.

$$D_2(P, T) = SD_1\left[J - \frac{N \cdot P}{273.16 + T}\right] \cdot 10^{-6} \quad (29)$$

where:

P= air pressure in millibars

T= temperature in °C

J and N= constants supplied by the EDM manufacturer

Table C.1 lists some manufacturers of conventional instruments, and the J and N constants that the Trimble Survey Controller software uses to compute the PPM correction for those instruments.

Table C.1 PPM Constants for Conventional Instruments

Manufacturer of conventional instruments	J constant	N constant
Trimble	270.0	79.2000
Sokkia SET	279.0	79.4000
Topcon	279.7	79.6000
Geotronics	275.0	79.5500
Leica	282.0	79.4000
Zeiss	255.0	79.1000
Pentax	279.0	79.4000
Nikon	275.0	79.5065

Note – *The J constant value is the refractive index of the instrument. The N constant value is for use with pressure measurements in millibars. In the .dc file it is converted to a value that can be used with pressure measurements in mmHg.*

Curvature and Refraction Correction

The curvature and refraction correction is applied to vertical angles according to the coefficient of refraction that you set.

$$VA_3 = VA_2 - \left[\frac{(1-k)SD_3}{2R}\right] \cdot \frac{180}{\pi} \qquad (30)$$

where:

k = coefficient of terrestrial refraction, selected in the *Corrections* field in the Survey Style

R = approximate spheroid radius = 6378137.298 (WGS-84 semi-major axis)

SD_3 = slope distance, from Equation (32)

VA_2 = vertical angle, from instrument

VA_3 = corrected vertical angle

Instrument and Target Height Reduction

The corrected vertical angle (VA_4) from the instrument to the target is:

$$VA_4 = \tan^{-1}\left[\frac{SD_2 \sin VA_3}{SD_2 \cos VA_3 + H_I - H_T}\right] \quad (31)$$

where:

H_I = instrument height

H_T = target height

SD_2 = slope distance

VA_3 = vertical angle, from Equation (30).

VA_4 = corrected vertical angle

The slope distance from source point to target point (SD_3) is given by the following:

$$SD_3 = \frac{SD_2 \sin VA_3}{\sin VA_4} \quad (32)$$

Face 1/Face 2 Determination

This section describes how the Trimble Survey Controller software reduces Face 2 readings to Face 1 readings in order to perform calculations. It does this automatically.

The observed raw vertical angle is used to determine whether an observation is Face 1 or Face 2:

- If the vertical angle is not present the observation is assumed to be Face 1.
- If the vertical angle is in the range 0° to 180°, the observation is Face 1.
- If the vertical angle is in the range 180°–360°, the observation is Face 2.

Orientation Correction

To orient circle readings so that they become azimuths, an orientation correction is applied. The orientation correction is the difference between the backsight circle reading and the backsight azimuth. This term is applied to all the other observations (circle readings) at a station.

The formula is:

$$Az_{\chi} = HA_{\chi} + (Az_B - HA_B) \quad (33)$$

where:

Az_x = azimuth to any point X

HA_x = observed bearing to any point X

Az_B = actual backsight azimuth (‘reference azimuth’)

HA_B = observed backsight circle reading

Slope Reduction

The horizontal and vertical components of an observation (HD_1 and VD_1) are found from the vertical angle and slope distances by:

$$HD_1 = SD_3 \sin VA_4 \quad (34)$$

$$VD_1 = SD_3 \cos VA_4 \quad (35)$$

where:

HD_1 = horizontal distance

VD_1 = vertical distance

VA_4 = zenith angle

SD_3 = slope distance

Coordinate Calculation

Coordinates of a target point are calculated from observations and the coordinates of the instrument point using:

$$N_2 = N_1 + HD_1 \cos Az_1 \quad (36)$$

$$E_2 = E_1 + HD_1 \sin Az_1 \quad (37)$$

$$Z_2 = Z_1 + VD_1 \quad (38)$$

where:

N_1, E_1, Z_1 = Northing, Easting, Elevation of instrument point

N_2, E_2, Z_2 = Northing, Easting, Elevation of target point

HD_1 = horizontal distance

VD_1 = vertical distance

Az_1 = from Equation (33)

Mean Turned Angle Calculations

When the software calculates the mean turned angle and the mean distance for a point, it also calculates standard errors as follows:

For the angles, the standard error of the mean of a set of measurements formula is used:

$$\sigma = \sqrt{\frac{\Sigma v^2}{n(n-1)}}$$

For distances, the standard error of the set of measurements formula is used:

$$\sigma = \sqrt{\frac{\Sigma v^2}{(n-1)}}$$

Resection Calculation

The resection calculation is a least-squares calculation that uses all available data.

Observations to the same point taken on different faces are treated as separate observations. However, the results are the same as those gained from using meaned (averaged) observations.

The residuals are given for each ***point***, not each observation.

The formula used for the standard errors is as follows:

$$\sigma = \frac{(\sqrt{\Sigma v^2})}{(n-1)}$$

Traverse Calculation

This section shows the formulae that the software uses when it calculates a traverse.

Compass adjustment

The Compass adjustment distributes the error in proportion to the length of the traverse lines. The formulae are as follows:

$$\text{Northing adjustment} = \frac{D}{\Sigma D} \times \text{Northing misclosure}$$

where:

D = horizontal distance

ΣD = sum of the horizontal distances in the traverse

$$\text{Easting adjustment} = \frac{D}{\Sigma D} \times \text{Easting misclosure}$$

where:

D = horizontal distance

ΣD = sum of the horizontal distances in the traverse

Transit adjustment

The Transit adjustment distributes the error in proportion to the northing and easting of each traverse point.

$$\text{Northing adjustment} = \frac{\Delta N}{\Sigma \Delta N} \times \text{Northing misclosure}$$

where:

ΔN = change in northing for the traverse line

$\Sigma \Delta N$ = sum of the changes in northings of all the traverse lines

$$\text{Easting adjustment} = \frac{\Delta E}{\Sigma \Delta E} \text{ x Easting misclosure}$$

where:

ΔE = change in easting for the traverse line

$\Sigma \Delta E$ = sum of the changes in eastings of all the traverse lines

Angular adjustments

There are three options for distributing the angular error in a traverse:

- Proportional to distance–the error is distributed among the angles based on the sum of the inverses of the forward and back traverse distances for each point. The formula used is as follows:

$$\text{angular adjustment} = \frac{\frac{1}{to\ dist} + \frac{1}{from\ dist}}{\sum\left(\frac{1}{to\ dist} + \frac{1}{from\ dist}\right)} \times \text{ angular misclosure}$$

- Equal proportions—the error is distributed evenly among the angles in the traverse.
- None—the error is not distributed.

Elevation adjustments

There are three options for distributing the elevation error in a traverse:

- Proportional to distance—the error is distributed in proportion to the length of the traverse line to the point.
- Equal proportions—the error is distributed evenly among the traverse lines.
- None—the error is not distributed.

The Trimble Survey Controller Software Database

The Trimble Survey Controller software includes a dynamic database. This stores networks of connected vectors during RTK and conventional surveys, making the positions of some points dependent on the positions of others. If you change the coordinates of a point that has dependent vectors (an instrument station, a backsight point, or a GPS base station, for example), this affects the coordinates of all points that depend on it.

You can change the coordinates of a point. To do this:

- Measure another point with the same name as the existing point and select Overwrite when you get the *duplicate point, out of tolerance* warning.
- Key in another point with the same name as the existing point and select Overwrite when you get the *duplicate point, out of tolerance* warning.

Note – *The duplicate point, out of tolerance warning only appears if the new point is out of tolerance with the original point. By default, this message always appears but if you have changed the tolerance values it may not. For more information, see Duplicate Point Actions, page 140.*

The Trimble Survey Controller software uses database search rules to resolve the coordinates of dependent points based on the new coordinates for a point they depend on. If the coordinates of a point with dependent points moves by a certain amount, the dependent points are shifted by the same amount.

If a point name already exists in the database, the Trimble Survey Controller software always issues a *duplicate point, out of tolerance* warning message when you try to store a point with the same name that is outside the duplicate point tolerance. The exception to this is when you store a Face 2 observation to a point that already has a Face 1 observation—in this case the Face 2 observation is checked to see if it is within tolerance of the Face 1 observation and then stored. For more information about Face 1 and Face 2 observations, see Measuring a Point in Two Faces, page 487.

Warning – When you get the duplicate point warning, you could be about to overwrite a point that has dependent vectors. The coordinates of the dependent vectors could change.

Database Search Rules

This section explains the database search rules relevant to the Trimble Survey Controller software database.

The Trimble Survey Controller software lets multiple points with the same point name (point ID) exist in the same job:

- If you measure or key in a point with a name that already exists in the database, you can choose to ***overwrite*** when you store the new one. All previous points of the same name, with the same or a lower search class, are deleted.

  Note – *Deleted points remain in the database and have a search class of Deleted. For more information, see Search Class, page 212.*

- If you measure or key in a point with a name that already exists in the database, you can choose to ***store another*** point. Both points are stored in the database, and both are downloaded with the job. The Trimble Survey Controller software search rules ensure that the point with the highest class is used for calculations. If there are two points of the same class, the ***first*** is used.

To distinguish between points of the same name and to decide how these points are to be used, the Trimble Survey Controller software applies a set of search rules. When you ask for the coordinates of a point in order to perform a function or calculation, these search rules sort the database according to:

- the order in which the point records were written to the database
- the classification (search class) given to each point

Order in the Database

A database search starts at the beginning of the job database and works down to the end of the job, looking for a point of the name specified.

The Trimble Survey Controller software finds the first occurrence of a point of that name. It then searches the rest of the database for points of the same name.

Note – *The database search has changed for version 7.50 of the Trimble Survey Controller software. Previously the software searched from the end of the job database and worked up.*

The rules generally followed by the software are:

- If two or more points have the same class as well as the same name, it uses the first point.
- If two or more points have the same name but different classes, it uses the point of higher class, even if this is not the first occurrence of the point.

Search Class

The Trimble Survey Controller software gives most points a classification. It uses this classification to determine the relative importance of points stored in the job database.

Note – *Matched pair and mean turned angle records do not have a classification because they are exceptions to the search rules. For more information, see Exceptions to the search rules, page 215.*

The classes are arranged in a descending hierarchy, as follows:

- Control – (the highest class) can only be set when a point is keyed in or uploaded. This classification is also given to points that are adjusted in a traverse computation.
- Normal – is given to all measured points apart from staked points. Uploaded points can also be given this class.
- As-staked – is given to points measured during stakeout.

- Backsight – is given to observations made to the backsight point during a station setup and to observations made during a resection.
- Check – is given to a conventional check point observation, or a GPS point measured with a duplicate name and stored as a Check class point. For more information, see Duplicate Point Actions, page 140.
- Deleted – is given to points that have been overwritten, where the original point had the same (or a lower) search class than the new point. It is also given to points/lines/curves and roads that were deleted manually in the job database.

  Deleted points are not displayed in point lists and they are not used in calculations. They do, however, remain in the database.

Note – *You cannot overwrite a Control class point with a measured point.*

Control class is used in preference to Normal, As-staked, Backsight, or Check class. It can only be set by you. Use Control class for points that you want to use in preference to points of the same name in the same job database. For more information, see Assigning Control class to a point, page 214.

Normal class is used in preference to As-staked, Backsight, or Check class, and As-staked class is used in preference to Backsight or Check class.

If points have the same class as well as the same name, the first point in the database is used.

Example

If the Point 1000 is entered as the start point when calculating a From a baseline offset, the Trimble Survey Controller software looks for the first occurrence of Point 1000. It then searches the rest of the database looking for any point named 1000:

- If no other point of this name is found, it uses the one it has to calculate the offset.
- If another Point 1000 is found, the software compares the classes of the two points. It uses the Point 1000 that has the highest classification.

  For example, if both points were keyed in and one was given a Normal classification, the other a Control classification, the Trimble Survey Controller software uses the Control class point to calculate the offset—regardless of which record the search finds first.
- If the points are of the same class, the Trimble Survey Controller software uses the first one.

  For example, if both points named 1000 were keyed in and both were given a Normal classification, the first one is used.

Assigning Control class to a point

Control class is the highest classification that you can give to a point. Any high-accuracy point that you use as a fixed standard in a job can be a Control point.

If you set the search class to Control when you key in the coordinates for a point, you can be sure that those coordinates will not change until you key in another point of the same name and the same search class (control) and choose to overwrite the first point.

The Trimble Survey Controller software never elevates measured points to Control class. This is because measured points have measurement errors and may change or be measured again during the course of the job. If the keyed in point CONTROL29 is Control class, generally you would not want the coordinates of that point to change. A Control class point is held fixed for the job.

The Trimble Survey Controller software can measure control points—observed control points—but it does not give them Control classification. This is because, in calibration, the measured point often has the same name as the keyed in control point. This makes it easier to set up the calibration. It also makes it easier to manage your data if you know that all references to point CONTROL29 on the ground, for example, are also references to point CONTROL29 in the database.

Exceptions to the search rules

There are several cases when the usual search rules are not used. They are:

- In calibration—calibration searches for the highest class point stored as grid coordinates. This grid point is used as one of a pair of calibration points. The Trimble Survey Controller software then searches for the highest class GPS point stored as WGS-84 coordinates or as a WGS-84 vector. This point is used as the GPS part of the point pair.
- When starting an RTK rover—when you start a rover survey, if the broadcast base point is called BASE001, choosing *Start survey* causes the Trimble Survey Controller software to search for the highest class GPS (WGS-84) point of that name. If no GPS point exists with the name BASE001, but BASE001 exists with grid or local coordinates, the Trimble Survey Controller software converts the grid or local coordinates of the point into a GPS (WGS-84) point. It uses the projection, datum transformation, and current calibration to calculate the point. It is then stored, as BASE001, with WGS-84 coordinates and is given a Check class classification so that the original grid or local coordinates will still be used in calculations.

Note – *The WGS-84 coordinates of the base point in the Trimble Survey Controller software database are the coordinates from which GPS vectors are solved.*

If there is no base point in the database, the position broadcast by the base receiver is stored as a Normal class point and it is used as the base coordinates.

- When using mean turned angle records—mean turned angle records in the database are Normal class points and a Control class point is always used in preference. However, a mean turned angle record is always used in preference to any other Normal class, Face 1, or Face 2 point, or matched pair record. If there are two mean turned angle records of the same name in the database, the first one is used.

  Note – *Matched pair records are not used by the Trimble Survey Controller search rules. A mean turned angle record always exists when there is a matched pair record and is always used in preference.*

- In a conventional survey when the orientation is derived from a keyed in azimuth and is later updated by providing coordinates for the backsight—in a conventional survey the orientation for a station setup can be defined in the following ways when the coordinates for the backsight point are not known:

  – an azimuth can be keyed in

  – the azimuth can be left as null

  A keyed in azimuth is always used in preference to a computed azimuth. To force the Trimble Survey Controller to use a computed azimuth, edit the keyed in azimuth and set it to null.

- In a conventional survey with angles-only observations—in a conventional survey an Angles only point has a lower search class than any other point of the same class.

Glossary

This section explains some of the terms used in this manual.

almanac

Data, transmitted by a GPS satellite, that includes orbit information on all the satellites, clock correction, and atmospheric delay parameters. The almanac facilitates rapid SV acquisition. The orbit information is a subset of the ephemeris data with reduced precision.

Anti-Spoofing (AS)

A feature that allows the U.S. Department of Defense to transmit an encrypted Y-code in place of P-code. Y-code is intended to be useful only to authorized (primarily military) users. Anti-Spoofing is used with Selective Availability to deny the full precision of GPS to civilian users.

autonomous positioning

The least precise form of positioning that a GPS receiver can produce. The position fix is calculated by one receiver from satellite data alone.

base station

In a GPS survey, you observe and compute baselines (the position of one receiver relative to another). The base station acts as the position from which all unknown positions are derived.

A base station is an antenna and receiver set up on a known location specifically to collect data to be used in differentially correcting rover files. Trimble GPS Community Base Station and a receiver in base station mode are examples of base stations.

baud — A unit of data transfer speed (from one binary digital device to another) used in describing serial communications; generally one bit per second.

C/A code — See **Coarse Acquisition code**.

CMR — Compact Measurement Record. A satellite measurement message that is broadcast by the base receiver and used by RTK surveys to calculate an accurate baseline vector from the base to the rover.

Coarse Acquisition (C/A) code — A pseudorandom noise (PRN) code modulated onto an L1 signal. This code helps the receiver compute the distance from the satellite.

constellation — A specific set of satellites used in calculating positions: three satellites for 2D fixes, four satellites for 3D fixes.

All satellites visible to a GPS receiver at one time. The optimum constellation is the constellation with the lowest PDOP. See also **PDOP**.

data logging — The process of recording satellite data in a file stored in the receiver, the TSC1 memory, or on a PC card.

data message — A message, included in the GPS signal, that reports on the location and health of the satellites as well as any clock correction. It includes information about the health of other satellites as well as their approximate position.

datum — See **geodetic datum**.

Differential Positioning — Precise measurement of the relative position of two receivers tracking the same satellites simultaneously.

DOP

Dilution of Precision, an indicator of the quality of a GPS position. DOP takes into account the location of each satellite relative to other satellites in the constellation, as well as their geometry relative to the GPS receiver. A low DOP value indicates a higher probability of accuracy.

Standard DOPs for GPS applications are:

- PDOP – Position (three coordinates)
- RDOP – Relative (Position, averaged over time)
- HDOP – Horizontal (two horizontal coordinates)
- VDOP – Vertical (height only)
- TDOP – Time (clock offset only)

Doppler shift

The apparent change in frequency of a signal caused by the relative motion of satellites and the receiver.

DTM

Digital Terrain Model. An electronic representation of terrain in three dimensions.

dual-frequency

A type of receiver that uses both L1 and L2 signals from GPS satellites. A dual-frequency receiver can compute more precise position fixes over longer distances and under more adverse conditions because it compensates for ionospheric delays.

Earth-Centered-Earth-Fixed (ECEF)

A cartesian coordinate system used by the WGS-84 reference frame. In this coordinate system, the center of the system is at the earth's center of mass. The z axis is coincident with the mean rotational axis of the earth and the x axis passes through 0° N and 0° E. The y axis is perpendicular to the plane of the x and z axes.

elevation

Height above mean sea level. Vertical distance above the geoid.

elevation mask The angle below which Trimble recommends that you do not track satellites. Normally set to 13 degrees to avoid interference from buildings and trees as well as ground multipath errors.

ellipsoid A mathematical model of the earth formed by rotating an ellipse around its minor axis. For ellipsoids that model the earth, the minor axis is the polar axis and the major axis is the equatorial axis. An ellipsoid is completely defined by specifying the lengths of both axes, or by specifying the length of the major axis and the flattening.

ephemeris The current satellite position predictions, transmitted in the data message.

epoch The measurement interval of a GPS receiver. The epoch varies according to the survey type:

- for real-time surveys it is set at one second
- for postprocessed surveys it can be set to a rate of between one second and one minute

feature codes Simple descriptive words or abbreviations that describe the features of a point. For more information see Chapter 16, Using Feature and Attribute Libraries.

fixed solution Indicates that the integer ambiguities have been resolved and a survey is initialized. This is the most precise type of solution.

float solution Indicates that the integer ambiguities have not been resolved, and that the survey is not initialized.

GDOP Geometric Dilution of Precision. The relationship between errors in user position and time, and errors in satellite range. See also **DOP**.

geodetic datum A mathematical model designed to fit part or all of the geoid (the physical earth's surface). A geodetic datum is defined by the relationship between an ellipsoid and the center of the earth. It takes into account the size and shape of the ellipsoid, and the location of the center of the ellipsoid with respect to the center of the earth (a point on the topographic surface established as the origin of the datum).

Various datums have been established to suit particular regions. For example, European maps are often based upon the European datum of 1950 (ED-50). Maps of the United States are often based upon the North American Datum of 1927 or 1983 (NAD-27, NAD-83). All GPS coordinates are based upon the WGS-84 datum surface.

geoid The surface of gravitational equipotential that closely approximates mean sea level.

GPS Global Positioning System. Based on a constellation of 24 operational satellites orbiting the earth at a high altitude.

GPS time A measure of time used by the NAVSTAR GPS system. GPS time is based on UTC but does not add periodic 'leap seconds' to correct for changes in the earth's period of rotation.

HDOP Horizontal Dilution of Precision. See also **DOP**.

integer ambiguity The whole number of cycles in a carrier phase pseudorange between the GPS satellite and the GPS receiver.

ionosphere The band of charged particles 80 to 120 miles above the earth's surface. The ionosphere affects the accuracy of GPS measurements if you measure long baselines using single-frequency receivers.

L1 The primary L-band carrier used by GPS satellites to transmit satellite data. The frequency is 1575.42 MHz. It is modulated by C/A code, P-code, or Y-code, and a 50 bit/second navigation message.

L2 The secondary L-band carrier used by GPS satellites to transmit satellite data. The frequency is 1227.6 MHz. It is modulated by P-code or Y-code, and a 50 bit/second navigation message.

local ellipsoid The ellipsoid specified by a coordinate system. The WGS-84 coordinates are first transformed onto this ellipsoid, then converted to grid coordinates.

multipath Interference, similar to ghosting on a television screen. Multipath occurs when GPS signals traverse different paths before arriving at the antenna. A signal that traverses a longer path yields a larger pseudorange estimate and increases the error. Reflections from structures near the antenna can cause the incidence of multiple paths to increase.

NAVDATA The 1500-bit navigation message broadcast by each satellite. This message contains system time, clock correction parameters, ionospheric delay model parameters, and details of the satellite's ephemeris and health. The information is used to process GPS signals to obtain user position and velocity.

NMEA A standard, established by the National Marine Electronics Association (NMEA), that defines electrical signals, data transmission protocol, timing, and sentence formats for communicating navigation data between marine navigation instruments.

parity A form of error checking used in binary digital data storage and transfer. Options for parity checking include Even, Odd, or None.

P-code The ‘precise’ code transmitted by the GPS satellites. Each satellite has a unique code that is modulated onto both the L1 and L2 carrier waves. The P-code is replaced by a Y-code when Anti-Spoofing is active.

PDOP Position Dilution of Precision, a unitless figure of merit expressing the relationship between the error in user position and the error in satellite position. Geometrically, PDOP is proportional to 1 divided by the volume of the pyramid formed by lines running from the receiver to four satellites observed. Values considered good for positioning are small (for example, 3). Values greater than 7 are considered poor. Small PDOP is associated with widely separated satellites. PDOP is related to horizontal and vertical DOP by $PDOP^2=HDOP^2+VDOP^2$. See also **DOP**.

PDOP mask The highest PDOP value at which a receiver will compute positions.

postprocess To process satellite data on a computer after it has been collected.

PRN Pseudorandom number, a sequence of digital 1’s and 0’s that appear to be randomly distributed like noise, but that can be exactly reproduced. PRN codes have a low autocorrelation value for all delays or lags except when they are exactly coincident.

Each NAVSTAR satellite can be identified by its unique C/A and P pseudorandom noise codes, so the term ‘PRN’ is sometimes used as another name for GPS satellite or SV.

projection Projections are used to create flat maps that represent the surface of the earth or parts of that surface.

QC records Quality Control records. With precise positioning applications, this receiver option lets you process RTCM-104 corrections and satellite data in real time to provide position precision statistics.

ratio During initialization, the receiver determines the integer number of wavelengths between each satellite and the GPS antenna phase center. For a particular set of integers, it works out the probability that this is the correct set. The receiver then calculates the ratio of the probability of correctness of the currently-best set of integers to the probability of correctness of the next-best set. A high ratio indicates that the best set of integers is much better than any other set. (This gives us confidence that it is correct.) The ratio must be above 5 for New Point and OTF initializations.

RDOP Relative Dilution of Precision. See also **DOP**.

reference station See **base station**.

RMS Root Mean Square. This is used to express the accuracy of point measurement. It is the radius of the error circle within which approximately 70% of position fixes are to be found. It can be expressed in distance units or in wavelength cycles.

rover Any mobile GPS receiver and field computer collecting data in the field. The position of a roving receiver can be differentially corrected relative to a stationary base GPS receiver.

RTCM Radio Technical Commission for Maritime Services, a commission established to define a differential data link for the real-time differential correction of roving GPS receivers. There are two types of RTCM differential correction messages, but all Trimble GPS receivers use the newer Type 2 RTCM protocol.

RTK Real-time kinematic, a type of GPS survey.

S/A	See **Selective Availability**.
Selective Availability (S/A)	Artificial degradation of the GPS satellite signal by the U.S. Department of Defense. The error in position caused by S/A can be up to 100 meters.
single-frequency	A type of receiver that only uses the L1 GPS signal. There is no compensation for ionospheric effects.
SNR	Signal-to-Noise Ratio, a measure of the strength of a satellite signal. SNR ranges from 0 (no signal) to around 35.
Super-trak	A Trimble proprietary method of processing the L2 signal when the P-code is encrypted.
SV	Satellite Vehicle (or Space Vehicle).
TDOP	Time Dilution of Precision. See also **DOP**.
TOW	Time of Week in seconds, from midnight Saturday night/Sunday morning GPS time.
tracking	The process of receiving and recognizing signals from a satellite.
UTC	Universal Time Coordinated. A time standard based on local solar mean time at the Greenwich meridian. See also **GPS time**.
VDOP	Vertical Dilution of Precision. See also **DOP**.
WAAS	Wide Area Augmentation System. A satellite-based system that broadcasts GPS correction information. WAAS capable GPS receivers can track WAAS satellites. WAAS is synonymous with the European Geostationary Navigation Overlay Service (EGNOS) and Japan's Multifunctional Transport Satellite Space-based Augmentation System (MSAS).

WGS-84 World Geodetic System (1984), the mathematical ellipsoid used by GPS since January 1987. See also **ellipsoid**.

Y-code An encrypted form of the information contained in the P-code. Satellites transmit Y-code in place of P-code when Anti-Spoofing is in effect.

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Trimble

CHAPTER

10

Batteries and Antennas

In this chapter:

- Introduction
- Batteries
- GPS antenna types
- Measuring antenna heights
- Antenna.ini file

Introduction

This chapter describes the antennas and batteries that can be used during a GPS survey.

Batteries

When setting up a base receiver, make sure the power source is sufficient to provide an uninterrupted supply for the duration of the survey. This is particularly important if the base receiver is normally left unattended. Generally, a 6 AH or 10 AH battery is sufficient, but for some applications a heavy-duty battery (and general purpose battery cable) may be the only reliable option.

The battery for a GPS Total Station® 4800 rover receiver is attached to the base of the PowerLiTE™ pole. For other rover receivers, camcorder batteries provide a reliable power supply while adding minimal weight.

To supply power to the equipment, use any of the following batteries and battery accessories:

- PowerLiTE Lithium-ion battery (for the GPS Total Station 4800 rover receiver only)
- Camcorder battery (2.3 AH)
- Camcorder battery cable – single, dual, or quad
- 6 AH battery with case and cable
- 10 AH battery with case and cable
- General-purpose battery cable

The dual camcorder battery cable connects two batteries in series. To use both batteries, connect the cable to the port labeled PWR 2&3 on Site Surveyor™ 4400 and Series 4000™ receivers. The receiver port automatically switches to the second battery when the voltage of the first battery falls below the required level.

Even though the two batteries are connected in series, only one is used at a time. The battery indicator in the status line of the TSC1 data collector screen shows how much power remains in the battery that is currently being used.

The quad camcorder battery cable connects four batteries in two pairs. Each pair is connected in parallel. To use both pairs, connect the cable to the port labeled PWR 2&3 on Site Surveyor 4400 and Series 4000 receivers. The receiver port automatically switches to the second pair when the voltage of the first pair falls below the required level.

Warning – Use the single camcorder cable to provide power to the 4600LS receiver. Do not use the dual or quad cables unless there is only one battery on the dual cable, or one pair on the quad cable.

The general-purpose battery cable (part number 14555-00) is a fused cable with battery clips that permit connection to a 12 V DC battery, and a Lemo connector that plugs directly into the GPS receiver.

Note – *If using a general-purpose battery cable, make sure the polarity is correct, especially when powering a GPS Total Station 4700 receiver.*

GPS Antenna Types

The first time you use a Survey Style, you are prompted to specify the type of antenna used.

When choosing antennas, be aware that:

- GPS Total Station 4800 receivers use a built-in antenna.
- GPS Total Station 4700, Site Surveyor 4400, and dual-frequency Series 4000 receivers usually use Trimble's Micro-centered™ or Compact L1/L2 antenna.
- For some applications, the rugged L1/L2 antenna may be the most reliable dual-frequency antenna.

- Single-frequency Series 4000 receivers use the Compact L1 or Compact Dome antenna.
- 4600LS receivers use a built-in antenna.

Note – *The default antenna type under Rover options in a Survey Style is Micro-centered L1/L2. The default antenna type under Base options is Micro-centered L1/L2 w/Ground (a Micro-centered L1/L2 antenna with a ground plane).*

Generally, attach the base antenna to a tripod and the rover antenna to a range pole.

Measuring Antenna Heights

The antenna receives GPS signals at the Antenna Phase Center (APC). The APC is inside the plastic housing, so it is not possible to measure directly to it. Instead, you usually measure the height from the survey mark on the ground to a specified part of the antenna housing. Enter the antenna height, then set the *Meas. to* field to specify where the height is measured to on the housing.

With a GPS Total Station 4800 antenna, for example, enter 1.800 m in the *Antenna height* field and set the *Meas. to* field to Bottom of antenna mount. With a Micro-centered antenna, measure to the bottom of the plastic antenna housing. Enter this value in the *Antenna height* field and set the *Meas. to* field to Bottom of antenna.

The Trimble Survey Controller software corrects the antenna height value according to the antenna type selected and the setting in the *Meas. to* field. It calculates the APC based on the antenna type, the uncorrected height, and the value in the *Meas. to* field. This APC height is used to calculate the ground height for points.

Measuring the Height of an Antenna on a Range Pole

Figure 10.1 shows how to measure the height of an antenna mounted on a range pole when the *Meas. to* field is set to Bottom of antenna or Bottom of antenna mount. With a fixed height range pole, the height is a constant value.

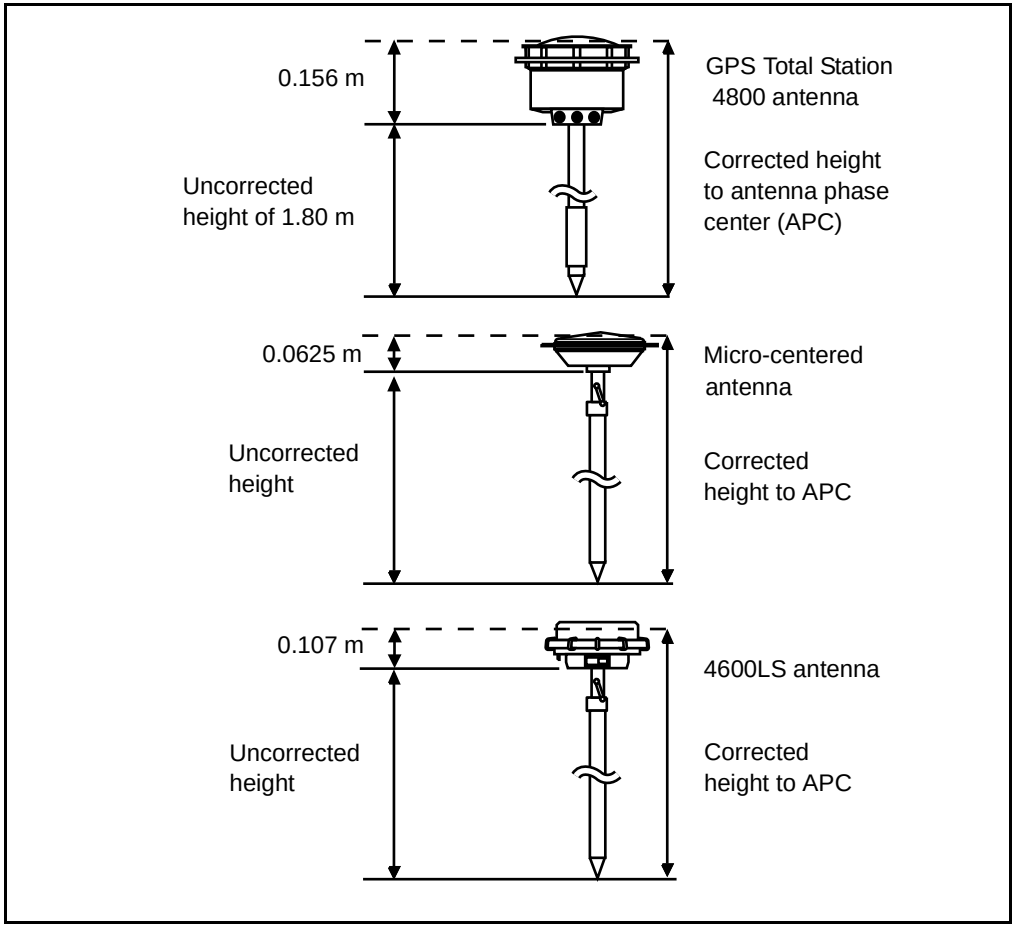


Figure 10.1 Measuring the height of a receiver mounted on a range pole

Measuring the Height of an Antenna on a Tripod

The way to measure this depends on the equipment used.

GPS Total Station 4800 receiver

If this antenna is mounted on a tripod, measure the uncorrected height to one of the eight protruding notches on the edge of the plastic antenna housing. These are located inside the external shock resistant housing ring. Use the special measuring tape provided by Trimble. Enter a value in the *Antenna height* field, and set the *Meas. to* field to Hook using 4800 tape.

Tip – If using a fixed height tripod, you can measure the height to the bottom of the antenna housing and set the *Meas to.* field to Bottom of antenna mount.

Micro-centered L1/L2 antenna

If this antenna is mounted on a tripod, measure the height to the bottom of the plastic housing. Enter this value in the *Antenna height* field and set the *Meas. to* field to Bottom of antenna.

Ground plane

If using a ground plane, see page 276.

Initializer plate

If using an initializer plate with a Series 4000 receiver, measure the antenna height to the bottom of the semicircular notch on the outside of the initializer plate. In the *Antenna type* field, choose the w/Init option (for example, Compact L1/L2 w/Init) and set the *Meas. to* field to Bottom of HI notch on RTK initializer.

4600LS receiver

If using this antenna, measure the height from the survey mark to the hook on the receiver housing. Use the special measuring tape provided by Trimble. See Figure 10.2. Enter this value in the *Antenna height* field, and set the *Meas. to* field to Hook using 4600LS tape.

Note – *To use an initializer bar with a 4600LS receiver, attach the initializer bar to the tripod and select this method.*

Figure 10.2 shows how to measure the antenna height of a 4600LS receiver mounted on a tripod.

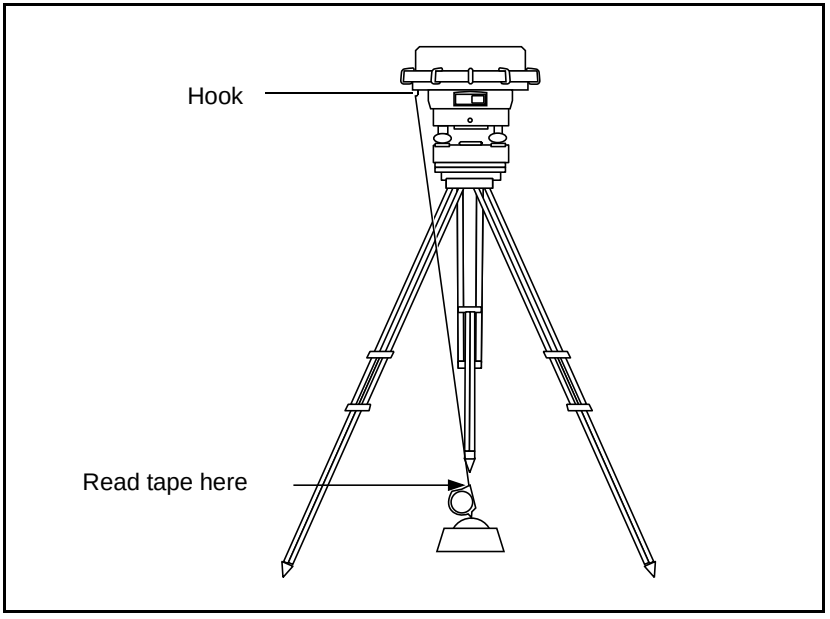


Figure 10.2 Measuring the antenna height of a 4600LS receiver mounted on a tripod

Measuring the Height of an Antenna When Using a Ground Plane

A ground plane reduces the incidence of multipath (see page 323). It is generally used only at a base receiver.

If using a ground plane, choose the w G/P option in the *Antenna type* field (for example, Compact L1/L2 w G/P).

Figure 10.3 shows how to measure the uncorrected height of a Micro-centered antenna (or a Compact L1/L2 antenna) that has a ground plane. Measure to the underside of the notch in the ground plane.

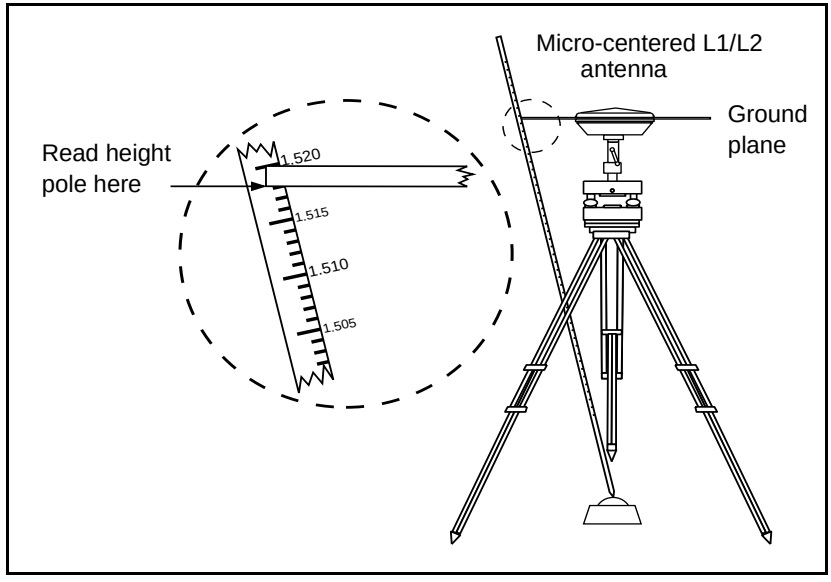


Figure 10.3 Measuring the height of the antenna when using a ground plane

Tip – Measure the height to three different notches around the perimeter of the ground plane. Then record the average as the uncorrected antenna height.

Antenna.ini File

The Trimble Survey Controller software includes an integrated Antenna.ini file that contains a list of antennas that you can choose from when creating a Survey Style. You cannot edit this list in the Survey Controller software. However, if you want to shorten the list or add a new antenna type, you can edit and upload a new Antenna.ini file, for example.

To edit the Antenna.ini file, use a text editor such as Microsoft Notepad. Edit the *Survey Controller* group, and transfer the new Antenna.ini file using Data Transfer or GPLoad to the Trimble Survey Controller software.

Note – *When you transfer an Antenna.ini file, it overwrites any existing file of that name.*

CHAPTER

11

Starting the Base Receiver

In this chapter:

- Introduction
- Base station coordinates
- Setting up the equipment for a real-time survey
- Setting up the equipment for a postprocessed survey
- Setting up the equipment for a real-time and postprocessed survey
- Starting a base survey
- Ending a base survey

Introduction

This chapter shows how to start the base receiver for a GPS survey.

Base Station Coordinates

When setting up a base, it is important to know the WGS-84 coordinates of the point as accurately as possible.

Note – *Every 10 m of error in a base station coordinate can introduce up to 1 ppm scale error on every measured baseline.*

The following recognized methods, listed in descending order of accuracy, are used to determine base station WGS-84 coordinates:

- published or precisely-determined coordinates
- coordinates computed from published or precisely-determined grid coordinates
- coordinates derived using a reliable differential (RTCM) broadcast based on published or precisely-determined coordinates
- a single point position derived using Trimble's GPSurvey™ software—use this method if no control exists for the location
- a WAAS position generated by the receiver—use this method if no control exists for the location and you have a receiver that tracks WAAS satellites.
- an autonomous position generated by the receiver—use this method for real-time surveys in a location where no control exists. Trimble strongly recommends that you calibrate any jobs started by this method on a minimum of four local Control points.

Tip – In the U.S.A., users can regard NAD83 geodetic coordinates as equivalent to WGS-84 coordinates.

Note – *If the keyed in WGS-84 coordinates differ from the current autonomous position generated by the receiver by more than 1000 m, a warning message appears.*

For more information about entering base station coordinates, see Starting a Base Survey, page 299.

Survey Integrity

To preserve the integrity of a GPS survey, consider the following:

- When starting subsequent base receivers for a particular job, make sure that each new base coordinate is in the same terms as the initial base coordinate.

Warning – Within a job, only use an autonomous position to start the ***first*** base receiver. An autonomous position is equivalent to an assumed coordinate in conventional surveying.

- Coordinates published by a reliable source and coordinates determined by control surveys should be in the same system.
- If subsequent base coordinates are not in the same terms, regard observations from each base as a separate job. Each needs a separate calibration.
- Because measured real-time kinematic points are stored as vectors from the base station, not as absolute positions, the origin of the survey must be an absolute WGS-84 position from which the vectors radiate.

  If other base stations are subsequently set up on points measured from the original base station, all vectors are resolved back to the original base station.

- It is possible to start the base on any kind of coordinates, for example, grid or local ellipsoid coordinates. In a real-time survey, however, the Trimble Survey Controller software must store a WGS-84 position for the base when a rover survey is started. It is this position that is held fixed as the origin of the network.

  When you start a rover survey, the Trimble Survey Controller software compares the WGS-84 position broadcast by the base receiver with points already in the database. If a broadcast point has the same name as a point in the database, but different coordinates, the Trimble Survey Controller software uses the coordinates that are in the database. These coordinates were keyed in or uploaded by you, so it assumes that you want to use them.

  If a point in the database has the same name as the one being broadcast by the base, but the coordinates are NEE or local LLH rather than WGS-84 coordinates, the Trimble Survey Controller software converts this point to WGS-84 coordinates using the current datum transformation and projection. It then uses these as the base coordinates. If no datum transformation and projection are defined, the broadcast WGS-84 point is automatically stored and used as the base.

  Note – *If a NEE or local LLH point is converted to WGS-84 by the software, do* ***not*** *use it in the calibration.*

Figure 11.1 shows a survey using two base stations.

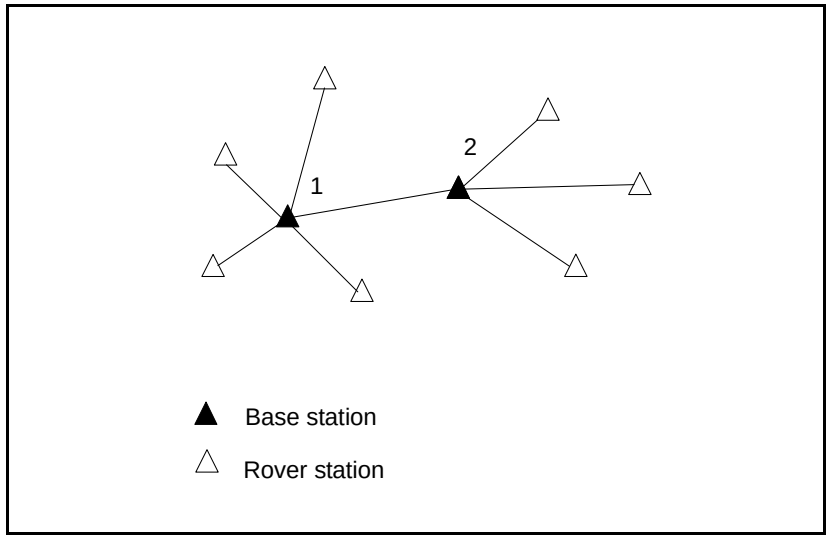


Figure 11.1 Using more than one base station in a survey

In this survey, Base station 2 was first surveyed as a roving point from Base station 1.

Note – *Base stations 1 and 2* ***must*** *be linked together by a measured baseline, and Base station 2* ***must*** *be started with the same name that it had when it was surveyed as a roving point from Base station 1.*

Setting Up the Equipment for a Real-Time Survey

This section shows how to assemble the hardware components at the base receiver for a real-time kinematic (RTK) or real-time differential (RT differential) survey. Follow these steps if you are using a GPS Total Station 4800 or 4700 receiver. If using a Series 4000™ receiver, a Site Surveyor 4400™ receiver, an MS750 receiver or a 4600LS™ receiver see Appendix D, Connection Diagrams.

Using a GPS Total Station 4800 Receiver

To assemble the base receiver hardware for a real-time survey using a GPS Total Station 4800 receiver, see Figure 11.2. Then do the following:

1. Set the GPS receiver over the ground mark using a tripod, a tribrach, and a tribrach adaptor.
2. Assemble and erect the radio antenna.
3. Connect the radio antenna to the radio using the cable attached to the antenna. If using a TRIMTALK™ radio, see Figure 11.4 on page 288.
4. Use the cable (part number 36241-50) to connect the radio to the GPS receiver port 3.

Note – *With slightly older equipment, you may have to use an adaptor cable (part number 34383) with the base station radio cable when connecting the base station radio to the GPS receiver.*

Warning – Do not force plugs into the receiver ports. Align the red dot on the plug with the red line on the socket and then insert the plug carefully.

5. Connect the power supply to the GPS receiver port 2 and turn on the receiver.
6. Connect the TSC1 data collector to the GPS receiver port 1.
7. Turn on the TSC1 and go to Starting a Base Survey, page 299.

Figure 11.2 shows how to set up the base receiver for a real-time survey using a GPS Total Station 4800 receiver.

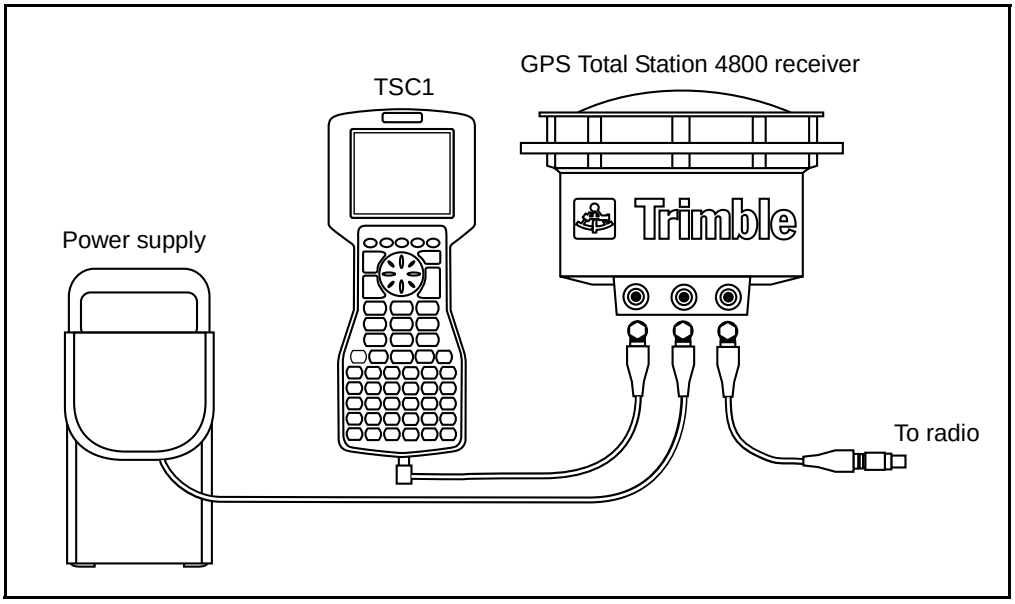


Figure 11.2 Real-time configuration using a GPS Total Station 4800 receiver (external radio)

Using a GPS Total Station 4700 Receiver

To set up a base receiver for a real-time survey using a Trimble GPS Total Station 4700 receiver, see Figure 11.3. Then do the following:

1. Set the GPS antenna over the ground mark using a tripod, a tribrach, and a tribrach adaptor. If one of the GPS antennas has a ground plane, use this as the base antenna. (See Measuring the Height of an Antenna When Using a Ground Plane, page 276.)
2. Connect the GPS antenna to the GPS receiver port labeled GPS ANTENNA. Use the N-type to Lemo co-axial cable.
3. Assemble and erect the radio antenna.

4. Connect the radio antenna to the radio using the cable attached to the antenna. If using a TRIMTALK radio, see Figure 11.4 on page 288.
5. Connect the radio to the GPS receiver port 3.
   - If using a Trimble radio, use the 0-shell Lemo to 5-pin Lemo cable.
   - If using a radio provided by a third party, use the appropriate cable.

     Note – *For some third-party radios, a separate power supply is needed for the radio.*

Warning – Do not force plugs into the receiver ports. Align the red dot on the plug with the red line on the socket and then insert the plug carefully.

6. Connect the power source to the GPS receiver port 2 and turn on the receiver.
7. Connect the TSC1 data collector to the GPS receiver port 1. Use the 0-shell Lemo to 0-shell Lemo cable.
8. Turn on the TSC1 and go to Starting a Base Survey, page 299.

Figure 11.3 shows how to set up the base receiver for a real-time survey using a GPS Total Station 4700 receiver.

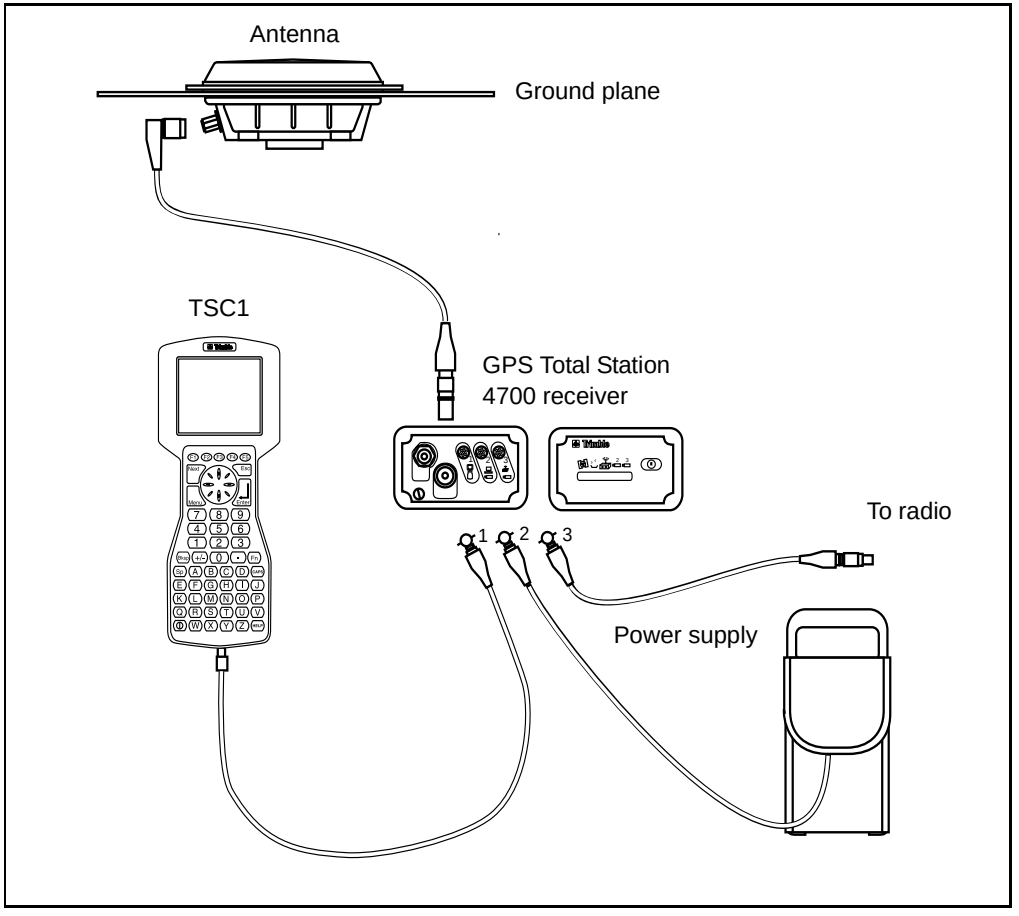


Figure 11.3 Real-Time configuration using GPS Total Station 4700 receiver (external radio)

Figure 11.4 shows a Trimble radio connected to a radio antenna.

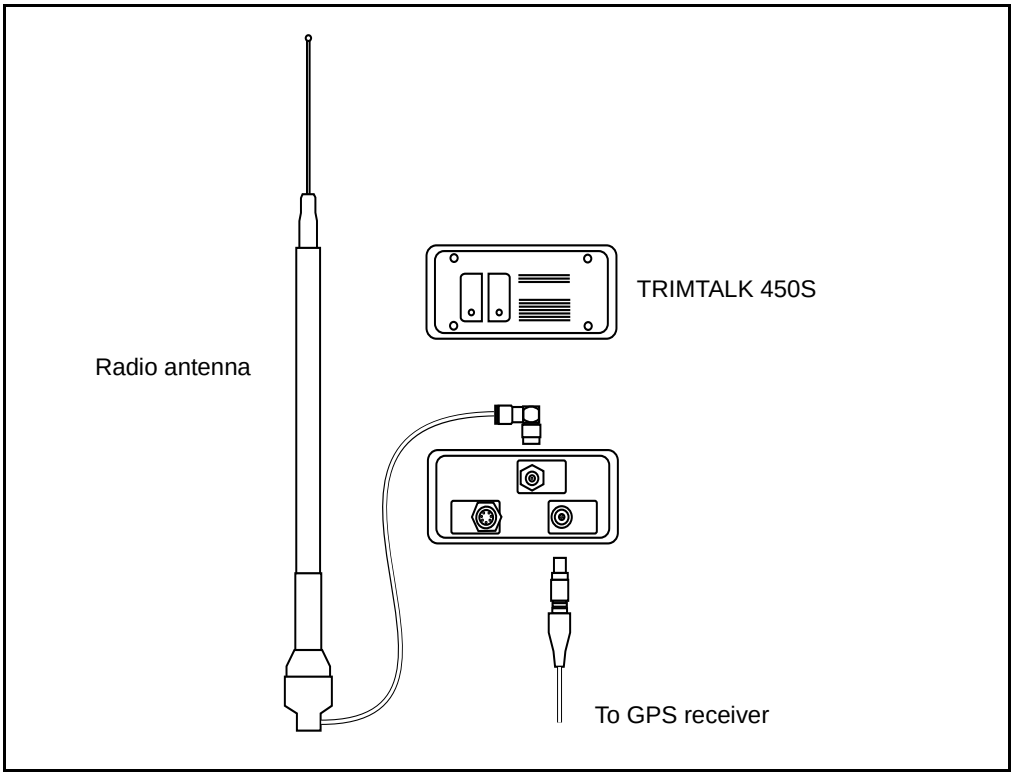


Figure 11.4 Trimble radio connection

Radio Solutions

Trimble provides a comprehensive range of radio solutions that have been tested and proven. TRIMTALK radios are powered from the receiver's power supply using a common data/power cable. This configuration simplifies battery issues, as the receiver and the radio use the same power source. The GPS Total Station 4800 and 4700 receivers can use a TRIMTALK 450S or a TRIMMARK IIe radio at the base, and an internal radio at the rover.

Cellular modems can be used at both the base and rover receivers. For information about setting up cellular modems in the Survey Style, see Radios, page 129.

Note – *Cellular modems used with the Trimble Survey Controller software must support Hayes compatible AT commands.*
Base receivers used with modems must support CTS flow control.

You can use the Trimble Survey Controller software to configure the radios. For more information, see Configuring a radio using the Trimble Survey Controller software, page 293.

Radio considerations

Real-time survey methods rely on trouble-free radio transmission.

Note – *The precision of measured points is not affected by radio performance.*

To reduce the effects of interference from other base stations operating on the same frequency:

- For your base station, use a transmission delay that does not coincide with others on the same frequency.

  For more information, see Operating Several Base Stations on One Radio Frequency, page 290.

Sometimes the conditions or topography of a site adversely affect radio transmission, resulting in limited coverage.

To increase site coverage:

- move the base stations to prominent points around the site
- erect the base radio antenna as high as possible
- use radio repeaters

Tip – Double the height of the broadcast antenna to increase the coverage by approximately 40%. To achieve the same effect, it would be necessary to quadruple the radio broadcast power.

Operating Several Base Stations on One Radio Frequency

In an RTK survey you can reduce the effects of radio interference from other base stations on the same frequency by operating your base station with a different transmission delay. This allows you to operate several base stations on one frequency. The general procedure is as follows:

1. Check that you have the correct hardware and firmware.
2. Set up the equipment and start a survey at each base station, specifying a transmission delay and a station index number.
3. Start a rover survey and specify which base to use.

Hardware and firmware requirements

To operate several base stations on one frequency, you must use receivers that support the CMR Plus correction record format. You ***cannot*** use Series 4000™ or 4600LS™ receivers.

Only one Site Surveyor™ 4400 or MS750™ receiver can be used—it can only be used as the base with the 0 ms transmission delay. You do not need to set this. If you use a 4400 or MS750™ receiver, it automatically broadcasts with a 0 ms transmission delay.

All other base and rover receivers must be GPS Total Station™ 4700 or 4800 receivers with firmware version 1.20 or later.

Warning – Do not use transmission delays if you intend to use radio repeaters.

Starting the base with a transmission delay

When you use multiple base stations, you set the transmission delay for each base when you start the base survey. Each base must broadcast with a different transmission delay and station index number. The delays allow the rover receiver to receive corrections from all of the base stations at once. The station index numbers let you select which base station to use at the rover.

Note – *You can only set the base radio transmission delay when using a GPS Total Station 4700 or 4800 receiver with firmware version 1.20 or later.*

You can only specify which base station you want to receive corrections from when using a GPS Total Station 4700 or 4800 receiver as the rover. You ***cannot*** *use a Site Surveyor™ 4400 or MS750 receiver as the rover receiver.*

When you carry out surveys using different base stations in one job, make sure that the coordinates of the base stations are in the same coordinate system and are in terms of each other.

Before you start the base receiver, do the following:

1. Select the CMR Plus correction message format. Select this in the Survey Style for both the base and the rover.
2. Set the over air baud rate in the radio to at least 4800 baud.

   Note – *If you use a 4800 over air baud rate you can only use two base stations on one frequency. Increase the over air baud rate if you want to increase the number of base stations on one frequency.*

When you start the base survey, do the following:

1. In the *Station index* field, enter a value. This value must be in the range 0 to 29. This number is broadcast in the correction message.

Tip – You can configure the default station index number in the Survey Style. For more information, see Station index, page 127.

2. If the receiver you are using supports transmission delays, the *Transmission delay* field appears. Choose a value, depending on how many base stations you want to use. See Table 11-1.

Table 11-1 Number of bases/transmission delays

Number of base stations	Use these delays...			
	Base 1	Base 2	Base 3	Base 4
One	0 ms			
Two	0 ms	500 ms		
Three	0 ms	350 ms	700 ms	
Four	0 ms	250 ms	500 ms	750 ms

For more information about starting the base survey, see Starting a Base Survey, page 299.

For information about starting the rover and selecting which station index to use, see Starting a Rover Survey, page 315.

Radio Repeaters

Radio repeaters increase the broadcast range of a base radio by receiving the base transmission and then rebroadcasting it on the same frequency.

Trimble provides five radio solutions for use with the Trimble Survey Controller system.

Table 11.2 lists possible radio solutions, and shows the number of repeaters that can be used with each.

Table 11.2 Radio repeater options

Radio	Number of repeaters
TRIMTALK 450	1
TRIMTALK 900	1, 2, 3, 4, or 5
TRIMTALK 450S (12.5 kHz)	1
TRIMTALK 450S (25 kHz)	1 or 2
TRIMMARK II / IIe	Please refer to the TRIMMARK II™ documentation
TRIMCOMM	Please refer to the TRIMCOMM™ documentation
Pacific Crest / Satel / Clarion	Please refer to the manufacturer's specifications

Note – *To use any of these radios as repeaters, they must be configured as repeaters. For instructions on how to do this, see the next section.*

Configuring a radio using the Trimble Survey Controller software

Use the Trimble Survey Controller software to:

- change the frequency of a radio
- change the mode of a radio, from a broadcasting/receiving radio to a repeater radio
- change the wireless data rate

Note – *You cannot configure a radio using a 4600LS receiver. Connect the TSC1 data collector directly to the radio.*

Note – *You can only change the frequency when configuring a Pacific Crest radio.*

To configure a radio:

1. Connect the TSC1 data collector, receiver, power, and radio. See Figure 11.2 on page 285, Figure D.1 on page 604, Figure 12.1 on page 307, or Figure 12.3 on page 311 (depending on the equipment).

   Alternatively, use a Y-cable to connect the power and the TSC1 directly to the radio.

2. On the TSC1, highlight your Survey Style and press Edit.

3. Select *Base radio* or *Rover radio* depending on which radio you are configuring.

4. Set the *Type* field and, if connecting directly, the *Controller port* field.

   If connecting through a receiver, set the *Receiver port* field.

5. Press Connect.

   Note – *If the* Connect *softkey is not displayed, you cannot configure the type of radio you have selected.*

   If configuring a radio other than the internal radio of a GPS Total Station 4800 or 4700 receiver, the following message appears:

   Please confirm. Disconnect power from radio.

6. Disconnect the power from the radio and press Yes.

   A message appears:

   Please confirm. Connect power to radio.

7. Reconnect the power to the radio and press Yes. (There is no need to press this for a Pacific Crest radio.)

   The second *Base radio*/*Rover radio* screen appears.

8. Change the settings in the *Frequency* field, the *Mode* field, and the *Wireless data rate (bps)* field, as required.

   The radio firmware version is also displayed.

Note – *When configuring a GPS Total Station 4700 or 4800 internal radio, the Mode and the Wireless data rate (bps) fields are replaced by the Base radio mode field.*
When configuring the wireless data rate for this type of radio, make sure that the rate you choose is supported by the radio firmware.

9. Press OK when the details are correct. (There is no need to press this for a Pacific Crest radio.)

   Note – *In some countries it is illegal to change the frequency of a radio. The Trimble Survey Controller software uses the latest GPS position to see if you are in one of these countries. If you are, only the available frequencies are displayed in the Frequency field.*

Setting Up the Equipment for a Postprocessed Survey

This section shows how to assemble the hardware components at the base receiver for a postprocessed kinematic, a postprocessed differential or a FastStatic survey. Follow these steps when using a GPS Total Station™ 4800 or 4700 receiver. If using a Series 4000™ receiver, a Site Surveyor 4400™ receiver, or a 4600LS™ receiver see Appendix D, Connection Diagrams.

Using a GPS Total Station 4800 Receiver

To assemble the base receiver hardware for a postprocessed survey using a GPS Total Station 4800 receiver, see Figure 11.5. Then do the following:

1. Set the GPS receiver over the ground mark using a tripod, a tribrach, and a tribrach adaptor.
2. Connect the power supply to the GPS receiver port 2 and turn on the receiver.

Warning – Do not force plugs into the receiver ports. Align the red dot on the plug with the red line on the socket and then insert the plug carefully.

3. Connect the TSC1 data collector to the GPS receiver port 1.
4. Turn on the TSC1 and go to Starting a Base Survey, page 299.

Figure 11.5 shows how to set up the equipment for a postprocessed survey using a GPS Total Station 4800 receiver.

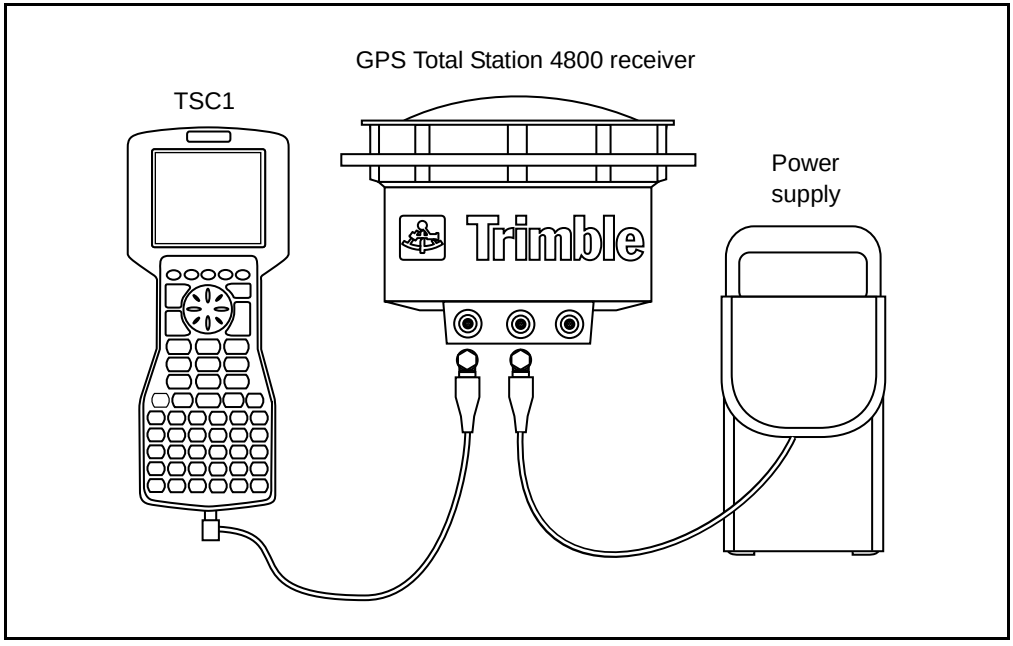


Figure 11.5 Postprocessed configuration using a GPS Total Station 4800 receiver

Using a GPS Total Station 4700 Receiver

To set up a base receiver for a postprocessed survey using a Trimble GPS Total Station 4700 receiver, see Figure 11.6. Then do the following:

1. Set the GPS antenna over the ground mark using a tripod, a tribrach, and a tribrach adaptor. If one of the GPS antennas has a ground plane, use this as the base antenna. (See Measuring the Height of an Antenna When Using a Ground Plane, page 276.)
2. Connect the GPS antenna to the GPS receiver port labeled GPS ANTENNA. Use the N-type to Lemo co-axial cable.

Warning – Do not force plugs into the receiver ports. Check the number of pins in the plug to make sure that the socket is compatible. Align the red dot on the plug with the red line on the socket and then insert the plug carefully.

3. Connect the power source to the GPS receiver port 2 and turn on the receiver.
4. Connect the TSC1 data collector to the GPS receiver port 1. Use the 0-shell Lemo to 0-shell Lemo cable.
5. Turn on the TSC1 and go to Starting a Base Survey, page 299.

Figure 11.6 shows how to set up the equipment for a postprocessed survey using a GPS Total Station 4700 receiver.

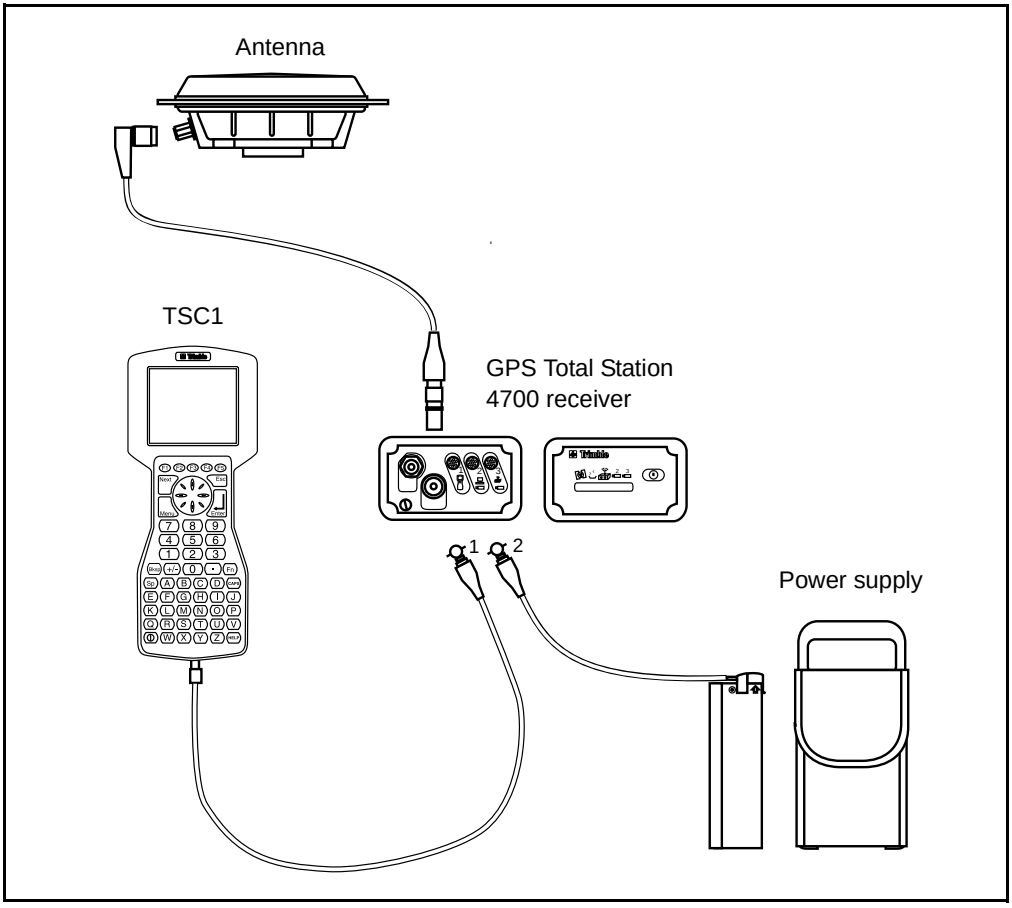


Figure 11.6 Postprocessed configuration using a GPS Total Station 4700 receiver

Setting Up the Equipment for a Real-Time and Postprocessed Survey

To conduct a survey that uses both real-time and postprocessed techniques, follow the assembly instructions for real-time surveys. If the receiver has no memory (or has a limited memory), assign a TSC1 data collector to store raw data at the base receiver.

Starting a Base Survey

To conduct a survey using a predefined Survey Style, make sure that the required job is open. The title of the main menu should be the current job name.

From the main menu, choose *Survey*. The *Select Survey Style* menu appears. Select a Survey Style from the list. To create a new Survey Style, press New and see Creating a New GPS Survey Style, page 122.

A *Survey* menu is generated. It displays items specific to the chosen Survey Style and includes the *Start base receiver* and *Start survey* items.

The first time a particular Trimble Survey Style is used, the Trimble Survey Controller software prompts you to customize the Style for your specific hardware. This happens when the survey is started. For more information, see Using the Style Wizard to Customize a Trimble GPS Survey Style, page 119.

Note – *The first time that a Series 4000 receiver is turned on, no receiver information is displayed in the status line of the TSC1 data collector. When you start a survey (or select an item from the Instrument menu), there is a delay of about 5 minutes while the Trimble Survey Controller software automatically negotiates a high baud rate. To avoid this delay, use the front panel of the receiver to set the baud rate on port 1 to 38400 and the parity to 8-Odd-1.*

If the Power-up control setting is set to restore the factory defaults, there is a similar delay every time the receiver is turned on. To change this setting, refer to the Series 4000 receiver manual.

To start a base survey:

Warning – In a real-time survey, make sure that the radio antenna is connected to the radio before starting the base survey. If it is not, the radio will be damaged.

1. From the *Survey* menu, choose *Start base receiver.*

   – If the TSC1 is connected to a GPS Total Station 4800 or 4700 receiver that was logging data, the data logging is stopped.

   – If this is the first time that this Survey Style is being used, the Style wizard prompts you to specify what equipment is in use. For more information, see Using the Style Wizard to Customize a Trimble GPS Survey Style, page 119.

   The *Survey*/*Start base* screen appears.

   Note – *When a survey is started, the Trimble Survey Controller software automatically negotiates the highest possible baud rate for communicating with the connected receiver.*

2. Enter the base station name and coordinates using one of the following methods (for more information, see Base Station Coordinates, page 280):

   – If WGS-84 coordinates are known:

   Highlight the *Point name* field and press ⊙. Enter the point name, then press Key in.

   In the *Key in/Point* screen, set the *Type* field to Keyed in coordinates. Check that the coordinate fields are Latitude, Longitude, and Height (WGS-84). If they are not, press Options and change the *Coordinate view* setting to WGS-84. Key in the known WGS-84 coordinates for the base station, and press Enter.

   – If grid coordinates are known, and projection and datum transformation parameters are defined:

   Highlight the *Point name* field and press ⊙. Enter the point name and press Key in.

   In the *Key in/Point* screen, set the *Type* field to Keyed in coordinates. Check that the coordinate fields are *North*, *East*, *Elevation*. If they are not, press Options and change the *Coordinate view* setting to Grid. Key in the known grid coordinates for the base station, then press Enter.

   – If local geodetic coordinates are known and a datum transformation is defined:

   Highlight the *Point name* field and press ⊙. Enter the point name, then press Key in.

   In the *Key in/Point* screen, set the *Type* field to Keyed in coordinates. Check that the coordinate fields are Latitude, Longitude, and Height (Local). If not, press Options and change the *Coordinate view* setting to Local. Key in the known local coordinates for the base station, then press Enter.

– If you intend to postprocess the GPS observations as a Point position and later key in the values as known WGS-84 coordinates:

  Set up one set of equipment over a marked point for use as a base station. From the *Select Survey Style* menu, choose a FastStatic Survey Style. Then select *Measure points*. Measure the point for several hours.

  Download these measurements and use the Trimble GPSurvey software to process them as a Point position.

  Return to the site and follow the instructions for entering base station coordinates if WGS-84 coordinates are known (see page 301).

– In a real-time survey do one of the following:

  – Select the current WAAS position derived by the GPS receiver.

  – Select the current autonomous position derived by the GPS receiver.

  Then, highlight the *Point name* field and press ⊙. Enter the point name and press Key in to access the *Key in/Point* screen. Press Here and the current position is displayed. Press Enter to accept and store this position.

Note – *If you want a WAAS position, ensure the receiver is tracking a WAAS satellite by checking the WAAS icon is displayed on the status line when you press Here. The receiver can take 120 seconds to lock on to WAAS. Alternatively, check the Observation class field before starting the base.*

Warning – Within a job, only use an autonomous position (the Here softkey) to start the first base receiver.

Note – *If you do a real-time survey using RTCM corrections and use a base point name that is more than eight characters long, the name will be shortened to eight characters when it is broadcast.*

3. The *Observation class* field shows the observation class of the base point. For more information, see Observation class, page 376.
4. Enter values in the *Code* (optional) and *Antenna height* fields.
5. Set the *Meas. to* field as appropriate, and press Enter.
6. In the *Station index* field, enter a value.

   This value must be in the range 0 to 29. It is broadcast in the correction message.

Tip – Press Scan to view a list of other base stations operating on the frequency you are using. The list shows the station index numbers of the other bases and the reliability of each. Choose a different station index number to those displayed.

7. If the receiver you are using supports transmission delays, the *Transmission delay* field appears. Choose a value depending on how many base stations you intend to use. For more information about transmission delays, see Operating Several Base Stations on One Radio Frequency, page 290.
8. Press Start.

   The base receiver starts to record data.
9. Do one of the following:

   – If you are doing a real-time survey or are logging data in the receiver, the following message appears:

   Base started
   Disconnect controller from receiver

Disconnect the TSC1 data collector from the base receiver but ***do not*** turn off the receiver. You can now set up the rover receiver.

Note – *For a real-time survey, check that the radio is working before leaving the equipment. The data light should be flashing.*

– If you are logging data in the TSC1 data collector, the *Base* screen appears. It shows what point is being surveyed and the time that has elapsed since data logging started. Leave the TSC1 connected to the base receiver and set up the rover using another TSC1.

Ending a Base Survey

After an RTK survey or after logging data in the receiver, end the survey as follows:

1. Return to the equipment and select *Survey / End survey.* Press Yes to confirm that you want to end the survey, and again to power down the receiver.
2. Turn off the TSC1 data collector.
3. Disconnect the equipment.

After logging base station data in the TSC1, end the survey as follows:

1. Return to the equipment and press End.
2. Press Yes to confirm that you want to end the survey, and again to power down the receiver.
3. Turn off the TSC1 data collector.
4. Disconnect the equipment.

CHAPTER

12

Starting the Rover Receiver

In this chapter:

- Introduction
- Setting up the equipment for a real-time survey
- Setting up the equipment for a postprocessed survey
- Setting up the equipment for a real-time and postprocessed survey
- Starting a rover survey
- RTK initialization methods
- Recommended RTK initialization procedure
- Postprocessed initialization methods
- Swapping bases during a real-time rover survey
- Ending a rover survey

Introduction

This chapter shows how to start the rover receiver for a GPS survey. It describes how to set up the equipment for use with different survey techniques.

You must initialize kinematic surveys to obtain centimeter-level precision. This chapter explains some common initialization methods, and recommends a method to use when initializing RTK surveys.

Note – *When surveying with GPS, make sure that you still follow good survey practices. Revise and update your code of good survey practice regularly, and* ***always*** *check your work.*

Setting Up the Equipment for a Real-Time Survey

This section shows how to assemble the hardware components at the rover receiver for a real-time kinematic (RTK) or real-time differential (RT differential) survey. Follow these steps if using a GPS Total Station 4800 or 4700 receiver. If using a Series 4000™ receiver, a Site Surveyor 4400 receiver, an MS750 receiver, or a 4600 LS™ receiver see Appendix D, Connection Diagrams.

Using a GPS Total Station 4800 Receiver and the Internal Radio

To set up a rover receiver for a real-time survey using a GPS Total Station 4800 receiver and the internal radio, see Figure 12.1. Then do the following:

1. Attach a battery to the PowerLiTE™ range pole.
2. Attach the 4800 receiver to the PowerLiTE range pole.
3. Connect the TSC1 data collector to the GPS receiver port 1.
4. Turn on the TSC1 and go to Starting a Rover Survey, page 315.

Note – *With this method, power is supplied by the battery in the range pole.*

Figure 12.1 shows how to set up the rover equipment for both a real-time survey using the internal radio and a postprocessed survey.

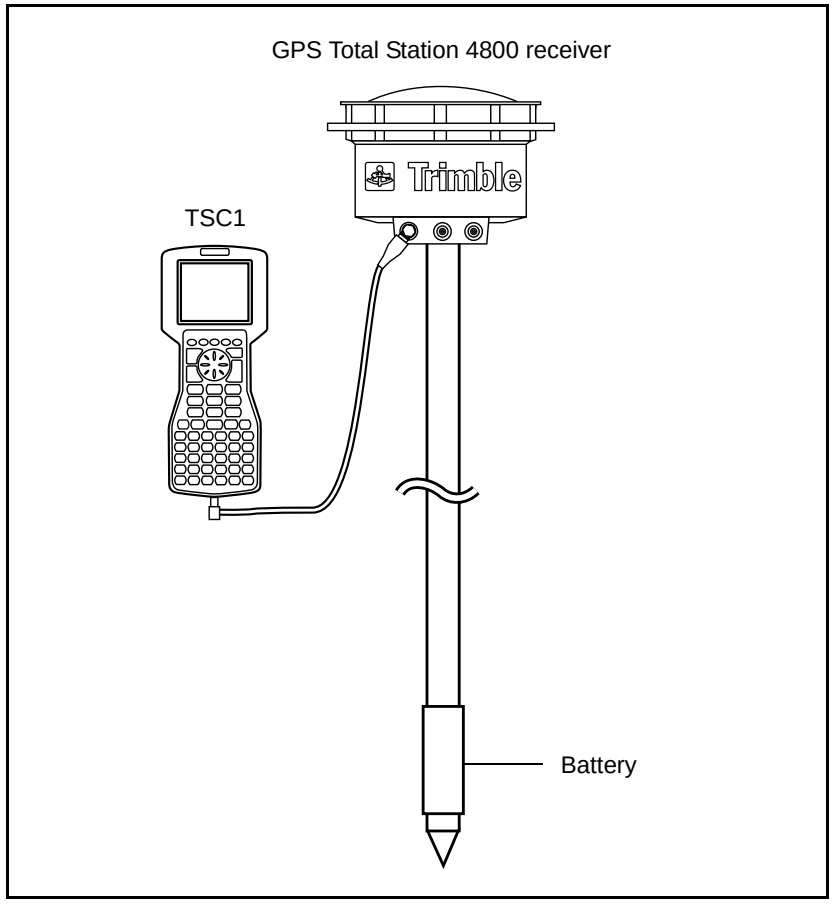


Figure 12.1 Real-time (internal radio) or postprocessed configuration using a GPS Total Station 4800 receiver

Using a GPS Total Station 4800 Receiver and an External Radio

To set up a rover receiver for a real-time survey using a GPS Total Station 4800 receiver and an external radio, see Figure 12.2. Then do the following:

1. Attach a battery to the PowerLiTE range pole.
2. Attach the GPS antenna to the range pole.

   Note – *Power for the GPS Total Station 4800 receiver is supplied by the battery in the range pole.*

3. Assemble the radio antenna and place the radio in a hip-pack or backpack.
4. Use the rover receiver Y-cable (part number 34382 or 37155, depending on the equipment) to connect the radio and its power supply to the GPS receiver port 3. Route the long end of the cable through the hip-pack before connecting it to the receiver. Connect the radio power supply and the radio cable to the two short ends in the hip-pack.
5. Turn on the receiver.
6. Connect the TSC1 data collector to the GPS receiver port 1.
7. Turn on the TSC1 and go to Starting a Rover Survey, page 315.

Figure 12.2 shows how to set up the rover equipment for a real-time survey using the external radio.

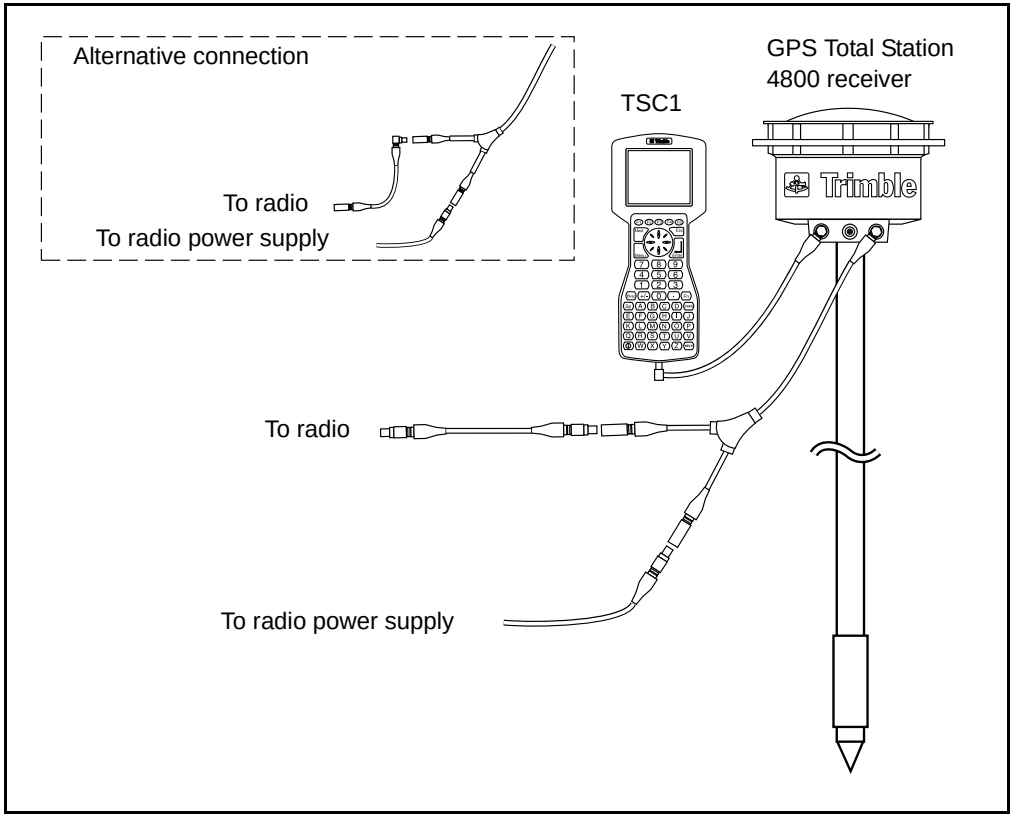


Figure 12.2 Real-time (external radio) configuration using a GPS Total Station 4800 receiver

Using a GPS Total Station 4700 Receiver and the Internal Radio

To set up a rover receiver for a real-time survey using a Trimble GPS Total Station 4700 receiver and the internal radio, see Figure 12.3. Then do the following:

1. Use a backpack to carry the GPS receiver, and mount the GPS antenna on a range pole.
2. Connect the GPS antenna to the GPS receiver port labeled GPS ANTENNA. Use the N-type to Lemo co-axial cable.
3. Assemble the radio antenna and fix it to the outside of the backpack.
4. Connect the radio antenna to the GPS receiver port labeled RADIO ANTENNA.

Warning – Do not force plugs into the receiver ports. Align the red dot on the plug with the red line on the socket and then insert the plug carefully.

5. Connect the power source to the GPS receiver port 2 and turn on the receiver.
6. Connect the TSC1 data collector to the GPS receiver port 1. Use the 0-shell Lemo to 0-shell Lemo cable.
7. Turn on the TSC1 and go to Starting a Rover Survey, page 315.

Figure 12.3 shows how to set up the rover receiver for a real-time survey using a GPS Total Station 4700 receiver and the internal radio.

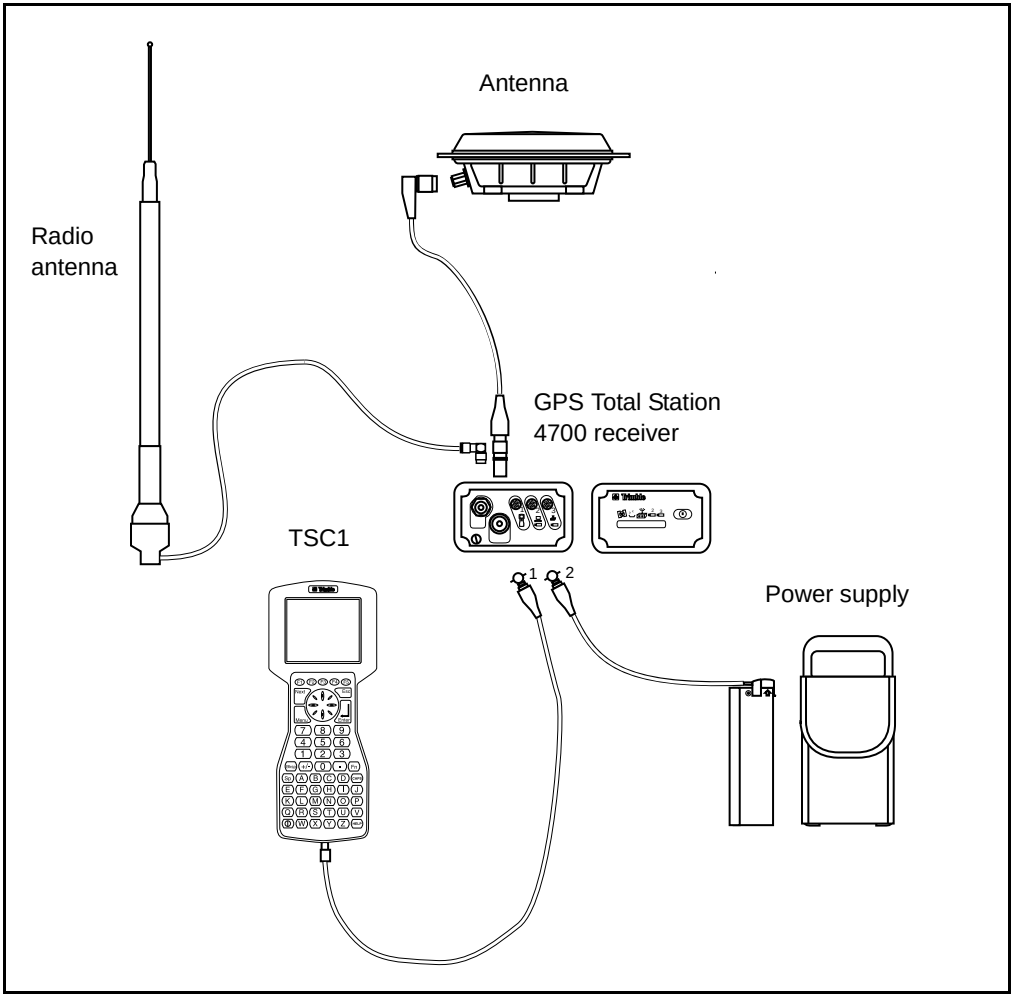


Figure 12.3 Real-time configuration using a GPS Total Station 4700 receiver and the internal radio

Using a GPS Total Station 4700 Receiver and an External Radio

To set up a rover receiver for a real-time survey using a Trimble GPS Total Station 4700 receiver and an external radio, see Figure 12.4. Then do the following:

1. Use a backpack to carry the GPS receiver, and mount the GPS antenna on a range pole.
2. Connect the GPS antenna to the GPS receiver port labeled GPS ANTENNA. Use the N-type to Lemo co-axial cable.
3. Assemble the radio antenna and fix it to the outside of the backpack.
4. Use the radio cable (part number 36241-03) to connect the radio to the GPS receiver port 3.

   Note – *For some third-party radios, a separate power supply is needed for the radio.*

Warning – Do not force plugs into the receiver ports. Align the red dot on the plug with the red line on the socket and then insert the plug carefully.

5. Connect the power source to the GPS receiver port 2 and turn on the receiver.
6. Connect the TSC1 data collector to the GPS receiver port 1. Use the 0-shell Lemo to 0-shell Lemo cable and route it through the backpack.
7. Turn on the TSC1 and go to Starting a Rover Survey, page 315.

Figure 12.4 shows how to set up the rover receiver for a real-time survey using a GPS Total Station 4700 receiver and an external radio.

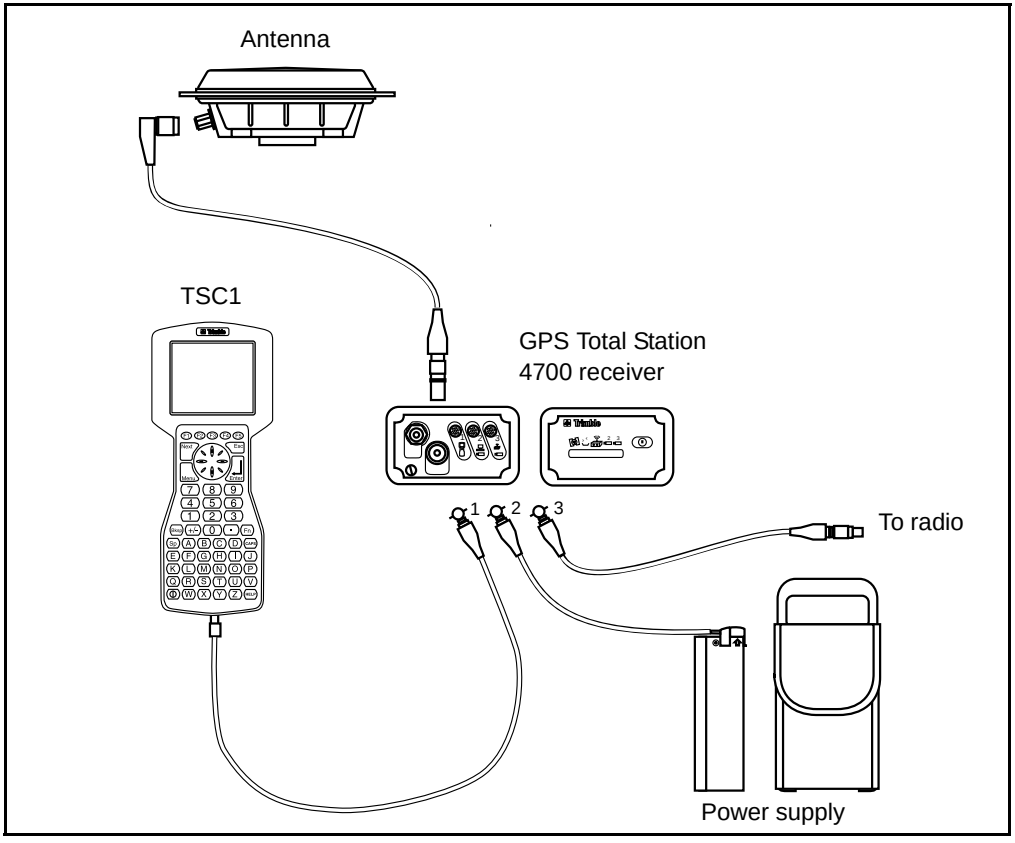


Figure 12.4 Real-time configuration using GPS Total Station 4700 receiver and an external radio

Setting Up the Equipment for a Postprocessed Survey

This section shows how to assemble the hardware at the rover receiver for a postprocessed kinematic (PP kinematic) survey, a PP differential survey, or a FastStatic survey. It describes the steps for a Trimble GPS Total Station 4800 or 4700 receiver. For a Series 4000™ receiver, a Site Surveyor 4400™ receiver, an MS750 receiver, or a 4600 LS™ receiver see Appendix D, Connection Diagrams.

Using a GPS Total Station 4800 Receiver

To assemble the rover receiver hardware for a postprocessed survey, see Figure 12.1 on page 307. Then do the following:

1. Attach a battery to the PowerLiTE™ range pole.
2. Attach the 4800 receiver to the PowerLiTE range pole and turn it on.
3. Connect the TSC1 data collector to the GPS receiver port 1.

Warning – Do not force plugs into the receiver ports. Align the red dot on the plug with the red line on the socket and then insert the plug carefully.

4. Turn on the TSC1 and go to Starting a Rover Survey, page 315.

   Note – *The power is supplied from the battery in the range pole.*

Using a GPS Total Station 4700 Receiver

To assemble the rover receiver hardware for a postprocessed survey, see Figure 11.6 on page 298. Then do the following:

1. Attach the GPS antenna to a range pole.
2. Connect the GPS antenna to the GPS receiver port labeled ANTENNA. Use the N-type to Lemo co-axial cable.

Warning – Do not force plugs into the receiver ports. Align the red dot on the plug with the red line on the socket and then insert the plug carefully.

3. Connect the power source to the GPS receiver port 2 and turn on the receiver.
4. Connect the TSC1 data collector to the GPS receiver port 1. Use the 0-shell Lemo to 0-shell Lemo cable.
5. Turn on the TSC1 and go to Starting a Rover Survey, page 315.

Setting Up the Equipment for a Real-Time and Postprocessed Survey

A Survey Style such as RTK & infill uses both real-time and postprocessed techniques. To conduct such a survey, assemble the rover exactly as for a real-time survey. If the receiver has no memory (or limited memory), leave the TSC1 connected to the base receiver for the purpose of data storage. A second TSC1 is required for the rover receiver.

Starting a Rover Survey

Only start a survey once you have started the base receiver (see Chapter 11, Starting the Base Receiver).

To conduct a survey:

1. Make sure that the required job is open. The title of the main menu should be the current job name.
2. From the main menu, choose *Survey*. Select a Survey Style from the list. This must be the same Survey Style used for the base survey.

A *Survey* menu is generated. It displays items specific to the chosen Survey Style and includes the *Start base receiver* and *Start survey* items.

When you start a survey using a particular Trimble Survey Style for the first time, the Trimble Survey Controller software prompts you to customize the Style for your specific hardware. For more information, see Using the Style Wizard to Customize a Trimble GPS Survey Style, page 119.

When the survey starts, the menu items *Start base receiver* and *Start survey* no longer appear. For kinematic surveys, a new item, *Initialization*, appears.

GPS Total Station 4800 or 4700 receiver

If the TSC1 is connected to a GPS Total Station 4800 or 4700 receiver that was logging data, the data logging is stopped. Data logging is restarted, in a different file, if you start a survey using a Survey Style that specifies data logging.

Note – *When you start a survey, the Trimble Survey Controller software automatically negotiates the highest possible baud rate for communicating with the connected receiver.*

Starting a Real-Time Rover Survey

To start the rover receiver for a real-time survey:

1. Select *Start survey.*
2. Make sure the rover is receiving radio corrections from the base.

   Note – *An RTK survey needs radio corrections.*

3. If the receiver you are using supports transmission delays and the *Prompt for station index* field in the *Rover options* option in the Survey Style is set to Yes, the *Select base station* screen appears. It shows all the base stations operating on the frequency you are using. The list shows the station index numbers of each base and the reliability of each. Highlight the base you want to use and press Enter.

   For more information about using transmission delays, see Operating Several Base Stations on One Radio Frequency, page 290.

Tip – If you want to check the point name of the base station being used in the rover survey, select *Files / Review current job* and inspect the Base point record.

4. If necessary, initialize the survey.

   For a differential survey, no initialization is necessary, and you can start to survey immediately. (See Chapter 15, Point Measurement Methods.)

   Note – *If you are doing an RTK survey but do not require centimeter-level results, select Survey/Initialization. Press* Init *and set the Method field to No initialization.*

   For an RTK survey, initialize before starting centimeter-level surveying:

   – If you are using a dual-frequency receiver with the OTF option, the survey automatically starts to initialize using the OTF initialization method.

   – If the OTF option is not installed, or if the receiver is a single-frequency receiver, the Trimble Survey Controller software enters the *Initialization* screen. Initialize the survey using one of the available methods—Known Point, Initializer Bar/Plate, or New Point. See RTK Initialization Methods, page 321.

5. When the survey is initialized you can perform a site calibration, measure points, or stake out.

Starting an RTK & Infill Rover Survey

To start the rover receiver for an RTK & infill survey:

Note – *If you are using postprocessed techniques, to process the data you must have the baseline processing module of the Trimble Geomatics Office™ software installed.*

1. Select *Start Survey.*
2. Make sure the rover is receiving radio corrections from the base.

   Note – *An RTK survey needs radio corrections.*

3. If the receiver you are using supports transmission delays and the *Prompt for station index* field in the *Rover options* option in the Survey Style is set to Yes, the *Select base station* screen appears. It shows all the base stations operating on the frequency you are using. The list shows the station index numbers of each base and the reliability of each. Highlight the base you want to use and press Enter.

   For more information about using transmission delays, see Operating Several Base Stations on One Radio Frequency, page 290.

Tip – If you want to check the point name of the base station being used in the rover survey, select *Files / Review current job* and inspect the Base point record.

4. Initialize the survey using an RTK initialization method. For more information, see page 321.
5. Measure points as usual.

Switching to PP infill

During periods when no base corrections are received, the following message flashes in the status line:

Radio link down

To continue surveying select *Start PP infill* from the *Survey* menu. When postprocessing infill starts, this item changes to *Stop PP infill*.

Raw data is logged at the rover during postprocessing (PP) infill. For successful baseline resolution, you must now use postprocessed kinematic observation techniques.

Note – *Initialization cannot be transferred between the RTK survey and the PP infill survey. Initialize the PP infill survey like any other postprocessed kinematic survey. See Postprocessed Initialization Methods, page 329.*

Only rely on the OTF (automatic) initialization if certain that the receiver will observe at least five satellites, without interruption, for the next fifteen minutes. Otherwise select *Initialization* from the *Survey* menu and perform an initialization.

Note – *You cannot stake out points during a postprocessed survey.*

When base corrections are received again, one of the following messages appears in the status line:

Radio link up (RTK=Fixed)

Radio link up (RTK=Float)

Which message appears depends on the initialization mode of the RTK survey. The first message is displayed if the receiver has retained the RTK initialization during the PP infill survey—it does this if the number of satellites does not fall below four throughout the PP infill survey.

Select *Stop PP infill* from the *Survey* menu to stop data logging at the rover. When postprocessing infill stops, this item changes back to *Start PP infill*. Real-time measurements are resumed.

Starting a Postprocessed Rover Survey

To start the rover receiver for a postprocessed survey, select *Start survey.*

Note – *If using postprocessed techniques, to process the data you must have the baseline processing module of the Trimble Geomatics Office software installed.*

For a FastStatic or differential survey, initialization is not required and surveying can begin immediately. See Chapter 15, Point Measurement Methods.

For a PP kinematic survey, initialization must be gained to achieve centimeter-level precisions when the data is processed:

- With dual-frequency receivers, the initialization process begins automatically if at least five L1/L2 satellites are being observed. The OTF option is not required for this initialization.
- With a single-frequency receiver, the *Initialization* screen appears when you select *Start Survey.* Initialize the survey using one of the available methods: Known Point or New Point.

For more information about initializing a postprocessed survey, see Postprocessed Initialization Methods, page 329. To measure points see Chapter 15, Point Measurement Methods.

Working in Float mode

Work in Float mode if you do not want to initialize a survey. Start the survey and select *Initialization*. When the *Initialization* screen appears, press Init. Set the *Method* field to No initialization and press Enter.

RTK Initialization Methods

If base corrections are being received and there are four or more satellites, the survey can be initialized. A survey must be initialized before centimeter-level surveying can begin.

Use one of the following methods to initialize dual-frequency RTK surveys:

- Known Point
- New Point
- Initializer Bar/Plate

If the rover receiver has the On-The-Fly (OTF) option installed, initialization is performed automatically. The New Point method is not available, but you can initialize on a known point. To do this, select *Survey* / *Initialization* and press Init.

Note – *At least five L1/L2 satellites are required for OTF initialization. After initialization, at least four satellites must be tracked. If the number of satellites drops below four, the survey must be reinitialized.*

Use one of the following methods to initialize single-frequency RTK surveys:

- Known Point
- New Point
- Initializer Bar/Plate

Table 12.1 summarizes methods of initializing a real-time kinematic survey, and the time required for each method.

Table 12.1 Initializing a Real-time kinematic survey

	Time required for each initialization method				
Survey and receiver type	**Known Point**	**Initializer Bar/Plate**	**New Point**	**OTF**	**Range (km)**
RTK Single-frequency	~15 s (5+ SVs) ~30 s (4 SVs)		~20 m	No	<10
RTK Dual-frequency	~15 s (5+ SVs) ~30 s (4 SVs)		~60 s, 5+ SVs	No	<10
RTK Dual-frequency with OTF	~15 s (5+ SVs) ~30 s (4 SVs)		No	~60 s, 5+ SVs	<10

Note – *Initialization must be maintained throughout the survey by continuously tracking a minimum of four satellites. If initialization is lost at any time, reinitialize and then continue the survey.*

After initialization, the survey mode changes from Float to Fixed. The mode remains Fixed if the receiver continuously tracks at least four satellites. If the mode changes to Float, reinitialize the survey.

Multipath

Initialization reliability depends on the initialization method used and on whether or not multipath occurred during the initialization phase. Multipath occurs when GPS signals are reflected off objects (such as the ground or a building).

The occurrence of multipath at the GPS antenna adversely affects GPS initializations and solutions:

- If initialization is by the Known Point or Initializer Bar method, multipath can cause an initialization attempt to fail.

- If initialization is by the OTF or New Point method, it is difficult to detect the presence of multipath during the initialization. If there is multipath, the receiver may take a long time to initialize or it may not initialize at all. See Recommended RTK Initialization Procedure, page 328.

The initialization process in Trimble receivers is very reliable but if an incorrect initialization does occur, Trimble's RTK processing routines detect it within 15 minutes (if the mode has remained Fixed). When the error is detected, the receiver automatically discards the initialization and issues a warning.

Note – *If you survey points with a bad initialization, position errors result. To minimize the effect of multipath during an OTF initialization, move around.*

On-The-Fly (OTF) Initialization

If a system has On-The-Fly (OTF) capability, initialization is automatic. Wait for the system to initialize. When the status line shows RTK=Fixed, the survey is initialized and you can start to measure points.

Known Point Initialization

To perform a Known Point initialization:

1. Position the rover antenna over a known point.
2. From the *Survey* menu, choose *Initialization*.
3. Set the *Method* field to Known Point and press Enter.
4. Enter a value in the *Point name* field. (This must be the name of a known point in the Trimble Survey Controller software database.) While still in the *Point name* field, press List. Select the point from the list of known points.
5. Enter values in the *Code* and *Antenna height* fields, and make sure that the setting in the *Meas. to* field is correct.

6. When the antenna is centered and vertical over the point, press Start or Enter.

   The data collector starts to record data, and the static icon (see page 42) appears in the status line.

   Keep the antenna vertical and stationary while data is recorded.

7. When the receiver is initialized, the results are displayed and the OK softkey appears. Press it to accept the initialization.

8. If the initialization fails, the results are displayed. The Trimble Survey Controller software asks if you want to retry. Press Yes or No.

New Point Initialization (No OTF)

To perform a New Point intialization:

1. Position the rover antenna a distance away from the base receiver.

Tip – Trimble recommends that you use a bipod attached to the range pole when using this method.

2. From the *Survey* menu, choose *Initialization*.

3. Set the *Method* field to New Point and press Enter.

4. Enter values for the *Point name*, *Code*, and *Antenna height* fields.

5. When the antenna is centered and vertical over the point, press Start or Enter.

   The data collector starts to record data, and the static icon appears in the status line.

   Keep the antenna vertical and stationary while data is recorded.

6. When the receiver has initialized, the OK softkey appears. Press it to store the point.

Using the Initializer Bar

There are two ways to initialize a Trimble 4600LS receiver using the Initializer Bar method.

Method 1 (Slot method)

1. Attach the roving antenna to the initializer bar as shown in Figure 12.5.
2. With a pocket compass, measure the azimuth from the base antenna to the rover antenna. This value should be accurate to 20°. Also measure the vertical offset of the rover antenna. If the antennas at the base and rover receivers are identical, the vertical offset is zero.
3. From the *Survey* menu, choose *Initialization*.
4. Set the *Method* field to Init bar (slot) and press Enter.
5. In the *Azimuth* field, enter the value measured with the pocket compass. Enter appropriate values in the *Horizontal offset* and *Vertical offset* fields.

   Note – *The horizontal offset is 0.25 m. This is indicated on the bar.*
6. When the rover antenna is properly attached and aligned, press Start or Enter.

   The data collector starts to record data, and the static icon appears in the status line.
7. When the receiver has initialized, the results are displayed and the OK softkey appears. Press it to accept the initialization.

Figure 12.5 shows the initializer bar setup using Method 1 (the Slot method).

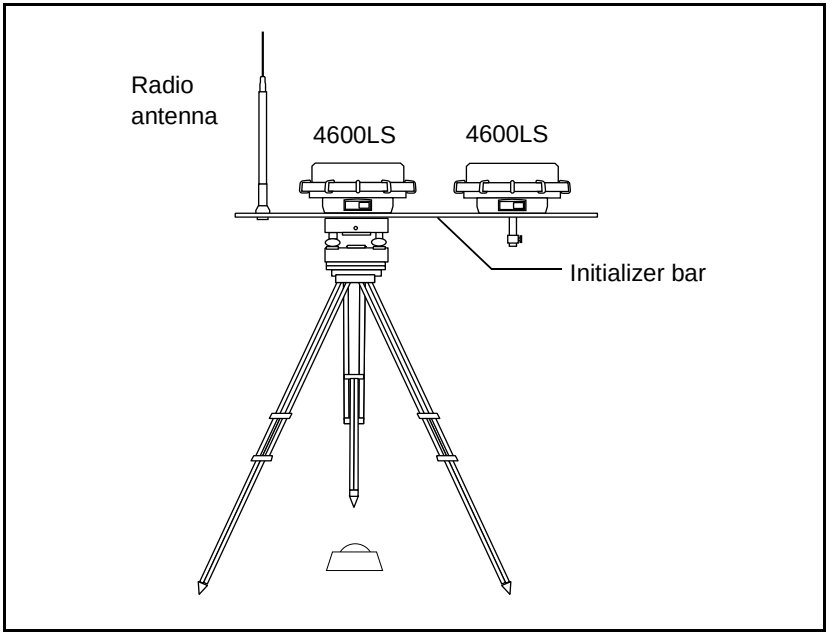


Figure 12.5 Initializer bar – method 1 (slot method)

Method 2 (Notch method)

If the rover is subsequently initialized during the survey, it is possible to leave the antenna on the range pole and lean/plumb it against the initializer bar in the notch provided (see Figure 12.6). The procedure is similar to Method 1 but you set the *Method* field to Init bar (notch), and enter the height of the rover antenna instead of the vertical offset. The horizontal offset is 0.35 m. Figure 12.6 shows the initializer bar setup using Method 2 (the Notch method).

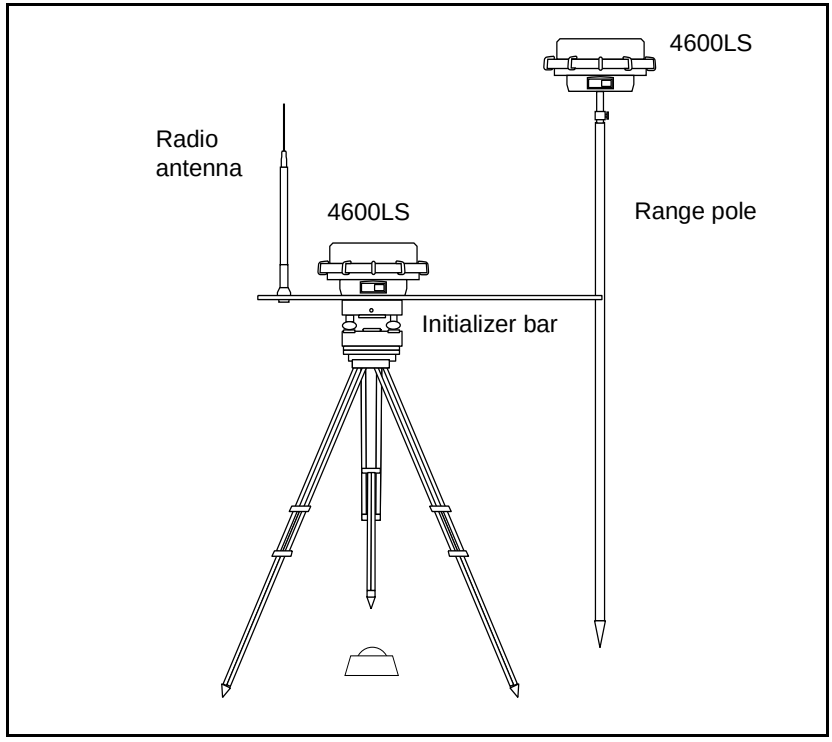


Figure 12.6 Initializer bar – method 2 (notch method)

Note – *With this method, the tip of the range pole must be level with the base mark.*

Recommended RTK Initialization Procedure

This section describes the procedure that Trimble recommends for performing a check on a New Point or an OTF RTK initialization.

Minimize the chance of surveying with a bad initialization by adopting good survey techniques. A bad initialization occurs when the integer ambiguities are not correctly resolved. The Trimble Survey Controller software automatically reinitializes when this is detected, but cannot do so if you end the survey too soon. As a precaution, always perform the RTK initialization described below.

When initializing, always choose a site that has a clear view of the sky and is free of obstructions that could cause multipath.

Note – *Known Point is the quickest method of initialization when known points exist.*

To perform a New Point or OTF initialization:

1. Initialize the survey using the New Point or OTF method of initialization.

Tip – When performing an OTF initialization, move around. This reduces the effect of multipath.

2. When the system is initialized, establish a mark about 9 meters or 30 feet from where the initialization occurred.
3. Conduct a static point measurement over the mark. Once this is done, discard the current initialization.
4. If using an adjustable height range pole, change the height of the antenna by approximately 8 inches.
5. Reoccupy the mark observed in Step 2, and reinitialize the survey using the Known Point method of initialization. Remember to enter the new antenna height details.

Follow this procedure to substantially minimize the occurrence of a bad initialization.

Measuring a New point creates a Known point on which the first initialization is tested. Changing the antenna height moves the GPS antenna from the environment in which the test point was initially surveyed. Always enter the new antenna height before starting the Known Point initialization.

Postprocessed Initialization Methods

In a postprocessed survey initialization must be gained to attain centimeter-level precisions.

Use one of the following methods to initialize dual-frequency postprocessed (PP) kinematic surveys in the field:

- On-The-Fly (OTF)
- Known Point
- New Point

Note – *The OTF receiver option is not necessary for postprocessed OTF initializations.*

Use one of the following methods to initialize single-frequency PP kinematic surveys in the field:

- Known Point
- New Point

Always collect sufficient raw data when using these methods.

Table 12.2 shows the time required to initialize a postprocessed kinematic survey using the various initialization methods.

Table 12.2 Trimble PP Kinematic Initialization Times

Initialization method	4 SVs	5 SVs	6+ SVs
L1/L2 OTF initialization	N/A	15 min	8 min
L1/L2 New Point initialization	20 min	15 min	8 min

Table 12.2 Trimble PP Kinematic Initialization Times (Continued)

Initialization method	4 SVs	5 SVs	6+ SVs
L1 New Point initialization	30 min	25 min	20 min
Known Point initialization	at least four epochs		

Note – *In a postprocessed survey, collect enough data during initialization so that the WAVE™ processor can successfully process it. Table 12.2 shows Trimble's recommended times.*

After initialization, the survey mode changes from Float to Fixed. The mode remains Fixed if the receiver continuously tracks at least four satellites. If the mode changes to Float, reinitialize the survey.

Note – *If you do an On-The-Fly initialization in a postprocessed kinematic survey, it is possible to measure points before initialization is gained. The GPSurvey software can back-process the data later to give a fixed solution. If you do this but lose lock on the satellites while initializing, re-measure any one of the points that you surveyed before lock was lost.*

To work without initializing the survey (in Float mode), start a survey and select *Initialization*. When the *Initialization* screen appears, press Init. Set the *Method* field to No initialization and press Enter.

On-The-Fly (OTF) Initialization

If you are using a dual-frequency receiver, the initialization process begins automatically when at least five L1/L2 satellites are being tracked.

Known Point Initialization

In a postprocessed survey you can initialize on:

- a point measured previously in the current job
- a point that you will provide coordinates for later (before the data is postprocessed)

For instructions on how to do a Known Point initialization see page 323.

New Point Initialization

In a postprocessed survey, you can change the initialization times if necessary. The default times are Trimble's recommended minimum times. For instructions on how to do a New Point initialization see page 324.

Swapping Bases During a Real-Time Rover Survey

If you are using multiple bases on the same frequency, you can swap bases during the rover survey. For more information, see Operating Several Base Stations on One Radio Frequency, page 290.

To swap bases, do the following:

1. From the *Survey* menu, select *Swap base receiver.*

   The *Select base station* screen appears. It shows all the base stations operating on the frequency you are using. The list shows the station index numbers of each base and the reliability of each. Highlight the base you want to use and press Enter.

Note – *When you change to a different base, you need to perform an initialization. If the receiver has OTF capability, the initialization starts automatically.*

Ending a Rover Survey

When you have measured or staked out all points required, do the following:

1. From the *Survey* menu, choose *End survey.*

   Press Yes to confirm the instruction. The Trimble Survey Controller software asks if you want to power down the receiver. Press Yes again to power down the receiver.

2. Turn off the TSC1 data collector ***before*** disconnecting the equipment.

3. Return to the base station and end the base survey (see Ending a Base Survey, page 304.)

CHAPTER

13

Calibration

In this chapter:

- Introduction
- When to calibrate
- Notes and recommendations
- Performing a manual site calibration
- Using auto calibrate

Introduction

This chapter shows how to perform a calibration in the field, both manually and automatically. Before reading it, you should be familiar with Chapter 5, Coordinate Systems. There is also useful information about base station coordinates on page 280.

When to Calibrate

For a GPS survey or a survey that combines GPS measurements and conventional measurements with local control points, always complete a calibration ***before*** staking out any points, or computing offset or intersection points.

For a survey that uses conventional measurements only, no calibration is required.

Notes and Recommendations

- You can perform a calibration using one of the real-time GPS Survey Styles in the Trimble Survey Controller software. Do a manual calibration, or let the Trimble Survey Controller software do it automatically. If all the points have been measured, there is no need to connect the TSC1 data collector to a receiver during a manual calibration.
- Multiple calibrations can be performed in one job. The last calibration performed and applied is used to convert the coordinates of all previously surveyed points in the database.
- You can use up to 20 points for a calibration. Trimble strongly recommends a minimum of four three-dimensional local grid coordinates (N, E, E) and four observed WGS-84 coordinates, with the local projection and datum transformation parameters (the coordinate system). This should provide adequate redundancy.

Note – *You can use a combination of one-dimensional, two-dimensional, and three-dimensional local grid coordinates.*

If no projection and no datum transformation are defined, you must have at least one 2-dimensional grid point.

If the coordinate system is not specified, the Trimble Survey Controller software calculates a Transverse Mercator projection and a three-parameter datum transformation.

- Use Trimble Geomatics Office, Data Transfer, Trimble Survey Office, GPSurvey, TRIMMAP™ software, or ASCII transfer to upload control points.
- Be careful when naming points that are to be used in a calibration. First familiarize yourself with the database search rules on page 211.
- The set of WGS-84 coordinates must be independent of the set of grid coordinates.
- You select the grid coordinates. Select the vertical coordinates (Elevation), the horizontal coordinates (Northing and Easting values), or all of these together.
- Place the calibration points around the perimeter of the site. Do not survey outside of the area enclosed by the calibration points, as the calibration is not valid beyond this perimeter.
- The origin of the horizontal adjustment in a calibration is the centroid of the measured calibration points. The origin of the vertical adjustment is the first point in the calibration that has an elevation.
- When reviewing a calibration point in the database, notice that the WGS-84 values are the ***measured*** coordinates. The grid values are derived from these, using the current calibration.

  The original keyed-in coordinates remain unchanged. (They are stored elsewhere in the database as a point with the *Type* field showing Keyed in coordinates and the *Stored as* field showing Grid.)

- When you are calibrating a no projection, no datum job, (where Ground coordinates are required after calibration) you must define the reference elevation (average site elevation). When the job is calibrated, the reference elevation is used to compute the scale factor for the projection, using the inverse of the ellipsoid correction.

  When Grid coordinates are specified, the scale factor in the projection is set to one after a site calibration.

- When you are calibrating a Scale-only job, the scale factor specified in the Scale-only job is used as the scale factor in the projection after calibration.

Performing a Manual Site Calibration

To calibrate a survey manually the general procedure is as follows:

1. Key in, upload, or use a conventional instrument to measure the grid coordinates of the control (calibration) points.
2. Check or set the calibration tolerances (see Site Calibration, page 137).
3. Measure the control points using GPS.
4. Name or select the pairs of points to be used for the calibration. A pair of points consists of the grid coordinates and the WGS-84 coordinates for the same point.
5. Perform the calibration.
6. Check residuals, and recalibrate if necessary.
7. Apply the calibration.

Note – *Before starting a manual calibration, read the Notes and Recommendations at the beginning of this chapter.*

The following steps describe how to select the points for a calibration and then perform the calibration using the Trimble Survey Controller software. Do this once you have entered grid coordinates, checked the settings in the Survey Style, and measured the points using GPS.

1. From the main menu, choose *Survey.* Select a real-time Survey Style.
2. From the *Survey* menu, choose *Site calibration*. The *Site calibration* screen appears.
3. Press Add. The *Calibration point* screen appears as shown in Figure 13.1.

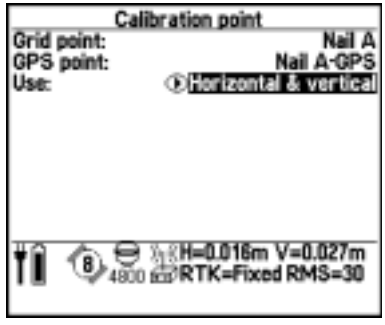


Figure 13.1 Calibration point screen

4. Enter the name of the grid point. To do this, highlight the *Grid point* field and press List. Select a point that you have keyed in, uploaded, or measured using a conventional instrument. Do the same for the *GPS point* field. The two point names do not have to be the same, but they should correspond to the same physical point.

   Set the *Use* field as required. Choose whether to use the vertical coordinate of the grid point, the horizontal coordinates, or both horizontal and vertical coordinates.

5. Press Calc. The *Site calibration* screen appears, as shown in Figure 13.2.

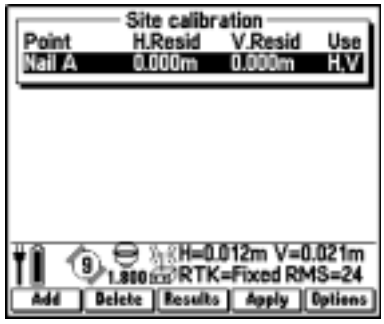


Figure 13.2 Site calibration screen

The residuals for each point are not displayed until at least three 3D points are included in the calibration to provide redundancy.

6. Press Results to see the horizontal and vertical shifts that the calibration has calculated. The *Calibration results* screen appears, as shown in Figure 13.3.

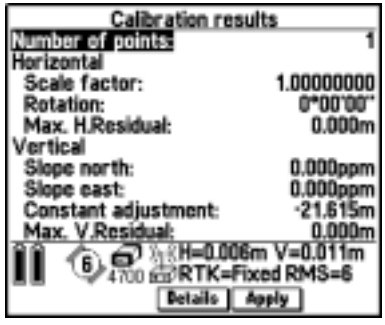


Figure 13.3 Calibration results screen

7. To add more points, press Esc to return to the *Calibration* screen.

8. Repeat Steps 3 through 6. Continue until all the points are added.

9. Do one of the following:
   - If the residuals are acceptable, press Apply to store the calibration.
   - If the residuals are not acceptable, recalculate the calibration.

Recalculating a Calibration

Recalculate a calibration if the residuals are not acceptable, or if you want to add or delete points. Recalculate using one of the following:

- some of the points
- only the horizontal component of a point
- only the vertical component of a point

To recalculate a calibration:

1. From the main menu, select *Survey.* Select a real-time Survey Style.
2. From the *Survey* menu, choose *Site calibration*.
3. Do one of the following:
   - To remove (exclude) a point, highlight the point name and press Delete.
   - To add a point, press Add. For more information, see Step 4 on page 337.
   - To change which components are used for a point, highlight the point name and press Enter. Change the *Use* field as required. (Choose whether to use the vertical coordinate of the grid point, the horizontal coordinates, or both horizontal and vertical coordinates.)
4. Press Apply to apply the new calibration.

Note – *Each calibration calculation is independent of the previous one. When a new calibration is applied, it overwrites any previously calculated calibration.*

Using Auto Calibrate

A calibration calculates the parameters needed to convert the GPS-measured coordinates into local grid coordinates. During an RTK survey, the Trimble Survey Controller software can do this automatically. When you use the Auto calibrate function, it automatically computes and stores a calibration every time a calibration point is measured.

In general, to calibrate a survey automatically:

1. Key in, upload, or use a conventional instrument to measure the grid coordinates of the local control points.
2. Set the *Auto calibrate* field to Yes.
3. Use GPS to measure the calibration points.

These three steps complete the automatic calibration.

The following steps are optional:

4. Inspect the calibration results.
5. Change the results if they are unsatisfactory.

Note – *Carry out the complete calibration* ***before*** *staking out any points, computing offset and/or intersection points, or computing a resection from GPS points.*

Keying In Grid Coordinates

To key in grid coordinates:

1. From the main menu, select *Key in / Points*. The *Key in*/*Point* screen appears. Move the highlight to the *Point name* field and press ⊙.
2. Type the point name. Press Enter.
3. Type details or features of the point in the *Code* field. Press Enter.
4. Set the *Type* field to Coordinates. Check that the coordinate fields are *North*, *East*, and *Elevation*. If they are not, press Options and change the *Coordinate view* setting to Grid. Key in the known grid coordinates and press Enter.
5. Set the *Search class* field to Control. (This ensures that the point is not overwritten by a measured point.) For more information on Search class rules, see Database Search Rules, page 211.
6. Repeat Steps 2 and 3 for all grid coordinate points. Then press Esc or OK to return to the *Key in* screen. Press Esc again to return to the main menu.

Uploading Grid Coordinates

Upload coordinates using Trimble Geomatics Office, Data Transfer, Trimble Survey Office, GPSurvey, or TRIMMAP software, or ASCII transfer. For more details see Data Transfer Between the TSC1 and the Office Computer, page 156.

Make sure that these coordinates are:

- uploaded as grid coordinates (N, E, E), not as WGS-84 coordinates (L, L, H)
- Control class points

Using a Conventional Instrument to Measure Grid Points

Please see Station Setup, page 468.

Setting Auto Calibrate to Yes

To set Auto calibrate to Yes:

1. From the main menu, choose *Survey.* The *Select Survey Style* menu appears.
2. Highlight your RTK Survey Style and press Edit. The menu that appears has the same name as the RTK Survey Style that you added.
3. Select *Site calibration*. The *Site calibration* screen appears.
4. Set the *Auto calibrate* field to Yes. (To change the calibration tolerances see Site Calibration, page 137.) Press Enter to accept the screen. This takes you back to the menu for the chosen Survey Style.
5. Press OK or Esc to return to the *Select Survey Style* menu. Press Esc again to return to the main menu, or Enter to access the *Survey* menu.

Using GPS to Measure Calibration Points

Use GPS to survey the points. The Trimble Survey Controller software automatically matches the grid points to the WGS-84 values and then calculates, stores, and applies the calibration.

When one point has been calibrated or a projection and datum transformation have been defined, the Find softkey appears. You can use this to navigate to the next point.

As you measure another calibration point, the new calibration is calculated, stored, and applied to the job.

To measure a calibration point:

1. From the main menu, choose *Survey.*
2. From the *Select Survey Style* menu, choose your RTK Survey Style.
3. Select *Measure points*. Arrow down and change the *Type* field to Calibration point.
4. Access the *Grid point name* field and press List. A list of keyed in grid coordinates appears. Highlight the point to be measured and press Enter. The point name is inserted into the *Grid point name* field.

Tip – If you have not yet keyed in the grid coordinates for this point, press Key in while the cursor is in the *Point name* field. The *Key in/Point* screen appears. Enter the coordinates and then press Enter.

The *GPS point name* field is filled in by the Trimble Survey Controller software depending on the settings in the *Calibration point name* field in the *Site calibration* option in the Survey Style.

5. Enter values for the *Code* and *Antenna height* fields. Press Enter to accept the screen.
6. When the antenna is centered and vertical over the control point, press Measure or Enter. The data collector starts to record data.

   Keep the antenna vertical and stationary while data is recorded.
7. When the preset required time has elapsed, the Store softkey appears. Inspect the precisions. If they are satisfactory, press Store to store the point.
8. The calculations are then done automatically and the results are stored. While this is happening, the following messages appear:

   Please wait. Storing point
   Calculating calibration
   Storing calibration

Note – *When the Trimble Survey Controller software is performing an automatic calibration, the results of the calibration are not normally displayed. However, if a calibration exceeds the tolerances that have been set, the residuals* ***are*** *displayed. For more information, see the next section.*

9. Enter the next calibration point name in the *Point name* field and press Find. The graphical display screen appears, with the azimuth and distance to the next point displayed on the right.

   To use the arrow display, start moving with the TSC1 data collector held in front of you as normal. The arrow points in the direction of the next calibration point. Walk towards the point. About 10 feet (or three meters) from the point, the arrow disappears and the point is displayed. For more information, see Using the Graphical Display to Navigate, page 400.

   When the point is located, press Esc.

10. Go back to Step 4 and measure the next calibration point. Repeat the procedure until all the calibration points are measured.

If Calibration Tolerances Are Exceeded

The calibration residuals are only displayed if the calibration tolerances are exceeded.

The residuals appear in the *Site calibration* screen, as shown in Figure 13.4.

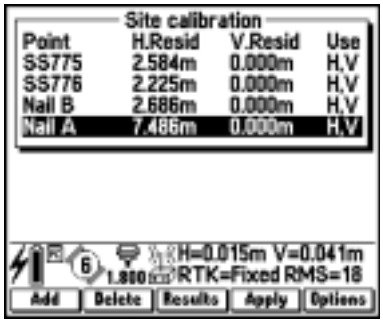


Figure 13.4 Site calibration screen

Should this happen, consider removing the point with the most extreme residuals:

- If at least four points are left after removing that point, recalibrate using the remaining points.
- If not enough points are left after removing that point, measure it again and recalibrate.

It may be necessary to remove (and measure again) more than one point.

To remove a point from the calibration calculations:

1. Highlight the point name and press Enter.
2. Change the setting in the *Use* field to Off and press Enter.

   The calibration is recalculated and the new residuals are displayed.
3. Press Apply to accept the calibration.

Inspecting the Results of an Automatic Calibration

To view the results of an automatic calibration:

1. From the *Survey* menu, choose *Site calibration*. The *Site calibration* screen appears.
2. Press Results to see the *Calibration results* screen. For more information, see Figure 13.3 on page 338.

Changing the Results of an Automatic Calibration

To change a calibration that has been calculated using the *Auto calibrate* function, select *Site calibration* from the *Survey* menu. Then proceed as described in Performing a Manual Site Calibration, page 336.

CHAPTER

14

Instrument Menu

In this chapter:

- Introduction
- Satellites
- Position
- Copy receiver files
- Receiver status
- Options
- Remote controller
- Navigate to point
- Station setup details
- Instrument controls
- Target

Introduction

If the TSC1 data collector is connected to a GPS receiver or a conventional instrument, this menu appears when you choose the *Instrument* icon from the main menu.

Items in the *Instrument* menu depend on the equipment that is connected to the TSC1. If this is a GPS receiver, the items are:

- Satellites
- Position
- Copy receiver files (optional—this depends on what receiver you use)
- Receiver status
- Options
- Remote controller
- Navigate to point

If a conventional instrument is connected to the TSC1 data collector, the items in the Instrument menu are:

- Station setup details
- Target
- Instrument controls (optional—this is available when a servo or robotic instrument is connected)

Satellites

From the main menu, select *Instrument* / *Satellites*. The *Instrument/Satellites* screen displays text (list) or a graphical (plot) information about the satellites being tracked by the receiver.

For information about the satellite icon in the status line, see Table 3.4 on page 44.

Satellite List Screen

In the list of satellites, each horizontal line of data relates to one satellite. A satellite is identified by the space vehicle number in the *SV* column. Azimuth (*Az*) and elevation (*Elev*) define a satellite's position in the sky. The signal-to-noise ratios (*SNRL1* and *SNRL2*) indicate the strength of the respective GPS signals. The greater the number the better the signal. If L1 or L2 are not being tracked, then ----- appears in the appropriate column. See also Table 14.2 on page 350.

The check mark on the left of the screen indicates whether the satellite is in the current solution. See Table 14.1.

Table 14.1 Explanation of check marks

Situation	What a check mark indicates
No survey is running	Satellites being used in the current position solution
RTK survey is active	Satellites common to the base and rover receivers
Postprocessed survey is running	Satellites for which one or more epochs of data have been collected

To obtain more information about a satellite, highlight its number and press Info. In the *Instrument* / *Satellites* / *Info* screen, press Prev or Next to select the desired satellite. Alternatively, enter the SV number from the keypad. To disable the tracking of satellites, press Disable. When a satellite is disabled in this way, the Disable softkey changes to Enable. Press it to enable the satellite again.

Note – *If you disable a satellite, it remains disabled until you enable it again. The receiver stores the fact that a satellite is disabled, even when it is turned off. WAAS satellites cannot be disabled.*

Figure 14.1 shows a typical list screen.

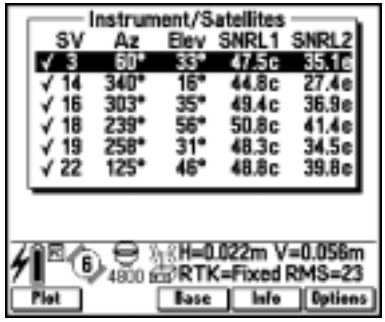


Figure 14.1 Satellite list screen

In a real-time survey, press Base to see which satellites are being tracked by the base receiver. No values appear in the *Az* and *Elev* columns, as this information is not included in the correction message broadcast by the base.

Note – *The* Base *softkey is not available if you are using a Series 4000 receiver.*

Table 14.2 explains the letters that appear in the *SNRL1* and the *SNRL2* columns.

Table 14.2 Letters in SNRL columns

Letter	Explanation
c	C/A-code is being tracked
x	P-code is encrypted and the cross-correlation technique is being used in the calculations
e	P-code is encrypted and Trimble's Super-trak™ technology is being used in the calculations

In a postprocessed survey, L1 appears. Press it to display a list of cycles tracked on the L1 frequency for each satellite. Figure 14.2 shows an example of this list.

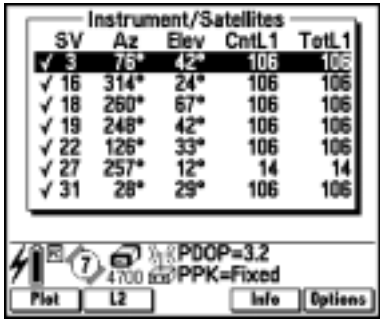


Figure 14.2 L1 satellite list screen in a postprocessed survey

The value shown in the *CntL1* column is the number of cycles on the L1 frequency that have been tracked continuously for that satellite. The value shown in the *TotL1* column is the total number of cycles that have been tracked for that satellite since the start of the survey.

With a dual-frequency receiver, L2 appears. Press it to display a list of cycles tracked on the L2 frequency for each satellite.

The SNR softkey appears. Press it to return to the original screen and view information about the signal-to-noise ratio for each satellite.

Satellite Plot Screen

Use Plot and List to toggle between the list and plot screens. Figure 14.3 shows a typical plot screen.

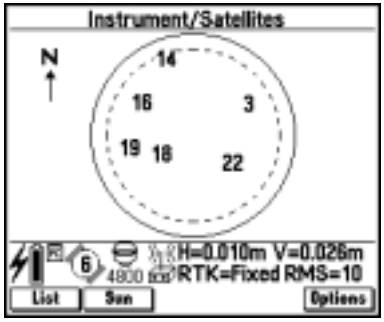


Figure 14.3 Satellite plot screen

In the plot screen:

- The outside circle represents the horizon or 0° elevation.
- The inner dashed circle represents the elevation mask setting.
- The SV numbers on the diagram are placed in the position of that particular satellite.
- The zenith (90° elevation) is the center of the circle.
- Satellites that are tracked but not in the solution appear in reverse video (white on black).

The plot screen can be oriented towards north, or towards the sun if you do not know where north is. Press Sun to orient the display towards the sun.

Position

From the main menu, select *Instrument* / *Position.*

If the antenna height is defined, the software computes the position of the roving antenna:

- Press Base to display the position of the base antenna as well.
- Press Options to determine whether the position is shown as WGS-84, Local, or Grid.

Copy Receiver Files

This option is only displayed when a 4600LS receiver, or a GPS Total Station 4800 or 4700 receiver, is in use. Use this option to copy and delete files in the connected receiver.

From the main menu, select *Instrument* / *Copy receiver files*. The *Copy receiver files* list appears. This is a list of all files stored in the receiver.

Note – *If a file is in use, a padlock icon (🔒) appears next to the file name. You cannot copy or delete the file while it is being used.*

To see more information about a file:

- Highlight the file name and press Info.

To delete a file:

- Highlight the file name and press Delete.

To undelete a file:

- Press Undelete, highlight the file name and press Enter.

To copy files to the Trimble Survey Controller software:

1. Select the file(s) to be copied:
   – To copy one file, highlight the file name and press Enter.

– To copy more than one file, highlight the first file and press ✓. Then highlight the next file and do the same. When all the files that are to be copied are highlighted, press Enter.

– To copy all files, press All and then press Enter.

2. The *Copy file to TSC1* screen appears. If a PC card is inserted, an extra field called *File location* appears. Select Main memory or PC card and press Start.

3. When the files have been copied a message appears:

   Copy file. Copy completed successfully

4. Press OK to return to the *Instrument* menu.

Receiver Status

From the main menu select *Instrument* / *Receiver status*.

The screen displays the power and memory status of the connected GPS receiver, the GPS time (in seconds), and the GPS week.

Press Errors to display the contents of the error log from the receiver.

Options

From the main menu, select *Instrument* / *Options*.

The screen displays the configuration of the connected GPS receiver. It includes information such as the serial number, the firmware version, and hardware and firmware options.

Remote Controller

From the main menu, select *Instrument* / *Remote controller.*

This gives you access to Trimble's Remote Controller software functionality using the Trimble Survey Controller software. You can use it to view and set values in the receiver, such as NMEA output.

The Remote Controller function is based on the front panel of a Series 4000™ receiver. Figure 14.4 shows the first screen that appears.

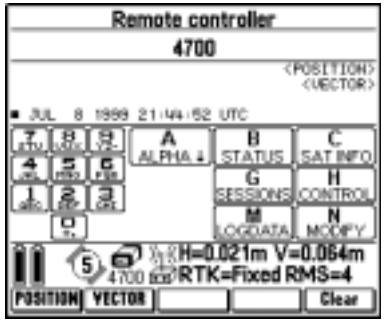


Figure 14.4 Remote controller screen

In the Trimble Survey Controller software, the softkeys correspond to menu items. The hard keys (A), (B), (C), (G), (H), (M), and (N) correspond to the menus. Use the hard keys (0) to (9) to enter alphanumeric characters.

Press Clear to return to the previous menu and press Esc to return to the Trimble Survey Controller software.

Warning – When you use the Remote Controller function in the Trimble Survey Controller software, you can make settings in the receiver that can affect the current survey. In some cases data can be lost.

Navigate to Point

It is not essential to have a radio link or a survey running to navigate to a point. If there is no radio link, all positions are autonomous. If radio corrections are received but the receiver is not initialized, all positions are Float solutions.

If you are using a GPS receiver that can track WAAS signals, when the radio link is down you can use WAAS positions instead of autonomous positions. To use WAAS positions, set the *WAAS* field in the Survey Style to On.

Note – *If you use the Navigate to point function with an external display, the Trimble Survey Controller software uses the same Survey Style settings used in the previous survey.*
The display does not work if that survey used a Survey Style—such as FastStatic—that has no External display (NMEA output) options. For the display to work, the Enabled field in the External display (NMEA output) option must be set to Yes. Access this field in the Stakeout option for the Survey Style you are using, or in the Options screen when navigating to the point.

To navigate to a point:

1. From the main menu, select *Instrument* / *Navigate to point*.
2. In the *Point name* field, enter the name of the point that you want to navigate to.
3. Set the *Navigate* field. The options are To the point, From fixed point, and From start position. The From fixed point and From start position options both provide cross-track information in the graphical screen display. For more information about these see, page 402.
4. Enter a value in the *Antenna height* field and press Start . The stakeout graphical screen display appears. The coordinate differences are displayed, together with a graphical representation of this.

Figure 14.5 shows two screens with different display configurations:

– In the left screen, the *Display grid deltas* field in the *Options* screen is set to No.

– In the right screen, the *Display grid deltas* field is set to Yes.

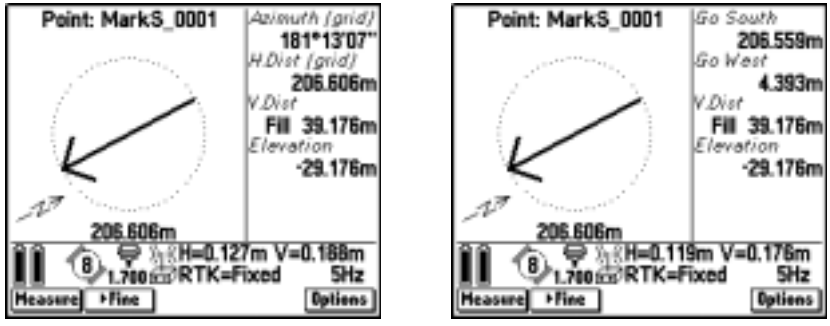


Figure 14.5 Grid deltas – not displayed, displayed

5. Use the graphical display or the text display to navigate to the point.

To use the arrow as a guide, start moving. Hold the TSC1 data collector in front of you as normal. The arrow points in the direction of the point to be staked out. Walk forwards towards the point.

The direction arrow only works correctly when you are moving ***forwards*** and holding the TSC1 data collector in front of you. In a real-time survey, the display updates one position per second or five positions per second, depending on the equipment used (see Fine and Coarse Modes, page 399). If you are not sure how to use the arrow, use the text side of the display to locate the point.

About three meters (or ten feet) from the point, the arrow disappears and the point is shown as a bull's-eye symbol. Your current position is shown as a cross. See Figure 14.6. When these two symbols coincide, check the precisions and mark the point if required.

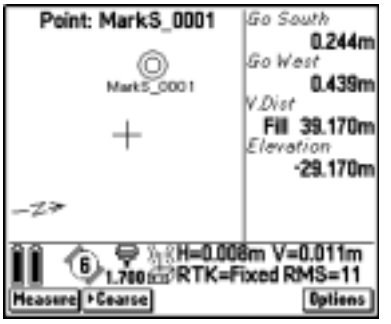


Figure 14.6 Navigate to point graphical display

When the screen display changes from an arrow to a bull's-eye and a cross, the orientation of the display is fixed.

Station Setup Details

If the TSC1 data collector is connected to a conventional instrument, select *Instrument* / *Station setup details* to view the instrument type and current station setup information.

Instrument Controls

If the TSC1 data collector is connected to a servo or robotic conventional instrument, the *Instrument controls* option appears. Use this option to control the movement of the instrument. Figure 14.7 shows the screen that appears:

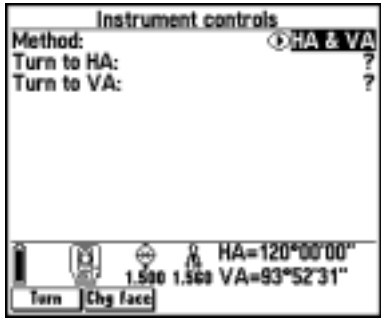


Figure 14.7 Instrument controls screen

If you are using a robotic instrument, you can use the TSC1 data collector to operate the instrument remotely through radio communication. This allows the TSC1 data collector to guide the instrument to measure or stakeout points from the target (prism).

Turning the Instrument

Choose one of the following methods to turn the instrument:

- HA & VA
- Point name

HA & VA

Use this option to turn the instrument to a specified angle.

Do one of the following:

- Enter the horizontal angle in the *Turn to HA* field to turn the instrument to a horizontal angle only, and press Turn.

- Enter the horizontal angle in the *Turn to HA* field and the vertical angle in the *Turn to VA* field to turn the instrument to a horizontal and vertical angle, and press Turn.

The instrument turns to the angle(s) you entered.

Point Name

Use this option to turn the instrument to a specified point.

- Enter a point name in the *Point name* field and press Turn.

The instrument turns to the point you entered.

Changing the Face

To switch between Face 1 and Face 2 (direct and reverse) of the instrument, press Chg face.

The message Please wait. Instrument Turning appears and the instrument turns to the opposite face.

Locating and Locking on to the Target

The Joystick softkey appears in the *Instrument controls* screen when you operate the instrument remotely from the target (prism). Use the softkey to turn the instrument towards the target when lock has been lost.

To turn the instrument towards the target:

1. Press Joystick. The *Joystick Mode* screen appears, as shown in Figure 14.8.

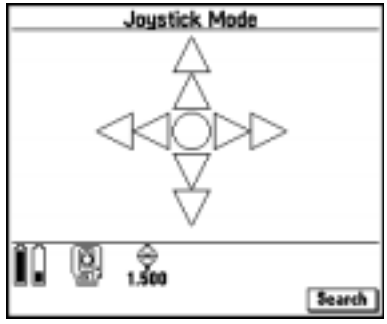


Figure 14.8 Joystick mode screen

2. Press ◄, ►, ▼, or ▲ on the arrow keypad of the TSC1 data collector to select a direction to turn the instrument. The instrument will turn in the direction indicated by the solid/filled arrow, as shown in Figure 14.9.

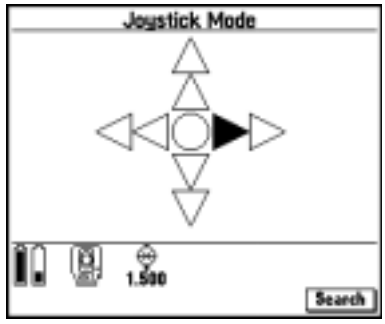


Figure 14.9 Joystick mode screen–direction of instrument turning

Note – *When the instrument is on Face 2, the up and down arrows are reversed. For example, if you press ▼, the instrument will turn in an upwards direction. If you press ▲, the instrument will turn in a downwards direction.*

3. Select the same direction to increase the instrument turning speed. The second directional arrow will become solid. Select the same arrow to decrease the speed again.
4. Press Esc or another arrow to stop the instrument from turning. The directional arrows will become hollow.

   The instrument is now pointing towards the target.

To make the instrument locate and lock on to the target:

- Press Search.

  The message Searching... appears on the screen and the instrument starts searching for the target.

The results of the search are indicated by the following status line messages:

- Target Locked–indicates that the target has been located and tracking locked.
- Target Detected–indicates that the target has been located (when the instrument is in servo mode).
- No Target–indicates that the target was not located.

Target

If the TSC1 data collector is connected to a conventional instrument, select *Instrument* / *Target* to view the target height and the prism constant currently in use.

CHAPTER

15

Point Measurement Methods

In this chapter:

- Introduction
- Default point name
- Point name incrementation
- Next free point name search
- Survey/measure points screen in a gps survey
- Survey/measure points screen in a conventional survey
- Measuring a topo point in a GPS survey
- Measuring a FastStatic point
- Measuring an observed control point
- Measuring a rapid point
- Measuring continuous topo points
- Measuring an as-staked point
- Measuring a laser point
- Measuring a calibration point
- Measuring a check point
- Point storage in the Trimble Survey Controller software
- Quality control records

Introduction

In a conventional survey, the only type of points that you can measure are topo points or check points. In a GPS survey, you measure points by choosing one of several predefined point types.

In a GPS survey, the Survey Style (and so the survey type) you choose determines the type of point(s) that can be measured. A single Survey Style cannot measure every kind of point, so it is necessary to use different Survey Styles to measure different kinds of point. An RTK Survey Style, for example, can be used to measure observed control points, Rapid points, topo points, and calibration points, but to measure a FastStatic point, you must use a FastStatic Survey Style. For more information, see Chapter 7, Survey Styles.

This chapter shows how to change some survey settings. It shows how to measure different types of point, and explains the quality control records that are stored when a point is measured using GPS.

Note – *For RTK surveys, initialize the survey before measuring points.*

Default Point Name

When you start a new survey, the Trimble Survey Controller software inserts a default value in the *Point name* field for a topo point, Rapid point, and continuous point. This default point name is the next available point name in the current job.

If no points of that type have been measured in the current job, the Trimble Survey Controller software searches the last job and inserts the next available point name. It does this so that you can download several jobs into one Trimble Geomatics Office or Trimble Survey Office project.

If you do not want to use the default point name that appears, change the value in the *Point name* field. This value increments once a point is measured.

Point Name Incrementation

When measuring topo points, Rapid points, or continuous points, the Trimble Survey Controller software automatically increments the value in the *Point name* field.

For topo points, it is possible to change the value of this increment. To do this, select *Topo point* from the option menu for the chosen Survey Style. Set the *Auto point step size* field to the value the name should increment by each time a point is measured. A negative value decreases the value in the *Point name* field.

Next Free Point Name Search

In *Point name* fields there is a Find softkey that allows you to search for the next available point name.

For example, if your job contains points numbered in the 1000's, 2000's and 3000's, and you want to find the next available point name after 1000:

1. In the *Point name* field, press Find. The *Find next free point name* screen appears.
2. Enter the point name you want to start searching from (in this example, 1000) and press OK.
3. The Trimble Survey Controller software searches for the next available point name after 1000 and inserts it in the *Point name* field.

Survey/Measure Points Screen in a GPS Survey

From the main menu, choose *Survey*. Select a GPS Survey Style, then select *Measure points*. The *Survey*/*Measure points* screen appears, as shown in Figure 15.1.

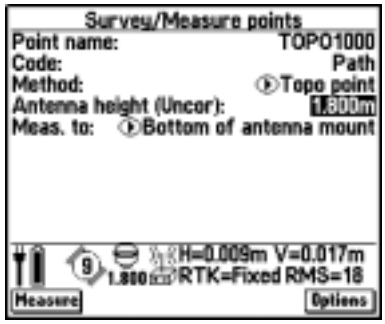


Figure 15.1 Survey/Measure points screen

Enter a point name and change the *Type* field to the type of point to be measured. (For more information about each type of point that can be measured, see the following sections.) Enter a value in the *Antenna height* field and check the setting in the *Meas. to* field.

To change some settings for the current survey, press Options. It is not possible to change the current Survey Style or the system settings.

Note – *You can view points that you have measured in the current job graphically in the current job map. For more information, see Map of Current Job, page 95.*

Survey/Measure Points Screen in a Conventional Survey

Please see Measuring Points, page 482.

Measuring a Topo Point in a GPS Survey

You can measure a topo point in every type of survey except a FastStatic survey.

To measure a topo point:

1. From the main menu, select *Survey* / *Measure points*.
2. Enter values in the *Point name* and *Code* fields (the latter is optional) and change the *Type* field to Topo point.
3. Enter a value in the *Antenna height* field and make sure that the setting in the *Meas to.* field is correct.
4. When the antenna is vertical and stationary, press Enter or Measure to start recording data.

   The static icon appears in the status line.
5. The Store softkey appears when the preset occupation time and precisions have been reached. Press it to store the point.

Tip – In the Survey Style, set the *Auto store point* field to Yes to automatically store the point when the preset occupation time and precisions have been met.

Measuring a FastStatic Point

You can only measure a FastStatic point in a FastStatic survey.

Note – *FastStatic surveys are postprocessed and do not need to be initialized.*

To measure a FastStatic point:

1. From the main menu, select *Survey* / *Measure points*.
2. Enter values in the *Point name* and *Code* fields (the latter is optional).

3. Enter a value in the *Antenna height* field and make sure that the setting in the *Meas to.* field is correct.
4. Press Enter or Measure to start measuring the point.
5. The Store softkey appears when the preset occupation time is reached (see Table 15.1). Press it to store the point.

Table 15.1 shows the occupation times for FastStatic surveys.

Table 15.1 Trimble FastStatic occupation times

Receiver type	4 SVs	5 SVs	6+ SVs
Single-frequency	30 min	25 min	20 min
Dual-frequency	20 min	15 min	8 min

Tip – No satellite tracking is necessary between measuring points. You can turn off the equipment.

Measuring an Observed Control Point

When the Trimble Survey Controller software measures an observed control point, it stores a point when the preset number of epochs has elapsed and the precisions have been attained.

To measure a observed control point:

1. From the main menu, select *Survey* / *Measure points*.
2. Enter values in the *Point name* and *Code* fields (the latter is optional), and change the *Type* field to Observed control point.
3. Enter a value in the *Antenna height* field and make sure that the setting in the *Meas to.* field is correct.
4. Press Enter or Measure to start recording data.
5. The Store softkey appears when the preset number of epochs and precisions are reached. Press it to store the point.

Note – *For an RTK survey, initialize the survey before starting to measure the point. For a postprocessed kinematic survey, you can start measuring before the survey is initialized but you cannot store the point until it is initialized.*

Measuring a Rapid Point

A Rapid point is stored when the preset precisions are attained. There is no minimum occupation time and point storage is automatic.

To measure a Rapid point:

1. From the main menu, select *Survey* / *Measure points*.
2. Enter values in the *Point name* and *Code* fields (the latter is optional), and change the *Type* field to Rapid point.
3. Enter a value in the *Antenna height* field and make sure that the setting in the *Meas to.* field is correct.
4. Press Enter or Measure to start recording data. The point is automatically stored when the preset precisions are reached.

Note – *When using WAAS positions in a survey, the only type of point you can store is a Rapid point.*

Measuring Continuous Topo Points

Continuous topo points are stored automatically and continuously after a preset time and/or distance once the required precisions are reached.

In a real-time survey, the Trimble Survey Controller software can measure a line of continuous ***offset*** points at the same time as a line of continuous topo points.

Measuring a Line of Continuous Points

To measure a line of continuous topo points:

1. From the main menu, select *Survey* / *Continuous topo*.
2. Set the *Type* field to Fixed distance continuous, Fixed time continuous, or Time & distance continuous.

   Note – *For a postprocessed survey, you can only use the Fixed time continuous method. The time interval is set to the same value as the logging interval.*
3. Enter a value in the *Antenna height* field and make sure that the setting in the *Meas to.* field is correct.
4. Enter a value in the *Horizontal distance* field and/or the *Time interval* field, depending on the method you are using.
5. If measuring Fixed distance or Time & distance continuous points, set the *Offset* field to None.
6. Enter a value in the *Start point name* field. This increments automatically.
7. Press Measure to start recording data, and then move along the feature to be surveyed.

   There is an audible beep every time a point is recorded.

   Note – *To change the distance interval, time interval, or offset while measuring points, enter new values in the fields.*
8. To stop measuring continuous points, press End.

Measuring a Line of Continuous Offset Points

To measure a line of continuous offset points:

1. From the main menu, select *Survey* / *Continuous topo*.
2. Set the *Type* field to Fixed distance continuous or Time & distance continuous.

3. Enter a value in the *Antenna height* field and make sure that the setting in the *Meas to.* field is correct.
4. If the *Type* field is set to Time & distance continuous, enter a value in the *Time interval* field.
5. Enter the interval in the *Horizontal distance* field, and change the setting in the *Offset* field to None, One, or Two.
6. Enter a value for the center line in the *Start point name* field. This increments automatically.
7. Enter the horizontal offset distance for Offset one (the first line of offset points).

   Note – *Enter a left or a right offset. For a left offset, enter a negative offset distance or use the* Left *and* Right *softkeys.*
8. Enter the vertical offset distance for Offset one.
9. Enter a value in the *Start point name* field for Offset one. This increments automatically.
10. If measuring two offset lines, repeat Steps 5 through 9 for Offset two.
11. Press Measure to start recording data, and then move along the feature to be surveyed.

    There is an audible beep every time a point is recorded.
12. To stop measuring continuous offset points, press End.

Calculating continuous offset points

The Trimble Survey Controller software calculates continuous offset points.

When three continuous points have been measured, the half-angle is calculated between the two lines described by the three points. The offset point is then placed at a distance computed from the offset value and the half-angle.

For the first continuous point, the offset point is placed at right angles to the line to the next continuous point. For the last continuous point, it is placed at right angles to the line to the previous continuous point.

These calculations ensure that the offset line stays parallel to the continuous line of points.

Figure 15.2 shows how continuous offset points are calculated.

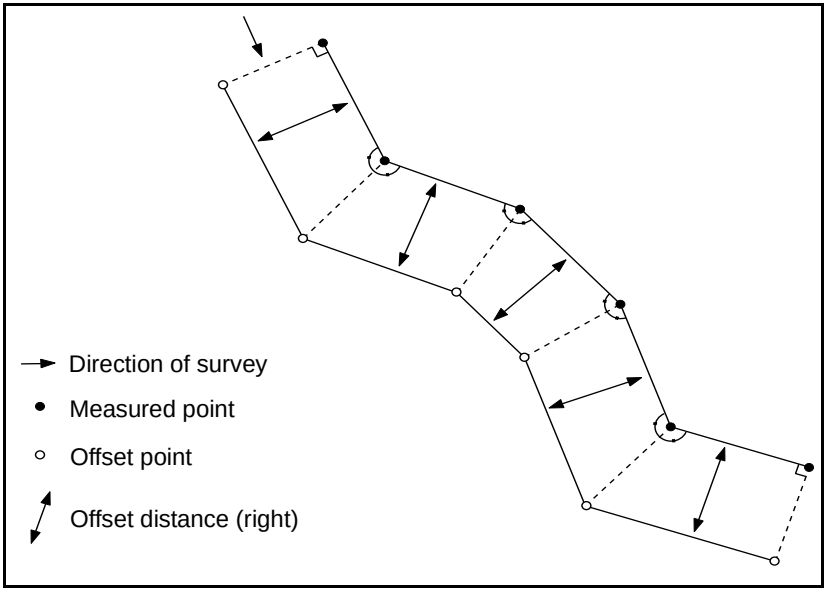


Figure 15.2 Calculation of continuous offset points

The line between offset points is parallel to the lines between the continuous points and is offset by the value specified.

Measuring an As-Staked Point

You can only measure an as-staked point when performing stakeout operations in a real-time GPS survey or a conventional survey.

In a GPS survey, a point is staked out then measured. For more information, see Chapter 17, GPS Stakeout. In a conventional survey, the point is staked out then stored. For more information, see Staking Out, page 501.

Measuring a Laser Point

Use a laser rangefinder to measure a laser point. For more information, see Chapter 20, Laser Observations.

Measuring a Calibration Point

In a real-time survey, you measure calibration points. Generally a point in the database has keyed in grid coordinates and you measure it as a calibration point using GPS. When you store the calibration point, the Trimble Survey Controller software does one of the following depending on the setting in the *Auto calibrate* field in the Survey Style:

- If *Auto calibrate* is set to Yes, the software immediately performs an automatic calibration using all calibration points that have been surveyed.
- If *Auto calibrate* is set to No, the point is added to the calibration and the *Site calibration* screen is displayed.

For more information, see Using GPS to Measure Calibration Points, page 342.

Note – *In the Site calibration option in the Survey Style, calibration points are configured to be measured with the same settings as topo points or observed control points. Calibration points are different in that a* Find *softkey is available allowing you to navigate to the next calibration point, and the Auto calibrate setting described above can be used.*

Measuring a Check Point

In a GPS survey, measure a point a second time. Give the second point the same name as the first point. If the duplicate point tolerances are set to zero (see Duplicate Point Actions, page 140), the Trimble Survey Controller software warns that the point is a duplicate when you try to store it. Select *Store as check* to store the second point as a Check class point.

In a conventional survey press Check and measure the point. It is stored as a Check class point. For more information, see Measuring a Check Point, page 490.

Point Storage in the Trimble Survey Controller Software

How you record a point determines how it is stored. Points are stored either as vectors or as positions. For example, RTK points and conventionally observed points are stored as vectors, while keyed-in points, real-time differential points, and postprocessed points are stored as positions.

From the main menu, select *Files* / *Review current job*. A point record contains information about the point such as the point name, the code, the method, the coordinates, or the GPS data file name.

The *Method* field describes how the point was created.

The coordinates are expressed as WGS-84, local, or grid coordinates, depending on the setting in the *Coordinate view* field. To change a *Coordinate view* setting, do one of the following:

- Select *Configuration* / *Job* / *Units*
- Select *Files* / *Review current job*, access the point record, and press Options

Note – *Define a datum transformation and/or a projection if you want to display local or grid coordinates for a GPS point. Alternatively, calibrate the job.*

Each point record uses the antenna height given in the previous Antenna height record. From this, the Trimble Survey Controller software generates a ground height or elevation for the point.

The *Stored as* field shows how the point was stored. Table 15.2 lists possible values and their meanings.

Table 15.2 Point storage

Value	What point is stored as
Grid	Grid coordinates
Local	Local geodetic coordinates
WGS-84	WGS-84 geodetic coordinates
ECEF	WGS-84 Earth-Centered-Earth-Fixed X, Y, Z coordinates
ECEF deltas	WGS-84 Earth-Centered-Earth-Fixed X, Y, Z vector
Polar	Azimuth, horizontal distance, and vertical distance. This is a vector.
HA VA SD	A horizontal circle reading, vertical circle reading (a zenith angle), and slope distance. This is a vector.
HA VA SD (raw)	A horizontal circle reading, vertical circle reading (a zenith angle), and slope distance with no corrections applied. This is a vector.
Mag.Az VA SD	A magnetic azimuth, vertical (zenith) angle, and slope distance vector.

Table 15.2 Point storage (Continued)

Value	What point is stored as
MHA MVA MSD	A meaned horizontal angle from the backsight, meaned vertical angle (a zenith angle), and meaned slope distance. This is a vector.
MHA MHD MVD	A meaned horizontal angle from the backsight, meaned horizontal distance, and meaned vertical distance. This is a vector.

Read the *Stored as* field in conjunction with the *Method* field.

Note – *Points stored as vectors are updated if the calibration or coordinate system of the job changes, or the antenna height of one of the source points is changed.*

Points stored as WGS-84 coordinates (an offset point calculated using the From a baseline method, for example) are not updated.

For GPS points, Quality Control (QC) records are stored at the end of the point record. For more information, see Quality Control Records, page 379.

Point Classification

When points are stored they have either one or two classifications:

- Points that have been measured using GPS have an Observation class and a Search class.
- Points that have been keyed in, computed, or measured with a conventional instrument or laser rangefinder have only a Search class.

Observation class

For real-time surveys, the Observation class is L1 Fixed, L1 Float, or L1 Code and precisions are recorded. For postprocessed surveys, the Observation class is Autonomous and no precisions are recorded.

Table 15.3 lists the Observation classes and resulting solutions.

Table 15.3 Observation classes

Observation class	Result
L1 Fixed	An L1 fixed real-time kinematic solution.
L1 Float	An L1 float real-time kinematic solution.
L1 Code	An L1 code real-time differential solution.
Autonomous	A postprocessed solution.
WAAS	A position that has been differentially corrected using WAAS signals.

Search class

A Search class (see Table 15.4) is applied to a point when it is measured, keyed in, or computed.

A Search class is used by the Trimble Survey Controller software when details of a point are required for stakeout or calculations (for Cogo calculations, for example). When you select a point name, the database is searched from the start down. The first search is for a Control class point. If no point is found, the next search is for a Normal class point, then an As-staked point, then a Backsight class point. If still no point is found, the final search is for a Check class point.

Table 15.4 describes the different Search classes.

Table 15.4 Search classes

Search class	Description
Control class point	The highest order of Search class. A Control class point can only be overwritten by another Control class point. Key in or upload Control points. Points that are adjusted in a traverse are stored as Control points.
Normal class point	Most points are usually measured as Normal class. A Normal class point can only be overwritten by another Normal class point later in the database, or by a Control class point.
As-staked class point	If a point was staked out and then measured, it has an As-staked classification.
Backsight class point	If a point was observed as a backsight or a resection target in a conventional survey, it has a Backsight classification.
Check class point	Check class is the lowest order of Search class that will be found by the Trimble Survey Controller software search rules. Check class points can be overwritten by any class of point except deleted points. A Check point can only be measured; it cannot be keyed in.
Deleted class point	When points are deleted in the Trimble Survey Controller software, the original class is given the prefix 'Deleted'. Deleted class points are not displayed in lists, used in calculations, or found by database searches.

Note – *Measured points have a Search class of Normal or lower.*

For more information, see Database Search Rules, page 211.

Quality Control Records

Quality Control (QC) records contain extra information about a point measured by GPS. You can record QC records if the receiver has the QC option installed.

This section covers three types of Quality Control records: QC1, QC2, and QC3. If the receiver supports the recording of QC records, a QC1 record is always stored. In addition, either a QC2 ***or*** QC3 can be stored as well. QC2 and QC3 records contain similar information, but cannot be stored together as they have a different format.

The Trimble Survey Controller software can store QC2 and QC3 records only when a real-time technique is used to measure points.

Note – *If you intend to use real-time results with the Trimble Geomatics Office or TRIMNET™ network adjustment software, record QC1 and QC2 records for each point.*

Use the point configuration to select what records are to be stored with a particular type of point. For a topo point, for example, do one of the following:

- Edit the Survey Style. To do this, select *Configuration* / *Survey Styles*. Select the relevant Survey Style, then press Edit. Select *Topo point* and set the *Quality Control* field as required.
- From the *Survey* menu, choose *Measure points*. Set the *Type* field to Topo point and press Options. Edit the *Quality control* field as required.

QC1 record

A QC1 record contains information about the quality of the GPS position. See Figure 15.3.

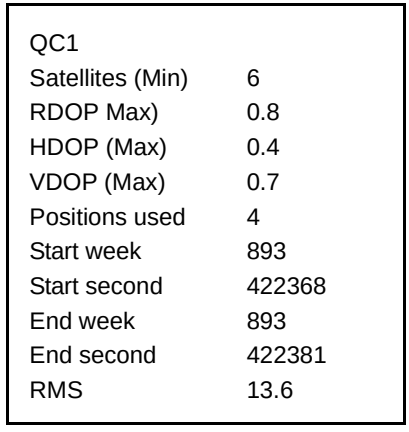


Figure 15.3 Information in QC1 Record

Note – *You can display the Start and End times in either a local or UTC date and time format, or GPS weeks and seconds. To change the display, from the main menu, select Configuration / Controller / Time/date and edit the GPS time display field as required.*

QC2 record

A QC2 record contains more information about the quality of the GPS position. QC2 contains the covariance matrix parameters that are used by the TRIMNET software when it performs a network adjustment. See Figure 15.4.

QC2	
Satellites	6
Error scale P	0.005m
VCV xx	0.00000319
VCV xy	–0.00000053
VCV xz	0.00000372
VCV yy	0.00000075
VCV yz	–0.00000090
VCV zz	0.00000784

Figure 15.4 Information in QC2 Record

QC3 record

A QC3 record contains more information about the quality of the GPS position. QC3 contains the standard error values, error ellipse statistics, and unit variance. See Figure 15.5.

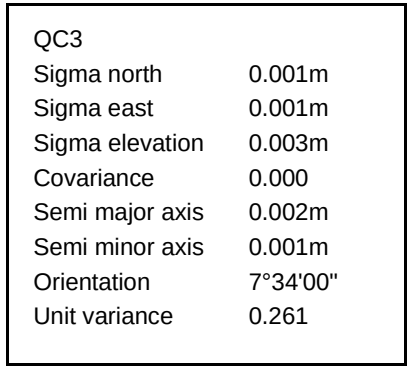


Figure 15.5 Information in QC3 Record

CHAPTER

16

Using Feature and Attribute Libraries

In this chapter:

- Introduction
- Uploading a feature and attribute library
- Creating a feature and attribute library
- Adding, deleting, and editing feature codes
- Adding, deleting, and undeleting a feature and attribute library
- Copying a feature and attribute library
- Collecting feature and attribute information

Introduction

Feature coding is a method of describing each point using an alphanumeric code. These codes are later processed by the office software to generate plans.

Some feature codes also have attributes. An attribute is an extra piece of descriptive information about a point.

Note – *You can use attribute information in the Trimble Geomatics Office, or Trimble Survey Office™ software. It is not necessary to process the feature codes.*

Attributes and feature codes are combined in a feature and attribute library that can be uploaded to the TSC1 data collector. During a survey, you can extract feature codes from this library quickly and easily. Feature codes that have associated attributes prompt you to enter the necessary attribute information, so the appropriate data is always collected.

To use an existing feature and attribute library, upload it to the TSC1. Once this is done, you can use the Trimble Survey Controller software to add, modify, or delete feature codes from that library. You can also use the TSC1 to create a new library.

As you work, assign a feature code to each point and enter any corresponding attribute data. Later, use the office software to:

- download the points
- process the feature codes and attribute data
- automatically generate a plan
- export the attributes in a range of GIS export formats

Note – *The Trimble Survey Controller software is able to maintain multiple feature and attribute libraries.*

Uploading a Feature and Attribute Library

To upload a feature and attribute library file from the office computer to the TSC1 data collector, use a package such as the Trimble Geomatics Office, Data Transfer, Trimble Survey Office, GPLoad, or TRIMMAP software.

Note – *When using TRIMMAP, you can only upload feature codes to create feature and attribute libraries in the Trimble Survey Controller software. You cannot upload features with attributes using TRIMMAP.*

The file transfer is controlled by the office software. For more information, see Data Transfer Between the TSC1 and the Office Computer, page 156.

Creating a Feature and Attribute Library

Create a feature and attribute library using the Trimble Geomatics Office, Trimble Survey Office or GPS Pathfinder® Office (Data Dictionary Editor) software. Alternatively, use the Trimble Survey Controller software.

Libraries created using the Trimble Geomatics Office (or Trimble Survey Office) Feature and Attribute Editor utility or the GIS Data Dictionary Editor utility can contain feature codes with attributes that automatically prompt you for attribute entry. Features codes created using the Trimble Survey Controller software, however, do not have attributes associated with them.

To create a feature and attribute library in the Trimble Survey Controller software:

1. Select *Configuration* / *Feature & attribute libraries.*
2. Press New.
3. Type the name of the new feature and attribute library and press Enter.

   The Trimble Survey Controller software limits this name to 20 characters.

4. Press Enter again to accept the screen.

Note – *It is possible to create libraries with the same name. Although each of these is a separate entity, it is less confusing to use a different name for each library.*

Adding, Deleting, and Editing Feature Codes

If a feature and attribute library is uploaded to the Trimble Survey Controller software, some of the feature codes can contain attribute subrecords. Feature codes with attributes have an attribute icon (Ⓐ) next to the code in the library.

Note – *If the library being used contains attributes but no attributes have been stored, the checkmark icon (✓) replaces the attribute icon (Ⓐ). If attributes have been stored, the lock icon (🔒) replaces the attribute icon.*

Once a feature code has attributes, that feature code cannot be added, deleted, or edited using the Trimble Survey Controller software. To change it, use the office software.

To add a feature code to a feature and attribute library:

1. From the main menu, select *Configuration* / *Feature & attribute libraries*.
2. Highlight the library name and press Edit. If the library has no features, the following message appears:

   No features exist

3. Press New and enter the new feature code.

   The Trimble Survey Controller software limits the name of each feature code to 20 characters.

4. Press Enter twice to accept the new feature code. When the first feature code is in, the Delete and Edit softkeys appear. They are discussed in the following sections.
5. To add another feature code to the library, press New.

To delete a feature code from a feature and attribute library:

1. From the main menu, select *Configuration* / *Feature & attribute libraries*.
2. Highlight the library name and press Edit.
3. Highlight the feature code to be removed and press Delete.
4. Repeat Step 3 for each feature code to be deleted.

To edit a feature code in a feature and attribute library:

1. From the main menu, select *Configuration* / *Feature & attribute libraries*.
2. Highlight the library name and press Edit.
3. Press Edit and edit the feature code.

   The Trimble Survey Controller software limits each feature code to 20 characters.
4. Press Enter twice to accept the edits to the feature code.
5. Repeat Steps 3 and 4 for each feature code to be edited.

Adding, Deleting, and Undeleting a Feature and Attribute Library

To add a new feature code library see Creating a Feature and Attribute Library, page 385. Do this at any time.

To delete a feature and attribute library, highlight the library name and press Delete.

When you press Delete, the Undelete softkey appears. Press it to retrieve a deleted library.

Note – *A deleted file stays on the Undelete list while memory space is available. When the TSC1 memory starts to get full, the oldest deleted file is finally deleted.*

Copying a Feature and Attribute Library

To make a copy of an existing feature and attribute library:

1. Highlight the name of the feature and attribute library to be copied and press Copy. In the *To name* field, type the name of the feature and attribute library to be created.
2. In the *File location* field, select a destination for the copied library. This can be Main memory or PC card.

   It is possible to copy a library to one that has the same name as the original.
3. Press Enter to create the duplicate library.

Tip – Use this Copy function to distribute one feature and attribute library to several field crews.

Collecting Feature and Attribute Information

You can enter one or more feature codes in any *Code* field in the Trimble Survey Controller software. The maximum number of characters in these fields is 42. To enter a code, key it in or select it from a predefined library.

To select a feature code from a feature and attribute library:

1. Make sure the appropriate library is selected. (To do this, access the *Code* field and press Library. Highlight the required library name and press Enter. The current library has a check mark next to it.)
2. To select a feature code from the library, do one of the following:

   – Type the first letter(s) of the feature code required. This highlights a feature code in the library that starts with the letters you typed. If necessary, press ↓ to move down until the correct feature code is highlighted. Press Enter to insert it in the *Code* field.

– Press Sp. When the library of codes appears, highlight the required code, and press Enter to insert it in the *Code* field.

3. To select another feature code, repeat Step 2.
4. When all codes are entered, press Enter again.

Note – *It is not possible to select a different feature and attribute library for the current job once a point with attributes is stored.*

Names and Symbols

Feature code names that contain spaces appear in the Trimble Survey Controller software with a small dot between the words, Fire•Hydrant, for example. These dots do not appear in the office software.

Some symbols are not supported in feature and attribute libraries, for example ! and [ ]. If you use unsupported symbols when creating a library in the office software, the Trimble Survey Controller software converts them to the underscore symbol '_' when they are uploaded.

Using Feature Codes with Predefined Attributes

You can use feature and attribute libraries that were created using Trimble Geomatics Office's (or Trimble Survey Office's) Feature and Attribute Editor or Trimble's GIS Data Dictionary Editor software to store additional attribute information for feature codes. In the Trimble Survey Controller software, these feature codes have an attribute icon (Ⓐ) next to the feature code in the library.

When entering attribute information, key in values or select them from a list, depending on the library you created in the office software.

Note – *Feature classifications defined in feature and attribute libraries as Point, Line, or Area in the office software all appear as Point features in the Trimble Survey Controller software.*

It is possible to enter attribute data before measuring a point or while measuring it. The Attrib softkey appears when feature codes with attributes are used.

Tip – To make attribute data capture more efficient, use the office software to predefine default values, minimum and maximum ranges, auto-generated times and dates, and well-structured menu options. If using auto-generated times, make sure that the local time is set correctly in the Trimble Survey Controller software.

Note – *If you specify in the office software that field entry is not permitted for an attribute, you cannot use the Trimble Survey Controller software to enter that attribute data.*

To enter attributes before measuring a point:

1. Enter the feature code and press Attrib. A screen with the feature code and attribute fields appears.
2. Enter values in the attribute fields.

   The maximum number of characters in text attribute fields is usually 100. Your definition of a feature and attribute library can specify fewer.

Tip – Use the Repeat softkey to repeat the last stored set of attributes for the current feature.

The Prev and Next softkeys appear when there are multiple feature codes with attributes in the *Code* field. Use them to swap between attributes.

To enter attributes while measuring a point:

1. Enter the feature code. The Attrib softkey appears.
2. Press Measure to start measuring the point.

   A screen with the feature code and attribute fields is displayed.
3. Enter values in the attribute fields. Press Enter to accept the attributes.
4. Press Store to store the point and the associated attributes.

   Attributes are stored after the point is stored.

Tip – The Trimble Survey Controller software can automatically store the point while you are still entering attribute data. To enable this, set the *Auto store point* option in the Survey Style to Yes.

Resurveying Points That Already Have Attributes

To stake out and re-measure points for which you already have attribute data:

1. If the job is not yet in the Trimble Survey Controller software, upload it from the Trimble Geomatics Office, Trimble Survey Office software.

   Note – *Upload relevant features and attributes as well as the points.*

2. From the Survey Style *Survey* menu, choose *Stakeout*.
3. Set the as-staked point details:
   - Set the *As-staked name* field to Design name
   - Set the *As-staked code* field to Design code
4. Stake out the points.
5. Measure the as-staked point.

   The attribute data displayed for the point is the attribute data that you entered previously. The defaults in the feature and attribute library are not used. Update the values as required.

Entering Attributes for a Point Using Feature Codes Without Predefined Attributes

Another way to enter attributes is through Note records using the : softkey.

It is possible to enter several attributes for one point. For a point that has a feature code of Tree, for example, you can enter its type, height, girth, and spread as attributes.

To enter attributes for a point using the : softkey:

1. Measure, key in, or compute the point.
2. Do one of the following:
   - Press Menu and select *Key in* / *Notes*.
   - If the *Key in/Note* screen is already open, press Next.
3. Enter the first attribute and press :. Enter the data and press : again.

   If a feature code and attribute library is selected for the job, it appears when you type the first letter of a code that is in the library.
4. Enter the next attribute and press :. The attributes for a tree, for example, could be:

   Type:Oak:Girth:1.0:Height:15:Spread:12
5. Repeat Step 4 until all attributes are entered, then press Enter.

Tip – Press Next to return to the screen where you stored the point without closing this window.

Note – *Attributes collected using note records with : separators are processed as note records in the Trimble Geomatics Office or Trimble Survey Office software. For more flexibility in the office software, collect attributes using attribute sub-records or features from the feature and attribute libraries created in the office software.*

Control Commands

With feature codes, points that have the same code can be joined by lines or represented by symbols on a plan. In a topographical survey, for example, survey the center line of a road and give it the code CL. Then set up the office software (that processes the feature codes) so that all points with the code CL are joined together.

If you survey the center line of two different roads, however, and the points all use the code CL, the two center lines will be joined together. To prevent this, use the code CL START for the first point on the first center line. Observe a succession of points with the code CL, then use the code CL END for the final point on the first center line. These start and end codes act as control commands.

Set up the feature code library for the office software to recognize these commands—points for the two center lines will no longer be confused.

CHAPTER

17

GPS Stakeout

In this chapter:

- Introduction
- General procedure
- Stakeout settings
- Fine and coarse modes
- Using the graphical display to navigate
- Staking out a point
- Staking out a line
- Staking out a curve
- Staking out a DTM

Introduction

The *Stakeout* menu provides options for staking out coordinates, lines, curves, slopes, and surfaces. Stakeout operations use the precision and benefits of a real-time survey. Postprocessed survey techniques are not used for stakeout.

To stake out a road, see Chapter 18, Roading.

To stake out using a conventional instrument, see Staking Out, page 501.

Warning – Do not stake out points and then change the coordinate system or perform a calibration. If you do, these points will not be in terms of the new coordinate system. They will also be inconsistent with points staked out after the change.

General Procedure

When staking out a point, set up the base receiver as usual and use the rover receiver to locate and stake out points.

Note – *To stake out Grid coordinates, define a projection and datum transformation. Trimble strongly recommends that you perform a full site calibration before staking out any points.*

To stake out a point:

1. Change the stakeout settings if necessary (see page 397).
2. Define the point/line/curve/DTM. To do this, use one of the following methods:
   - key in data
   - upload a file from a PC
   - calculate coordinates using one of the Cogo functions

3. From the main menu, choose *Survey*. From the *Survey* menu, choose *Stakeout*. Then select what is to be staked out—Points, Lines, Curves, or DTMs.
4. Initialize the survey.
5. Navigate to the point.
6. Stake out the point.
7. Measure the as-staked point (this step is optional).
8. Repeat Steps 5 and 6 until all points are staked out.
9. End the survey.

Note – *The defined point/line/curve must be stored in the Trimble Survey Controller software database before you can stake it out.*

Stakeout Settings

It is possible to change the as-staked point defaults, and to change how certain values are displayed during stakeout.

To specify what distances are used and displayed by the Trimble Survey Controller software:

1. From the main menu, select *Configuration* / *Job* / *Cogo settings*.
2. Set the *Distances* field as required. To apply ellipsoid correction, for example, set the *Distances* field to Ellipsoid.

Stationing values can be displayed in the following formats: 1000.0, 10+00.00, or 1+000.0.

To change the format:

1. Select *Configuration* / *Job* / *Units*.
2. Set the *Stationing* field as required.

To change the stakeout settings for a Survey Style:

1. From the main menu, select *Configuration* / *Survey Style*.
2. Highlight your RTK Survey Style and press Edit. Then select *Stakeout*. For more information about the fields that can be edited see Stakeout, page 135.

Tip – For the next section, use the online Help if necessary. Press the HELP key and then press S T and select the stakeout topic.

Alternatively, to change the stakeout settings for the current survey only:

1. From the *Survey*/*Stakeout* screen, press Options. The *Options* screen appears. Fields in this screen are similar to those in the *Stakeout* screen shown in Figure 17.1.

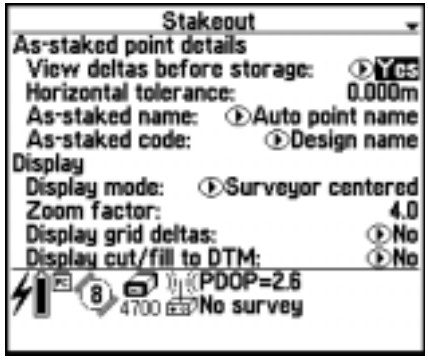


Figure 17.1 Stakeout options screen

2. Set the fields as required. For information about these fields, see Stakeout, page 135.

Fine and Coarse Modes

Choose from one of two modes when navigating to a point:

- Fine
- Coarse

Use the ►Coarse or ►Fine softkey in the *Stakeout* graphical display to change from one to the other:

- The ►Fine softkey appears when the Trimble Survey Controller software is in Coarse mode. Press it to go into Fine mode.
- The ►Coarse softkey appears when the Trimble Survey Controller software is in Fine mode. Press it to go into Coarse mode.

Table 17.1 shows how the update rate and precision associated with each mode depends on the receiver used.

Table 17.1 Fine and coarse mode in different receivers

Receiver	Fine mode	Coarse mode
GPS Total Station 4800	The display updates at a rate of one position per second. The precision of the position is higher.	The display updates at a rate of five positions per second. The precision of the position is lower.
GPS Total Station 4700		
Site Surveyor 4400 or 7400MSi		
Series 4000	The display updates at a rate of one position per second.	
4600LS		

Note – *When you press ►Fine the graphical display screen zooms in and magnifies the display by the zoom factor specified in the Survey Style.*

In practice, use the Coarse mode until close to the point. Then switch to Fine mode.

Using the Graphical Display to Navigate

When staking out a point, line, curve, or road, use either the text on the right of the screen or the graphical display on the left to navigate to the point. This section describes how to use the graphical display.

Figure 17.2 shows the text and graphical display for two screens. Each shows the compass arrow, but the text display configuration differs:

- In the left screen, the *Display grid deltas* field in the Stakeout *Options* screen is set to No.
- In the right screen, the *Display grid deltas* field is set to Yes.

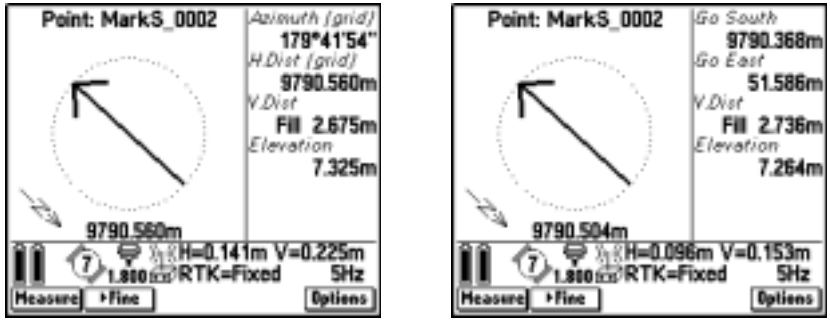


Figure 17.2 Graphical display – grid deltas displayed, grid deltas not displayed

To navigate using the graphical display:

1. Using the arrow as a guide, start moving towards the point, holding the TSC1 data collector in front of you. The arrow points in the direction of the point to be staked out. Walk towards the point. When you are walking in the direction of the point, the arrow points to the top of the screen.

Note – *The direction arrow only works correctly once you are moving. Always move* ***forwards*** *towards the point.*

2. About three meters (or ten feet) from the point, the arrow disappears and the point is shown as a bull's-eye symbol. Your current position is shown as a cross, as shown in Figure 17.3.

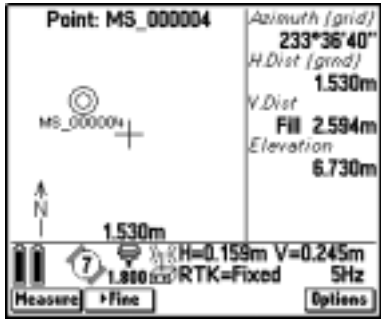


Figure 17.3 Graphical display showing bull's-eye and cross symbols

When the screen display changes from an arrow to a bull's-eye and a cross, the orientation of the display is fixed.

3. When you get closer to the point, press Fine to go into Fine mode. The display zooms in and updates at a rate of one position per second. For more information, see Fine and Coarse Modes, page 399.

4. Move towards the point until the circles and the cross in the graphical display coincide. Check the precisions, and mark the point.

If you are not sure how to use the graphical display, use the text side of the display to locate the point.

Staking Out a Point

To stake out a point:

1. From the main menu, choose *Survey*. From the *Select Survey Style* menu, choose an RTK Survey Style. Then select *Stakeout* / *Points*. A *Stakeout*/*Points* list appears.
2. Press Add to transfer points in the Trimble Survey Controller software database to the *Stakeout*/*Points* list. The *Select points* screen appears, as shown in Figure 17.4.

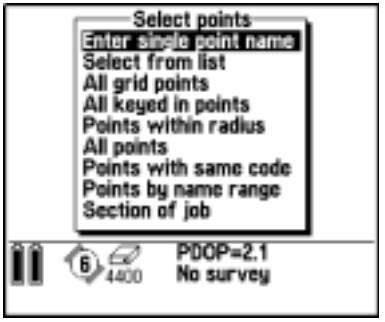


Figure 17.4 Select points screen showing selection methods

3. From this list, choose the method by which points are to be selected.

If you choose *Select from list*, for example, a list of points in the Trimble Survey Controller software database appears. See Figure 17.5.

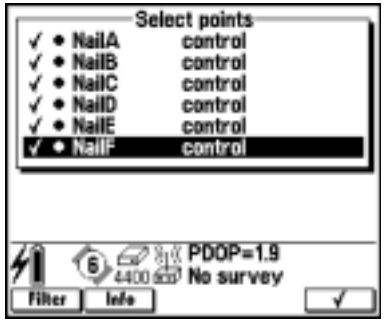


Figure 17.5 Select points screen showing list of points

Note – *The Select points list displays all points in the Trimble Survey Controller software database. If two points have the same name, only the point with the higher class—or the first point—is displayed.*

Press Filter *to choose which points are displayed.*

4. To select a point from the list, highlight it and press ✓. A check mark appears beside the selected point name. Do this for each point to be added to the Stakeout list.

5. Press Enter to return to the *Stakeout*/*Points* screen. See Figure 17.6.

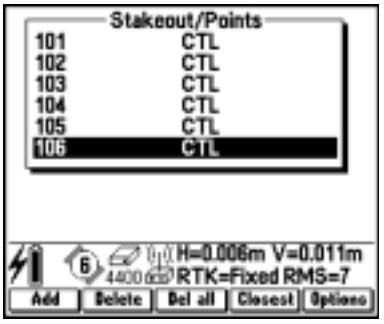


Figure 17.6 Stakeout/Points screen showing selected points

6. Press Options and select one of the following methods for staking out the point:

   – *To the point* – stakes out the point with directions from your current position

   – *From fixed point* – stakes out the point with cross-track information and directions from another point. Enter a point name in the *From point* field. Select from a list, key in, or measure this value.

   – *From start position* – stakes out the point with cross-track information and directions from the current position when you start to navigate

   – *From last point staked* – stakes out the point with cross-track information and directions from the last point that was staked out and measured. The ***staked*** point is used, not the design point.

     To stake out from the current position, access the *From point* field and press Null.

Note – *The cross-track function creates a line between the point to be staked out and one of the following: a fixed point, the start position, or the last point staked. The Trimble Survey Controller software displays this line and an extra field in the graphical stakeout screen gives the offset to the line. This field is Go left or Go right.*

Figure 17.7 shows a typical screen with cross-track information.

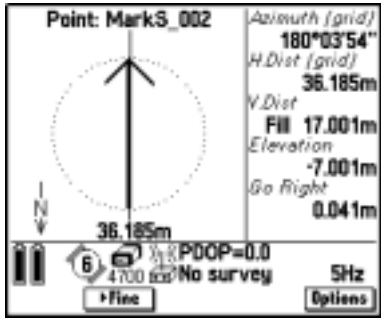


Figure 17.7 Screen showing cross-track information

7. Select the point to be staked out. To do this, highlight the point and press Enter.
8. Make sure that the survey is initialized. For more information, see RTK Initialization Methods, page 321.

9. The stakeout graphical screen display appears. It shows coordinate differences between the point and the current position, the elevation of the current position, and a graphical representation of the direction to the point. See Figure 17.8.

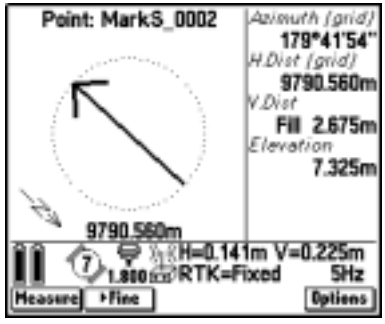


Figure 17.8 Graphical and text display – staking out a point

10. Use the graphical display or the text display (see Figure 17.8) to navigate to the point. For more information, see Using the Graphical Display to Navigate, page 400.
11. Closer to the point, press Fine to go into Fine mode.
12. When the cross and the bull's-eye in the graphical display coincide, check the precisions and mark the point.
13. Do one of the following:
    - To record the as-staked point, press Measure. The Trimble Survey Controller software measures the point.
    - If you do not want to record the as-staked point, press Esc. You return to the list and can stake out more points.

Staking Out a Line

To stake out a line:

1. From the main menu, choose *Survey*. From the *Select Survey Style* menu, choose an RTK Survey Style. Then select *Stakeout* / *Lines*. The *Survey*/*Stakeout*/*Line* screen appears.
2. Enter the name of the line to be staked out in the *Line name* field using one of the following methods:
   - Press List to display a list of lines stored in the Trimble Survey Controller software database. Use the ✓ softkey to select the line required.
   - Press Key in and define the line to be staked out.
3. Enter a value in the *Antenna height* field.
4. Choose a setting for the *Stake to* field (see Stake To Options, page 409). Other fields appear, depending on what you choose. Fill in the information required.
5. Make sure that the survey is initialized (see RTK Initialization Methods, page 321) and then press Start.

   The Trimble Survey Controller software displays a compass arrow and some text. There are values in the following fields, if they are appropriate to the stakeout method used:
   - *Azimuth* – the azimuth to the line or station on the line
   - *Go South*/*North* – the horizontal distance, in the north/south direction, to the line or station on the line
   - *Go East*/*West* – the horizontal distance, in the east/west direction, to the line or station on the line
   - *H. Dist* – the horizontal distance between the present position and the point on the line to be staked out
   - *V. Dist (cut*/*fill)* – the vertical distance between the present position and the point on the line to be staked out
   - *Stationing* – the station/chainage of the present position

- Δ *Station* – the difference in the stationing between the present position and the station to be staked out. A positive value means that the station is towards the beginning of the line. A negative value means that the station is towards the end of the line.
- *Offset (left/right)* – the offset of the present position in relation to the line. A positive value is an offset to the right and a negative offset is an offset to the left.
- *Grade to line* – the grade of the slope between the present position and the closest point on the line

6. Use the graphical display or the text display to navigate to the point. See Figure 17.9. For more information, see Using the Graphical Display to Navigate, page 400.

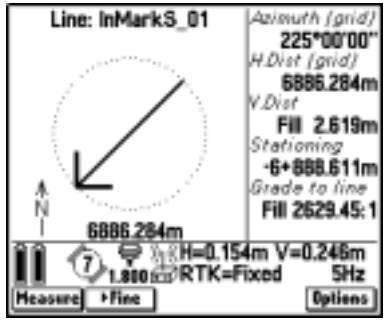


Figure 17.9 Staking out a line

7. Closer to the point, press Fine to go into Fine mode.
8. When the two symbols in the graphical display coincide, check the precisions and mark the point.
9. Press Measure to record the as-staked point. The Trimble Survey Controller software measures the point.
10. Press Esc to return to the *Survey*/*Stakeout*/*Line* screen, and press Sta– or Sta+ to select the next station on the line. Stake out the point as described above.

Stake To Options

When staking out a line, the options for the *Stake to* field are:

- To the line
- Station on the line – with this, also enter the station to be staked out
- Station/offset from line – with this, also enter the station to be staked out, a horizontal offset, and a vertical offset
- Slope from line – with this, also enter the slope parameters for a slope to the left and/or right of the line as required

To the Line

Select the To the line option to stake out points on a line, starting at the closest point (1) from your current position (2). If your current position is beyond the end of the line, the Trimble Survey Controller software directs you to the closest point along the extension of the line.

Figure 17.10 shows the text screen and a graphical representation of this option.

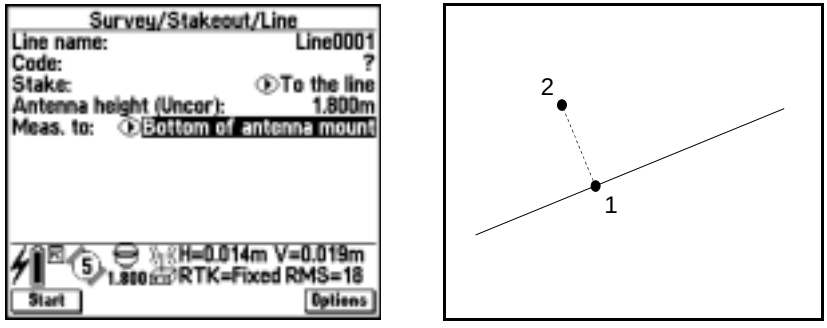


Figure 17.10 Stake to the line

Note – *In this chapter, a number in parentheses ( ) refers to a point in the corresponding figure.*

Station on the Line

Select the Station on the line option to stake out stations (1) on a line with a defined station increment (2).

Figure 17.11 shows the text screen and a graphical representation of this option.

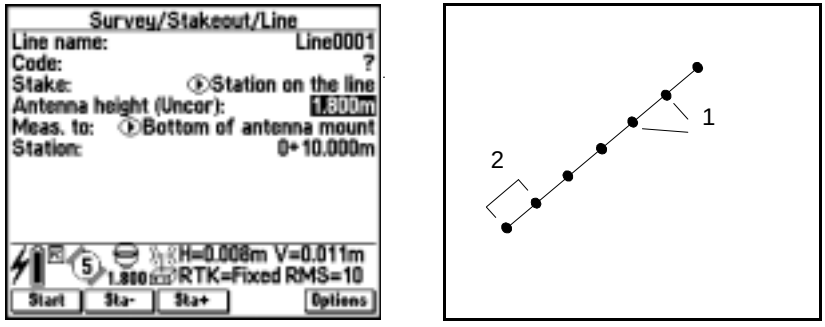


Figure 17.11 Stake to station on the line

Station/Offset from Line

Select the Station/offset from line option to stake out points (1) that are perpendicular to stations (3) on a defined line (2) and offset to the right or left by a set distance (4).

Figure 17.12 shows the text screen and a graphical representation of this option.

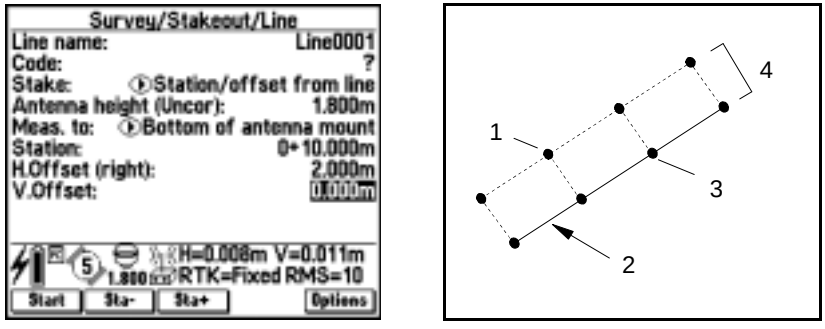


Figure 17.12 Stake to station/offset from line

Slope from Line

Select the Slope from line option to stake out a surface (2) at defined grades (3) from the defined line (cross-section = (1)). Different slopes can be defined on the left and the right of the line. At any point offset from the line, the value for cut (4) or fill (5) is displayed.

Figure 17.13 shows the text screen and a graphical representation of this option.

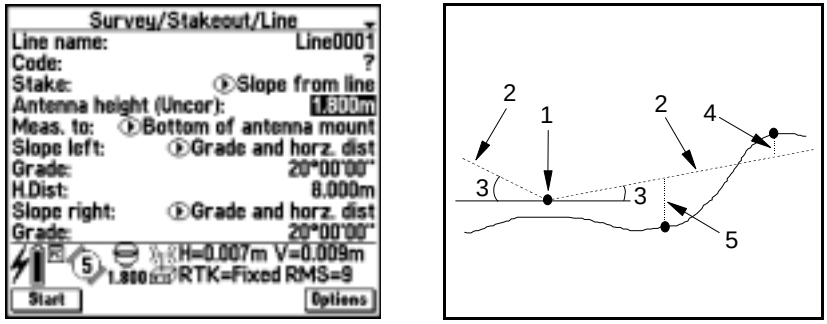


Figure 17.13 Stake to slope from line

The left side of the line is the side on your left when looking along the line in the direction of increasing stationing.

Use the *Slope left* field and the *Slope right* field to define the type of grade in one of the following ways:

- Horizontal and vertical distance
- Grade and slope distance
- Grade and horizontal distance

You can also enter a value in the *Grade* field (this is optional).

Staking Out a Curve

Note – *The Trimble Survey Controller software supports the design and stakeout of circular curves only. Use the road stakeout function to stake out other curve types.*

To stake out a curve:

1. From the main menu, choose *Survey*. From the *Select Survey Style* menu, choose an RTK Survey Style. Then select *Stakeout* / *Curve*.
2. Enter the name of the curve to be staked out in the *Curve name* field using one of the following two methods:
   - Press List. A list of curves stored in the Trimble Survey Controller software database appears. Use the ✓ softkey to select the curve required.
   - Press Key in and then define the curve that is to be staked out.
3. Enter a value in the *Antenna height* field.
4. Choose a setting for the *Stake to* field (see Stake To Options, page 414). Other fields appear, depending on what you choose. Fill in the information required.
5. Make sure that the survey is initialized (see RTK Initialization Methods, page 321) and then press Start. The Trimble Survey Controller software displays a compass arrow and some text.

   There are values in the following fields, if the fields are appropriate to the stakeout method used:
   - *Azimuth*
   - *Go South*/*North* – the horizontal distance, in the north/south direction, to the curve or station on the curve
   - *Go East*/*West* – the horizontal distance, in the east/west direction, to the curve or station on the curve

- *H. Dist* – the horizontal distance between the present position and the point on the curve to be staked out
- *V. Dist (cut/fill)* – the vertical distance between the present position and the point on the curve to be staked out
- *Stationing* – the station/chainage of the present position
- Δ *Station* – the difference in stationing between the present position and the station to be staked out. A positive value means that the station is towards the beginning of the curve. A negative value means that the station is towards the end of the curve.
- *Offset* (left/right) – the offset of the present position in relation to the line. A positive value is an offset to the right and a negative offset is an offset to the left.
- *Grade to curve* – the grade of the slope between the present position and the closest point on the curve

6. Use the graphical display or the text display (see Figure 17.14) to navigate to the point. For more information, see Using the Graphical Display to Navigate, page 400.

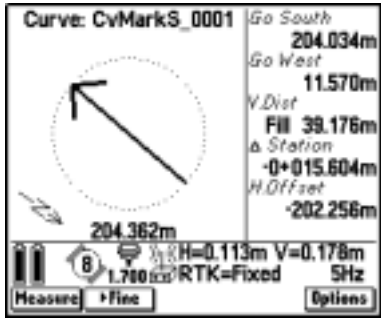


Figure 17.14 Staking out a curve

7. Closer to the point, press ▸Fine to go into Fine mode.
8. When the two symbols coincide, check the precisions and mark the point.

9. To record the as-staked point, press Measure. The Trimble Survey Controller software measures the point.
10. Press Esc to return to the *Survey*/*Stakeout*/*Curve* screen. Then press Sta– or Sta+ to select the next station on the curve.

Stake To Options

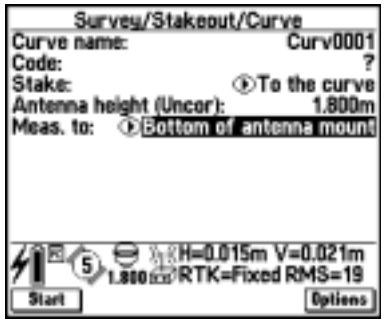
When staking out a curve, the options for the *Stake to* field are:

- To the curve
- Station on the curve – with this, also enter the station to be staked out
- Station/offset from curve – with this, also enter the station to be staked out and any horizontal and vertical offset
- Slope from curve – with this, also enter the slope parameters for a slope to the left and/or right of the curve, as required
- Intersect point of curve
- Center point of curve

To the Curve

Select the To the curve option to stake out points on a curve, starting at the closest point (1) to your current position (2). If your current position is beyond the end of the curve, the Trimble Survey Controller software directs you to the closest point along the extension of the curve.

Figure 17.15 shows the text screen and a graphical representation of this option.



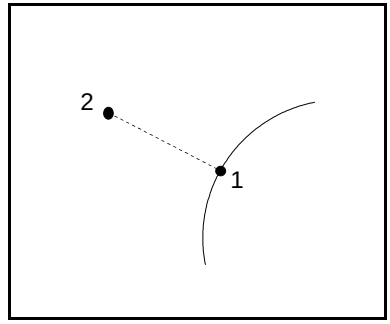


Figure 17.15 Stake to the curve

Station on the Curve

Select the Station on the curve option to stake out stations (1) on a curve with a defined station increment (2). Figure 17.16 shows the text screen and a graphical representation of this option.

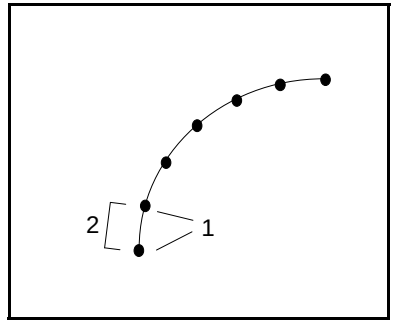


Figure 17.16 Stake to station on the curve

Station/Offset from Curve

Select the Station/offset from curve option to stake out points (1) perpendicular to stations (3) on the defined curve (2) and offset to the right or left by a certain distance (4).

Figure 17.17 shows the text screen and a graphical representation of this option.

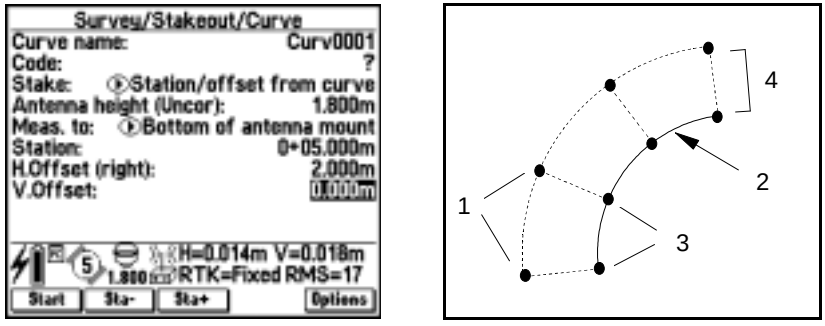


Figure 17.17 Stake to station/offset from curve

Slope from Curve

Select the Slope from curve option to stake out points at any position on a surface made up of sloping lines (2), at defined grades (3), perpendicular to the defined curve (cross-section = (1)). Different slopes can be defined on the left and the right of the curve. At any point offset from the curve the value for cut (4) or fill (5) is displayed.

Figure 17.18 shows the text screen and a graphical representation of this option.

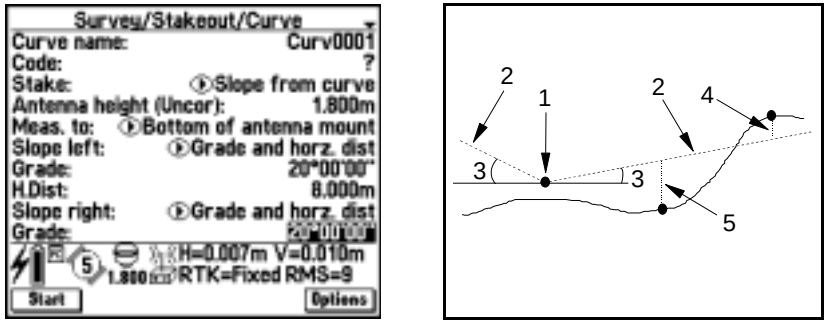


Figure 17.18 Stake to slope from curve

The left side of the curve is the side on your left when looking along the curve in the direction of increasing stationing.

Use the *Slope left* field and the *Slope right* field to define the type of grade in one of the following ways:

- Horizontal and vertical distance
- Grade and slope distance
- Grade and horizontal distance

You can also enter a value in the *Grade* field (this is optional).

Intersect Point of Curve

Select the Intersect point of curve option to stake out the intersection point (1) of a defined curve (2).

Figure 17.19 shows the text screen and a graphical representation of this option.

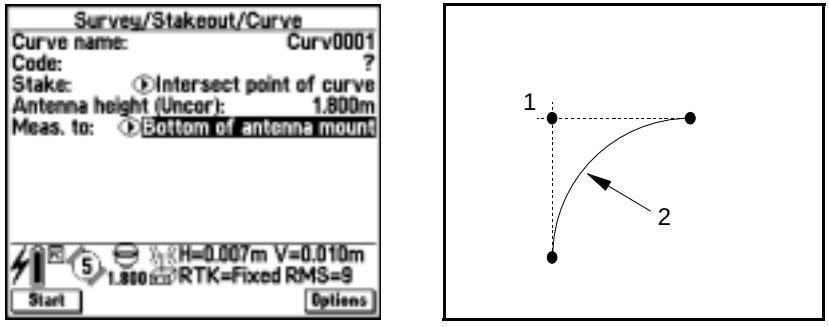


Figure 17.19 Stake to intersect point of curve

Center Point of Curve

Select the Center point of curve option to stake out the center point (1) of a defined curve (2).

Figure 17.20 shows the text screen and a graphical representation of this option.

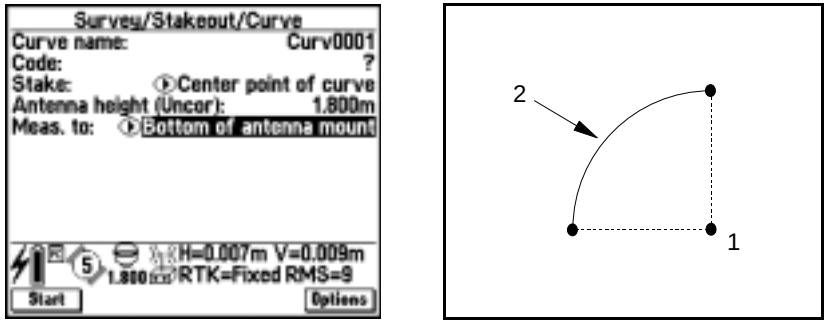


Figure 17.20 Stake to center point of curve

Staking Out a DTM

To stake out a DTM:

1. From the main menu, choose *Survey*. From the *Select Survey Style* menu, choose a real-time Survey Style. Then select *Stakeout* / *DTMs*. The *Survey*/*Stakeout*/*DTM* screen appears.
2. Access the *DTMs* field. From the list, select the model to be staked out.
3. If applicable, enter a value in the *Vertical offset* field.
4. Enter a value in the *Antenna height* field.
5. Press Start. The graphics screen appears. It displays the coordinates of the current position and the vertical distance above (cut) or below (fill) the DTM.
6. To record a point, press Measure. The Trimble Survey Controller software measures the point.
7. Press Esc to return to the *Survey*/*Stakeout*/*DTM* screen.

CHAPTER

18

Roading

In this chapter:

- Introduction
- Uploading or keying in road information
- Reviewing the road information
- Viewing a road in current job map
- Staking out points on the road by station and offset
- Measuring positions on the road

Introduction

This chapter shows you how to stake out roads and determine your position relative to a road design. It explains how to review roading information and select a point to stake out on a road. It shows how to navigate to a non-side slope point and a side slope point, and measure an as-staked point.

Warning – Do not stake out points and then change the coordinate system or perform a calibration. If you do, these points will not be in terms of the new coordinate system. They will also be inconsistent with points staked out after the change.

Uploading or Keying In Road Information

Before staking out a road or determining your position relative to a road, key in or upload a road definition.

To key in a road definition see Key In Roads, page 543, andKey In Templates, page 556.

To upload a road definition, use the RoadLink™ software (a module of the Trimble Geomatics Office™ software and the Trimble Survey Office™ software). For more information about how to transfer files see, Chapter 9, Data Transfer.

Each road is uploaded as a job. To open a job, select *Files* / *Job management*.

Note – *Once the files are uploaded, you can copy several roads into a single job. For more information, see Copying Data Between Jobs, page 6-6.*

Each road uploaded using RoadLink contains the coordinate system for the road. Roads always have grid coordinates.

Note – *The Trimble Survey Controller software treats all road distances, including stationing and offset values, as grid distances. The value in the Distances field (accessed by selecting Configuration / Job / Cogo settings) has no effect on the road definition or the way road distances are displayed.*

Reviewing the Road Information

To review road information in the Trimble Survey Controller software:

1. Open the job.
2. From the main menu, select *Files* / *Review current job*.

The following section describes the roading records that appear.

Roading Records

Information about a road appears in the following order:

1. The name of the road.

   This record includes:

   a. Horizontal alignment elements.

      These records appear in order of increasing stationing. There is a record for each alignment element.

   b. Vertical alignment elements.

      These records appear in order of increasing stationing. There is a record for each alignment element.

   c. Template records.

      Templates define the cross-sections used along the road. Template records show what templates are used at the various stations along the road. There is a record each time the template changes. These records appear in order of increasing stationing.

d. Superelevation and/or widening records.

   There is a record each time the superelevation and/or widening changes. These records appear in order of increasing stationing.

2. The name of the template(s).

   This record includes the template elements that define the cross-section of the road, starting from the center line. Each record defines an element in the template.

Note – *If a road has a horizontal and vertical alignment but no templates, all offset points display a null (?) value in the V.Dist field during stakeout.*

If a road definition is defined only as a horizontal alignment, you can only stake it out in two dimensions.

The horizontal and vertical alignments of a road do not necessarily start and end at the same stationing. When they do not, you can only stake out points in three dimensions if their stations lie within the horizontal alignment.

Viewing a Road in Current Job Map

To view the center line of a road in the Current job map screen, select *Files* / *Current job map*. A screen similar to the one shown in Figure 18.1 appears.

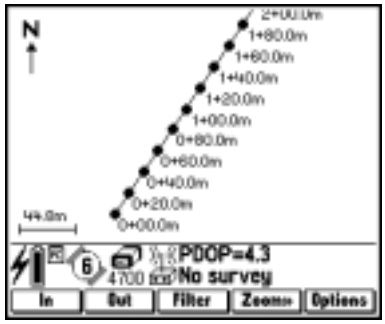


Figure 18.1 Road in current job map screen

Staking Out Points on the Road by Station and Offset

Before staking out a point on the road read General Procedure, page 396, and Stakeout Settings, page 397.

To select a point on a road:

1. From the main menu, choose *Survey.* From the *Select Survey Style* menu, choose a real-time Survey Style.
2. Select *Survey* / *Stakeout*. The *Stakeout* menu appears.

3. Select *Roads*. The *Survey* / *Stakeout* / *Road* screen appears, as shown in Figure 18.2.

Figure 18.2 Survey/Stakeout/Road screen

4. In the *Road name* field, select the road to be staked out.

Tip – To select a road, highlight the *Road name* field and press ⊙. Press List to view a list of available roads, and highlight the required road.

To review the selected road, press Review now. To edit the road, press Key in. Use the *Key in* / *Road* screen that appears to edit the road.

5. Press Enter to enter the name in the *Road name* field.

   The *Code* field displays the code of the offset to be staked out. The Trimble Survey Controller software uses the code from the template definition for the selected offset. When the offset is 0.000 m, the code defaults to CL.

Tip – If you stake out a point and then measure it, you can edit the code in the *Confirm staked deltas* screen. Alternatively, store the point and then select *Files* / *Review current job* to edit the code.

To change the default code for the template element, select either *Key In* / *Templates* or *Files* / *Review current job.*

6. In the *Stake* field select Station and offset.

7. Enter a value in the *Antenna height* field and make sure that the *Meas. to* field is set correctly.

   Note – *This is especially important when staking out a catch point. The Trimble Survey Controller software can accurately locate the point only if this setting is correct.*

8. Select the station to be staked out. Do one of the following:

   – Select it from a list.

   To do this, highlight the *Station* field and press ⊙. Press List to display a list of stations, as shown in Figure 18.3.

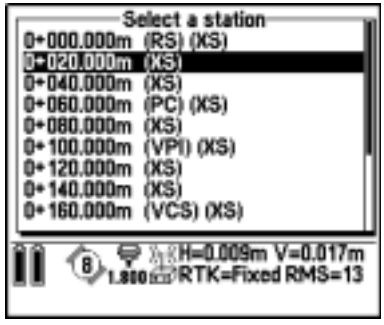


Figure 18.3 Select a station screen showing abbreviations used

The list contains the stations defined by the section interval, and the stations where the horizontal or vertical alignment changes.

Table 18.1 lists the abbreviations that the Trimble Survey Controller software uses.

Table 18.1 Stationing Abbreviations

Abbreviation	Meaning
RS	Road start
XS	Cross-section
TS	Tangent to spiral
SC	Spiral to curve

Table 18.1 Stationing Abbreviations (Continued)

Abbreviation	Meaning
CS	Curve to spiral
ST	Spiral to tangent
PC	Point of curvature (Tangent to curve)
PT	Point of tangent (Curve to tangent)
SS	Spiral to spiral
PI	Point of intersection
VCS	Vertical curve start
VCE	Vertical curve end
VPI	Vertical point of intersection
RE	Road end

– Enter a value.

  The value must be between the Start station and the End station for the road.

– Press Sta+ to select the next station in the list. Select Sta– to select the previous station in the list.

9. Select the offset to be staked out. Do one of the following:

   – Select a specific offset from a list.

To do this, highlight the *Offset* field and press ⊙. Then press List to display a list of offsets, as shown in Figure 18.4.

Figure 18.4 Select an offset screen

The list includes all offsets and their codes (if assigned).

In *Key in* / *Template*, these codes are assigned as part of the template element.

In the RoadLink software (a module of the Trimble Geomatics Office and Trimble Survey Office software), you assign a code in the template definition.

– Enter a value.

Enter a negative value for an offset to the left of the center line, a positive value for an offset to the right.

If you enter a value greater than the maximum offset in the template, a message appears. It warns that the offset is outside the range, and asks if you want to use the left (or right, depending on the value entered) side slope.

If you press No another message appears. It warns that point positions will be in two dimensions, and asks whether you want to continue. This option is useful if you need to stake out the two-dimensional position of a feature not defined in the template (the position of a lamppost, for example).

– Press Offs>> and select an option from the *Offset* menu, as shown in Figure 18.5.

Figure 18.5 Offset menu

Table 18.2 describes these options.

Table 18.2 Offset Menu Options

Option	Description
Leftmost	Selects the leftmost template element
Next left	Decrements the offset (selects the previous record in the list of offsets)
Next right	Increments the offset (selects the next record in the list of offsets)
Rightmost	Selects the rightmost template element

Tip – Select an offset from the list or by using the Offs>> softkey, and for all subsequent station values the offset value will update to reflect any widening or interpolation.

Enter an offset value and for all subsequent station values the offset value will be maintained, even when the entered value corresponds to a value in the list.

Consider Figure 18.6. Select offset 5 m at station 0 m and for subsequent stations the offset value will update to follow the solid line, moving from offset 5 m to offset 8 m. Enter 5 m for the offset and for subsequent stations the offset will follow the dashed line, maintaining offset 5 m.

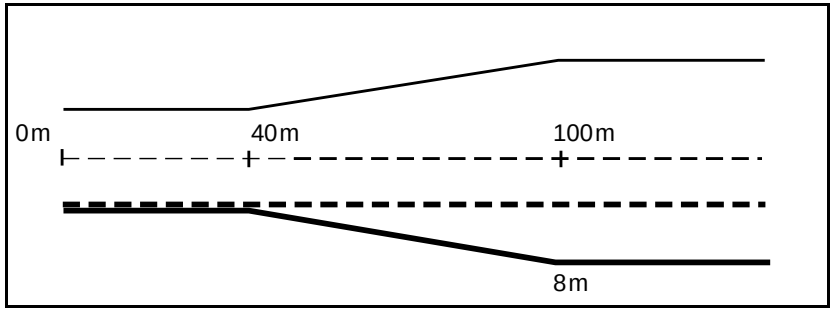


Figure 18.6 Offset selection

10. If there is a value in the *Construction H.Offset* field, the *Construction H.Offset applied* field specifies how it is applied. Do one of the following:

    – To apply the offset horizontally, select *Horizontal*.

    – To apply the offset at the slope value of the previous template element, select *Slope*.

    You cannot apply construction horizontal offsets at the slope value of the previous template element for points with zero offset.

Figure 18.7 shows how the *Horizontal* and *Slope* options are used in the *Construction H.Offset applied* field.The construction V.Offset value in the diagram is 0.000.

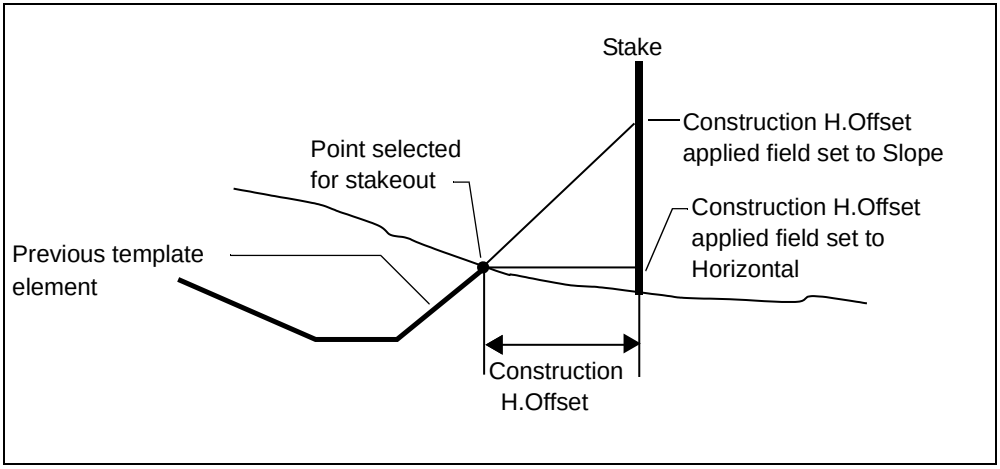


Figure 18.7 Options in the *Construction H.Offset applied* field

11. If there is a value in the *Construction H.offset* field, the Trimble Survey Controller software directs you to a point that is offset from the design point.

    A negative value offsets the point towards the centerline (in). A positive value offsets the point away from the centerline (out).

    Note – *If you enter a value for the Construction H.Offset on the centerline (at offset 0.00 m), a negative value offset is to the left.*

12. If there is a value in the *Construction V.Offset* field, the Trimble Survey Controller software directs you to a point that is offset vertically from the design point, as follows:

    – A negative value offsets the point vertically down.

    – A positive value offsets the point vertically up.

Note – *Construction offsets are not automatically applied to a side slope offset. For more information, see page 441.*

Construction offset values specified here are not applied to a DTM surface.

Navigating to a Point on the Road

The navigation process that the Trimble Survey Controller software uses depends on whether you are staking out a non-side slope point or a side slope point.

Note – *Before navigating to the point in a GPS survey, make sure that the survey is initialized. For more information, see RTK Initialization Methods, page 321.*

Icons in the graphical display screen

Table 18.3 lists the icons that appear in the top right of the graphical display screen when you stake out a point on a road. (The graphical display screen is shown in Figure 18.8 on page 434.)

Table 18.3 Icons in the Graphical Display Screen

Icon	Information about the point staked out
	The point is on the left side of the road and is in cut (the elevation of the design point is lower than the current position).
	The point is on the left side of the road and is in fill (the elevation of the design point is higher than the current position).
	The point is on the right side of the road and is in cut (the elevation of the design point is lower than the current position).
	The point is on the right side of the road and is in fill (the elevation of the design point is higher than the current position).

Note – *In addition, for side slope positions the slope value is displayed below the icon. For non-side slope positions the code (or offset value, if no code is assigned) is displayed below the icon.*

Navigating to a non-side slope point

To navigate to a non-side slope point:

1. Select a point and press Start. The stakeout graphical screen display appears, as shown in Figure 18.8.

   If using a conventional instrument, refer to the screen on the right.

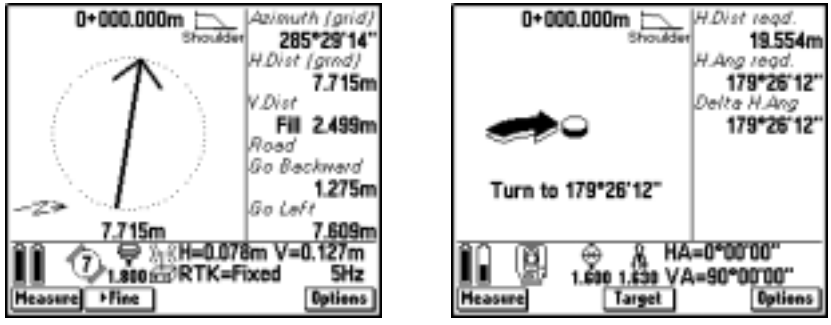


Figure 18.8 Stakeout graphical display for non-side slope point – GPS or conventional survey

The station value for the point appears at the top of the screen. An icon to the right indicates:

– on which side of the road the point lies

– whether the point is in cut or fill

– the code (or offset value, if no code is assigned) for the point

For more information, see Icons in the graphical display screen, page 433.

The left side of the screen shows the compass arrow, and the right side of the screen displays values in the following fields:

– *Azimuth* – the azimuth to the point

  In a conventional survey, this field is replaced by *Go In* (or *Go Out*).

– *Horizontal Distance* – the horizontal distance to the point. This value is also shown at the bottom of the graphical display screen.

  In a conventional survey, this field is replaced by *Go Left* (or *Go Right*).

– *Vertical Distance* (cut/fill) – the distance between the present position and the design position being staked out

– *Road: Go Forward* (or *Go Backward*) – the distance from the current position to the point, relative to the road. Forward is towards the end station, backward is towards the start station.

– *Road: Go Left* (or *Go Right*) – the distance from the current position to the point, relative to the road. If you are facing the end station, 'Left' is on your left.

Note – *The forward/backward and right/left values are relative to the cross-section of the point being staked out (see Figure 18.9). They are not relative to the current direction of travel or to the current stationing and they* ***do not*** *represent delta stationing and offset values for points on curved sections of the road.*

Note – *If you are using a conventional instrument, the road values only appear after you take a distance measurement.*

Figure 18.9 shows an example of the forwards direction and the right direction when staking out a point.

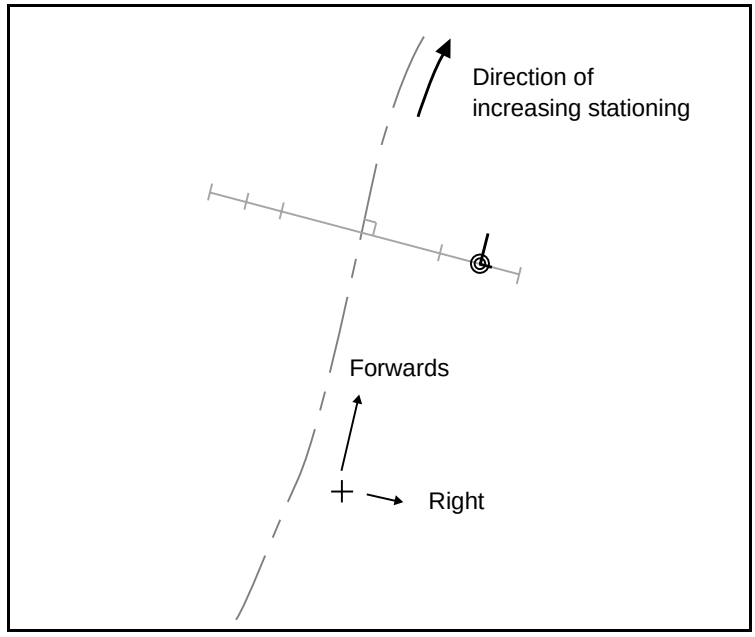


Figure 18.9 Forwards direction and right direction

2. Use the graphical display or the text display to navigate to the point. Do one of the following:

   – If you are using a conventional instrument, see Using the Graphical Display During Stakeout, page 504.

   – If you are using GPS, use the arrow as a guide and start moving towards the point, holding the TSC1 data collector in front of you. The arrow points in the direction of the point to be staked out. Walk towards the point. When you are walking in the direction of the point, the arrow points to the top of the screen.

     Note – *The direction arrow only works correctly once you are moving. Always move forward* ***towards*** *the point.*

When you get closer to the point, the arrow disappears. Instead, a bull's-eye symbol represents the point and a cross represents your position. See Figure 18.10.

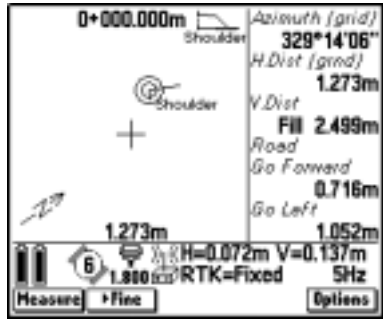


Figure 18.10 Stakeout graphical display for non-side slope point

Note – *When you navigate to a non-side slope point with construction offsets, the bull's-eye symbol represents the offset point.*

3. Press Fine to go into Fine mode. For more information, see Fine and Coarse Modes, page 399.
4. When the two symbols coincide, check the precisions and mark the point.

Note – *The symbol that shows the position of the point also shows the road–space coordinate frame. The longer line points in the direction of increasing station, the shorter line points in the direction of increasing offset (the offset increases from left to right). See Figure 18.11.*

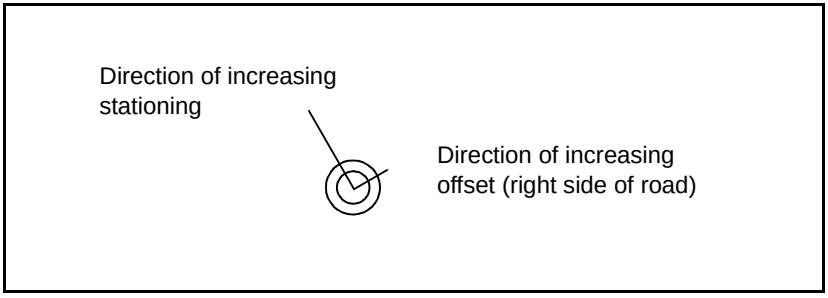


Figure 18.11 Point icon in the graphical display screen

5. Do one of the following:
   - Measure the point.

     For more information, see Measuring the As-Staked Position, page 444.
   - Stake out another point.

     To do this, press Esc to return to the *Stakeout*/*Roads* screen.

Navigating to a side slope point

To navigate to a side slope point:

1. Select a side slope point and press Start. The stakeout graphical screen display appears, as shown in Figure 18.12.

   If using a conventional instrument, refer to the screen on the right.

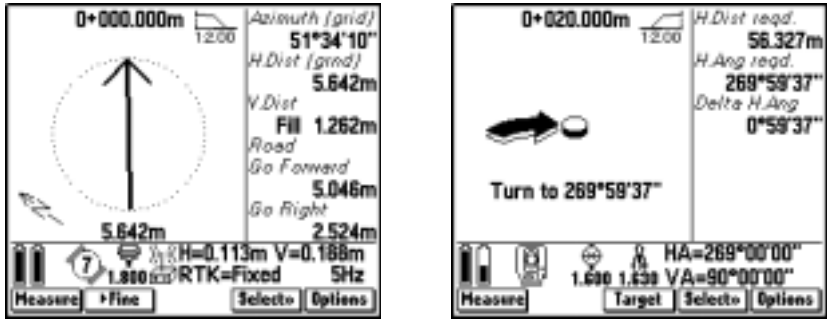


Figure 18.12 Stakeout graphical display for side slope point – gps or conventional survey

The station value for the point appears at the top of the screen. An icon to the right indicates:

– on which side of the road the point lies

– whether this is a cut slope or a fill slope

– the slope value of the side slope

For more information, see Icons in the graphical display screen, page 433.

Note – *For side slope offsets where the slope changes between templates, the Trimble Survey Controller software calculates the side slope for intermediate stations by interpolating the slope value. For more information, see When Side Slopes are Different, page 633.*

The screen shows a graphical display and text. The fields that appear are the same as the fields that appear in the display for a non-side slope point (see page 435).

Note – *Values in the ΔBackward (or ΔForward) and ΔLeft (or ΔRight) fields are relative to the cross-section of the point that is being staked out.They are not relative to the current stationing and* ***do not*** *represent delta stationing and offset values for points on curved sections of the road. For more information, see Figure 18.9 on page 436.*

The graphical display also shows a dashed line that connects the side slope catch position to the side slope hinge position.

Note – *A 'catch point' is the point where the side slope intersects with the ground.*

2. Press Select>> to select a side slope option, as shown in Figure 18.13.

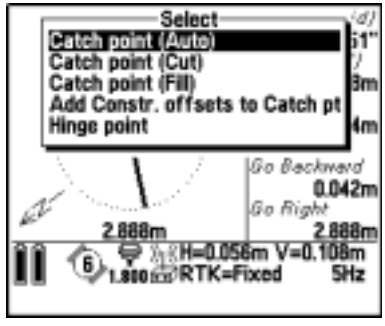


Figure 18.13 Select menu – side slope point

Table 18.4 explains the *Select* menu options for a side slope.

Table 18.4 Select Menu Options

Option	Description
Catch point (Auto)	The Trimble Survey Controller software selects the side slope (cut or fill) to intersect with the ground. This is the default.
Catch point (Cut)	Fixes the side slope as a cut side slope.
Catch point (Fill)	Fixes the side slope as a fill side slope.
Add Constr. offsets to Catch pt	Applies the horizontal and vertical construction offsets specified to the catch point. Navigate to the catch point before selecting this option. The position of the offset point depends on the catch point, so make sure that you stake out the catch point precisely.
Hinge point	Stakes out the base of the side slope. This is the most direct way to select the hinge point if the template includes a ditch offset. ***Notes***: Construction offsets are not applied to the hinge point when you use this method to select the hinge point. The default is Hinge.

Note – *Construction offsets are not automatically applied to a catch point. Navigate to the catch point and then press* Select>>*. Select Add Constr. offsets to Catch pt and navigate to the offset point.*

There is no need to press Select>> *when staking out a catch point with no construction offsets.*

The actual intersection position of the side slope with the existing ground surface—the catch point—is determined iteratively (by repetition). The Trimble Survey Controller software calculates the intersection of a horizontal plane passing through the current position, and either the cut or fill side slope. In Figure 18.14 x_n is the Go Right/Left value.

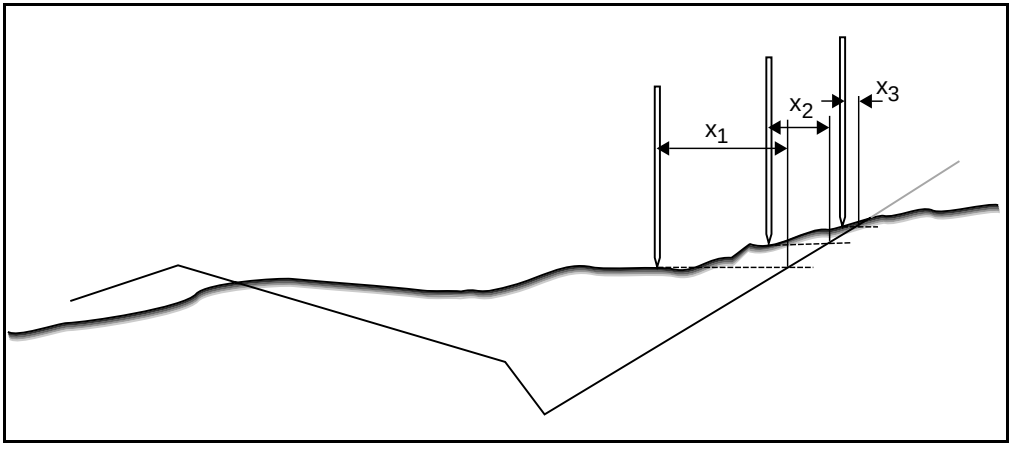


Figure 18.14 Locating a Catch Point

3. Navigate to the point.
4. Use the graphical display or the text display to navigate to the point. Do one of the following:
   - If you are using a conventional instrument, see Using the Graphical Display During Stakeout, page 504.
   - If you are using GPS, use the arrow as a guide and start moving towards the point, holding the TSC1 data collector in front of you. The arrow points in the direction of the point to be staked out. Walk towards the point. When you are walking in the direction of the point, the arrow points to the top of the screen.

     Note – *The direction arrow only works correctly once you are moving. Always move* ***forwards*** *towards the point.*

When you get closer to the point, the arrow disappears. Instead, a bull's eye symbol represents the point and a cross represents your position. See Figure 18.15.

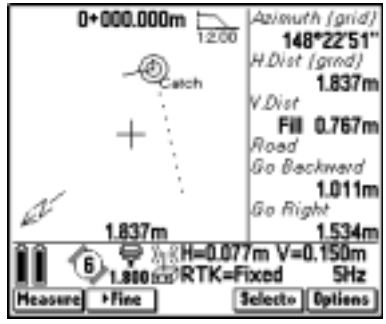


Figure 18.15 Stakeout Graphical Display – Side Slope Point

The position of the bull's-eye symbol shows the computed position of the catch point.

5. Press ►Fine to go into Fine mode. For more information, see Fine and Coarse Modes, page 399.

   Note – *Construction offsets are not automatically applied to a catch point. Navigate to the catch point and then go to Step 2. Select Add constr. offsets to Catch pt and navigate to the offset point.*

6. Locate and mark the point, then do one of the following:

   – Measure the point.

     See Measuring the As-Staked Position, page 444.

   – Stake out another point.

     To do this, press Esc to return to the *Stakeout*/*Roads* screen.

Measuring the As-Staked Position

Locate and mark the point. Then hold the range pole vertically over the point and do the following:

1. In the graphical display screen press Measure. Then do one of the following:
   - In a GPS survey, the *Survey*/*Measure points* screen appears. Enter a value for the point name and press Measure. The Store key appears when enough data has been collected. Press it to store the point.
   - In a conventional survey, the Store key appears. Press it to store the point.
2. If the *View deltas before storage* field in the *Stakeout settings* screen is set to Yes and you are staking out a non-side slope point, screens similar to those shown in Figure 18.16 appear.

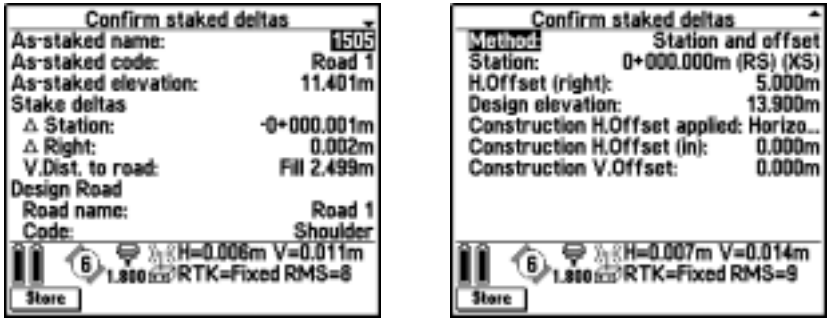


Figure 18.16 Stakeout deltas – non-side slope point

If you are staking out a side slope point, screens similar to those shown in Figure 18.17 appear.

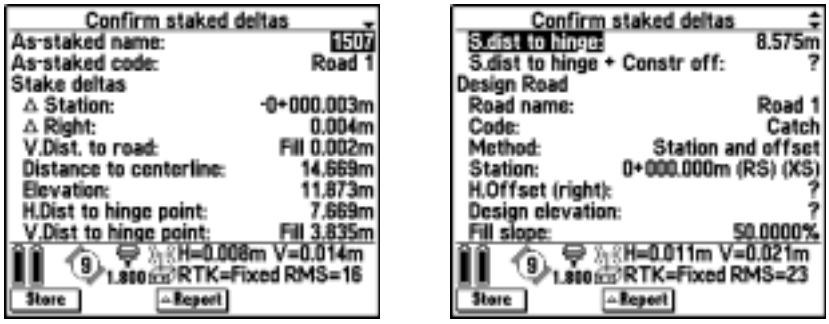


Figure 18.17 Stakeout deltas – side slope point

Note – *The value in the S.dist to hinge + Constr off: field includes any construction offset values specified and reports the slope distance from the hinge to the as-staked position. The value is null (?) if there is no horizontal construction offset specified or the horizontal construction offset is applied horizontally.*

Note – *The value in the Design elevation field and the H.Offset field for the design road is null (?) for catch points.*

Tip – Press Report to view the *Stake template deltas* screen. It shows the horizontal offset and vertical distance from the catch point to the end of each template element, up to and including the centerline. If the template includes a cut ditch the report will include the hinge position at the toe of the cut slope. The reported values exclude any construction offset specified.

Figure 18.18 explains some of these fields.

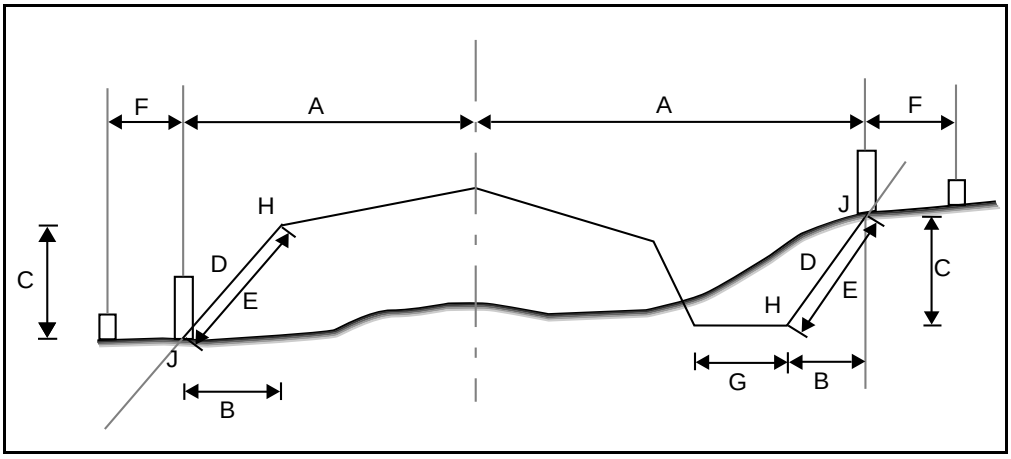


Figure 18.18 Typical cross-section of a road

Where:

- A = Distance to center line
- B = Horizontal distance to hinge point
- C = Vertical distance to hinge point
- D = Slope
- E = Slope distance to hinge point
- F = Construction horizontal offset
- G = Ditch offset
- H = Hinge point
- J = Catch point

3. Press Store to store the point.
4. To stake out more points return to Staking Out Points on the Road by Station and Offset, page 425.

   When there are no more points to stake out, press Esc to return to the *Survey* menu.

Measuring Positions on the Road

When you use the Trimble Survey Controller software to measure points, it can display your current position on the road.

Determining your Current Position Relative to a Road

To determine your current position relative to a road:

1. From the main menu, choose *Survey*. From the *Select Survey Style* list, choose a real-time Survey Style.
2. Select *Survey* / *Stakeout*. The *Stakeout* menu appears.
3. Select *Roads*. The screen shown in Figure 18.19 appears.

Figure 18.19 Survey/Stakeout/Road screen

4. In the *Road name* field, select the road to be staked out.

Tip – To select a road, highlight the Road name field and press ⊙. Press List to view a list of available roads, and highlight the required road. To review the selected road, press Review. To edit the road, press Key in and use the *Key in*/*Road* screen.

5. Press Enter to enter the name in the *Road name* field.
6. In the *Stake* field, select *Position on road*.

7. Enter a value in the Antenna height field and make sure that the *Meas. to* field is set correctly.
8. If there is a value in the *V.Offset* field, the Trimble Survey Controller software reports your position relative to the design, as adjusted by the specified vertical offset:
   - A negative value offsets the design vertically down.
   - A positive value offsets the design vertically up.

   Note – *The V.Offset value specified here is not applied to a DTM surface.*
9. Press Start. Figure 18.20 shows the Position on Road Graphical Display Screen that appears. It shows your position relative to the road. If you are using a conventional instrument, refer to the screen on the right.

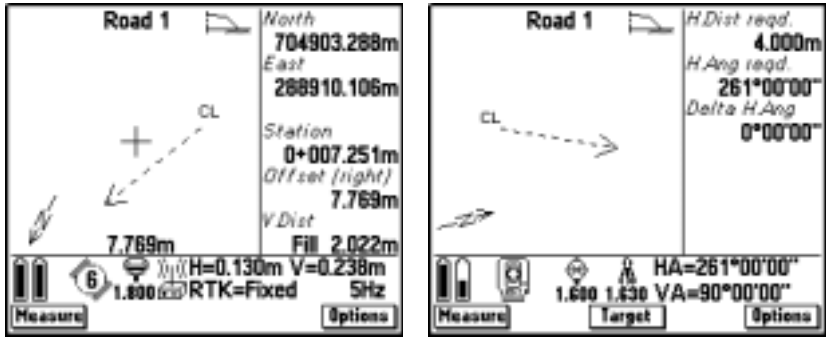


Figure 18.20 Position on road graphical display screens

Note – *If you are using a conventional instrument, the road values only appear after you take a distance measurement.*

The top of the screen displays the road name. For information about the icons that appear in the top right of the screen, see Table 18.3. The right side of the screen displays values in the following fields:

- North–the northing coordinate of the current position
- East–the easting coordinate of the current position

- Station - the station value of the current position relative to the road
- Offset (left/right) - the offset value of the current position relative to the road
- V. dist - the vertical distance (cut/fill) of the current position to the road

In the graphical display, the road is shown as an icon. It represents a portion of the centerline and shows the direction of increasing stationing. If your current position is more than 25 m (about 75 feet) from the centerline, the arrow guides you to a position on the centerline. (The software calculates this position by projecting your current position at right angles to the centerline.) If your current position is off the road; that is, your current position is before the start station or beyond the end station of the road, the arrow guides you to the start of the road. See Figure 18.21.

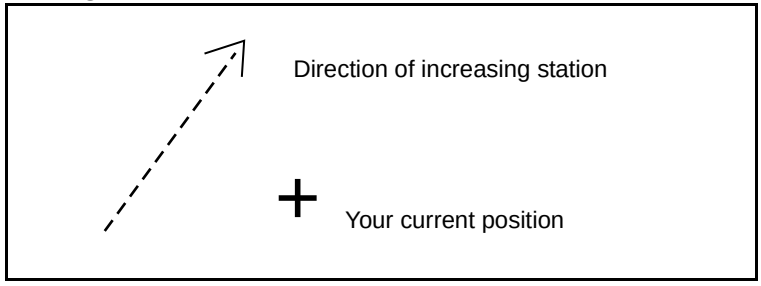


Figure 18.21 Road icon in the graphical display screen

10. Do one of the following:
    - Measure the point. For more information, see the next section.
    - Move to another position on the road and repeat the steps described above.

Measuring the Current Position Relative to the Road

To measure the current position relative to the road, do the following:

1. In the graphical display screen, press Measure. Then do one of the following:
   - In a GPS survey, the *Survey/Measure* points screen appears. Enter values for the point name and code and press Measure. The Store key appears. Press it to store the point.
   - In a conventional survey, press Accept. The Store key appears. Press it to store the point.
2. If the *View deltas before storage* field in the Stakeout settings screen is set to Yes, a screen similar to the one shown in Figure 18.22 appears.

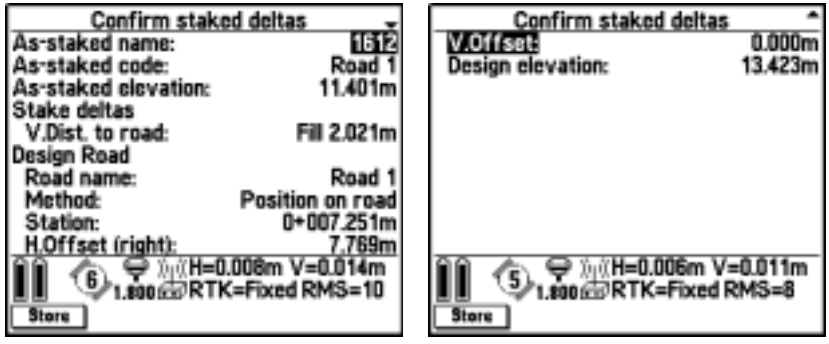


Figure 18.22 Survey screen

Note – *The design elevation excludes any V.Offset specified. If your position is before the start station or after the end station, the Station field displays 'Off road', and the Offset and V.Dist fields display null ('?'). If your position is within the start and end station values but at a greater offset than either the left or right catch points, the Station and Offset fields display the relevant values but the V.Dist field displays null ('?').*

CHAPTER

19

Using Conventional Instruments

In this chapter:

- Introduction
- Configuring the Trimble Survey Controller software
- Connecting to a conventional instrument
- Station setup
- Measuring points
- Measuring rounds of observations
- Staking out
- Ending a conventional survey

Introduction

This chapter describes how to use a conventional instrument with the Trimble Survey Controller software. It shows how to create a Conventional Survey Style, set up the equipment, and measure points. Other information about conventional instruments also occurs at relevant points elsewhere in this manual.

The Trimble Survey Controller software interfaces with the following brands of conventional instruments:

- Trimble
- Leica
- Geotronics (Spectra Precision)
- Sokkia
- Nikon
- Topcon
- Zeiss
- Pentax

Note – *Contact your local Trimble dealer for a current list of the instruments that the Trimble Survey Controller software supports.*

Configuring the Trimble Survey Controller software

Use a Survey Style to change the configuration of the Trimble Survey Controller software quickly and easily for different types of survey. Each Survey Style contains a set of information specific to your equipment and preferences. The information is stored as a pattern or template that you can call up and re-use when necessary. To survey using the Trimble Survey Controller software and a conventional instrument, select a Conventional Survey Style.

Conventional Survey Styles

A Conventional Survey Style defines the parameters for measuring and storing points.

The Trimble Survey Controller software provides a default Survey Style for use with a conventional instrument—Trimble Conventional. It is suitable for use with Trimble's conventional instrument. To use any other type of instrument, create a new Conventional Survey Style.

Creating a Conventional Survey Style

To create a Conventional Survey Style:

1. From the main menu, choose *Survey.* The *Select Survey Style* screen appears.
2. Press New.
3. Enter a name in the *Style name* field.
4. Set the *Style type* field to Conventional.
5. If a PC card is inserted, set the *File location* field as required.
6. Press Enter to accept the screen.

   A screen with options relevant to the chosen Style type appears, as shown in Figure 19.1.

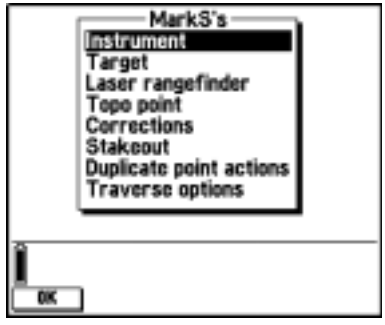


Figure 19.1 Options screen – conventional survey style

7. Select each item in turn and, in the screen that appears, set the fields to specify your equipment and preferences. For information about each menu item, see the following sections.

Tip – Alternatively, create a new Survey Style by copying and editing the Style called Trimble Conventional. For more information, see Copying and Editing a Survey Style, page 142.

Instrument

Select *Instrument* to specify the type of instrument used and its communication parameters.

The Trimble Survey Controller software interfaces with different brands of conventional instrument. Access the *Manufacturer* and *Model* (optional) fields to display a list of these names, and select the instrument you are using. Its default communications parameters appear. Change them if necessary. There is also a manual entry mode that lets you enter observations by keying them in.

Use the *Baud rate* field to configure the Trimble Survey Controller software baud rate to match that of the conventional instrument.

Use the *Parity* field to configure the Trimble Survey Controller software parity to match that of the conventional instrument.

When you change the instrument type, the baud rate and parity settings automatically change to the default settings for the selected instrument. For more information on configuring a conventional Survey Style and your conventional instrument, see Appendix E Conventional Instrument Settings.

Use the *HA VA status rate* field to set how often the Trimble Survey Controller software updates the horizontal and vertical angle display in the status line with information from the conventional instrument.

Note – *Some instruments beep when communicating with the Trimble Survey Controller software. You can turn off the beep in the instrument or set the HA VA status rate to Never.*

The *EDM precision* field appears if the instrument type specified has more than one measuring mode that can be set by the Trimble Survey Controller software. Use it to specify how the EDM measures distances. The options vary depending on the setting in the *Type* field. For example, if you are using a Trimble conventional instrument, the options are *5 mm*, *10 mm*, *20 mm*, and *Instrument default*. Select the *Instrument default* option to always use the setting on the instrument.

Note – *When you are using a Leica instrument in reflectorless mode, set the EDM precision to Instrument default.*

The *Set backsight* field appears if you can set the horizontal circle reading on the instrument when the backsight is observed. The options are *No*, *Zero*, and *Azimuth*. If you select the *Azimuth* option, when you observe the backsight the horizontal circle reading is set to the computed azimuth between the instrument point and the backsight point.

When the instrument type is a servo or robotic instrument, the *Stakeout auto turn* field appears. Set this field to Yes if you want the Trimble Survey Controller software to operate the servos automatically during stakeout, when you are measuring a known (coordinated) point.

When the instrument type is a servo or robotic instrument, the *Servo options* field also appears. Use it to specify which servos are used—choose from HA only, or HA & VA.

The *Stakeout turn to zero* field appears when the instrument type is SET (Extended). Set this to Yes if you want the horizontal angle on the instrument to display 0° 00' 00" when the instrument is turned on line with the point in stakeout.

Use the *Instrument precision* fields to record the precisions of the instrument. Do one of the following:

- Leave them as null.
- Enter the manufacturer's values.
- Enter your own values based on your observing techniques.

If you enter values, they are used by the Trimble Geomatics Office software to compute the standard error statistics for an observation. If you leave the fields as null, the Trimble Geomatics Office software default values are used to compute the standard error statistics.

Target

Select *Target* to enter information about the target in use.

Use the *Prism constant* field to specify a prism constant (the distance offset specific to each prism). When the prism constant is to be subtracted from measured distances, make sure that you enter a negative value. For more information about how the correction is applied, see Prism Constant Correction, page 202.

For some instruments, the Trimble Survey Controller software checks to see if a prism constant has been applied by the instrument and the Trimble Survey Controller software. When you select *Station setup*, messages are displayed in the status line showing what has/has not been checked.

If the Trimble Survey Controller software cannot check the setting on the conventional instrument, do one of the following:

- If there is a prism constant set on the instrument, make sure that the prism constant in the Trimble Survey Controller software is set to 0.000.
- If there is a prism constant set in the Trimble Survey Controller software, make sure that the prism constant in the instrument is set to 0.000.

Use the *Height* field to specify a target height. This is the distance from the point you are measuring, to the center of the target. For no target height, access this field and press Null.

Laser Rangefinder

Select *Laser Rangefinder* to set the parameters for using a laser rangefinder with a conventional instrument. For more information about configuring a laser, see Chapter 20, Laser Observations.

Topo point

Select *Topo point* to set the parameters for observing topographic points.

Use the *Measure display* field to define how the observations are displayed on the TSC1 data collector.

Table 19.1 describes the display options.

Table 19.1 Measure display options

Option	Corrections applied	Description
HA VA SD (raw)	None	Observation as seen on the conventional instrument display
HA VA SD	Prism constant	Raw observation corrected for prism constant
HA HD VD	Prism constant Pressure and temperature Instrument height and Target height Curvature and refraction	HA and HD from Station ground point to Target ground point and the height difference (VD) between these points
Az VA SD	Prism constant Pressure and temperature Orientation Curvature and refraction	Raw observation corrected for prism constant, orientation, and atmospheric effects.

Table 19.1 Measure display options (Continued)

Option	Corrections applied	Description
Az HD VD	Prism constant Pressure and temperature Orientation Instrument height and Target height Curvature and refraction	Same as HA HD VD but with backsight orientation applied to the HA
Δ Grid	Prism constant Pressure and temperature Orientation Instrument height and Target height Curvature and refraction Polar to rectangular	Trigonomical calculation of the Δ NEE relative to the instrument The same information as AZ HD VD but presented as rectangular coordinates
Grid	Prism constant Pressure and temperature Orientation Instrument height and Target height Curvature and refraction Polar to rectangular conversion Full coordinate transformation	Reduced grid coordinates

Use the *Auto point step size* field to set the increment size for automatic point numbering. The default is 1, although you can use larger step sizes as well as negative steps.

Set the *View before storage* field to Yes to view observations before they are stored.

Corrections

Select *Corrections* to set the corrections associated with conventional observations.

Warning – Check the conventional instrument to make sure that corrections are not being applied by both the instrument and the Trimble Survey Controller software.

Use the *PPM* field to specify a PPM (parts per million) correction. This correction applies a scale factor to the electronic distance measurement based on environmental conditions. Manually key in the PPM correction, or enter the pressure and temperature of the surrounding environment and let the Trimble Survey Controller software compute it.

Use the *Curvature and refraction* field to specify the index of refraction value. This is used to compute the curvature and refraction correction that is applied to vertical angle observations. Table 19.2 describes the options.

Table 19.2 Curvature and refraction options

Option	Description
0.142	for use during the day
0.2	for use at night
None	no correction applied

For some instruments, the Trimble Survey Controller software automatically checks to see if various corrections (PPM, prism constant, and curvature and refraction) are being applied correctly. If it finds that the corrections are being applied twice, a warning message appears.

For details of the formulas and calculations used, see Conventional Instrument Calculations, page 200.

Stakeout

To set the as-staked point details:

1. Set the *View deltas before storage* field to Yes.

   This lets you view the difference between a design point and the measured as-staked point before storing the point.

2. Enter a value in the *Horizontal tolerance* field.

The Trimble Survey Controller software displays the deltas if this tolerance is exceeded. The default is 0.000 (deltas always displayed).

3. Set the name of the as-staked point to be the next auto point name or a point name that is equivalent to its design name.
4. Set the code of the as-staked point to be the design point name or the design point code.
5. To display the as-staked deltas as grid (Northing, Easting, Elevation) values, choose Yes in the *Display grid deltas* field.

The stakeout graphical display screen displays directions using the conventional instrument as a reference point.

To set the display:

1. Choose a setting in the *Deltas* field. The options are:
   - Angle and distance – navigate to a point using angle and distance
   - Distances – navigate to a point using distances only

   For a comparison of these options see Figure 19.27 on Graphical display screen – distance measurement made, page 506.
2. Use the *Distance tolerance* field to specify the allowable error in distance.

   If the target is within this distance from the point, the graphical stakeout display indicates that the distance(s) is correct.
3. Use the *Angle tolerance* field to specify the allowable error in angle.

   If the conventional instrument is turned away from the point by less than this angle, the graphical stakeout display indicates that the angle is correct.

4. If you define a DTM and set the *Display cut/fill to DTM* field to Yes, the TSC1 displays cut or fill relative to that DTM.

   Use the *DTM* field to specify the name of the DTM to be used.

Duplicate point actions

In a conventional survey, you can set the tolerances for a duplicate point warning. You specify the maximum distance that the new point can be from the existing point. A duplicate point warning appears when you try to store a new point, but only if the duplicate point is outside the tolerance you set.

For more information, see Duplicate Point Actions, page 140.

Note – *In a conventional survey, when you enter a point name that already exists, the message* Point already exists *does not appear. This is because you may want to regularly measure points on both faces.*

When you use a conventional instrument to measure points on two faces, the Trimble Survey Controller software behaves according to the settings in the *Duplicate point actions* screen. For example:

If you make a Face 1 observation to a point and then store a Face 2 observation to the same point (with the same point name), the Trimble Survey Controller software performs a duplicate ***observation*** tolerance check between the two observations, based on the *F1/F2 observation tolerance* settings:

- If the Face 1 and Face 2 observations are within tolerance, they are averaged. A matched pair record is stored immediately after the Face 2 observation. Furthermore, a mean turned angle record is stored after the matched pair. For more information about matched pairs and mean turned angles see, Measuring a Point in Two Faces, page 487.
- If the Face 1 and Face 2 observations are out of tolerance, the *Observation: Out of tolerance* screen appears. The options are:
  - Discard – discard the observation without storing
  - Rename – rename to a different point name

- Store as check – store with a classification of Check
- Store another – store the observation and the matched pair
- Store and reorient – (this option only appears if you are observing a backsight point) store another observation that will provide a new orientation for subsequent points measured in the current station setup. Previous observations are not changed. Use this if you are doing multiple rounds of observations.

Note – *If the target height changed between the Face 1 and Face 2 observations, the Trimble Survey Controller software reduces the Face 1 and Face 2 observations to HA HD VD, and produces a matched pair that is the mean HA HD VD.*

When you make the next observation to the same point, the Trimble Survey Controller software performs a duplicate ***point*** tolerance check using the best point in the database and the point just measured:

- If it is within tolerance, the new observation is stored
- If it is out of tolerance, the *Duplicate point : Out of tolerance* screen appears.

  For more information, see Duplicate point : Out of tolerance screen, page 140.

Traverse options

Use these options to specify how a traverse calculation is adjusted. Table 19.3 shows the options and what they do:

Table 19.3 Traverse adjustment options

Field	Option	What it does
Adjustment method	Compass	Adjusts the traverse by distributing the errors in proportion to the distance between traverse points
	Transit	Adjusts the traverse by distributing the errors in proportion to the northing and easting ordinates of the traverse points
Error distribution		
Angular	Proportional to distance	Distributes the angular error among the angles in the traverse based on the sum of the inverses of the distances between traverse points
	Equal proportions	Distributes the angular error evenly among the angles in the traverse
	None	Does not distribute the angular error
Elevation	Proportional to distance	Distributes the elevation error in proportion to the distance between traverse points
	Equal proportions	Distributes the elevation error evenly among the traverse points
	None	Does not distribute the elevation error

Note – *The Compass option is the same as the Bowditch method of adjustment.*

For information about calculating and adjusting a traverse, see Traverse, page 571.

Connecting to a Conventional Instrument

This section shows how to assemble the equipment to do a survey with a conventional instrument.

Using a Trimble Conventional Instrument

To assemble the equipment see Figure 19.2, then do the following:

1. Set up the conventional instrument on a tripod.
2. Connect the TSC1 data collector to the instrument using the 0-shell Lemo to 0-shell Lemo cable that is supplied with the instrument.

Warning – Do not force plugs into the ports. Align the red dot on the plug with the red line on the socket and then insert the plug carefully.

3. Turn on the conventional instrument.
4. Turn on the TSC1 and go to Station Setup, page 468.

Figure 19.2 shows the TSC1 data collector connected to Trimble's conventional instrument.

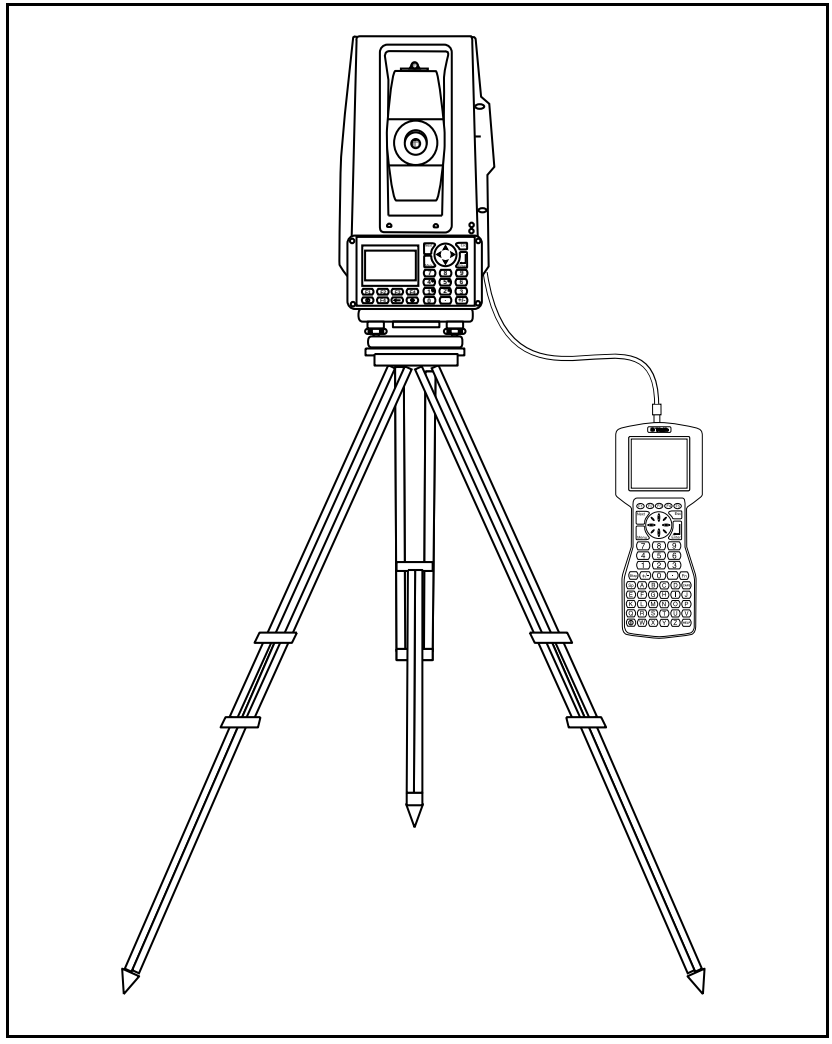


Figure 19.2 TSC1 data collector connected to a Trimble conventional instrument

Using a Third-Party Conventional Instrument

To assemble the equipment, see Figure 19.3, then:

Warning – Before connecting the TSC1 data collector to a Leica (using GSI) or Geodimeter instrument, select the appropriate Survey Style. This Survey Style must specify the correct type of instrument. Otherwise, the Trimble Survey Controller will not connect to the instrument and the instrument will have to be reset.

1. Turn on the TSC1 data collector.
2. From the main menu, select *Survey.*
3. Select the appropriate Survey Style.
4. Connect the TSC1 data collector to the instrument. Attach the 0-shell Lemo to DB9 (male) cable (part number 37779) to one of the following:
   - the computer download cable for the instrument
   - a cable provided by your local distributor
5. Turn on the conventional instrument.
6. Perform a Station Setup, page 468.

If you are using a robotic instrument:

If you are operating a robotic instrument remotely, make sure the TSC1 data collector is connected to the remote end (target) and that the instrument is configured for remote operation.

Figure 19.3 shows the standard connection to a conventional instrument.

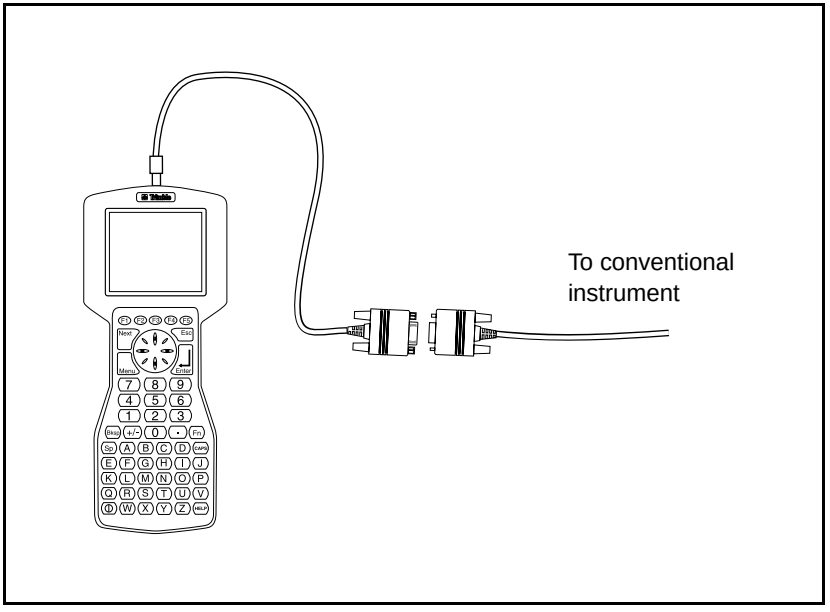


Figure 19.3 Standard connection to a third-party conventional instrument

Before starting a survey, make sure the instrument settings are compatible with the Trimble Survey Controller software. Find the settings for each model of instrument in Appendix E, Conventional Instrument Settings. Alternatively, contact your local Trimble dealer.

Auto-Connecting to a Conventional Instrument

When you turn on the TSC1 data collector, the Trimble Survey Controller software tries to auto-connect to any device that it could be connected to. It first tries to connect to the device specified in the last Survey Style used. If this fails, it uses the information contained in all available Survey Styles to determine what instrument is connected to the TSC1.

Working through the list, the Trimble Survey Controller software checks the top and bottom ports of the TSC1 data collector for each instrument specified in the Styles. The more Survey Styles there are stored, the longer the auto-connect process takes.

Tip – To speed up the process, select a Survey Style.

If many Survey Styles are defined, the auto-connect process may take a long time. However, the Trimble Survey Controller software will connect to the device specified in the Survey Style when a survey is started.

When the Trimble Survey Controller software is connected to an instrument, the conventional instrument icon appears.

Note – *If you turn on the TSC1 data collector and it is plugged into a Trimble conventional instrument, the Trimble Survey Controller software automatically turns on the instrument.*

Station Setup

Before starting work in the field, make sure that the conventional instrument is correctly configured in the Survey Style that you intend to use, and that the correct job is open.

If you intend to combine GPS observations and conventional measurements in the same job, make sure that you define an appropriate coordinate system for the job. For more information, see Choosing a Coordinate System for a Conventional Survey, page 85.

Then set up the instrument on a tripod over a point and connect it to the TSC1 data collector as shown in Connecting to a Conventional Instrument, page 464.

Before measuring points, rounds of observations, or staking out, perform a station setup on the TSC1 data collector.

To perform a station setup:

1. From the main menu, select *Survey*. Choose the required Survey Style from the list and press Enter.
2. Select *Station setup*.

   For some instruments the Trimble Survey Controller software automatically checks to see if various corrections (PPM, prism constant, and curvature and refraction) are being applied correctly. When you select *Station setup*, messages are displayed in the status line showing what has/has not been checked. If the Trimble Survey Controller software finds that the corrections are being applied twice, a warning message appears.
3. Follow the instructions in one of the following sections, depending on the information available. This could be:
   - known coordinates for both the instrument point and the backsight point
   - known coordinates for the instrument point, unknown coordinates for the backsight point
   - unknown instrument point coordinates, several known points surrounding the instrument point (resection)
   - unknown instrument point coordinates (to be provided later), no known points to use as a backsight

Note – *If you are using a coordinate system and zone from the Trimble Survey Controller software library, make sure that you use valid coordinates for that zone.*

Known Coordinates for Both the Instrument Point and the Backsight Point

If the instrument point and the backsight point are already stored in the Trimble Survey Controller software database:

1. In the *Instrument point name* field, enter the station point name.
2. Enter a value in the *Instrument height* field.

   Note – *For a two-dimensional or planimetric survey, leave the Instrument height field set to null (?). No elevations are calculated. A Default elevation must be defined before the Trimble Survey Controller can coordinate 2D observations.*

3. Enter a value in the *Backsight point name* field.

   The Trimble Survey Controller software calculates the azimuth and inserts it in the *Azimuth* field, changing the field name to *Azimuth (Computed)*.

4. In the *Backsight height* field, enter the height of the backsight target.
5. Choose an option in the *Method* field. The options are:
   - Angles only – measures horizontal and vertical angles
   - Angles and distance – measures horizontal and vertical angles and slope distance
6. Sight the center of the backsight target and press Measure.

The horizontal and vertical distance deltas are displayed on the screen. These are the differences between the calculated position and the observed position of the backsight. See Figure 19.4.

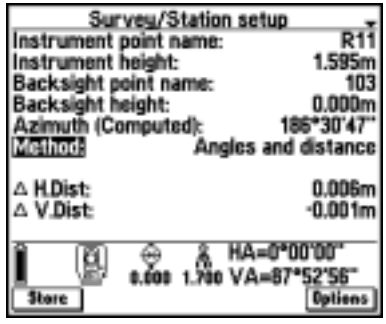


Figure 19.4 Survey/Station setup screen – known coordinates

Press ▼ repeatedly to view the measurement information. Alternatively, press Fn ▼ to page down.

7. Press Store to accept the station setup.

   Station setup is complete.

Known Coordinates for the Instrument Point, Unknown Coordinates for the Backsight Point

If the instrument point is already stored in the Trimble Survey Controller software database and the backsight coordinates are unknown:

1. In the *Instrument point name* field, enter the station point name.
2. Enter a value in the *Instrument height* field.

   Note – *For a two-dimensional or planimetric survey, leave the Instrument height field set to null (?). No elevations are calculated.*

3. Enter a value in the *Backsight point name* field. Because the backsight point is not in the database, the Trimble Survey Controller software asks if you want to key in the point. Press No.

4. In the *Backsight height* field, enter the height of the backsight target.

5. In the *Azimuth* field, key in the azimuth (bearing) from the instrument point to the backsight point.

   The Trimble Survey Controller software uses this azimuth to calculate a coordinate for the backsight point. The *Azimuth* field name changes to *Azimuth (Keyed in)*.

   Note – *If you do not know the azimuth at this stage, you can edit the azimuth record later in Review, or you can measure the backsight point using GPS. The coordinates of any points measured from that station will then be computed.*

6. Choose an option in the *Method* field. The options are:

   – Angles only – measures horizontal and vertical angles

     With this method, no coordinates are calculated for the backsight point. (No coordinates can be obtained if there is no distance.)

   – Angles and distance – measures horizontal and vertical angles and slope distance

7. Sight the center of the backsight target and press Measure.

The measurement information is displayed on the screen. No deltas are displayed because there are no known coordinates for the backsight. See Figure 19.5.

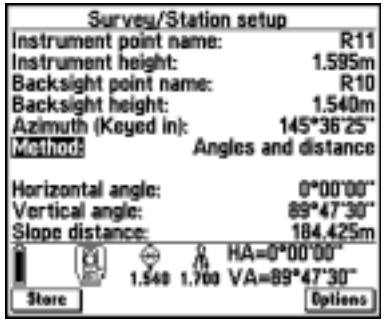


Figure 19.5 Survey/Station setup screen – known instrument, unknown backsight

8. Press Store to accept the station setup.

   Station setup is complete.

Unknown Instrument Point Coordinates, Several Known Points Surrounding the Instrument Point (Resection)

Use a resection calculation to compute coordinates for the instrument point by making observations to known points during the station setup process.

Note – *In a resection, only use points that can be viewed as grid coordinates. (The resection calculation is a grid calculation.)*

A resection needs a minimum of:

- three sets of angles
- two observations with horizontal and vertical angles and slope distances

The Trimble Survey Controller software uses a least-squares algorithm to compute the resection. This uses all of the data collected, which results in a statistically better result. For more information, see Resection Calculation, page 207.

When doing a resection, make sure that the geometry of the observations will produce a stable result. In a two-point resection, the result can be unreliable if the angle between the instrument point and the two resection points is close to 180°. In a three-point resection, the result can be unreliable if the three points and the instrument point lie on a circle. For all resections, results are unreliable if the points you are observing to are close together.

Table 19.4 shows the different types of resection provided by the Trimble Survey Controller software.

Table 19.4 Values computed by resection

Known coordinate values for instrument point	Values computed by resection
Northing, Easting, Elevation	Northing, Easting, Elevation
Northing, Easting	Elevation
Elevation	Northing, Easting
None	Northing, Easting, Elevation

To do a resection:

1. In the *Instrument point name* field, enter the station point name.

   The Trimble Survey Controller software warns that the point is not in the database, and the Key in, Resect, and Cancel softkeys appear.

2. Press Resect. The *Survey/Resection point* screen appears, as shown in Figure 19.6.

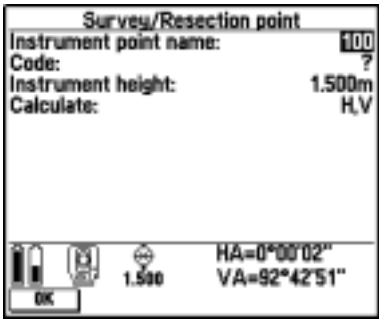


Figure 19.6 Survey/Resection point screen

3. In the *Instrument height* field, do one of the following:

   – For a two-dimensional resection, leave the field set to null (?).

   – For a three-dimensional resection, enter a value.

   If you entered a value in this field in the *Station Setup* screen, the Trimble Survey Controller software automatically transfers that value to this screen.

Warning – Once the resection is started you cannot enter a different instrument height.

The *Calculate* field indicates what values will be calculated by resection. For more information, see Table 19.4.

4. Press OK. The *Survey/Resection observation* screen appears, as shown in Figure 19.7.

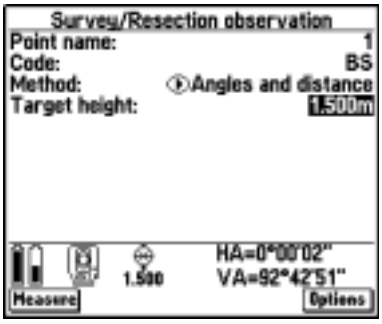


Figure 19.7 Survey/Resection observation screen

5. In the *Point name* field, enter the name of the point you are observing to.
6. In the *Code* field, enter a feature code (optional).
7. Choose an option in the *Method* field. The options are:
   - Angles only – measures the horizontal and vertical angles
   - Angles and distance – measures the horizontal and vertical angles and slope distance
8. In the *Target height* field, enter the height of the target you are observing.
9. Sight the center of the target and press Measure.

The measurement information is displayed on the screen, as shown in Figure 19.8.

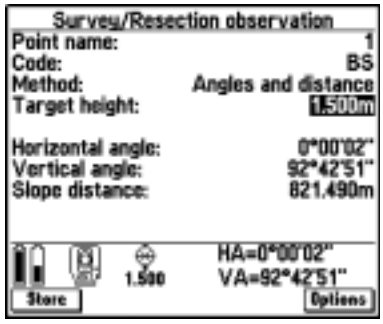


Figure 19.8 Survey/Resection observation screen – measurement information

10. If the information is correct, press Store to accept the observation. To discard the measurement, press Esc then Yes.
11. Repeat Steps 5 through 10 for all points that you are using in the resection calculation. When there is enough data for the Trimble Survey Controller software to calculate a resected position, the Calc softkey appears.
12. Press Calc to calculate the resection. The *Resection results* screen appears, as shown in Figure 19.9.

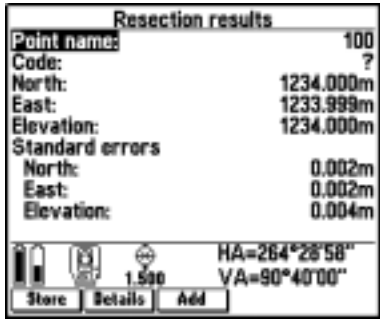


Figure 19.9 Resection results screen

Resection results screen

Use the *Resection results* screen to:

- store the results of the resection
- add more observations
- view specific point/observation details

The *Resection results* screen shows the coordinates of the instrument point as calculated by the resection. It also shows the standard errors for the coordinates. For information about the formula used to calculate the standard errors, see Resection Calculation, page 207.

Do one of the following:

- To store the results of the resection immediately, press Store.
- To return to the *Survey/Resection observation* screen and observe more points, press Add.

To view details of the resection, press Details. The *Resection* details screen appears, as shown in Figure 19.10.

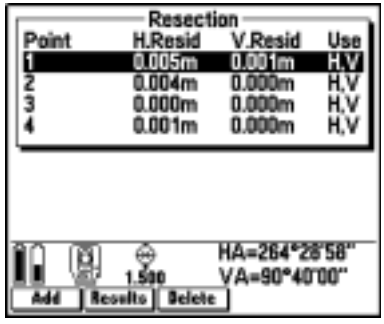


Figure 19.10 Screen showing resection details

To return to the *Resection results* screen and store the resected point, press Results then Store.

Resection details screen

Use the *Resection* details screen to:

- view individual point residuals
- delete observations from the resection
- change which observations are used to compute a solution

To return to the *Survey/Resection observation* screen and add more points, press Add.

To delete an observation from the resection calculation, highlight it and press Delete.

Warning – You cannot include an observation in a resection once the observation is deleted.
To see what a solution would be like if you deleted a particular observation, access the *Resection point* screen. In the *Use* field (see Figure 19.11) change the setting to Off.

To return to the *Resection results* screen, press Results.

To change which components (horizontal/vertical) of an observation are used in the resection calculation, highlight the point and press Enter. The *Resection point* screen appears, as shown in Figure 19.11.

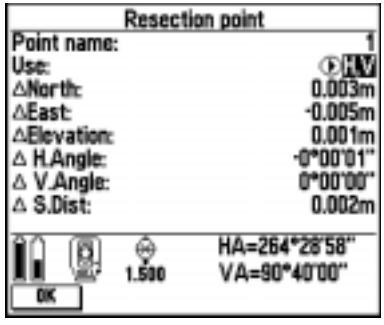


Figure 19.11 Resection point screen

Resection point screen

The *Resection point* screen shows the residuals of the observed point. The *Use* field shows which components of the observation are used in the resection calculation. Table 19.5 shows the options in this field.

Table 19.5 Use field options

Option	Description
H	Use only the horizontal values for that point in the calculation
V	Use only the vertical values for that point in the calculation
H,V	Use both the horizontal and vertical values for that point in the calculation
Off	Do not use the point in the calculation

Note – *If you change the setting in the Use field, the resection recomputes when you accept the screen.*

To store the results of a resection, return to the *Resection results* screen.

Unknown Instrument Point Coordinates (to be Provided Later), No Known Points to Use as a Backsight

If the coordinates of the instrument point (the station) are not known and will be provided later:

1. Enter a value in the *Instrument point name* field. The Trimble Survey Controller software warns that the point is not in the database. Press Cancel and continue. Any coordinates measured from this point will have null (?) values.
2. Enter a value in the *Instrument height* field.

   Note – *For a two-dimensional or planimetric survey, leave the Instrument height field set to null (?). No elevations are calculated.*

3. Enter a value in the *Backsight point name* field. The backsight point is not in the database, so the Trimble Survey Controller software asks if you want to key in the point. Press No.
4. In the *Backsight height* field, enter the height of the backsight target.
5. The value in the *Azimuth* field is null (?).
6. Choose an option in the *Method* field. The options are:
   - Angles only – measures horizontal and vertical angles
   - Angles and distance – measures horizontal and vertical angles and slope distance
7. Sight the center of the backsight target and press Measure.

   The measurement information is displayed on the screen, as shown in Figure 19.12.

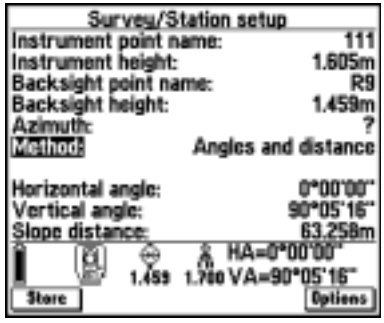


Figure 19.12 Survey/Station setup screen – unknown coordinates

8. Press Store to accept the station setup.

   Station setup is complete.

The instrument point and backsight point can be entered later. Key them in or measure them using GPS. The coordinates of any points measured from that station will then be computed.

Note – *When you enter the instrument point later, make sure you delete the original instrument point. The coordinates of any points measured from that station will then be computed.*

Alternatively, provide the coordinates later in the Trimble Geomatics Office or Trimble Survey Office software, after downloading the job.

Measuring Points

This section shows how to measure points using a conventional instrument and the Trimble Survey Controller software.

Survey/Measure Points Screen

When station setup is complete, select *Measure points* from the *Survey* menu. The *Survey/Measure points* screen appears, as shown in Figure 19.13.

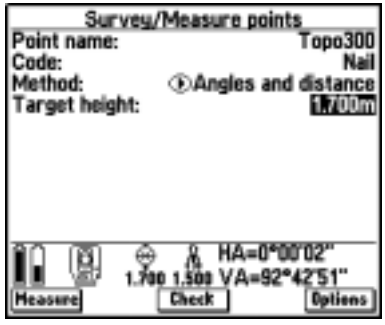


Figure 19.13 Survey/Measure points screen

To change the settings for the current survey, press Options. It is not possible to change the current Survey Style or the system settings.

Note – *You can view points and lines in the current job graphically in the job map. For more information, see Map of Current Job, page 95.*

If you are using a servo or robotic instrument to measure a known (coordinated) point, press Turn or set the *Stakeout auto turn* field to Yes in the Survey Style to automatically turn the instrument to the point.

Measuring a Topo Point

To measure a topographic point using the Trimble Survey Controller software and a conventional instrument:

1. Enter a value in the *Point name* field.
2. If applicable, enter a feature code in the *Code* field.
3. In the *Method* field, select a measurement method. See Choosing a method, below.
4. Enter a value in the *Target height* field.
5. Press Measure.

   If the *View before storage* field in the Survey Style is set to Yes, the measurement information appears on the screen. Edit the target height and code if necessary. Do one of the following:

   – Press Store to store the point.

   – Turn the instrument to the next point and press Read. The last point is stored and a measurement is made to the next point.

   If the *View before storage* field is set to No, the point is stored automatically and the point name increments (based on the *Auto point step size* setting).

   The Trimble Survey Controller software stores the raw observations (HA, VA, and SD).

Choosing a method

Choose one of the following methods to measure a topo point:

- Angles only – measures only the horizontal and vertical angles
- Angles and distance – measures the horizontal and vertical angles and slope distance
- H. Angle offset – first measures the vertical angle and slope distance then the horizontal angle to an inaccessible point

- Single dist. offset – measures horizontal and vertical angles and slope distance to a target, then computes a new position from the target to a specified direction and distance

If you are measuring a point by an *Angles only* or *H. Angle offset* method using a robotic instrument operated from the remote end (target), make sure the instrument is tracking the target. If tracking is not maintained, the current orientation of the instrument will be used for the measured angles.

Horizontal Angle Offset

Use the *H. Angle offset* method when the point to be measured is inaccessible, for example the center of a tree.

To measure a point using this method:

1. In the *Point name* field enter the name of the point.
2. In the *Code* field enter a feature code (optional).
3. In the *Method* field select H. Angle Offset.
4. In the *Target height* field enter the height of the target.
5. Place the target beside the object to be measured, sight the target, and press Measure.

The *Horizontal angle* field shows a null (?) setting and the screen of the TSC1 data collector looks similar to Figure 19.14.

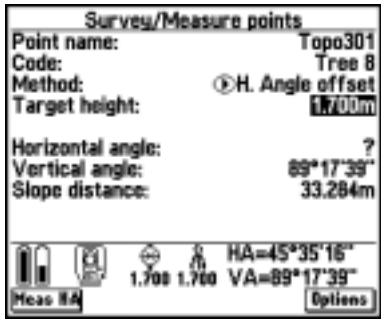


Figure 19.14 Survey/Measure points screen – horizontal angle offset

6. Turn the target to the center of the object and press Meas HA.The Trimble Survey Controller software inserts the measured value in the *Horizontal angle* field and:
   - If the *View before storage* field in the Survey Style is set to Yes, the measurement values are displayed. Press Store to store the point.
   - If the *View before storage* field is set to No, the point is stored automatically.

Single Distance Offset

Use the *Single dist. offset* method when a point is inaccessible but a horizontal distance from the target point to the object can be measured.

To measure a point using this method:

1. In the *Point name* field enter the name of the point.
2. In the *Code* field enter a feature code (optional).
3. In the *Method* field select Single dist. offset.
4. In the *Target height* field enter the height of the target.

5. In the *Distance* field enter the horizontal distance from the target (prism) point to the object to be measured.
6. In the *Direction* field enter the direction from the target (prism) point to the object to be measured. Figure 19.15 shows how the directions are defined.

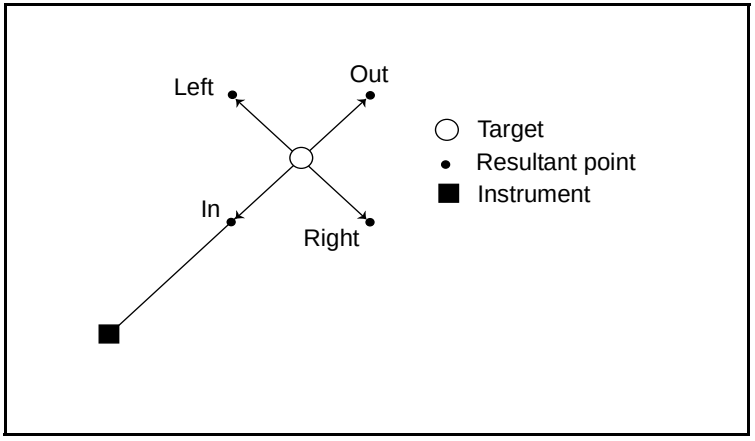


Figure 19.15 Direction options

If you are operating a robotic instrument remotely from the target, the left/right directions are reversed. However, the measurement is stored relative to the instrument position, as shown in Figure 19.15.

The Trimble Survey Controller software displays a screen similar to that shown in Figure 19.16.

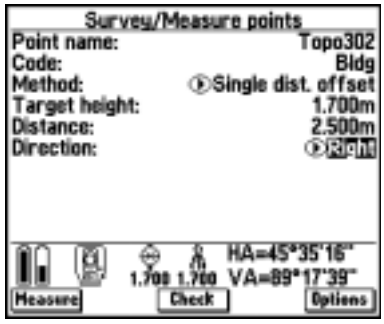


Figure 19.16 Survey/Measure points screen–single distance offset

7. Press Measure:

   – If the *View before storage* field in the Survey Style is set to Yes, the observation adjusted for the offset distance appears. Press Store to store the point.

   – If the *View before storage* field is set to No, the point is stored automatically.

   The Trimble Survey Controller software stores the adjusted horizontal angle, vertical angle, and slope distance in the point record, as well as an offset record with the offset measurement details.

Measuring a Point in Two Faces

The Trimble Survey Controller software lets you make Face 1 and Face 2 (direct and reverse) measurements at any time and in any order. It averages a pair of observations in a matched pair record. It then averages multiple matched pair records (rounds of observations) in a mean turned angle record.

For information on Face 1 and Face 2 tolerance checking, see Duplicate point actions, page 461.

Note – *You can measure points using either face in any order (for example, BS FS FS BS or BS FS BS FS). However, if you observe the backsight only on Face 1, only Face 1 observations to points are coordinated. Points observed on Face 2 are coordinated when the backsight is observed on Face 2.*

To measure a point using both faces:

1. Complete a station setup.
2. Measure a point. (See Measuring a Topo Point, page 483.)
3. Measure the same point again on the opposite face of the instrument. In the *Point name* field, use the same name as in Step 2.

   The Trimble Survey Controller software writes a matched pair record immediately after the observation on the opposite face is stored. This matched pair record contains the mean horizontal angle, the mean vertical angle, and the mean slope distance from the two previous observations.

   Immediately after a matched pair record, the Trimble Survey Controller software writes a mean turned angle record. This mean turned angle record contains the mean horizontal angle, the mean vertical angle, and the mean slope distance from all previous matched pairs observed from the current station setup.

   The mean slope distance displayed in the mean turned angle record in the Trimble Survey Controller software has been reduced for PPM, curvature and refraction, and prism constant. The raw mean slope distance is exported to the DC file and reduced in the Trimble Geomatics Office software.

   If you make another pair of Face 1 and Face 2 observations during the same station setup, another matched pair record is written to the database and a new updated mean turned angle record is written. The previous mean turned angle record disappears.

Note – *If you change the target height between the two observations, the Trimble Survey Controller software reduces the Face 1 and Face 2 observations to HA HD VD, and produces a matched pair that is the mean HA HD VD. The same happens to the mean turned angle record when you change the target height between matched pair records.*

If you observe a point using the Angles and distances method and then make a second (Face 2) observation to it using the Angles only method, you must still observe to the center of the target. The Trimble Survey Controller software averages the vertical angle measurements in the matched pair record. Alternatively, set the target height to null (?) when you make the second observation. If the target heights differ, only the horizontal angle measurements are meaned.

Backsight

When observing points on both faces, remember to observe the backsight on both faces. Once the backsight has been observed on Face 1 and Face 2, a matched pair record is written for the backsight. The orientation correction for any foresight points with a matched pair record is then based on the backsight matched pair record.

If you are using a servo or robotic instrument, use the Chg face softkey in the *Instrument / Instrument controls* menu to change face.

Measuring a Check Point

To measure a check point or to check the backsight, from the *Measure points* screen press Check. The *Survey*/*Check shot* screen appears as shown in Figure 19.17.

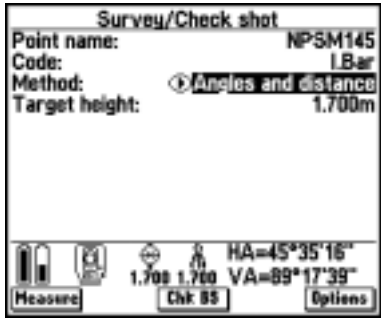


Figure 19.17 Survey/Check shot screen

To measure a check point:

1. In the *Point name* field, enter the name of the point to check.
2. In the *Method* field, select a measurement method.

   Other fields appear, depending on the method you choose. Fill these in as required.
3. In the *Target height* field, enter the height of the target.
4. Press Measure.

If *View before storage* is set to No, the point is stored with a classification of Check. If it is set to Yes, the Check shot deltas appear on the screen. See Figure 19.18.

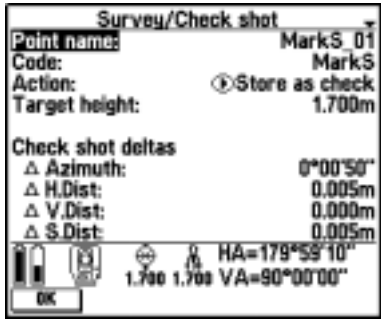


Figure 19.18 Survey/Check shot screen – check shot deltas

If you observe the point from the same station setup that you originally measured it from, the deltas are the difference in observation values between the original observation and the check observation. The deltas displayed are: horizontal angle, vertical distance, horizontal distance, and slope distance.

If you observe the point from a different station setup from the one you originally measured it from, the deltas are in terms of the best coordinates from the original point to the check point. The deltas displayed are: azimuth, vertical distance, horizontal distance, and slope distance.

5. Press Store to store the check point. Press Esc to abandon the measurement.

Press Chk BS to display the *Survey* / *Check backsight* screen. This is similar to the *Survey* / *Check point* screen, but the *Point name* field shows the backsight of the current station setup. You cannot edit this field.

To observe a check shot to the backsight, use the same procedure as described above.

To return to the *Survey* / *Check point* screen, press Chk topo.

Measuring Rounds of Observations

This section shows how to measure multiple sets (rounds) of observations with a conventional instrument and the Trimble Survey Controller software. A round consists of a set of both Face 1 and Face 2 observations.

With rounds, you measure the first face observations. The Trimble Survey Controller software builds the rounds list then guides you through a specified number of rounds of observations by:

- directing you to change face when required
- defaulting to the correct point details for each observed station
- displaying the results and allowing you to delete bad data

Building the Rounds List

The rounds list contains the points used in the rounds observations. The Trimble Survey Controller software automatically builds this list during the first round of observations made on the first face (typically Face 1). The backsight point observed during station setup, is added to the list first. The last point is added when the first round of observations is completed on the first face.

When a point is added to the rounds list, the Trimble Survey Controller software takes note of the following details:

- Point name
- Feature code
- Target height
- Prism constant

The Trimble Survey Controller software uses this information as the default values for all subsequent rounds observations.

The rounds list cannot be edited, so observe all points that are to be included in the rounds observations during the first round on the first face.

To add a point to the rounds list:

1. Complete a station setup. For more information, see Station Setup, page 468.

   The backsight point will be added to the rounds list first.

2. From the *Survey* menu, select *Measure rounds*.

   The Survey/Measure rounds screen appears. See Figure 19.19.

Figure 19.19 Survey/Measure rounds screen

   The *Survey/Measure rounds* screen shows what face the instrument is on, and the number of the current round (shown in brackets). For example, Figure 19.19 indicates the instrument that is on Face 1 of the first round.

3. To change the settings for the current survey, press Options. The *Options* screen appears as shown in Figure 19.20.

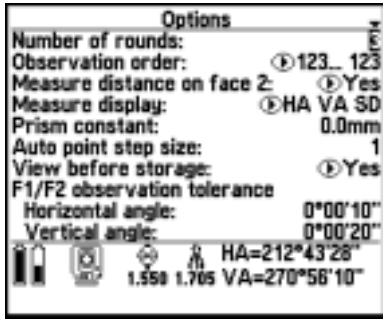


Figure 19.20 Options screen–rounds

Use the *Options* screen to specify the prism constant of the target for each observation in the rounds list. Enter a negative value if the prism constant is to be subtracted from measured distances.

4. To add a point to the rounds list, follow the same procedure for measuring a topo point. For more information, see Measuring a Topo Point, page 483.

   If the *View before storage* field in the Survey Style is set to Yes, the measurement information is displayed. See Figure 19.21.

Figure 19.21 Survey/Measure rounds screen–measurement

   If the *View before storage* field is set to No, the point is stored automatically, and the point name increments (based on the *Auto point step size* setting).

5. When the rounds list is complete, press End face.

   The message First face completed appears and the Trimble Survey Controller software prompts you for the next point to be measured in the rounds of observations.

Note – *If you press Esc in the Survey/Measure rounds screen, the current rounds list is lost. A new station setup is required to start another round.*

Measuring a Point in a Round of Observations

When the rounds list has been built, the *Survey/Measure rounds* screen displays the default target details for the next point to be observed.

If the TSC1 data collector is connected to a servo or robotic instrument and the *Stakeout auto turn field* is set to Yes in the Survey Style, the Trimble Survey Controller software automatically turns the instrument to the calculated horizontal and vertical angle.

Warning – When using servo or robotic instruments, check that the instrument has sighted the target accurately, and manually adjust it if required. Some instruments can perform accurate sighting automatically. For information on the instrument specifications, refer to the instrument manufacturer's documentation.

Making a measurement

Once the rounds list has been built, the Trimble Survey Controller software automatically displays the last used target information for the next point to be measured.

To measure a point:

1. Press Measure.

   When the observation is stored, the Trimble Survey Controller software defaults the point name and the target information for the next point in the rounds.

   Note – *If you observe a point on the wrong face, the Trimble Survey Controller software will warn you after you try to store the point.*

2. Repeat this procedure until all observations are completed on the face.

When all observations have been completed, the Trimble Survey Controller software will display the results for the round. For more information, see Viewing the Results, page 498.

If you cannot complete the observations, press End face. The following warning message appears.

Please confirm: Not all points have been observed. End observations on this face?

Press Yes to confirm that you want to end observations on this face and begin observing the next set of rounds.

If the *Measure distance on face 2* field is set to No, the measurement method for observations on Face 2 will always use *Angles only* by default.

If the TSC1 data collector is connected to a servo or robotic instrument, the Turn softkey is also available. After a point is stored, press Turn to automatically turn the instrument to the next target. If the *Stakeout auto turn* field in the Survey Style is set to Yes, the instrument will automatically turn.

Duplicate Point Actions (Rounds)

The Trimble Survey Controller software treats points in rounds observations according to the Survey Style settings in the *Duplicate point actions* screen. For more information, see Duplicate point actions, page 461.

If you use the default settings in the *Duplicate points action* screen, the *Duplicate point: Out of tolerance* screen appears every time a point of the same name is observed. If you change the settings, the *Duplicate point: Out of tolerance* screen appears only when the tolerance values have been exceeded.

For larger scale surveys, you may need to increase the *Duplicate point tolerance* settings for the Survey Style. Set the tolerances at an appropriate value to check for gross errors, and examine the observation residuals for better quality control. For information on viewing the observation residuals, see Viewing the Results, page 498.

When a new point is further from the point observed in the previous round than the tolerance specified in the Survey Style settings, the *Duplicate point: Out of tolerance* screen appears. Set the Action field to one of the following options:

- Discard–discard the point without storing
- Store another–store the point

Duplicate Backsight Point

When the orientation is changed between consecutive rounds, that is the backsight point is re-observed in the new round, the *Duplicate backsight point* screen appears. The options are:

- Discard–discard the observation without storing
- Store and reorient–store another observation that provides a new orientation for subsequent points measured in the current round. Previous observations are not changed.

F1/F2 Observation Tolerance

If the Face 1 and Face 2 observations are out of tolerance, the *Observation: Out of tolerance* screen appears. The options are:

- Discard–discard the observation without storing
- Store another–store the observation, the matched pair and the mean turned angle

Note – *To change the F1/F2 Observation tolerance setting during the survey, press Options from the Survey/Measure rounds screen.*

Skipping Observations

During rounds observations, you can skip an observation by pressing Skip if the current point cannot be measured. The Trimble Survey Controller software will then default to the next point in the rounds list.

It is not possible to skip observations:

- when building the rounds list
- if the observations are made to the first point (backsight) in the rounds list

When the Trimble Survey Controller software has reached the end of the rounds list and points have been skipped, the warning message Observe skipped points? appears.

Press Yes to observe the points that were skipped during that round. The observations can be skipped again if required. Select No to end the round.

Points that are skipped on the first face are automatically skipped on the second face. Similarly, if a point is skipped on the second face, the first face observation will be disregarded. If a point is skipped in one round, all subsequent rounds continue to prompt for observations to that point.

Viewing the Results

At the end of each round, the Trimble Survey Controller software displays the *Rounds summary* screen, as shown in Figure 19.22.

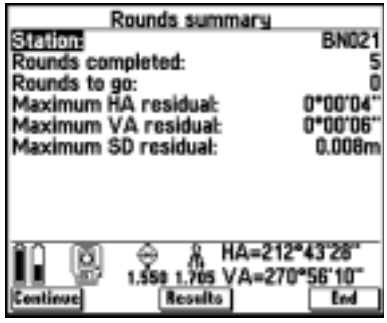


Figure 19.22 Rounds summary screen

Use the *Rounds summary* screen to:

- continue and observe more rounds

- view specific point/observation details
- end the current rounds session

The *Rounds summary* screen shows details of the rounds that have been completed. The maximum residuals are displayed for quick reference.

Note – *In two-dimensional surveys where the instrument or target heights are null, the observed vertical angle and slope distance residuals and standard deviation are displayed as* N/A.

Do one of the following:

- To return to the *Survey/Measure rounds* screen and observe another round, press Continue.
- To end the current rounds session, press End.

To view details of the observations, press Results. The *Station* details screen appears, as shown in Figure 19.23.

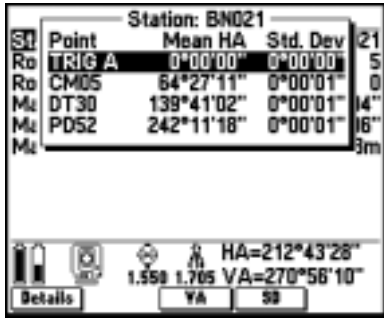


Figure 19.23 Screen showing station details

To return to the *Rounds summary* screen, press Esc.

Station details screen Results

Use the *Station* details screen to:

- view the observation details from the current station in the round.

- view individual point residuals and remove bad observations from a round.

The *Station* detail screen shows the mean (turned) horizontal angle and standard deviation for all points observed from the station. To change the observation display view, do one of the following:

- Press VA to display the mean vertical angle.
- Press SD to display the mean slope distance.

To return to the mean horizontal angle view, press HA.

To view individual point residuals for each round and remove bad observations, highlight the point and press Details. The *Point* details screen appears, as shown in Figure 19.24.

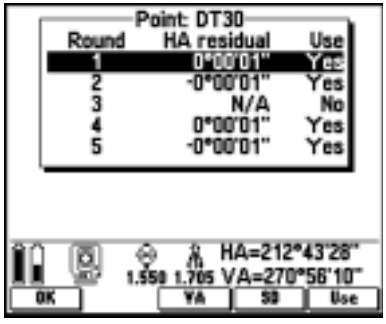


Figure 19.24 Screen showing point details

Point details screen

The *Point* details screen shows the residuals of the observed point for each round. The *Use* column shows the observations in use (displayed as *Yes*), and those that have been removed (displayed as *No*). If observations have been skipped in a round, *N/A* is displayed.

Use the HA, VA or SD softkeys to change the residual display views.

If the residuals for an observation are high, it may be desirable to disable the observation from the round. To disable an observation component (HA, VA or SD), highlight it and press Use.

When *Use* is set to No, the pairs of observations (Face 1 and Face 2) made to the point in the round are deleted. The mean observations, residuals and standard deviations are recalculated.

The Use softkey is not available for backsight points. Observations to the backsight are used to orientate observations and cannot be deleted.

To accept the changes and return to the *Station* details screen, press OK.

Staking Out

The *Stakeout* menu provides options for staking out coordinates, lines, curves, slopes, roads, and surfaces. This section shows how to stake out a point using a conventional instrument.

For information about staking out a road, see Chapter 18, Roading.

Warning – Do not stake out points and then change the coordinate system or perform a calibration. If you do, these points will not be in terms of the new coordinate system. They will also be inconsistent with points staked out after the change.

General Procedure

To stake out a point, set up the conventional instrument and complete a station setup:

1. Change the stakeout settings if necessary (see the next section).
2. Define the point/line/curve/DTM. To do this, use one of the following methods:
   - key in data
   - upload a file from a PC
   - calculate coordinates using one of the Cogo functions
3. From the main menu, select *Survey*. From the *Survey* menu, select *Stakeout*, then choose what you want to stake out (Points, Lines, Curves, Roads, or DTMs).
4. Turn the conventional instrument to the angle indicated on the screen. If you are using a servo or robotic instrument, press Turn or set the *Stakeout auto turn* field to Yes in the Survey Style to automatically turn the instrument to the angle indicated on the screen.

   If you are operating a robotic instrument remotely, the instrument will automatically track the prism as it moves (if lock is maintained). The stakeout graphical display will update accordingly.

   The graphics indicate when the instrument is on line.
5. Move the target so that it is on line and press Measure. Adjust the target distance from the instrument as indicated by the graphics, and measure again.
6. When the graphical display indicates that the target is on the point, press Accept.
7. Store the as-staked point (this step is optional).
8. Repeat Steps 5 and 6 until all points are staked out.
9. End the survey.

Note – *The defined point/line/curve/road/surface must be stored in the Trimble Survey Controller software database before you can stake it out.*

Stakeout Settings

You can change the default values for as-staked points. You can also change how certain values are displayed during stakeout.

To specify what distances are used and displayed by the Trimble Survey Controller software:

1. From the main menu, select *Configuration* / *Job* / *Cogo settings*.
2. Set the *Distances* field as required. To apply sea level correction, for example, set the *Distances* field to Sea level.

Stationing values can be displayed in the following formats: 1000.0, 10+00.00, or 1+000.0.

To change the format:

1. From the main menu, select *Configuration* / *Job* / *Units*.
2. Set the *Stationing* field as required.

To change the stakeout settings for a Survey Style:

1. From the main menu, select *Configuration* / *Survey Style*.
2. Highlight your Conventional Survey Style and press Edit.
3. Select *Stakeout*. For more information about the fields that can be edited, see Stake To Options, page 414.

Tip – For the next section, use the online Help if necessary. Press the HELP key and then press S T and choose the stakeout topic.

To change the stakeout settings for the current survey only:

1. From the *Survey/Stakeout* screen press Options. The *Options* screen appears, as shown in Figure 19.25.

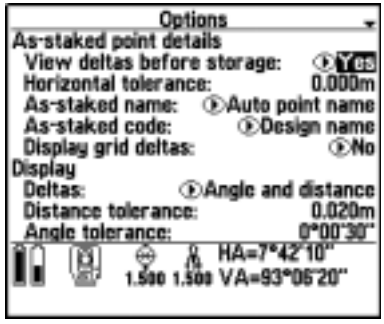


Figure 19.25 Options screen – stakeout

2. Set the fields as required. For more information, see Stakeout, page 459.

Using the Graphical Display During Stakeout

When staking out a point, line, curve, or road, use either the text on the right of the screen or the graphical display on the left to navigate to the point. This section describes how to use the graphical display.

The general rule in using the graphical stakeout is that a solid/filled arrow means action. Use these arrows to locate the point within a certain tolerance. You can configure the tolerances for both angles and distances in the *Options* screen.

The stakeout graphical display operates in one of two modes: Distances, or Angle and distance. To choose a mode, set the *Display/Deltas* field in the *Options* screen. The next section shows examples of each mode.

To use the graphical display during stakeout:

1. When you select a point to stake out, the stakeout graphical display screen appears. See Figure 19.26.

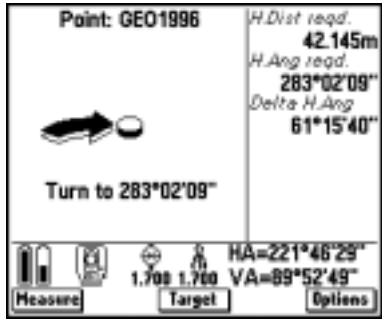


Figure 19.26 Initial screen of graphical display – stakeout

   A large arrow indicates the direction in which the instrument must be turned. The screen also indicates the angle that the instrument must display.

   If you are using a servo or robotic instrument, press Turn or set *Stakeout auto turn* to Yes in the Survey Style, to turn the instrument automatically to the angle indicated on the screen.

   If you are operating a robotic instrument remotely from the target, the graphical display is reversed and the arrows are shown from the target (prism) to the instrument.

2. When the instrument is within the angular tolerance, the graphical display shows two hollow/outline arrows. (Use the *Options* screen to set angular tolerance.)

3. Press Measure. When the distance measurement is made, a screen similar to one of those shown in Figure 19.27 appears.

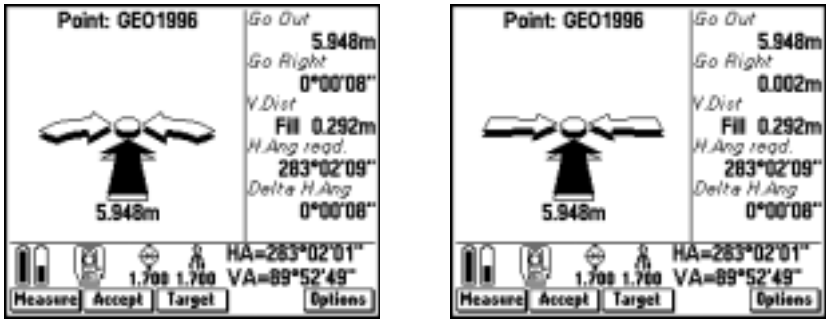


Figure 19.27 Graphical display screen – distance measurement made

The left and right arrows are curved or straight depending on the mode set in the *Options* screen:

– In the left screen above, the *Display/Deltas* field is set to Angle and distance. The arrows are curved.

– In the right screen, the *Display/Deltas* field is set to Distances. The arrows are straight.

The hollow left and right outline arrows show that the instrument is on line. The solid arrow indicates that the target must move away from the instrument.

4. When the target has moved, press Measure again. If the instrument is turned off line, the two outline arrows disappear and a solid one appears. Figure 19.28 shows two different ways to view this.

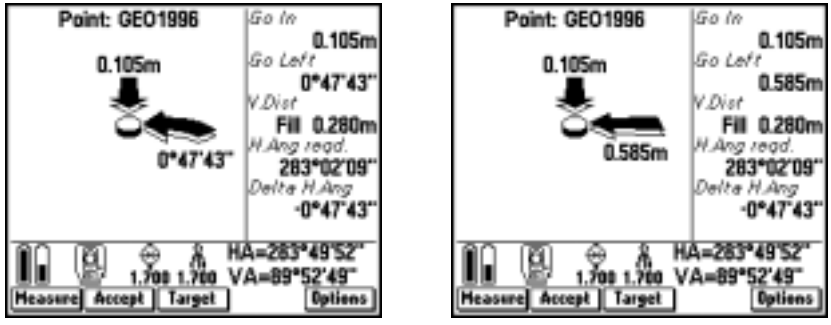


Figure 19.28 Graphical display screen – measurement made, instrument off line

– In the left screen above, the *Display/Deltas* field is set to Angle and distance. The instrument must be turned to the left by the amount shown. When the instrument is on line again, the two outline arrows reappear. Direct the target on line.

  The down arrow indicates that the target must move towards the conventional instrument.

– In the right screen, the *Display/Deltas* field is set to Distances. The target must move to the left. The instrument is then turned to follow the target. When the instrument is on line, the two outline arrows reappear.

Tip – If you are using a servo instrument press Turn, or Fn T to turn the instrument back on line.

5. When the target has moved, press Measure again.

   If the instrument is on line, two left/right outline arrows appear. If the distance is not yet correct, a solid up/down arrow shows the direction and amount that the target must move towards or away from the instrument. See Figure 19.27.

6. Press Measure again. If the measurement to the target is within the angular and distance tolerances set in the *Options* screen, four hollow/outline arrows appear and the center point is filled in. See Figure 19.29.

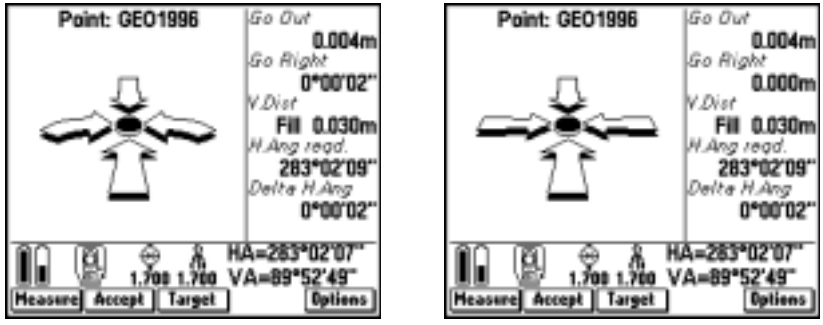


Figure 19.29 Graphical display screen – point located within tolerance

If you are operating a robotic instrument remotely, the instrument automatically tracks the prism as it moves and continuously updates the graphical display. If a measurement to the target is within the angular and distance tolerances, press Measure.

7. Do one of the following:

   – If you want to record the as-staked point:

     If the *View deltas before storage* field is set to Yes, press Accept. The measurement and the stakeout deltas are displayed. Press Store to store the point.

     If the *View deltas before storage* field is set to No, press Store to store the point.

– If you do not want to record the as-staked point, press Esc then Yes. You return to the list and can stake out more points.

Staking Out a Point

To stake out a point:

1. From the main menu, select *Survey*. From the *Select Survey Style* menu, select your Conventional Survey Style.
2. Select *Station Setup* and perform a station setup.
3. Select *Stakeout* / *Points*. The *Stakeout/Points* list appears.
4. Press Add to transfer points in the Trimble Survey Controller software database to the *Stakeout/Points* list. The *Select points* screen appears, as shown in Figure 19.30.

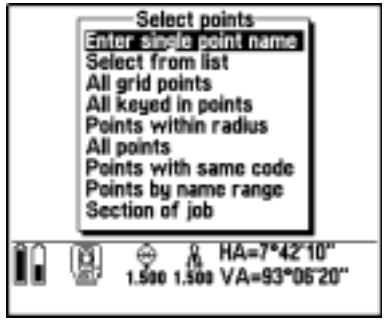


Figure 19.30 Select points screen – selection methods

5. From the list, choose the method by which points are to be selected.

If you choose *Select from list*, for example, a list of points in the Trimble Survey Controller software database appears. See Figure 19.31.

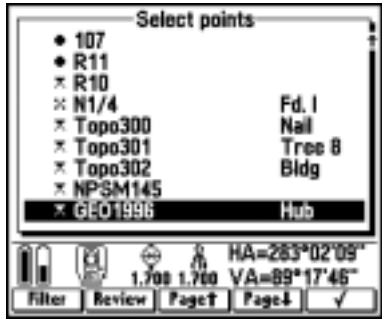


Figure 19.31 Select points screen – list of points

To select a point, from the list, highlight it and then press ✓. A check mark appears beside the selected point name. Do this for each point that you want to add to the Stakeout list.

6. Press Enter to return to the *Stakeout/Points* screen.
7. Select the point to be staked out. (To do this, highlight the point and press Enter.)

   The stakeout graphical display screen appears. It displays the angle to which you should turn the instrument and the distance from the instrument to the point, together with a graphical representation of this. See Figure 19.32.

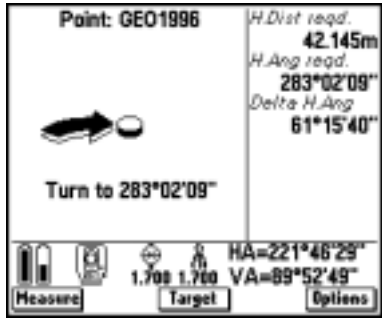


Figure 19.32 Initial screen of graphical display – stakeout

8. Use the graphical display screen, or the text display, to navigate the target to the point, as shown in Figure 19.32. For more information, see Using the Graphical Display During Stakeout, page 504.
9. When all arrows are hollow, mark the point. Do one of the following:
   - If you want to record the as-staked point:

     If the *View deltas before storage* field is set to Yes, press Accept. The measurement and the stakeout deltas are displayed. Press Store to store the point.

     If the *View deltas before storage* field is set to No, press Store to store the point.
   - If you do not want to record the as-staked point, press Esc then Yes. You return to the list and can stake out more points.

Staking Out a Line

To stake out a line:

1. From the main menu, select *Survey*. From the *Select Survey Style* menu, select your Conventional Survey Style.
2. Select *Station Setup* and perform a station setup.
3. Select *Stakeout* / *Lines*. The *Survey/Stakeout/Line* screen appears.
4. In the *Line name* field, enter the name of the line to be staked out. Do one of the following:
   - Press List to display a list of lines stored in the Trimble Survey Controller software database. Highlight the required line and press Enter.
   - Press Key in and define the line to be staked out.
5. Enter a value in the *Target height* field.

6. Choose a setting for the *Stake to* Field. For more information, see Stake to options, page 514.

   Other fields appear, depending on what you choose. Fill in the information required.

7. Press Start. The TSC1 data collector displays a large arrow that indicates the direction in which you must turn the instrument.

8. When the target is on line with the instrument, press Measure. There are values in the following fields, if they are appropriate to the stakeout method used:

   – *H. Dist reqd* – the horizontal distance from the instrument to the line or station on the line.

   – *H. Ang reqd* – the horizontal angle reading that should appear on the instrument to point in the direction of the line or station on the line.

   – *Delta H. Ang* – the angle that the instrument needs to turn to point in the direction of the line or station on the line.

   – *Go In/Out* – the horizontal distance along the instrument line of sight, to the line or station on the line.

   – *Go Left/Right* – the horizontal distance perpendicular to the instrument line of sight, to the line of station on the line.

   – *V. Dist (cut/fill)* – the vertical distance between the target position and the point on the line to be staked out.

   – *Stationing* – the station/chainage of the target position perpendicular to the line.

   – Δ *Station* – the difference in the stationing between the target position and the station to be staked out. A positive value means that the station to be staked out is towards the beginning of the line. A negative value means that the station to be staked out is towards the end of the line.

   – *H.Offset* – the offset of the target position in relation to the line. A positive value is an offset to the right and a negative offset is an offset to the left.

– *Grade to line* – the grade of the slope between the target position and the closest point on the line.

9. Use the graphical display or the text display to navigate the target to the point, as shown in Figure 19.33. For more information, see Using the Graphical Display During Stakeout, page 504.

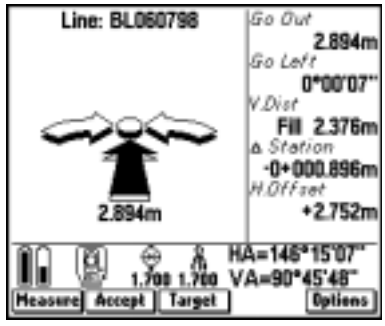


Figure 19.33 Graphical display screen – navigate to line

10. When all four arrows are hollow, mark the point. Do one of the following:

– If you want to record the as-staked point:

If the *View deltas before storage* field is set to Yes, press Accept. The measurement and the stakeout deltas are displayed. Press Store to store the point.

If the *View deltas before storage* field is set to No, press Store to store the point.

– If you do not want to record the as-staked point, press Esc then Yes. You return to the *Survey/Stakeout/Line* screen. Press Sta– or Sta+ to select the next station on the line, and stake out the points as described above.

Stake to options

When staking out a line, the options for the *Stake to* field are:

- Station on the line – with this, also enter the station to be staked out.
- Station/offset from line – with this, also enter the station to be staked out, a horizontal offset, and a vertical offset.
- Slope from line – with this, also enter the slope parameters for a slope to the left and/or right of the line as required.

For more information about these options, see Stake To Options, page 414.

Staking Out a Curve

To stake out a curve:

1. From the main menu, select *Survey*. From the *Select Survey Style* menu, select your Conventional Survey Style.
2. Select *Station Setup* and perform a station setup.
3. Select *Stakeout* / *Curves*. The *Survey/Stakeout/Curve* screen appears.
4. In the *Curve name* field, enter the name of the curve to be staked out. Do one of the following:
   – Press List to display a list of curves stored in the Trimble Survey Controller software database. Highlight the required curve and press Enter.
   – Press Key in and define the curve to be staked out.
5. Enter a value in the *Target height* field.
6. Choose a setting in the *Stake to* field. For more information, see Stake to options, page 516.

   Other fields appear, depending on what you choose. Fill in the information required.

7. Press Start. The TSC1 data collector displays a large arrow that indicates the direction in which you must turn the instrument.
8. When the target is on line with the instrument, press Measure.

   There are values in the following fields, if they are appropriate to the stakeout method used:

   – *H. Dist reqd* – the horizontal distance from the instrument to the curve or station on the curve.

   – *H. Ang reqd* – the horizontal angle reading that should appear on the instrument to point in the direction of the curve or station on the curve.

   – *Delta H. Ang* – the angle that the instrument needs to turn to point in the direction of the curve or station on the curve.

   – *Go In/Out* – the horizontal distance along the instrument line of sight, to the curve or station on the curve.

   – *Go Left/Right* – the horizontal distance, perpendicular to the instrument line of sight, to the curve of station on the curve.

   – *V. Dist (cut/fill)* – the vertical distance between the target position and the point on the curve to be staked out.

   – *Stationing* – the station/chainage of the target position, perpendicular to the curve.

   – Δ *Station* – the difference in the stationing between the target position and the station to be staked out. A positive value means that the station to be staked out is towards the beginning of the curve. A negative value means that the station to be staked out is towards the end of the curve.

   – *H.Offset* – the offset of the target position in relation to the curve. A positive value is an offset to the right and a negative offset is an offset to the left.

   – *Grade to curve* – the grade of the slope between the target position and the closest point on the curve.

9. Use the graphical screen display or the text display to navigate the target to the point, as shown in Figure 19.34. For more information, see Using the Graphical Display During Stakeout, page 504.

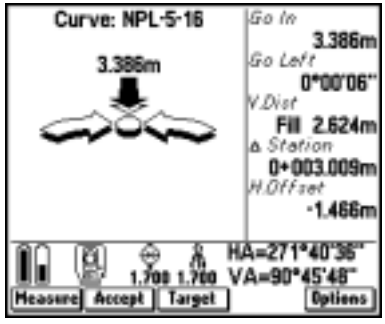


Figure 19.34 Graphical display screen – navigate to curve

10. When all four arrows are hollow, mark the point. Do one of the following:

   – If you want to record the as-staked point:

     If the *View deltas before storage* field is set to Yes, press Accept. The measurement and the stakeout deltas are displayed. Press Store to store the point.

     If the *View deltas before storage* field is set to No, press Store to store the point.

   – If you do not want to record the as-staked point, press Esc then Yes. You return to the *Survey/Stakeout/Curve* screen. Press Sta– or Sta+ to select the next station on the curve, then stake out the points as described above.

Stake to options

When staking out a curve, the options for the *Stake to* field are:

- Station on the curve – with this, also enter the station to be staked out.

- Station/offset from curve – with this, also enter the station to be staked out and any horizontal and vertical offset.
- Slope from curve – with this, also enter the slope parameters for a slope to the left and/or right of the curve, as required.
- Intersect point of curve.
- Center point of curve.

For more information about these options, see Stake To Options, page 414.

Staking Out a DTM

To stake out a digital terrain model (DTM):

1. From the main menu, select *Survey.* From the *Select Survey Style* menu, choose your Conventional Survey Style.
2. Select *Station Setup* and perform a station setup.
3. Select *Stakeout* / *DTMs*. The *Survey/Stakeout/DTM* screen appears.
4. In the *DTM* field, select the terrain model to be staked out.
5. Enter a value in the *Target height* field and, if applicable, the *V.Offset* field.
6. Press Start.
7. When the graphical display screen appears, press Measure.

   The screen displays the coordinates of the current position and the vertical distance above (cut) or below (fill) the DTM.
8. Do one of the following:

   – If you want to record the point:

   If the *View deltas before storage* field is set to Yes, press Accept. The measurement and the stakeout deltas are displayed. Press Store to store the point.

If the *View deltas before storage* field is set to No, press Store to store the point.

The Trimble Survey Controller software stores the point and the stakeout deltas.

– If you do not want to record the point, press Esc then Yes. You return to the list and can stake out more points.

9. Press Esc to return to the *Survey/Stakeout/DTM* screen.

Staking Out a Road

To stake out a road using a conventional instrument, use the graphical screen shown in Using the Graphical Display During Stakeout, page 504. For more information about staking out a road, see Chapter 18, Roading.

Ending a Conventional Survey

If a survey is running, end it before editing the current Survey Style or changing Survey Styles. You must also end the survey before accessing job functions such as copying a job (see Copying a Job, page 91).

To end a survey, select *End survey* from the *Survey* menu.

If you are operating a robotic instrument remotely, the instrument can be powered down from the remote end (target) once *End survey* is selected.

Warning – The current station setup is lost when you select *End Survey*.

CHAPTER

20

Laser Observations

In this chapter:

- Introduction
- Configuring the Trimble Survey Controller software
- Configuring the laser
- Connecting the laser to the TSC1 data collector
- Taking a measurement with the laser rangefinder
- Laser softkey

Introduction

If a point cannot be occupied directly by a GPS rover, one way to measure it is to use a laser rangefinder with the Trimble Survey Controller software. This combination of laser rangefinder and Trimble Survey Controller software can also be used with a conventional instrument. Alternatively, the laser rangefinder can be plugged into the TSC1 data collector and used standalone with the Trimble Survey Controller software.

The Trimble Survey Controller software supports the following laser rangefinders:

- Laser Technology Criterion 300
- Laser Technology Criterion 400
- Laser Technology Impulse
- Laser Atlanta Advantage CI
- Leica Disto memo
- Leica Disto pro
- MDL LaserAce 300
- MDL Generation II Surveyor

Note – *Contact your local Trimble dealer for a current list of lasers that the Trimble Survey Controller software supports.*

Configuring the Trimble Survey Controller software

To use a laser rangefinder with the Trimble Survey Controller software, first configure a Survey Style appropriately. A laser rangefinder can be used with any Survey Style.

To configure the Survey Style:

1. From the main menu, choose *Survey.* Highlight a Survey Style and press Edit.
2. Select *Laser rangefinder* and press Enter.

3. Set the *Type* field to one of the following:
   - LTI Criterion 300
   - LTI Criterion 400
   - LTI Impulse
   - Laser Atlanta Advantage
   - Leica Disto memo/pro
   - MDL LaserAce 300
   - MDL Generation II
4. Set the *Controller port* and *Baud rate* fields if required.

   The default value in the *Baud rate* field is the manufacturer's recommended setting.

   If the Trimble Survey Controller software can automatically instruct the laser to take a measurement when you press Measure, you can edit the *Auto measure* field as required.
5. Set the *Auto store point* field as required.

   The precision fields contain the manufacturer's precision values for the laser. They are for information only.
6. Press Enter.

Magnetic Declination

Most lasers have a magnetic compass. Make sure that this compass is calibrated before making any measurements.

When a value for magnetic declination is entered in the Trimble Survey Controller software, it is applied to all subsequent laser measurements.

To enter a value for magnetic declination:

1. Select *Configuration* / *Job* / *Cogo settings*.
2. Enter a value in the *Magnetic declination* field.

For more information about magnetic declination, see Magnetic Declination, page 109.

Warning – If you enter a value for magnetic declination in the Trimble Survey Controller software, make sure that no magnetic declination value is set in the laser.

Vertical Angle Display

To configure how the laser measurements are displayed—as vertical angles measured from the zenith or inclinations measured from horizontal—set the *Laser VA display* field in the *Units* screen. For more information, see System Units, page 101

Configuring the Laser

Before using the laser with the TSC1 data collector, set various options on the laser. Table 20.1 shows the settings for each laser supported by the Trimble Survey Controller software.

Table 20.1 Laser settings

Laser	Laser setting
LTI Criterion 300 or LTI Criterion 400	From the main menu, press the down arrow or up arrow key until the Survey menu appears, then press ENTER. Select Basic measurements and press ENTER. A screen showing the fields HD and AZ appears.
LTI Impulse	Set up the laser to operate in CR 400D format. Make sure that a small 'D' is displayed on the screen. (If necessary, press the Fire2 button on the laser).
Laser Atlanta Advantage	Set the Range/Mode option to Standard (Averaged) and the Serial/Format option to Trimble Pro XL.
Leica Disto memo/pro	Set the unit to meters or feet, not feet and inches.

Table 20.1 Laser settings (Continued)

Laser	Laser setting
MDL Generation II	No special settings are required.
MDL LaserAce	Set the Data record format to Mode 1. When using the angle encoder, set the magnetic declination to zero in the Trimble Survey Controller. The angle encoder in the LaserAce corrects for the magnetic declination.

Note – *The laser rangefinder must be configured to update the inclinometer and slope distance readings after each measurement.*

Connecting the Laser to the TSC1 Data Collector

Use the null modem 0-shell Lemo to DB9 cable (part number 37779) to connect the TSC1 data collector to the DB9 connector from the laser. Connect it to the port you specified in the Survey Style.

Note – *For a conventional survey with the instrument type set to Manual, connect the laser to the top port of the TSC1 data collector.*

Taking a Measurement with the Laser Rangefinder

To measure a point with the laser rangefinder:

1. Configure the Survey Style that you intend to use.

   Note – *If Measure laser points does not appear in the Survey menu, the Laser rangefinder type field in the Survey Style is set to None. Change it to the laser type you are using.*

2. Connect the laser to the TSC1 data collector as described in Connecting the Laser to the TSC1 Data Collector, page 523.

3. Make sure that the laser is set up to take azimuth and distance measurements, and inclination (the last is optional).

4. On the TSC1, from the main menu, choose *Survey*. Highlight the Survey Style that you intend to use and press Enter.
5. Select *Measure laser points*.
6. Enter a value in the *Point name* field.
7. Enter a value in the *Code* field if required.
8. In the *Start point* field, enter the name of the point that laser measurements are to be taken from.
9. Enter a value in the *Laser height* field if required.
10. Enter a value in the *Target height* field if required.
11. Occupy the start point with the laser and press Measure. Follow the instructions on the TSC1 display screen.

    Wait for the laser compass to settle before taking a measurement.

    If the *Auto measure* field in the Survey Style *Laser Rangefinder* option is set to Yes, the Trimble Survey Controller software instructs the laser to take a measurement when you press Measure. The Trimble Survey Controller software displays this measurement when it is receives it.

Tip – It is possible to take a measurement on the laser without pressing Measure first. The laser measurement is displayed on the screen of the TSC1 data collector when the data is received.

    If the Trimble Survey Controller software receives only a distance measurement from the laser, another screen is displayed with the measured distance in a *Slope distance* field. Enter a vertical angle if the measured distance was not horizontal.

12. Press Store to store the point.

Note – *If using a laser without a compass, you must key in a magnetic azimuth before the Trimble Survey Controller software can store the point.*

Laser Softkey

In most *H. Dist* (horizontal distance) fields and *S. Dist* (slope distance) fields in the Trimble Survey Controller software, there is a Laser softkey. Use it to measure a distance with the laser and insert that value in the *H.Dist* field.

This function is useful when calculating an offset or intersection point.

To use the laser in a *H.Dist* field:

1. Configure the laser in the Survey Style that you intend to use.
2. To access the *H.Dist* field, press ⊙. Press Laser and follow the instructions on the TSC1 screen.
3. When the Trimble Survey Controller software receives the measurement, it inserts the horizontal distance into the *H.Dist* field.

CHAPTER

21

Key In Menu

In this chapter:

- Introduction
- Key in points
- Key in lines
- Key in curves
- Key in boundary
- Key in roads
- Key in templates
- Key in notes

Introduction

The *Key in* menu makes it possible to enter details directly into the Trimble Survey Controller software database without uploading or measuring. Use it to:

- define a point
- define a line
- define a curve
- define a boundary
- define a road
- define a template
- enter a note

Note – *To set the Distance units for calculations, press* Options.

The *Key in* menu can also be used to edit (change) the details of road definitions or points. For information on editing road definitions, see Editing a Definition, page 560.

Key In Points

To key in a point:

1. From the main menu, select *Key in* / *Points.*
2. Enter values in the *Point name* and *Code* fields.
3. Set the *Method* field (see Choosing a Method, below). Other fields appear, depending on what you select. Fill in the information required. Press Options to change the coordinate view if necessary.
4. Set the Search class for the point to Normal or Control. To set the Search class to Normal, set the *Control* field to No; to set the Search class to Control, set the *Control* field to Yes.

5. Do one of the following:
   - If using the Keyed in coordinates method, press Enter to store the point.
   - If using an intersection method, press Calc to calculate the new point.Then press Store to store the point.
6. Key in more points or press Esc twice to return to the main menu.

Choosing a Method

Options in the *Method* field are:

- Keyed in coordinates
- Brng-dist intersect – defines the point as a bearing-distance intersection from two points
- Brng-brng intersect – defines the point as a bearing-bearing intersection from two points
- Dist-dist intersect – defines the point as a distance-distance intersection from two points

Note – *If you are using an intersection method to define a new point, the source point(s) from which the new point is defined must exist in the job database.*

Keyed In Coordinates

Set the *Method* field to Keyed in coordinates when keying in a point, to enter the coordinates for that point.

Use the Options softkey to change the coordinate view to WGS-84, Local, Grid, or ECEF coordinate format. When you store the point, it is stored as the coordinate type you are viewing when you press Enter to store the point.

Bearing – Distance Intersection

If you set the *Method* field to Brng-dist intersect, enter the name of Point 1 (1). Enter the azimuth (2), the name of Point 2 (3), and the horizontal distance (4).

There are two solutions for this calculation (5 and 6). Press Other to see the second solution.

Figure 21.1 shows the screen that appears when you use the Bearing-distance intersection method. The screen on the right shows a graphical representation of a point keyed in using this method.

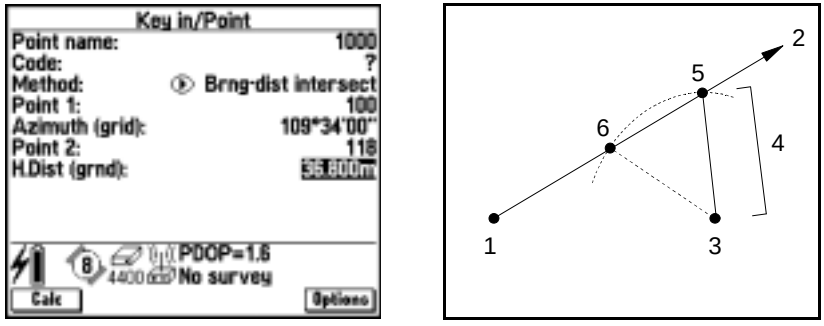


Figure 21.1 Key in/points using brng-dist intersect

Note – *In this chapter, a number in parentheses ( ) refers to a point in the corresponding figure.*

Bearing – Bearing Intersection

If you set the *Method* field to Brng-brng intersect, enter the name of Point 1 (1), the azimuth from Point 1 (2), the name of Point 2 (3), and the azimuth from Point 2 (4).

The solution is at the intersection of the two azimuths (5).

Figure 21.2 shows the screen that appears when you use the Bearing-bearing intersection method. The screen on the right shows a graphical representation of a point keyed in using this method.

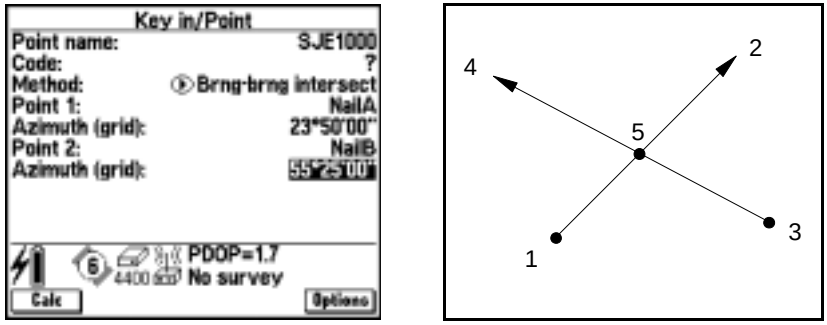


Figure 21.2 Key in/points using brng-brng intersect

Distance – Distance Intersection

If you set the *Method* field to Dist-dist intersect, enter the name of Point 1 (1) and the horizontal distance (2). Then enter the name of Point 2 (3) and the horizontal distance (4).

There are two solutions for this calculation (5 and 6). Press Other to see the second solution.

Figure 21.3 shows the screen that appears when you use the Distance-distance intersection method. The screen on the right shows a graphical representation of a point keyed in using this method.

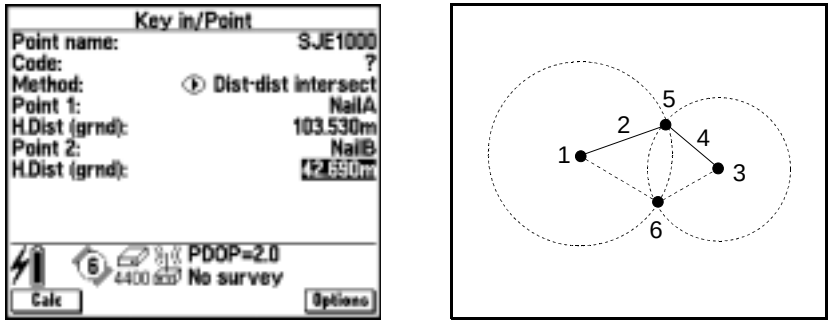


Figure 21.3 Key in/points using dist-dist intersect

Key In Lines

This section shows how to key in a line using the various methods offered by the Trimble Survey Controller software.

To key in a line:

1. From the main menu, select *Key in* / *Lines*.
2. Enter values in the *Line name* and *Code* fields.
3. Set the *Method* field (see Choosing a Method, below). Other fields appear, depending on what you select. Fill in the information required.

   Note – *The point(s) from which the line is defined must exist in the job database.*

4. Enter the grade for the line.

   A grade indicates that the line has a slope from the start point.

   – To change the units, highlight the *Grade* field and press Units.

   – To define the grade in various ways, press Options and change the *Grade* field.

5. For stationing along the line, enter the stationing value for the start point in the *Start station* field. Then enter the distance between stations in the *Station interval* field.

6. To enter ellipsoid distances, press Options and set the *Distances* field to Ellipsoid.

7. Press Calc to calculate the line.

   The design information is displayed on the screen that appears. It includes azimuth, length, and grade.

8. Press Store to store the line in the database.

9. Key in another line or press Esc twice to return to the main menu.

Choosing a Method

Options in the *Method* field are:

- Two points
- Brng-dist from a point

Two Points

If you set the *Method* field to Two points, enter values in the *Start point* and the *End point* fields.

Note – *The heights of the two points define the grade of the line.*

Bearing – Distance from a Point

If you set the *Method* field to Bearing-distance from a point, enter the name of the start point (1), the azimuth (2), and the length (3).

Figure 21.4 shows the screen that appears when you use the Bearing-distance from a point method. The screen on the right shows a graphical representation of a line keyed in using this method.

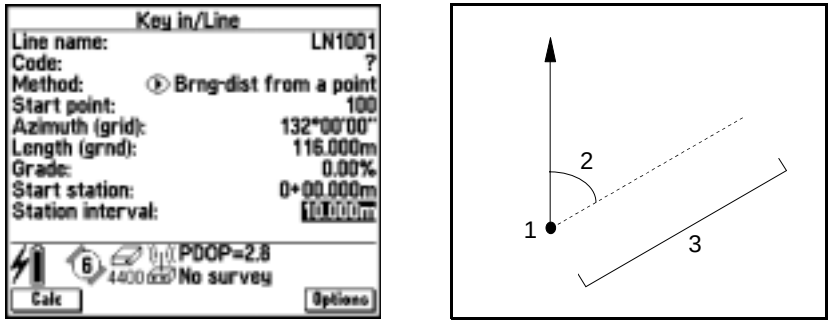


Figure 21.4 Key in/lines using brng-dist from a point

Key In Curves

This section shows how to key in a curve using the various methods offered by the Trimble Survey Controller software. The terminology used is explained by Figure 21.5, which shows the defining features of a curve.

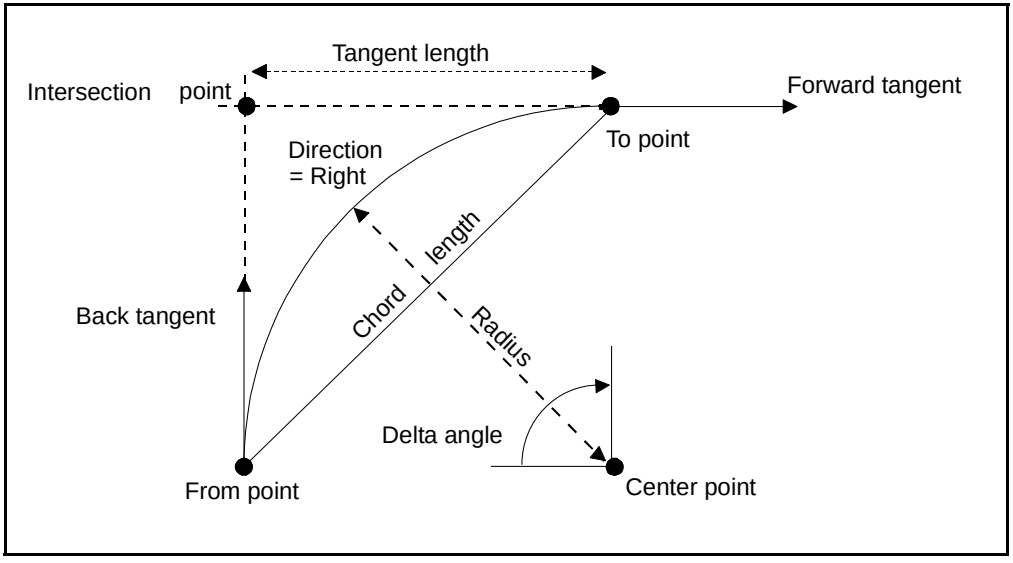


Figure 21.5 Features defining a curve

To key in a curve:

1. From the main menu, select *Key in* / *Curves.*
2. Enter values in the *Curve name* and *Code* fields.
3. Set the *Method* field (see Choosing a Method, below). Other fields appear, depending on what you select. Fill in the information required.

   Note – *The point(s) from which the curve is defined must exist in the job database.*
4. If necessary, choose the direction of the curve.

Direction defines whether the curve turns to the left (counterclockwise) or right (clockwise) from the start point. Figure 21.6 shows both a left and right curve.

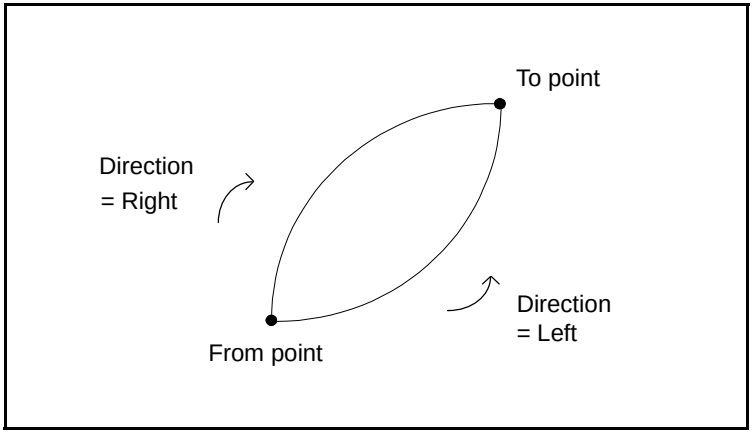


Figure 21.6 Direction of a curve

5. Enter the grade for the curve.

   A grade indicates that the curve has a vertical slope from the start point:

   – To change the units, highlight the *Grade* field and press Units.

   – To define the grade in various ways, press Options and change the setting in the *Grade* field.

6. For stationing along the curve, enter the stationing value for the start point in the *Start station* field. Then enter the distance between stations in the *Station interval* field.

7. To enter ellipsoid distances, press Options and set the *Distances* field to Ellipsoid.

8. Press Calc to calculate the curve.

   The design information is displayed on the screen that appears. It includes:

   – back tangent

   – forward tangent

   – radius

   – curve length

   – delta angle

   – chord length

   – tangent length

   – grade

9. Press Store to store the curve in the database.

10. Key in another curve or press Esc twice to return to the main menu.

Note – *The Trimble Survey Controller software only supports the design of circular curves.*

Choosing a Method

Options in the *Method* field are:

- Two points and radius
- Delta angle and radius
- Curve length and radius
- Intersect point and tangents

Before choosing a method

When defining a curve from a back tangent, make sure that you understand the naming and direction conventions used by the Trimble Survey Controller software.

The back tangent value is related to the direction in which the stationing or chainage increases. For example, when you stand at the intersection point looking in the direction of increasing stationing or chainage, the forward tangent is in front of you and the back tangent is behind you.

Figure 21.7 shows how a back tangent value is related to the direction in which the stationing or chainage increases.

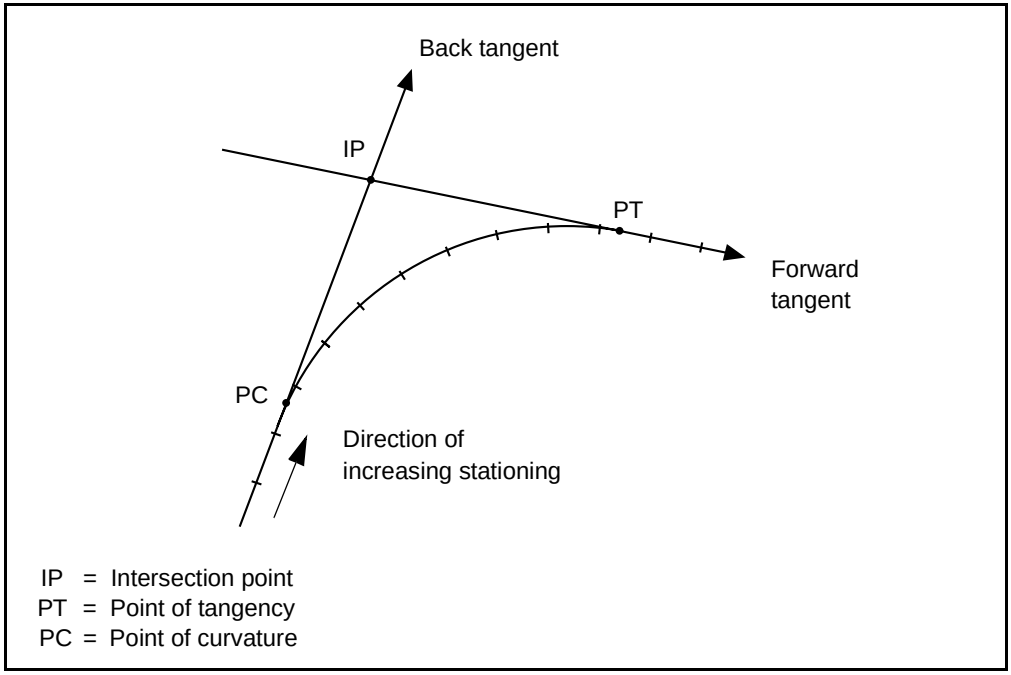


Figure 21.7 Back tangents and forward tangents

Two Points and Radius

If you set the *Method* field to Two points and radius, enter the names of the start point (1) and the end point (2), and enter the radius (3).

Figure 21.8 shows the screen that appears when you use the Two points and radius method. The screen on the right shows a graphical representation of a curve keyed in using this method.

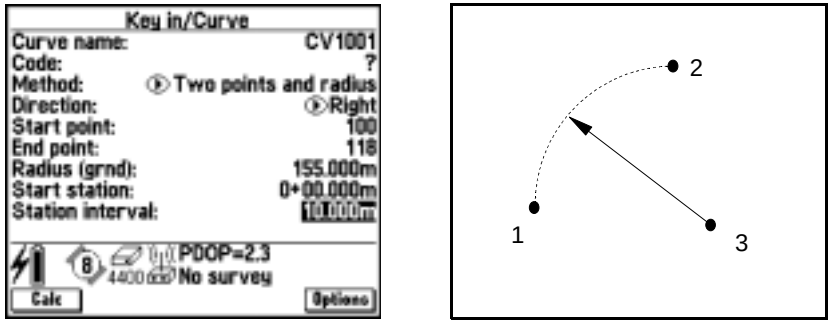


Figure 21.8 Key in/curves using two points and radius

Note – *The heights of the two points define the grade of the curve.*

Delta Angle and Radius

If you set the *Method* field to Delta angle and radius, enter the name of the start point (1), the back tangent (2), the radius (3), and the turned angle (4) of the curve.

Figure 21.9 shows the screen that appears when you use the Delta angle and radius method. The screen on the right shows a graphical representation of a curve keyed in using this method.

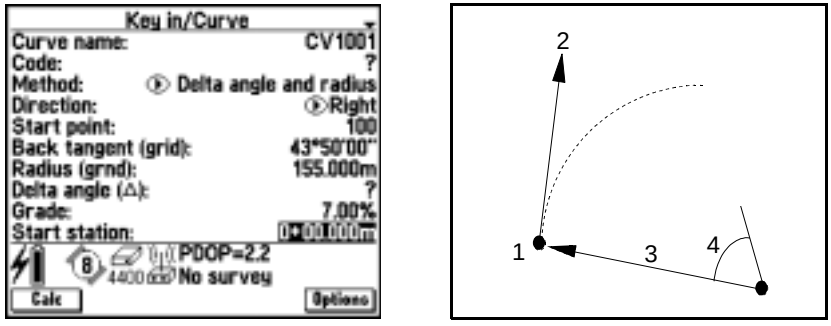


Figure 21.9 Key in/curves using delta angle and radius

Curve Length and Radius

If you set the *Method* field to Curve length and radius, enter the name of the start point (1), the back tangent (2), the radius (3), and the length of the curve.

Figure 21.10 shows the screen that appears when you use the Curve length and radius method. The screen on the right shows a graphical representation of a curve keyed in using this method.

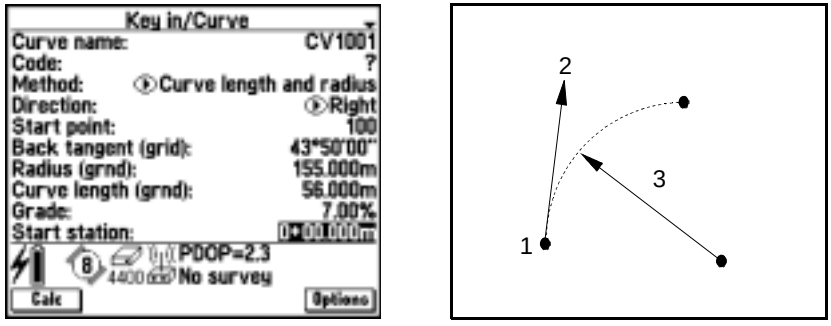


Figure 21.10 Key in/curves using curve length and radius

Intersection Point and Tangents

If you set the *Method* field to Intersection point and tangents, enter the name of the intersection point (1), the back tangent (2), the forward tangent (3), and the radius (4) of the curve.

Figure 21.11 shows the screen that appears when you use the Intersection point and tangents method. The screen on the right shows a graphical representation of a curve keyed in using this method.

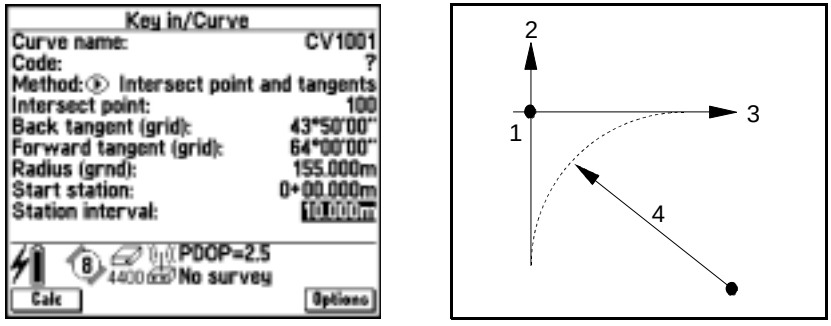


Figure 21.11 Key in/curves using intersect point and tangents

Key In Boundary

This section shows how to calculate the coordinates of points on a boundary. You enter a bearing and a distance from an existing point, and the Trimble Survey Controller software calculates the coordinates of the new point. Repeat the steps for the next point on the boundary.

To key in a boundary:

1. From the main menu, select *Key in* / *Boundary.*
2. Enter the name of the start point (1), the azimuth (2), the horizontal distance (3), and a vertical distance.
3. Enter a name for the intersection point in the *Point name* field.
4. Press Calc to obtain the coordinates of the new point (4).
5. Press Store to store the new point.

The Trimble Survey Controller software returns to the *Key in*/*Boundary* screen and inserts the name of the point just created (4) in the *Start point* field.

6. To compute the misclosure of a circuit of points, give the last point the same name as the first point. When you press Calc the boundary misclosure appears on the screen. Store the last point as a check to avoid overwriting the first point.

Figure 21.12 shows the text screen and a graphical representation of the *Key in*/*Boundary* calculation.

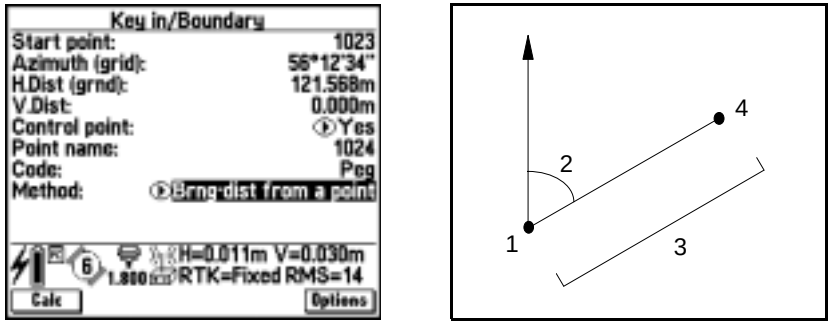


Figure 21.12 Key in/boundary

Key In Roads

This section shows how to key in a road definition that is defined by:

- horizontal alignment

and (optionally) one or more of the following components

- vertical alignment
- template positioning
- superelevation and widening records

Note – *If a road definition is defined only as a horizontal alignment, it can only be staked out in two dimensions.*
The horizontal and vertical alignments of a road do not necessarily start and end at the same stationing. When they do not, you can only stake out points in three dimensions if their stations lie within the horizontal alignment.

To enter a new road definition:

1. From the main menu, select *Key in* / *Roads*.
2. In the *Name* field, enter a name for the new road definition. Press Enter.
3. Do one of the following:
   - Copy an existing road definition into the current road.

     To do this, press Copy. A list of available road definitions appears. Highlight the one to be copied and press Enter. This copies all components comprising that road definition into the current road.

Tip – To view details of a road definition before copying it, highlight the road name and press Review. Press Esc to return to the list or, to view details of other roads in the list, press Prev or Next. For more information, see Reviewing a Definition, page 559.

   - Choose a component to key in.

Follow the steps outlined in the relevant section below.

Horizontal Alignment

Note – *If this is the first component to be keyed in, select Key in / Roads and provide a name for the road definition before starting. Do this only once for each new road definition.*

To add a horizontal alignment to a new road definition:

1. Select *Horizontal alignment*.
2. Press New to enter the first element that defines the alignment. The *Horizontal element* screen appears, as shown in Figure 21.13.

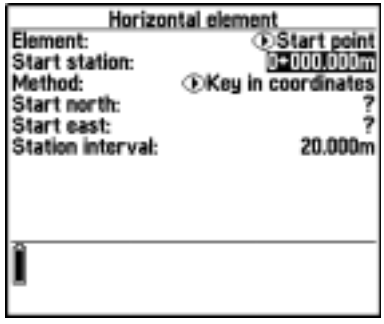


Figure 21.13 Horizontal element screen

The *Element* field is set to Start point. You cannot change this.

3. For stationing along the road, enter the stationing value for this start point in the *Start station* field.
4. Choose an option in the Method field. Do one of the following:
   - Key in coordinates
   - Select point

If you set the *Method* to *Key in coordinates*, enter values in the *Start north* and *Start east* fields

If you set the *Method* field to *Select point*, enter a value in the *Point name* field. The *Start north* and *Start east* fields will update with the values for the entered point.

Tip – To edit the *Start north* and *Start east* values when they have been derived from a point, change the method to *Key in coordinates*.

5. Enter the distance between the stations in the *Station interval* field.
6. Press Enter to add the horizontal element.
7. Press New to enter another horizontal alignment element (for example, a line) that defines the road.
8. Choose an option in the *Element* field. For information about each option, see below.

   Other fields appear, depending on what you choose.
9. Fill in the information required, then press Enter to store the element.
10. When you have entered the last element, press Accept.

Tip – To delete an element, highlight it and press Delete.

When you add an element, it appears below the previous element that you added. To insert it at a particular place in the list, highlight the element that you want it to follow. Press New and enter details of the element.

11. Enter the other road components or press Store to store the road definition.

Choosing an element (horizontal alignment)

Options in the *Element* field are:

- Line
- Arc
- Entry spiral
- Exit spiral

Line

If you select Line in the *Element* field, the *Start station* field displays the start station value for the line that you are defining. You cannot edit this.

In the *Azimuth* and *Length* fields, key in values that define the line. If this is not the first line to be defined, the *Azimuth* field displays an azimuth calculated from the previous element. If you edit this and then accept the definition, you are warned that the alignment has non-tangential transitions.

The *End north* and *End east* fields update to display the coordinates at the end of the element just added.

Arc

If you select Arc in the *Element* field, the *Start station* field displays the start station value for the arc that you are defining. You cannot edit this.

The *Start azimuth* field displays the azimuth as calculated from the previous element. If you edit this, you are warned that the alignment has non-tangential transitions when you accept the definition.

Set the *Method* field. Table 21.1 shows what methods are available and what fields appear when you select them.

Table 21.1 Horizontal Alignment Using Arcs

Method	What you do
Curve length and radius	Select a setting (Right or Left) in the *Curve direction* field In the *Radius* and *Length* fields, enter values that define the curve

Table 21.1 Horizontal Alignment Using Arcs (Continued)

Method	What you do
Delta angle and radius	Select a setting (Right or Left) in the *Curve direction* field In the *Angle* and *Radius* fields, enter values that define the curve
Deflection angle and length	Select a setting (Right or Left) in the *Curve direction* field In the *Angle* and *Length* fields, enter values that define the curve

The *End North* and *End East* fields update to display the coordinates at the end of the element just added.

Entry spiral/Exit spiral

If you select Entry spiral/Exit spiral in the *Element* field, the *Start station* field displays the start station value for the entry spiral or exit spiral that you are defining. You cannot edit this.

The *Start azimuth* field displays the azimuth as calculated from the previous element. If you edit this, you are warned that the alignment has non-tangential transitions when you accept the definition.

Select a setting (Right or Left) in the *Curve direction* field. In the *Radius* field, enter the radius of the arc associated with the spiral. In the *Length* field, enter the length of the spiral.

The *End North* and *End East* fields update to display the coordinates at the end of the element just added.

Note – *When you select an exit spiral to connect two arcs (known as hanging or combining spirals), the end coordinates of the spiral are incorrect until the second arc is added. If you select an entry spiral the coordinates are correct.*

Notes for Keying in and Editing Horizontal Alignments

The Trimble Survey Controller software warns you if you enter non-tangential elements. Do one of the following:

- Select *Yes* to adjust the current element to maintain tangency.
- Select *All* to adjust all elements to maintain tangency.
- Select *None* to accept non-tangency for all elements.
- Select *No* to accept non-tangency for the current element.

When you edit an element, the station and coordinate values for all subsequent elements update to reflect the change. All remaining values defining the subsequent elements are maintained. Exceptions to this are as follows:

- If you edit the radius of a spiral or arc, the Trimble Survey Controller software warns you that adjacent spiral/arc elements that define the curve will be updated with the same radius. Do one of the following:
  - Select *Yes* to adjust the adjacent elements.
  - Select *No* to discard the changes you have made.
- A spiral connecting two arcs (known as hanging or combining spirals) is referred to as an exit spiral when the radius of the second arc is greater than the radius of the first arc. If you edit the radius of the second arc so that it is smaller than the radius of the first arc, the Trimble Survey Controller software changes the spiral to an entry spiral with the radius of the second arc.
- Similarly, if you edit the radius of the first arc so that it is smaller than the radius of the second arc, the Trimble Survey Controller software changes the spiral to an exit spiral with the radius of the first arc.

Vertical Alignment

Note – *If this is the first component to be keyed in, select Key in / Roads and provide a name for the road definition before starting. Do this only once for each new road definition.*

To add a vertical alignment to a new road definition:

1. Select *Vertical alignment*.
2. Press New to enter the first element that defines the alignment. The *Vertical element* screen appears, as shown in Figure 21.14.

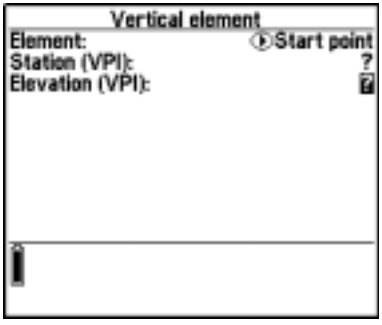


Figure 21.14 Vertical element screen

The *Element* field is set to Start point. You cannot change this.

3. In the *Station* and *Elevation* fields, key in the values that define the first Vertical Point of Intersection (VPI).
4. Press Enter to add the vertical element record.
5. Press New to enter another vertical alignment element (for example, a circular arc).
6. Choose an option in the *Element* field. For information about each option, see below. Other fields appear, depending on what you choose. Fill in the information required.
7. When you have entered the last element, press Accept.

Tip – To delete an element, highlight it and press Delete.

8. Enter the other road components or press Store to store the road definition.

Choosing an element (vertical alignment)

Options in the *Element* field are:

- Point
- Sym parabola
- Asym parabola
- Circular arc

Point

If you select Point in the *Element* field, use the *Station* and *Elevation* fields to key in values that define the VPI.

Note – *A vertical alignment must start and end with a point.*

Tip – You can also use points between the start and end points if the alignment changes direction when no parabola or arc is required.

Symmetric parabola

If you select Sym parabola in the *Element* field, use the *Station* and *Elevation* fields to key in values that define the VPI. Enter the length of the parabola in the *Length* field.

Asymmetric parabola

If you select the *Asymmetric parabola* option in the *Element* field, use the *Station* and *Elevation* fields to key in values that define the VPI. Enter the In and Out lengths of the parabola.

Circular arc

If you select Circular arc in the *Element* field, use the *Station* and *Elevation* fields to key in values that define the VPI. Enter the radius of the circular arc in the *Radius* field.

Note – *When you edit an element, only the selected element is updated. All adjoining elements remain unchanged.*

Template Positioning

Define the position of templates in a road definition by specifying the station at which the Trimble Survey Controller software starts to apply each template. A template is applied at the start station and template element values are then interpolated linearly (applied on a pro rata basis) from that point to the station where the next template is applied. For more information, see Interpolating Between Templates, page 628.

Note – *If this is the first component to be keyed in, select Key in / Roads and provide a name for the road definition before starting. Do this only once for each new road definition.*

To define the template positioning:

1. Select *Template positioning*.
2. Press New.

3. In the *Start station* field, specify the start station for the template(s). See Figure 21.15.

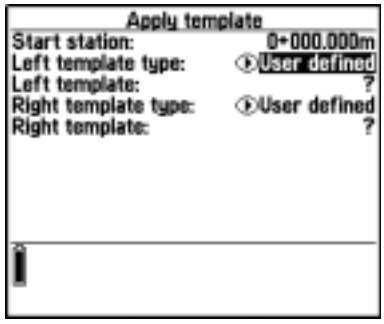


Figure 21.15 Apply template screen

4. The options in the *Left template* and *Right template* fields are as follows:

   – User defined—allows you to select templates for the left side and the right side of the horizontal alignment.

   – <None>—no templates are assigned. Use this option to create a gap in the road definition. For more information, see Template Application, page 631.

   – <Interpolate>—the template for this station is interpolated from the previous and next templates in the road definition. For more information, see Template Application, page 631

5. If you selected <None> or <Interpolate>, go to the next step. If you selected User defined, do one of the following:

   – Select from the list.

     To do this, highlight the *Left template* (or *Right template*) field and press ⊙. Press List to display the list of available templates. This list contains templates defined using the *Key in / Templates* command.

– Enter a template name.

This name must match an existing template name. If the name is invalid, the Trimble Survey Controller software warns you.
Press Enter and use the screen that appears to key in details for the new template. For more information, see Key In Templates, page 556.

6. Press Enter to apply the templates.
7. Press New to enter more templates at other positions.
8. When all template positions are entered press Accept.

Tip – To delete a highlighted entry, press Delete.

9. Enter the other road components or press Store to store the road definition.

Superelevation and Widening

Define where superelevation and widening values are applied in a road definition by specifying the station at which the Trimble Survey Controller software starts to apply them. Superelevation and widening values are applied at the start station, and values are then interpolated linearly (applied on a pro rata basis) from that point to the station where the next superelevation and widening values are applied. For more information, see Applying Superelevation Values, page 633.

Note – *If this is the first component to be keyed in, select Key in / Roads and provide a name for the road definition before starting. Do this only once for each new road definition.*

To add superelevation and widening values to a new road definition:

1. Select *Superelevation & widening*.
2. Press New.

3. In the *Start station* field, specify the station where the superelevation and widening starts. See Figure 21.16.

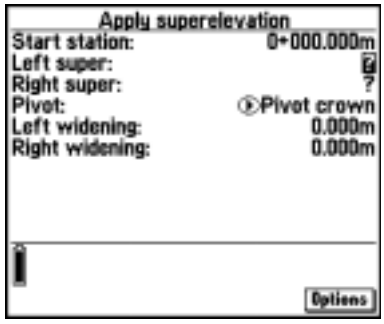


Figure 21.16 Apply superelevation screen

4. In the *Left super* and *Right super* fields, enter superelevation values for the left and right sides of the horizontal alignment.

Tip – To change the way a superelevation value is expressed, press Options and change the *Grade* field as required.

5. In the *Pivot* field, specify the position about which the template rotates. The options are Pivot left, Pivot crown, and Pivot right. For more information, see Pivots, page 635.
6. In the *Left widening* field, enter the widening value to be applied.

   This value is applied to each element in the template that has *Widening* set to Yes.
7. Do the same for the *Right widening* field.

   Note – *Widening is expressed as a positive value.*
8. Press Enter to add these superelevation and widening values to the road definition.
9. To enter more superelevation and widening records press New.
10. After entering the last superelevation and widening record, press Accept.

Tip – To delete an entry, highlight it and press Delete.

11. Enter the other road components or press Store to store the road definition.

Key In Templates

This section shows how to enter a template. For information on how to define the position of a template, see Template Positioning, page 552.

To enter a template:

1. From the main menu, select *Key in* / *Templates*.
2. In the *Name* field, enter a name for the new template and press Enter.
3. Do one of the following:
   – Copy an existing template into the current template. To do this, press Copy. A list of available template definitions appears. Highlight the one to be copied and press Enter.

Tip – To view details of a template before copying it, highlight the template name and press Review. Press Esc to return to the list or, to view details of other templates in the list, press Prev or Next.

   – Manually key in the elements of the new template.

Keying In Elements

To manually key in the elements in a template:

1. Select *Key in* / *Templates* and name the new template as described above.
2. Press New to enter the first element defining the template.

3. Set the *Element* field. For information about each option, see Choosing an element, below.

   Other fields appear, depending on what you choose.

4. Fill in the information required.
5. To add the template element, press Enter.
6. To enter more elements that define this template, press New.
7. When you have entered the last element, press Enter.

Tip – To delete an element, highlight it and press Delete.

8. Press Store to store the template.

Choosing an element

Options in the *Element* field are:

- Cross fall and offset
- Delta elevation and offset
- Delta elevation only
- Side slope

Cross fall and Offset

If you set the *Element* field to Cross fall and Offset:

a. In the *Cross fall* and *Offset* fields, enter the values that define the element.

Tip – To change the way a cross fall value is expressed, press Options and change the *Grade* field as required.

b. Enter a value in the *Code* field (this step is optional).

Tip – The annotation entered in the *Code* field is assigned to the end of the element and is displayed during stakeout. (The code ‘Shoulder’ is displayed in Figure 18.10 on page 437, for example.)

c. Set the *Apply superelevation* and *Apply Widening* fields to Yes or No as required.

Delta elevation and Offset

If you set the *Element* field to Delta elevation and Offset:

a. In the *Delta elevation* and *Offset* fields, enter the values that define the element.

b. Enter a value in the *Code* field (this step is optional).

c. Set the *Apply superelevation* and *Apply Widening* fields to Yes or No as required.

Delta elevation only

If you set the *Element* field to Delta elevation only:

a. In the *Delta elevation* field, enter the value that defines the element.

b. Enter a value in the *Code* field (this step is optional).

Side slope

If you set the *Element* field to Side slope:

a. In the *Cut slope*, *Fill slope*, and *Cut ditch width* fields, enter the values that define the element.

Note – *Cut and fill slopes are expressed as positive values.*

Figure 21.17 shows the cut ditch width.

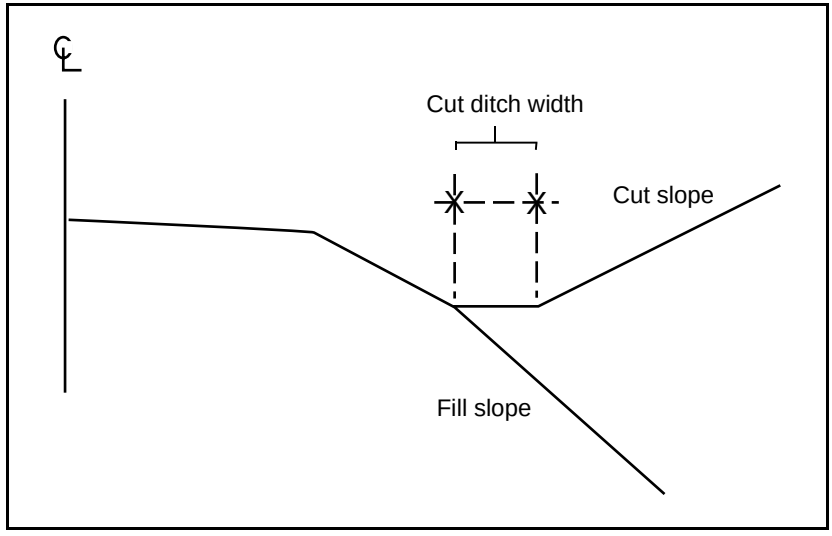


Figure 21.17 Cut ditch width

b. Enter a value in the *Code* field (this step is optional).

Reviewing a Definition

To view the details of an existing road definition select *Key in* / *Roads*. In the *Name* field press ⊙ then List. Highlight the road name and press Review. To return to the list press Esc or, to view details of other roads in the list, press Prev or Next.

Use the same process to review a template.

You can also review the details of a road or template component at any time. See page 57. Alternatively, select *Key in* / *Roads* or *Key in* / *Templates* (as if to edit the record).

Editing a Definition

Use the *Key in* menu to enter details directly into the Trimble Survey Controller software database without uploading or measuring. You can also use it to edit (change) the details of a road definition that is imported or keyed in, and to edit a definition that you started to key in but did not complete.

To edit a road definition imported from Trimble RoadLink or partially keyed in:

- Select *Key in* / *Roads* to edit a road definition

  Note – *This is not possible during a survey. End the survey, or* *see the tip on page 426.*

- Select *Key in* / *Templates* to edit a template definition

To select a road definition for editing, do one of the following:

- Select it from a list

  To do this, highlight the *Name* field and press ⏎. Press List to display a list of available roads.

- Enter the name of the road definition

  This name must match an existing road name.

Use the same process when selecting a template definition to edit.

Note – *When you edit a road or template definition, a new definition is stored. The original definition stays in the Trimble Survey Controller software database, but the deleted symbol (⊘) indicates that it is no longer available.*

Key In Notes

Enter a note in the Trimble Survey Controller software database at any time.

To key in a note:

1. From the main menu, select *Key in / Notes.*
2. Type in the details to be recorded. Alternatively press T/stamp to generate a record of the current time.
3. Press Enter to store the note in the database or Esc to discard it.

Note – *If a feature code list is selected for the job, you can use codes from the list when keying in a note. From the Key in/Notes screen, press* Sp *to display the feature code list. Select a code from the list or type the first few letters of the code.*

CHAPTER

22

Cogo Functions

In this chapter:

- Introduction
- Using cogo functions
- Inverse
- Intersections
- Traverse
- Subdivide a line
- Subdivide a curve
- Compute area
- Compute azimuth
- Compute distance

Introduction

The Trimble Survey Controller software provides coordinate geometry (Cogo) functions that perform various calculations using points stored in the database. The results can also be stored in the database. To access these functions, use the *Cogo* menu.

Warning – Do not compute intersection points and ***then*** change the coordinate system or perform a calibration. If you do, these points will not be in terms of the new coordinate system.

Using Cogo Functions

This section outlines the general procedure to follow in order to perform calculations using the Trimble Survey Controller software Cogo functions. For detailed instructions on how to use a particular function, see the appropriate section later in this chapter.

To use a Cogo function:

1. From the main menu, choose *Cogo*.
2. From the *Cogo* menu, choose the required Cogo function. Set the *Method* field if applicable.
3. Enter the variables such as point name, line name, distance, or azimuth.
4. Press Calc to calculate the results.
5. Press Store to store the results in the Trimble Survey Controller software database (this step is optional).

Embedded Cogo Softkey

A Calc softkey appears at the bottom of the main *Cogo* screen. Press it to calculate the results of a Cogo function.

A Cogo softkey appears when you access some of the fields in the main *Cogo* screen. This softkey provides a shortcut from the field to a Cogo calculation.

Note – *If the Cogo softkey appears when a particular field is accessed, it applies only to that field. It is an 'embedded' softkey.*
The Cogo calculation that it performs is different from the calculation that the main Calc softkey performs. While the embedded Cogo softkey is available, the Calc softkey that calculates the results of the main Cogo function is not.

Use the embedded Cogo softkey to calculate a value for a field in the current *Cogo* screen.

Example

An embedded Cogo softkey occurs in the *Subdivide a line* option, where the line is to be divided into segments of fixed length:

1. If the length is to be the same distance as between points A and B, access the *Segment length (grnd)* field and press Cogo. The *Cogo*/*Compute distance* screen appears.
2. Set *Method* to Between two points.
3. Enter the point name A in the *From point* field and the point name B in the *To point* field.
4. Press Enter or Cogo. The computed distance between A and B is displayed.
5. Press Prev to display previous calculations.

Tip – After pressing Prev, press Next to return to a display of the more recent calculation.

6. Press OK to return to the *Cogo/Subdivide a line* screen. The distance just calculated is inserted into the *Segment length (grnd)* field.

Tip – Use the embedded Cogo softkey to calculate azimuths and horizontal distances needed in other Cogo calculations.

When the Trimble Survey Controller software calculates a value this way, it automatically transfers the answer to the field that you accessed from the main *Cogo* screen.

Entering Point Names

When entering point names, access the *Point name* field and press List to select points from the database list. Press Key in to key in details, or Measure to measure a point.

Options Softkey

Press Options to display the *Options* screen. See Figure 22.1.

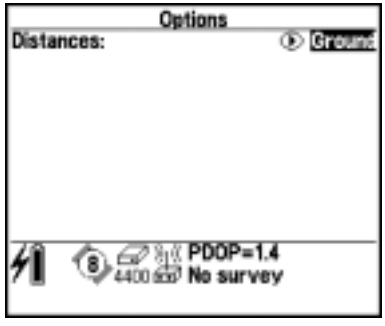


Figure 22.1 Options screen – cogo functions

Note – *The* Options *softkey in the Cogo/Traverse screen contains different options. For more information, see page 463.*

In the *Distances* field, set the type of distance to be calculated. Press Options to change this at any time. To apply an approximate sea level correction, for example, set the *Distances* field in this screen to Ellipsoid. These are illustrated in Figure 6.6 on page 105.

Note – *The Trimble Survey Controller software can only display grid distances between points if you defined a projection and datum transformation, selected Scale factor only, or keyed in the points as grid points.*

Messages

If the message

Unable to calculate a solution

appears, then the azimuth(s) and distance(s) do not intersect.

Multiple Solutions

For some computations, there are two solutions. Press Other to display the other solution.

Note – *If the Trimble Survey Controller software is configured to operate with quadrant bearings, substitute bearing for azimuth in the rest of this chapter.*

Inverse

To calculate the azimuth and distance between two points:

1. From the main menu, select *Cogo* / *Inverse*.
2. Enter names in the *From point* (1) and *To point* (2) fields.
3. Press Calc to obtain the azimuth (3), horizontal distance (4), change in elevation, and slope distance.

Figure 22.2 shows the text screen and a graphical representation of the *Cogo*/*Inverse* calculation.

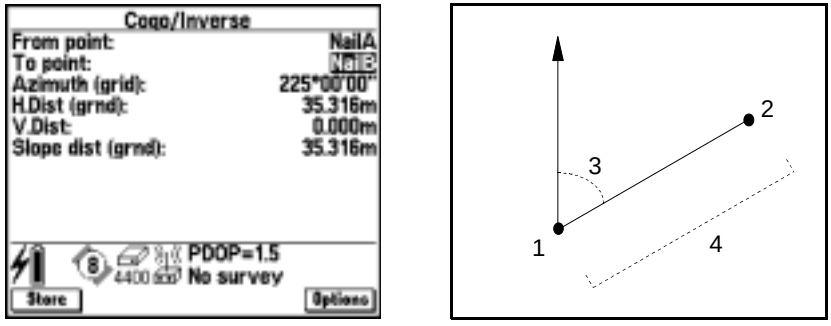


Figure 22.2 Cogo/inverse

Intersections

The Trimble Survey Controller software can calculate the coordinates of an intersection point from a combination of azimuths and/or distances from existing points.

To calculate an intersection:

1. From the main menu, select *Cogo* / *Intersections*.
2. Enter a name for the intersection point in the *Point name* field, then choose a setting in the *Method* field. Other fields appear, depending on the method you select. Fill in the information required.

Choosing a Method

In the *Method* field, the options for calculating an intersection are:

- Brng-dist intersect
- Brng-brng intersect
- Dist-dist intersect
- Brng-dist from a point

Bearing – Distance Intersection

If you set the *Method* field to Brng-dist intersect, enter the name of Point 1 (1), the azimuth (2), the name of Point 2 (3), and the horizontal distance (4).

Press Calc to calculate the intersection points (5 and 6). There are often two solutions for this calculation. Press Other to see the second solution.

Figure 22.3 shows the text screen and a graphical representation of the *Cogo*/*Intersections* calculation using this method.

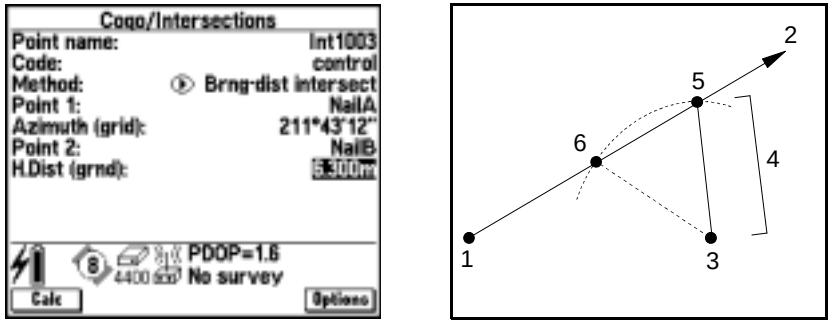


Figure 22.3 Cogo/intersections using brng-dist intersect

Bearing – Bearing Intersection

If you set the *Method* field to Brng-brng intersect, enter the name of Point 1 (1) and the azimuth (2). Enter the name of Point 2 (3) and the azimuth (4).

Press Calc to calculate the intersection point (5).

Figure 22.4 shows the text screen and a graphical representation of the *Cogo*/*Intersections* calculation using this method.

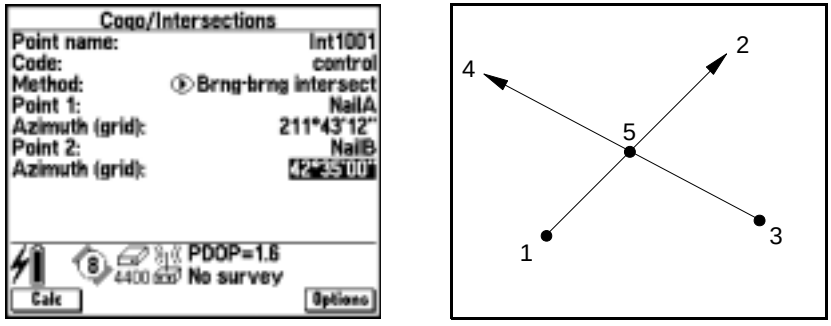


Figure 22.4 Cogo/intersections using brng-brng intersect

Distance – Distance Intersection

If you set the *Method* field to Dist-dist intersect, enter the name of Point 1 (1) and the horizontal distance (2). Enter the name of Point 2 (3) and the horizontal distance (4).

Press Calc to calculate the intersection points (5 and 6). There are two solutions for this calculation. Press Other to see the second solution.

Figure 22.5 shows the text screen and a graphical representation of the *Cogo*/*Intersections* calculation using this method.

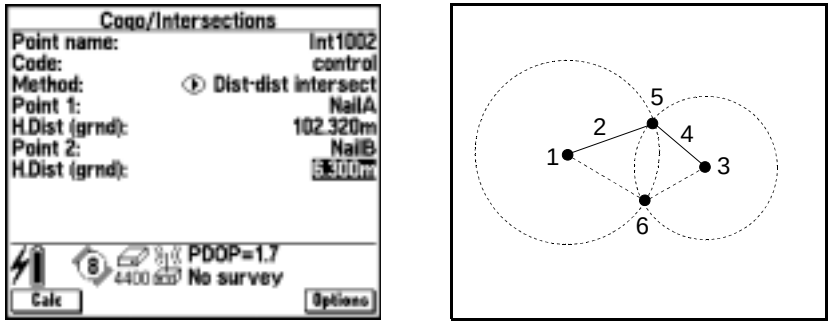


Figure 22.5 Cogo/intersections using dist-dist intersect

Bearing – Distance from a Point

If you set the *Method* field to Brng-dist from a point, enter the name of the start point (1), the azimuth (2), and the horizontal distance (3).

Press Calc to calculate the intersection point (4).

Figure 22.6 shows the text screen and a graphical representation of the *Cogo*/*Intersections* calculation using this method.

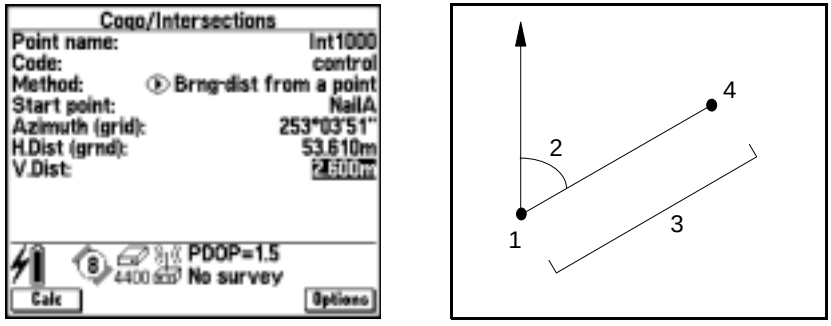


Figure 22.6 Cogo/intersections using brng-dist from a point

Traverse

The Trimble Survey Controller software can calculate a closure and adjust a traverse. The software helps you select the points to be used, calculates the misclosure, and then lets you compute either a Compass or Transit adjustment.

Note – *The Compass adjustment is sometimes known as the Bowditch adjustment.*

You can calculate closed-loop traverses (traverses that start and end on the same point), and traverses that start and end on pairs of known points.

For information about the calculations that the Trimble Survey Controller software performs when calculating a traverse, see Traverse Calculation, page 208.

To calculate a traverse, do the following:

1. From the main menu, select *Cogo* / *Traverse*. The *Cogo/Traverse* screen appears.
2. Enter the traverse name.
3. In the *Start station* field, enter the name of the first point in the traverse. The software only lets you enter a point that has conventional observations from it (an instrument point).

Tip – Press List to see a list of valid points that can be used as the start station.

4. Press OK. The traverse point list appears, see Figure 22.7. The start station point name is the only point in the list.

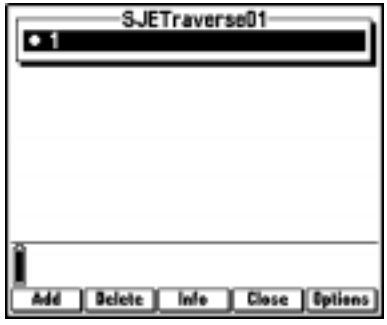


Figure 22.7 Traverse point list

5. Press Add to add the next point in the traverse. The *Select station to add* list appears. The list only displays valid points that can be added. For example, it only displays points that have been used as instrument points ***and*** have been measured (using a conventional instrument) from the previous point in the traverse list.

   Note – *When there is only one valid point to add, the Trimble Survey Controller software adds it to the traverse list automatically.*

6. Select the next station in the traverse.

Note – *To view the observed azimuth and distance between two points in the list, highlight the first point and press* Info.

7. Repeat steps 5 and 6 until all the points in the traverse have been added. If you need to remove any points from the list, highlight the point and press Delete. When you delete a point, all points after it are deleted as well.

   Note – *You cannot add more points after selecting a control point.*

   Note – *To compute a traverse closure, there must be at least one distance measurement between successive points in the traverse list.*

8. When all of the points have been added, press Close. The *Cogo/Traverse/Orientation* screen appears. It shows the backsight and foresight points that provide orientation for the traverse.

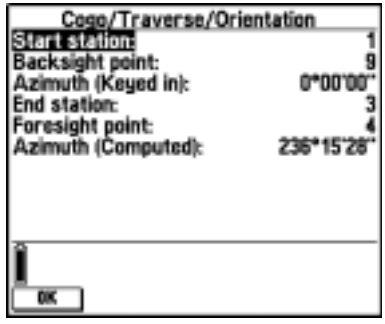


Figure 22.8 Cogo/Traverse/Orientation screen

9. The *Backsight point*, *Azimuth*, *Foresight point*, and *Azimuth* fields are filled in by the Trimble Survey Controller software. Edit these fields if necessary.

Note – *The Azimuth fields do not have to be completed. If the backsight azimuth is null, the traverse cannot be oriented and adjusted coordinates cannot be stored. The foresight azimuth may be null in a loop traverse, and if all angles have been observed, you can compute an angular and distance adjustment. An angular and distance adjustment cannot be computed on an open traverse if the backsight azimuth is null. An angular adjustment cannot be computed on an open traverse if the backsight azimuth is null. However, a distance adjustment can be computed.*

Press OK. The *Cogo/Traverse/Close results* screen appears:

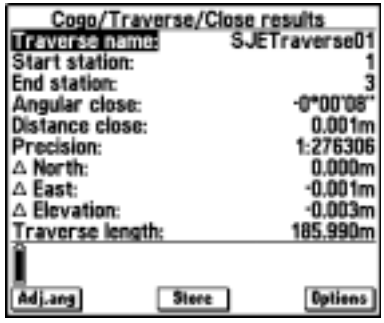


Figure 22.9 Cogo/Traverse/Close results screen

10. Inspect the results of the traverse and do one of the following:
    - To store the closure results, press Store.
    - To return to the *Cogo/Traverse/Orientation* screen press Esc.
    - To adjust the traverse, go to the next step.
11. Press Options. The *Traverse options* screen appears, check the settings. For more information about the settings, see Traverse options, page 463.

    When the settings are complete, press Enter. The *Cogo/Traverse/Close results* screen returns.

12. To adjust the angular misclosure in the traverse, press Adj.ang. The angular misclosure is distributed according to the setting in the *Options* screen. The *Cogo/Traverse/Adjustment results* screen appears and it shows the distance misclosure.

    Note – *The Adj.ang softkey does not appear if the angular adjustment method in the Options screen is set to None.*

13. Inspect the results of the traverse and do one of the following:

    – To store the angular adjustment details, press Store.

    – To adjust the distance misclosure, press Adj.dist. The distance misclosure is distributed according to the setting in the *Options* screen and the traverse is stored.

    When the traverse is stored, each point used in the traverse is stored as an adjusted traverse point with a search classification of Control. If there are any previously-adjusted traverse points of the same name, they are deleted.

Subdivide a Line

The Trimble Survey Controller software can divide a defined line into segments of fixed length or a fixed number of segments. New points are created along the line.

You can predefine the code of a subdivided point. For more information, see Subdivide Pts Code, page 109.

To subdivide a line:

1. From the main menu, select *Cogo* / *Subdivide a line*.
2. Enter the name of the line.
3. Choose a setting in the *Method* field.

   Other fields appear, depending on the method you select.
4. Fill in the information required.

Note – *When you enter the name of a defined line, the default value for the Start at station field is set to zero, and the default value for the End at station field is set to the length of the line. Points created in this way can be used during stakeout.*

Choosing a Method

In the *Method* field, the options for subdividing a line are:

- Fixed segment length
- Fixed number of segments

Fixed Segment Length

If you set the *Method* field to Fixed segment length, enter the segment length (2), and a horizontal offset (3) and vertical offset from the line. Enter the start station position (4) on the line, the end station position (5), and the name of the start point that will be incremented automatically.

Press Start to calculate the new points (4, 6, 7 or 8, 9, 10). When the operation is completed, the following message appears:

Subdivision of line completed successfully

Press OK to continue. Points are automatically stored in the database.

Figure 22.10 shows the text screen and a graphical representation of the *Cogo*/*Subdivide a line* calculation using the Fixed segment length method.

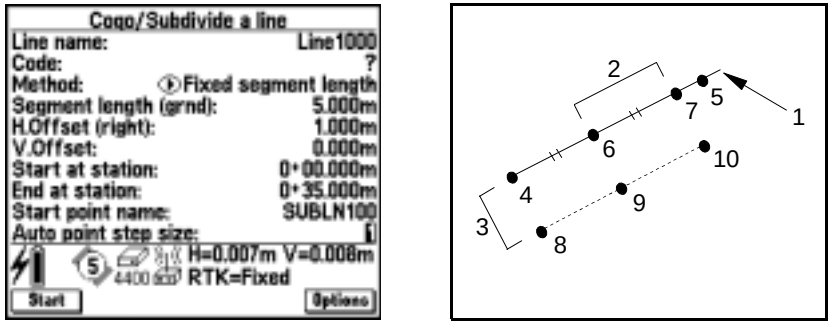


Figure 22.10 Cogo/subdivide a line using fixed segment length

Note – *If the defined line is longer than an integer number of segments, the last subdivided point is the end of the last full segment (Point 7, in this example).*

Fixed Number of Segments

If you set the *Method* field to Fixed number of segments, enter the number of segments, and a horizontal offset (2) and vertical offset from the line. Enter the start station position (3) on the line, the end station position (4), and the name of the start point that will be incremented automatically.

Press Start to calculate the new points (3, 5, 4 or 6, 7, 8). When the operation is completed, the following message appears:

Subdivision of line completed successfully

Press OK to continue. The points are automatically stored in the database.

Figure 22.11 shows the text screen and a graphical representation of the *Cogo*/*Subdivide a line* calculation using this method.

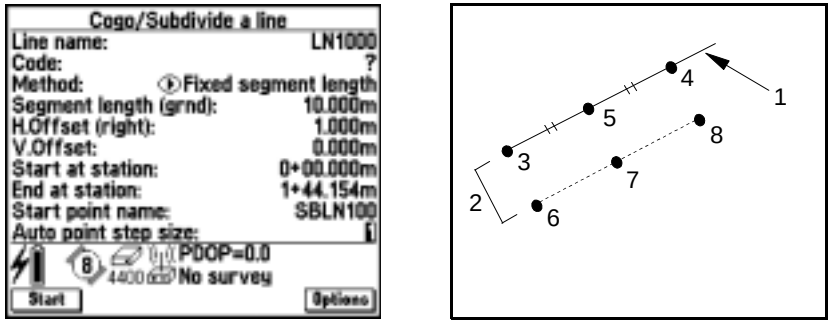


Figure 22.11 Cogo/subdivide a line using fixed number of segments

Subdivide a Curve

The Trimble Survey Controller software can divide a defined curve into segments of fixed length or a fixed number of segments. New points are created along the curve.

You can predefine the code of a subdivided point. For more information, see Subdivide Pts Code, page 109.

To subdivide a curve:

1. From the main menu, select *Cogo* / *Subdivide a curve*.
2. Enter the name of the defined curve.
3. Choose a setting in the *Method* field.

   Other fields appear, depending on the method you select.
4. Fill in the information required.

Note – *When you enter the name of a defined curve, the default value for the Start at station field is set to zero, and the default value for the End at station field is set to the length of the curve.*

Choosing a Method

In the *Method* field, the options for subdividing a curve are:

- Fixed segment length
- Fixed number of segments
- Fixed chord length
- Fixed angle subtended

Note – *You can use the points created using the Subdivide a curve option in the Stakeout screen.*

Fixed Segment Length

If you set the *Method* field to Fixed segment length, enter the segment length (2), and a horizontal offset (3) and vertical offset from the curve. Enter the start station position (4) on the curve, the end station position (5), and the name of the start point that will be incremented automatically.

Press Start to calculate the new points (4, 6, 7 or 8, 9, 10). When the operation is completed, the following message appears:

Subdivision of curve completed successfully

Press OK to continue. Points are automatically stored in the database.

Figure 22.12 shows the text screen and a graphical representation of the *Cogo*/*Subdivide a curve* calculation using this method.

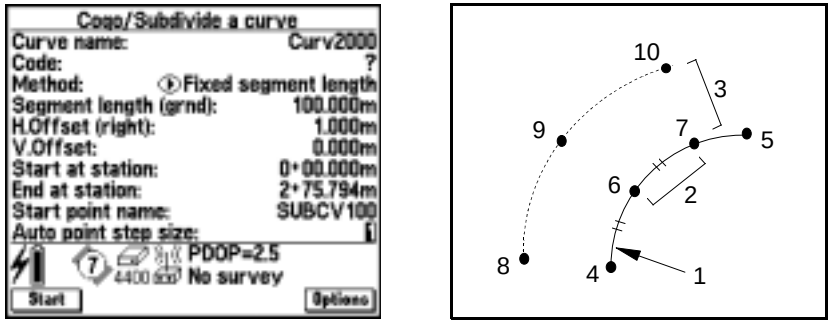


Figure 22.12 Cogo/subdivide a curve using fixed segment length

Fixed Number of Segments

If you set the *Method* field to Fixed number of segments, enter the number of segments, and a horizontal offset (2) and vertical offset from the curve. Enter the start station position (3) on the curve, the end station position (4), and the name of the start point that will be incremented automatically.

Press Start to calculate the new points (3, 5, 4 or 6, 7, 8). When the operation is completed, the following message appears:

Subdivision of curve completed successfully

Press OK to continue. The points are automatically stored in the database.

Figure 22.13 shows the text screen and a graphical representation of the *Cogo*/*Subdivide a curve* calculation using this method.

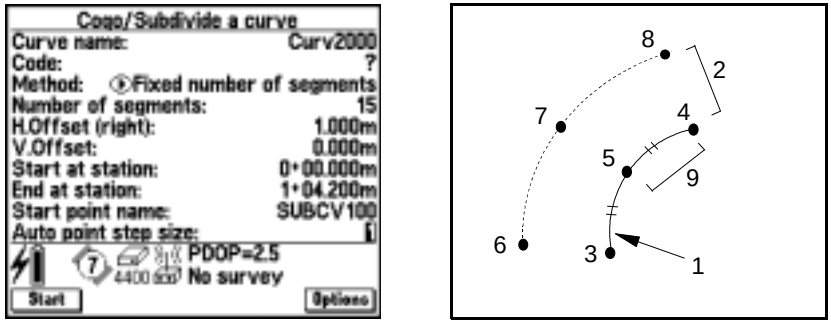


Figure 22.13 Cogo/subdivide a curve using fixed number of segments

Fixed Chord Length

If you set the *Method* field to Fixed chord length, enter the chord length (2), and any horizontal offset (3) and vertical offset from the curve. Enter the start station position (4) on the curve, the end station position (5), and the name of the start point that will be incremented automatically.

Press Start to calculate the new points (4, 6, 7 or 8, 9, 10). When the operation is completed, the following message appears:

Subdivision of curve completed successfully

Press OK to continue. Points are automatically stored in the database.

Figure 22.14 shows the text screen and a graphical representation of the *Cogo*/*Subdivide a curve* calculation using this method.

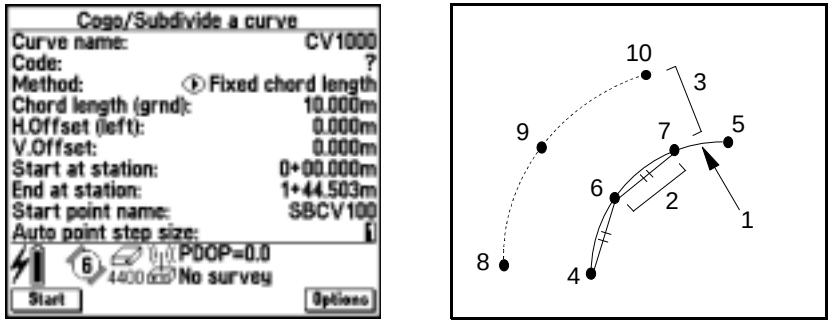


Figure 22.14 Cogo/subdivide a curve using fixed chord length

Fixed Angle Subtended

If you set the *Method* field to Fixed angle subtended, enter the subtended angle (2), and a horizontal offset (3) and vertical offset from the curve. Enter the start station position (4) on the curve, the end station position (5), and the name of the start point that will be incremented automatically.

Press Start to calculate the new points (4, 6, 7 or 8, 9, 10). When the operation is completed, the following message appears:

Subdivision of curve completed successfully

Press OK to continue. The points are automatically stored in the database.

Figure 22.15 shows the text screen and a graphical representation of the *Cogo*/*Subdivide a curve* calculation using this method.

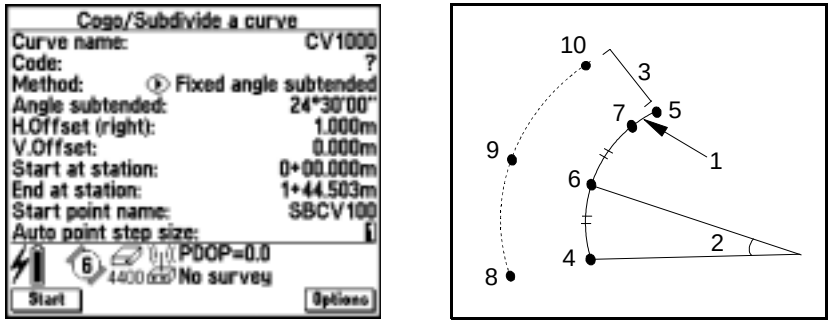


Figure 22.15 Cogo/subdivide a curve using fixed angle subtended

Compute Area

The Trimble Survey Controller software can calculate the area enclosed by three or more points selected from its database. It can use up to 100 points.

To compute an area:

1. From the main menu, select *Cogo* / *Compute area*.
2. Use the ✓ softkey to select the points on the perimeter of the area to be calculated.
3. Press Enter to calculate the area (1) and the perimeter (2).

   Note – *Select points in the order in which they occur on the perimeter.*
4. Press Options if you need to change the units.
5. Press Store to store the area result in the Trimble Survey Controller software database.

The computed area varies according to the *Distance* display setting. Table 22.1 shows the effect of the distance setting on the area calculated.

Table 22.1 Distances Setting Options

Distances setting	Computed area
Ground	At the average ground elevation
Ellipsoid	On the ellipsoid surface
Grid	Directly off the grid coordinates

Figure 22.16 shows the text screen and a graphical representation of the *Cogo*/*Compute area* calculation.

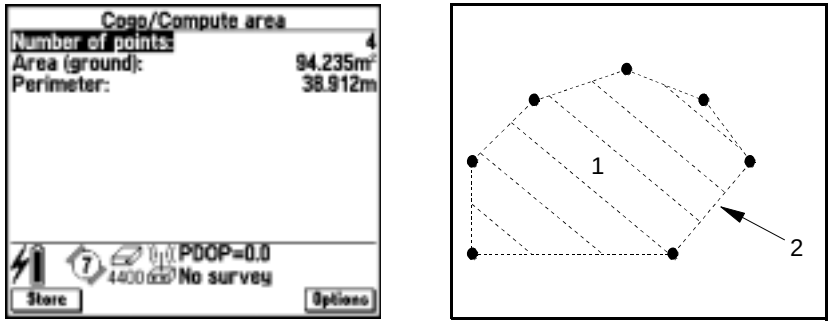


Figure 22.16 Cogo/compute area

For more information on the calculations performed by the Trimble Survey Controller software, see Area Calculations, page 199.

Compute Azimuth

The Trimble Survey Controller software can calculate an azimuth by various methods, using input data and points in the database. The input data can have different units. For example, you can add an angle in degrees to an angle in radians—the answer is returned in whatever format you specified in the job configuration.

To calculate an azimuth:

1. From the main menu, select *Cogo* / *Compute azimuth*.
2. Choose a setting in the *Method* field. Other fields appear, depending on the method you select. Fill in the information required.

Choosing a Method

In the *Method* field, the options for computing an azimuth are:

- Between two points
- Bisected azimuths
- Bisected corner
- Azimuth plus angle
- Azimuth to line offset

Between Two Points

If you set the *Method* field to Between two points, enter the names of the From point and the To point. The azimuth is calculated.

Bisected Azimuths

If you set the *Method* field to Bisected azimuths, enter the first azimuth (1) and the second azimuth (2). The azimuth (3) halfway between them is calculated.

Figure 22.17 shows the text screen and a graphical representation of the *Cogo*/*Compute azimuth* calculation using this method.

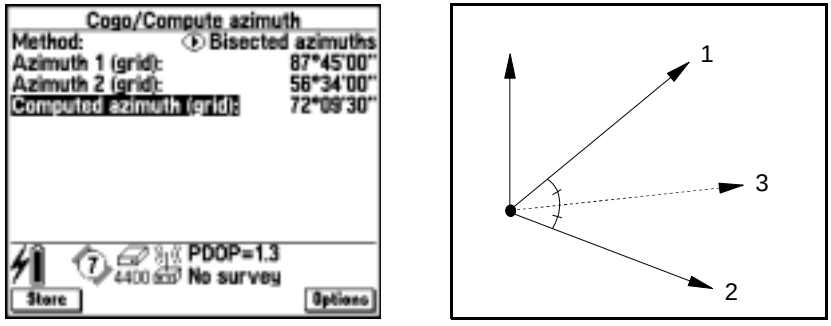


Figure 22.17 Cogo/compute azimuth using bisected azimuths

Bisected Corner

If you set the *Method* field to Bisected corner, enter the names of Side point 1 (1), the corner point (2), and Side point 2 (3). The azimuth from the corner point is calculated (4). It is halfway between Side point 1 and Side point 2.

Figure 22.18 shows the text screen and a graphical representation of the *Cogo*/*Compute azimuth* calculation using this method.

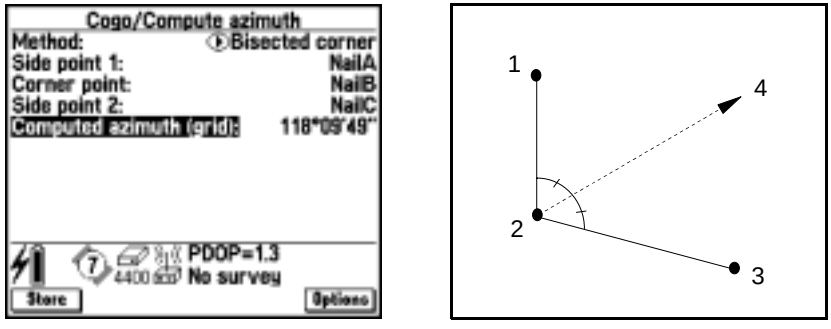


Figure 22.18 Cogo/compute azimuth using bisected corner

Azimuth Plus Angle

If you set the *Method* field to Azimuth plus angle, enter the azimuth (1) and the turned angle (2). The sum of the two is calculated (3).

Figure 22.19 shows the text screen and a graphical representation of the *Cogo*/*Compute azimuth* calculation using this method.

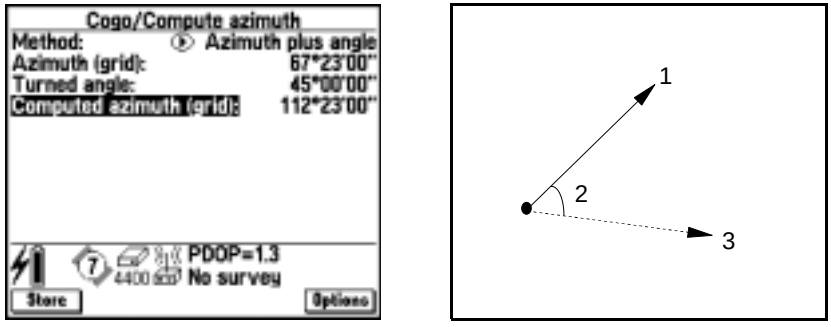


Figure 22.19 Cogo/compute azimuth using azimuth plus angle

Azimuth to Line Offset

If you set the *Method* field to Azimuth to line offset, enter the name of the line (1), the station value (2), and the horizontal offset (3). The azimuth (4) from the start station of the line to the offset point is calculated.

Figure 22.20 shows the text screen and a graphical representation of the *Cogo*/*Compute azimuth* calculation using this method.

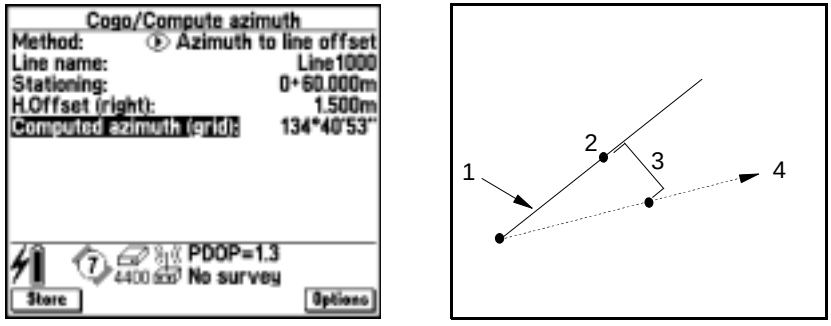


Figure 22.20 Cogo/compute azimuth using azimuth to line offset

Compute Distance

Use the Trimble Survey Controller software to calculate a distance by various methods, using input data and points in the database. The input data can have different units. For example, if you add a distance in meters to a distance in feet, the answer is returned in whatever format you specified in the job configuration.

To calculate a distance:

1. From the main menu, select *Cogo* / *Compute distanc*e.
2. Choose a setting in the *Method* field. Other fields appear, depending on the method you select. Fill in the information required.

Choosing a Method

In the *Method* field, the options for computing a distance are:

- Between two points
- Between point and line
- Between point and curve
- Divided distance
- Multiplied distance
- Added distances

Between Two Points

If you set the *Method* field to Between two points, enter the From point and the To point. The distance between them is calculated.

Between Point and Line

If you set the *Method* field to Between point and line, enter the names of the point (1) and the line (2). The Trimble Survey Controller software calculates the distance along the line (3) and the perpendicular distance to the line (4). The distance along the line is from the From point (5).

Figure 22.21 shows the text screen and a graphical representation of the *Cogo*/*Compute distance* calculation using this method.

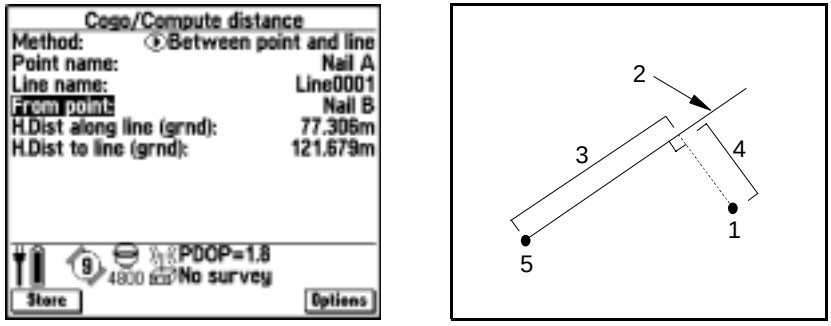


Figure 22.21 Cogo/compute distance using between point and line

Between Point and Curve

If you set the *Method* field to Between point and curve, enter the names of the point (1) and the curve (2). The Trimble Survey Controller software calculates the distance along the curve (3) and the perpendicular distance to the curve (4). The distance along the line is from the From point (5).

Figure 22.22 shows the text screen and a graphical representation of the *Cogo*/*Compute distance* calculation using this method.

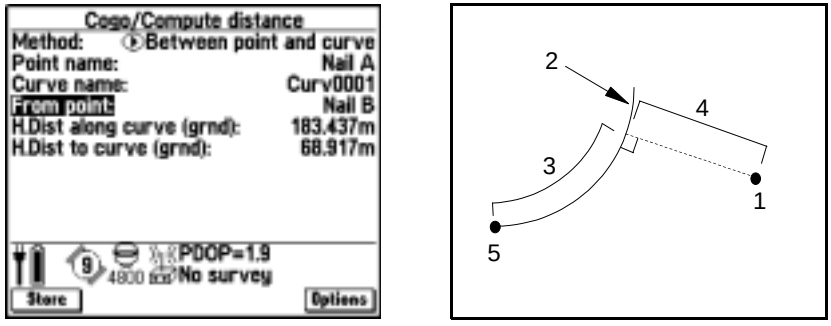


Figure 22.22 Cogo/compute distance using between point and curve

Divided Distance

If the *Method* field is set to Divided distance, enter values in the *Distance* and the *Divisor* fields. The distance of a segment is calculated.

Multiplied Distance

If the *Method* field is set to Multiplied distance, enter values in the *Distance* and the *Multiplier* fields. The total distance is calculated.

Added Distances

If the *Method* field is set to Added distances, enter values in the *Distance 1* and *Distance 2* fields. The sum of both distances is calculated.

CHAPTER

23

Offsets

In this chapter:

- Introduction
- Generating offsets
- Choosing a method

Introduction

A GPS antenna or conventional instrument target cannot always occupy a point directly, for example, if a point is the center of a tree or part of a building that is under a canopy. There are several ways to measure these points using the Trimble Survey Controller software. You can use a conventional instrument and measure a point using an offset method. For more information, see Choosing a method, page 483. Alternatively you can use a laser rangefinder, or calculate an offset from points in the database. This chapter shows how to calculate offsets using the Offset function in the Trimble Survey Controller software.

To do this, choose *Offsets* from the *Survey* menu in a real-time GPS survey or a conventional survey. Measure a topographic (topo) point or a Rapid point™ nearby, then make tape and/or azimuth measurements to the offset point. When you enter these measurements into the Trimble Survey Controller software, it calculates the coordinates of the offset point and stores them in the database.

Remember to include any change in height details, as the height (or elevation) of the offset point is also calculated.

Warning – In general, do not compute offset points and then change the coordinate system or perform a calibration. If you do, these points will not be in terms of the new coordinate system. An exception to this is offset points computed using the Brng-dist from a point method.

Generating Offsets

This section outlines the general procedure to follow to measure offsets.

To generate an offset point:

1. Measure points near to the offset point.
2. From the main menu, select *Survey* / *Offsets*.

3. Select a setting in the *Method* field (see Choosing a Method, page 596). Other fields appear, depending on what method you select. Fill in the information required.
4. Press Calc to calculate the solution(s). The Trimble Survey Controller software calculates and displays the coordinates for the offset point. Press Store to store these in the database.

Note – *If you use the Four point intersection method or the From a baseline method and then change the antenna height record for one of the source points, the coordinates of the offset point will not be updated.*

Entering Point Names

When entering point names for the measured points in the *Survey* / *Offsets* screen, press List to select points from the database list. Press Key in to key in details or Measure to measure a point.

Options Softkey

Press Options to display the *Options* screen.

Change the *Distances* setting and apply sea level correction if required.

Note – *If the measured points were measured using GPS, the coordinates of the offset point can only be displayed as grid values if a projection and a datum transformation are defined.*

Specify the magnetic declination if you are using a magnetic compass to provide azimuth measurements.

Azimuths/Angles

If necessary, define a South azimuth and change the incrementation direction of the grid coordinates. For more information, see South Azimuth, page 107 and Grid Coordinates, page 108.

Azimuth and angle measurements can be referenced to grid 0°, true north, magnetic north, or the sun. To change this reference, access the *Azimuth origin* field and select the required origin from the list:

- If working with magnetic azimuths, enter the local value for magnetic declination (see Magnetic Declination, page 109).
- If you are working with sun angles, the Trimble Survey Controller software uses GPS time and the current GPS position to calculate the position of the sun (the reference) at the time the angle is entered.

Message

If the message:

Unable to calculate a solution

appears, then the azimuth(s) and/or distance(s) do not intersect. Measure the offsets again.

Choosing a Method

In the *Method* field, the options for calculating an offset point are:

- From a baseline
- Four point intersection
- Bearing – distance from a point

Note – *For each of these methods, it is assumed that you have already measured the nearby source points and stored them in the Trimble Survey Controller software database.*

From a Baseline

Use the From a baseline method to calculate the coordinates of an offset point that is offset from a baseline defined by previously measured points:

1. From the main menu, select *Survey* / *Offsets*.
2. Enter the name of the offset point (8) in the *Point name* field, and change the setting in the *Method* field to From a baseline.
3. Enter the names of the start point (1), end point (2), the offset direction (3, 4, 5, 6), the horizontal offset (7), and a vertical distance from the end of the line.
4. Press Calc to calculate and display the coordinates of the offset point (8). Press Store to store these in the database.

Figure 23.1 shows the text screen and a graphical representation of the *Survey*/*Offsets* calculation using this method.

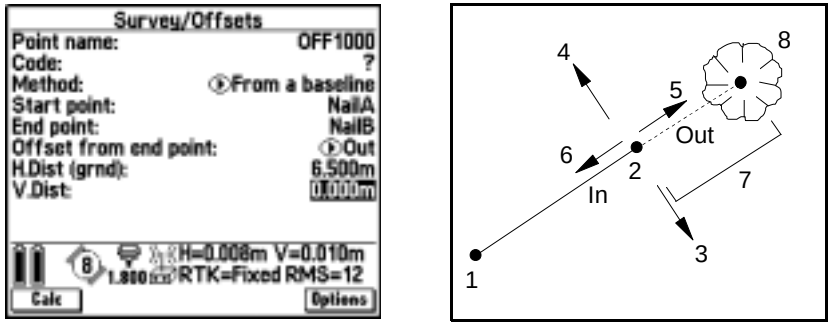


Figure 23.1 Survey/offsets using from a baseline

Note – *In this chapter, a number in parentheses ( ) refers to a point in the corresponding figure.*

Four Point Intersection

Use the Four point intersection method to calculate the coordinates of an offset point at the intersection of two lines defined by four previously measured points:

1. From the main menu, select *Survey* / *Offsets*.
2. Enter the name of the offset point (5) in the *Point name* field, and change the setting in the *Method* field to Four point intersection.
3. Enter the name of the start point (1) for line 1, the name of the end point (2) for line 1, the name of the start point (3) for line 2, the name of the end point (4) for line 2, and any vertical offset.
4. Press Calc to calculate and display the coordinates of the offset point (5). Press Store to store these in the database.

Figure 23.2 shows the text screen and a graphical representation of the *Survey*/*Offsets* calculation using this method.

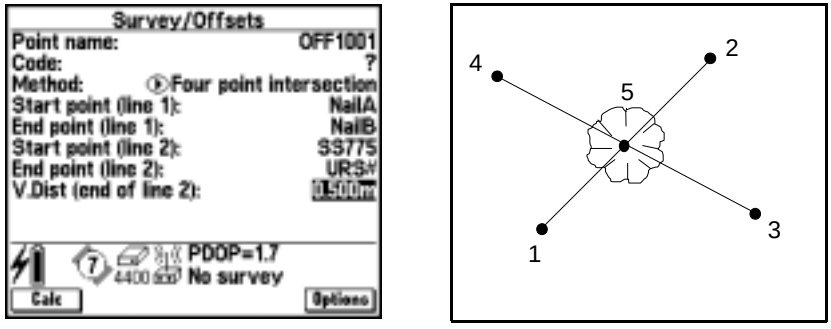


Figure 23.2 Survey/offsets using four point intersection

Note – *The two lines defined by the previously measured four points do not have to intersect but they do have to converge at some point. See Figure 23.3.*

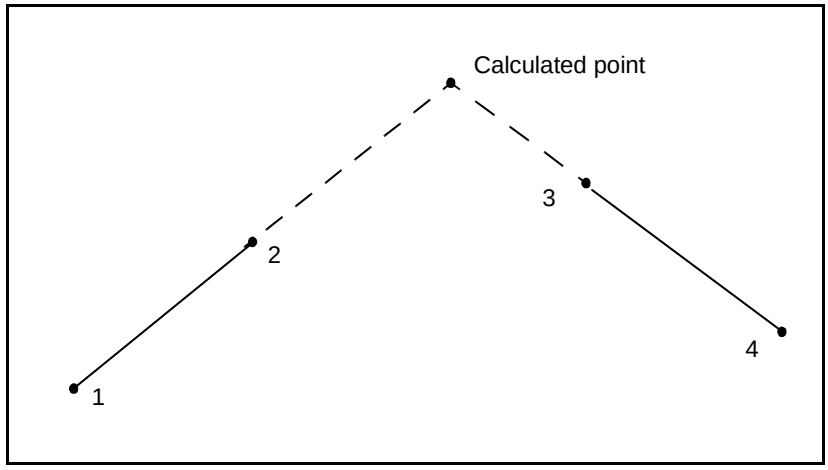


Figure 23.3 Point calculated where lines converge

Bearing – Distance from a Point

Use the Bearing-distance from a point method to calculate the coordinates of an offset point at a certain azimuth and distance from a previously measured point:

1. From the main menu, select *Survey* / *Offsets*.
2. Enter the name of the offset point (4) in the *Point name* field, and change the setting in the *Method* field to Brng-dist from a point.
3. Enter the name of the start point (1), the azimuth origin, the azimuth (2), the horizontal distance (3), and a vertical offset.
4. Press Calc to calculate and display the coordinates of the offset point (4). Press Store to store these in the database.

Figure 23.4 shows the text screen and a graphical representation of the *Survey*/*Offsets* calculation using this method.

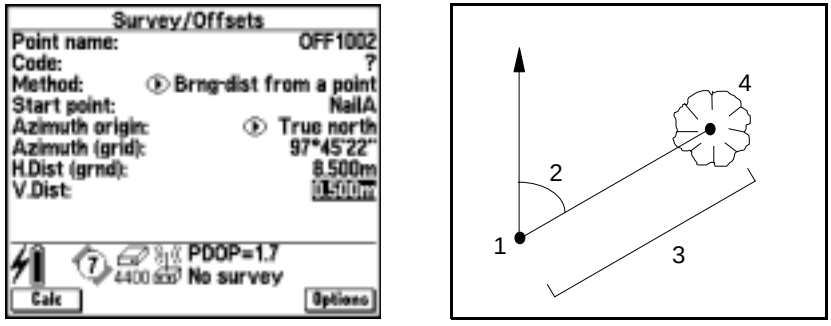


Figure 23.4 Survey/offsets using brng-dist from a point

APPENDIX

D

Connection Diagrams

In this chapter:

- Introduction
- Connecting the base receiver for a real-time survey
- Connecting the base receiver for a postprocessed survey
- Connecting the rover receiver for a real-time survey
- Connecting the rover receiver for a postprocessed survey

Introduction

This appendix shows how to connect a TSC1 data collector to a Series 4000™ receiver, a Site Surveyor 4400™ receiver, a 4600LS™ receiver, or an MS750™ receiver. It shows how to connect the base receiver for a real-time survey or a postprocessed survey, then how to connect the rover receiver for these surveys.

If using a GPS Total Station™ 4800 or 4700 receiver, see Chapter 11, Starting the Base Receiver and Chapter 12, Starting the Rover Receiver.

Connecting the Base Receiver for a Real-Time Survey

This section shows how to connect the base receiver for a real-time survey.

Using a Series 4000 or Site Surveyor 4400 Receiver

To set up a base receiver for a real-time survey using a Trimble Series 4000 or Site Surveyor 4400 receiver, see Figure D.1. Then do the following:

1. Set the GPS antenna over the ground mark using a tripod, a tribrach, and a tribrach adaptor. If one of the GPS antennas has a ground plane, use this as the base antenna. (See Measuring the Height of an Antenna When Using a Ground Plane, page 276.)

   Note – *If conducting an RTK survey using a single-frequency base or rover receiver (such as a Trimble Site Surveyor SE™ or a Site Surveyor Si™ receiver) and you plan to initialize the survey using an initializer bar or plate, assemble the initializer bar/plate now. For more information, see Figure 12.5 on page 326.*

2. Connect the GPS antenna to the GPS receiver port labeled ANTENNA. Use the N-type to Lemo co-axial cable.

3. Assemble and erect the radio antenna.
4. Connect the radio antenna to the radio using the cable attached to the antenna (see Figure D.2).
5. Connect the radio to the GPS receiver port labeled I/O 2.
   - If using a Trimble radio, use the 7-pin Lemo to 5-pin Lemo cable.
   - If using a radio provided by a third party, use the appropriate cable.

Warning – Do not force plugs into the receiver ports. Check the number of pins in the plug to make sure that the socket is compatible. Align the red dot on the plug with the red line on the socket and then insert the plug carefully.

6. Connect the power source to the GPS receiver port labeled PWR 2 & 3 and turn on the receiver.
7. If using a third-party radio solution, make sure that the radio is connected to the power source.
8. Connect the TSC1 data collector to the GPS receiver port labeled PWR-I/O 1. Use the 0-shell Lemo to 5-pin Lemo cable.
9. Turn on the TSC1 and go to Starting a Base Survey, page 299.

Figure D.1 shows a receiver setup for a real-time or postprocessed survey using a Trimble Series 4000 or Site Surveyor 4400 receiver.

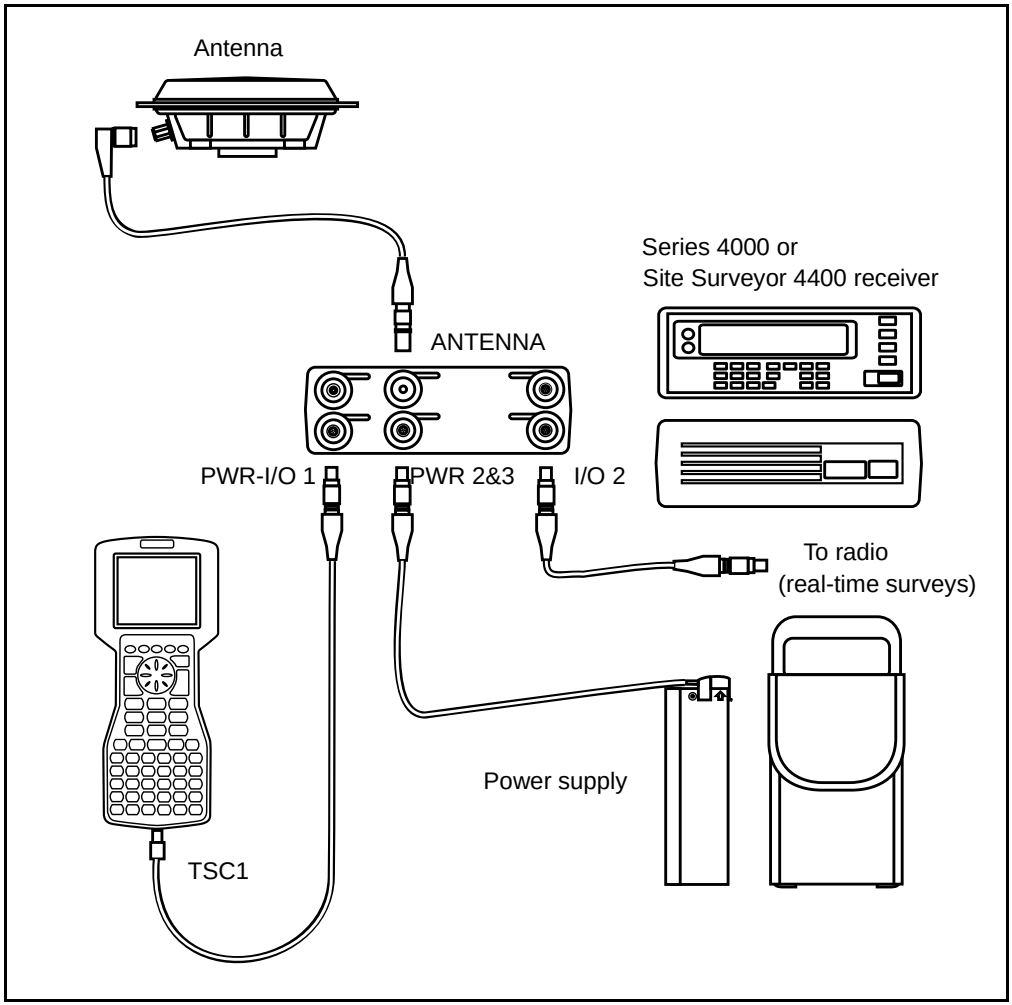


Figure D.1 Real-time or postprocessed configuration using a Series 4000 or Site Surveyor 4400 receiver

Figure D.2 shows a Trimble radio connected to a radio antenna.

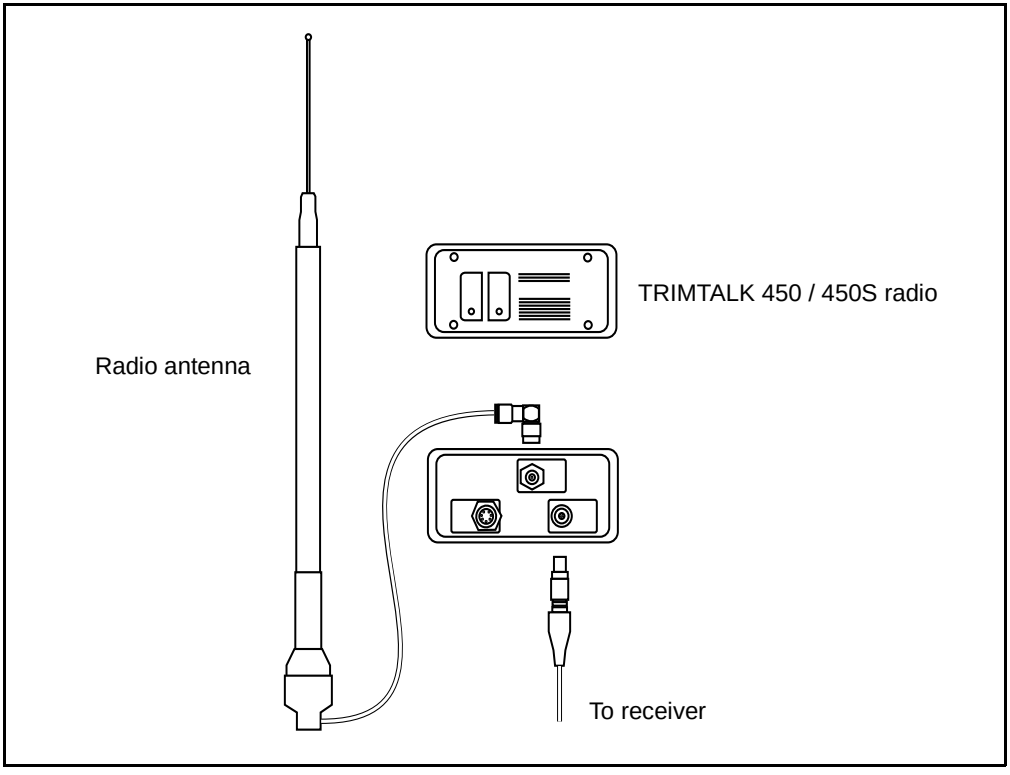


Figure D.2 Trimble radio connection

Using a 4600LS Receiver

To set up a base receiver for a real-time survey using a Trimble 4600LS receiver, see Figure D.3. Then do the following:

1. Set the 4600LS receiver over the ground mark using a tripod, a tribrach, and a tribrach adaptor.

   Note – *If you plan to initialize the survey using the initializer bar, assemble the initializer bar now. For more information, see Figure 12.5 on page 326.*

2. Assemble and erect the radio antenna.
3. Connect the radio antenna to the radio using the cable attached to the antenna (see Figure D.2).
4. Connect the radio to the 4600LS receiver port labeled PORT 2. Use the Y-cable.
5. Use the same Y-cable to connect the power source to the 4600LS receiver and turn on the receiver.

   If using a third-party radio solution, make sure that the radio is connected to a power source.

6. Connect the TSC1 data collector to the 4600LS receiver port labeled PORT 1. Use the 0-shell Lemo to 5-pin Lemo cable.
7. Turn on the TSC1 and go to Starting a Base Survey, page 299.

Figure D.3 shows the equipment setup for a real-time survey using a Trimble 4600LS receiver.

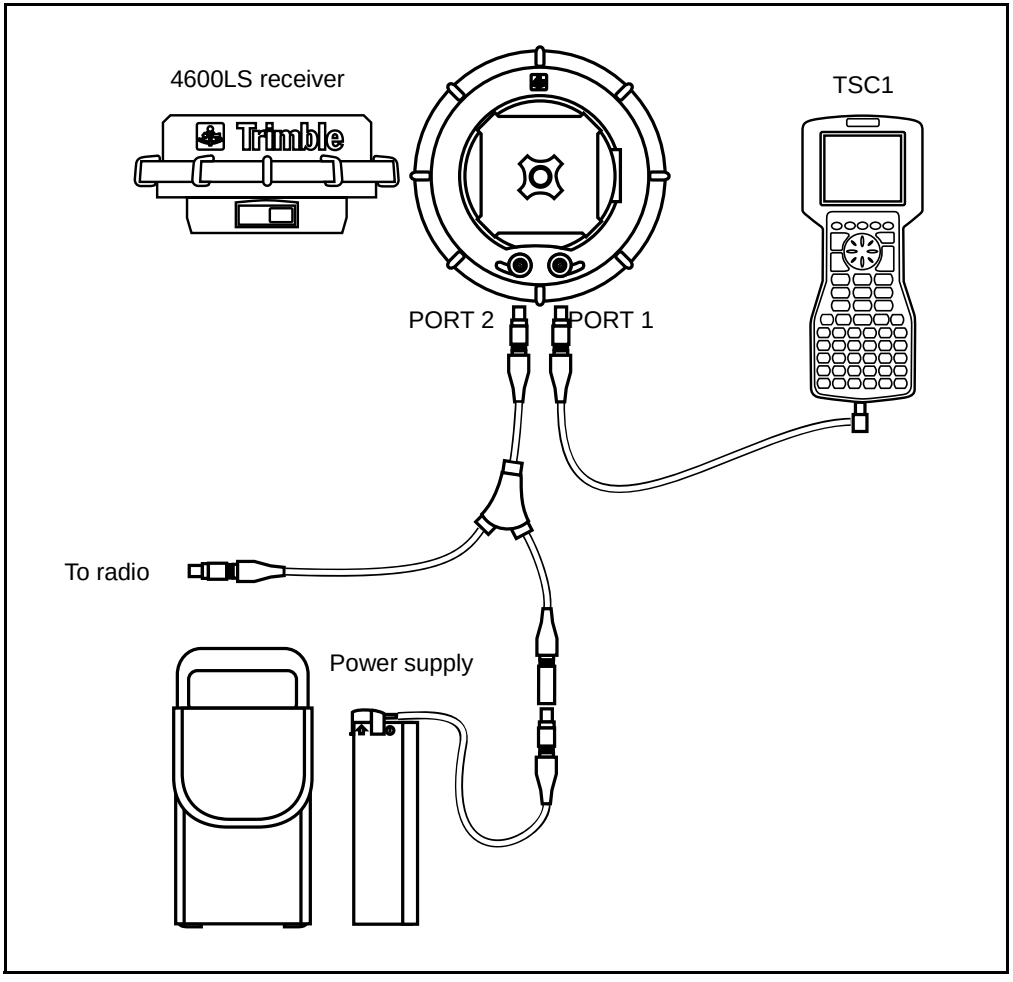


Figure D.3 Real-time configuration using a 4600LS receiver

Using an MS750 Receiver

To set up a base receiver for a real-time survey using a Trimble MS750 receiver, see Figure D.4. Then do the following:

1. Set the GPS antenna over the ground mark using a tripod, a tribrach, and a tribrach adaptor. If one of the GPS antennas has a ground plane, use this as the base antenna. For more information, see Measuring the Height of an Antenna When Using a Ground Plane, page 276.)
2. Connect the GPS antenna to the GPS receiver port labeled ANT. Use the N-type to N-type co-axial cable.
3. Assemble and erect the radio antenna.
4. Connect the radio antenna to the radio using the cable attached to the antenna.
5. Connect the radio to the MS750 receiver port labeled B. Use the cable with a double DB9 connector at one end (p/n 37382), and connect the radio cable to the port labeled B2 on the double DB9 connector.

   Note – *If you are using a TRIMTALK radio, use the cable p/n 21338 to connect to the port labeled AUX I/O on the radio. Connect a power supply to the port marked POWER & I/O. Do not use a dual camcorder battery cable to provide power to the radio because the pinout arrangement is different to the pinout arrangement on the radio.*
   Alternatively use the cable p/n 38955-00 to connect the TRIMTALK and an external power supply to port B on the receiver. If you are using this cable, you do not need to provide power to port A, and cable p/n 37382 can be used to connect to the TSC1.

   If you are using a third-party radio solution, make sure that the radio is connected to a power source.

6. Using the double cable (p/n 30231-00), connect the receiver power supply and the TSC1 to the receiver port labeled A. Connect the TSC1 to the DB9 connector using the cable p/n 32287-00 (it contains a null modem). Connect the camcorder battery power supply to the double cable using the cable p/n 24333.
7. Turn on the receiver.

8. Turn on the TSC1. See the notes in the next section then go to Starting a Base Survey, page 299.

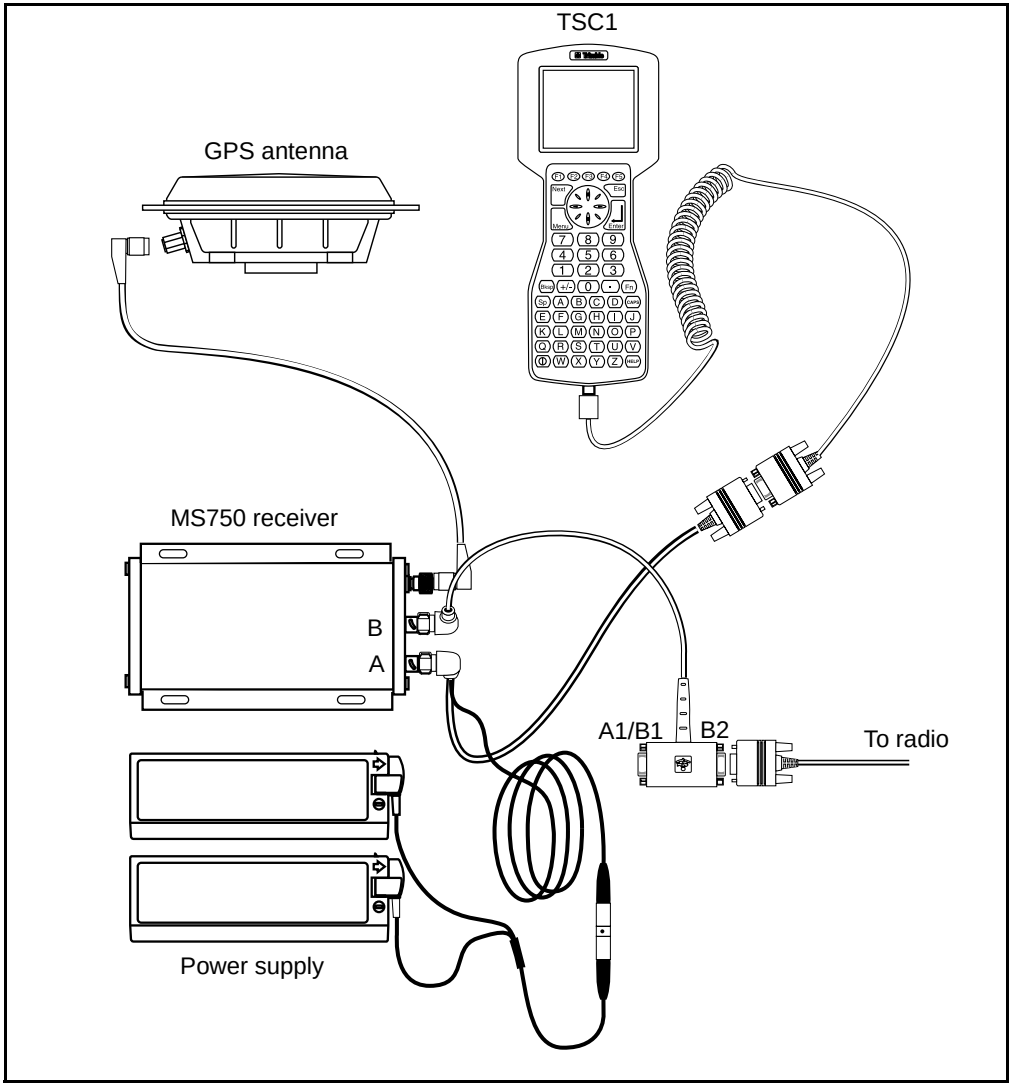


Figure D.4 Real-time configuration using an MS750 receiver

Notes when using an MS750 receiver

When using an MS750 receiver with the Trimble Survey Controller software, please note the following:

- You cannot do known point initializations when using the MS750 as a base or rover.
- You cannot do initializer bar initializations.
- You cannot configure radios via the receiver.
- Port A1 is the only port that supports RTS/CTS flow control.
- You cannot set transmission delays in an RTK survey.
- The MS750 receiver does not power the TSC1 when they are connected.
- The Trimble Survey Controller software supports only 1Hz data logging.
- The Trimble Survey Controller software supports only 1Hz and 5Hz stakeout. It does not support 10Hz and 20Hz stakeout.

Connecting the Base Receiver for a Postprocessed Survey

This section shows how to connect the base receiver for a postprocessed survey.

Using a Series 4000 or Site Surveyor 4400 Receiver

To set up a base receiver for a postprocessed (PP) survey using a Trimble Series 4000 or Site Surveyor 4400 receiver, see Figure D.1 on page 604. Then do the following:

1. Set the GPS antenna over the ground mark using a tripod, a tribrach, and a tribrach adaptor.
2. Connect the GPS antenna to the GPS receiver port labeled ANTENNA. Use the N-type to Lemo co-axial cable.

3. Connect the power source to the GPS receiver port labeled PWR 2 & 3 and turn on the receiver.
4. Connect the TSC1 data collector to the GPS receiver port labeled PWR-I/O 1. Use the 0-shell Lemo to 5-pin Lemo cable.
5. Turn on the TSC1 and go to Starting a Base Survey, page 299.

Using a 4600LS Receiver

To set up a base receiver for a postprocessed (PP) survey using a Trimble 4600LS receiver, see Figure D.5. Then do the following:

1. Set the 4600LS receiver over the ground mark using a tripod, a tribrach, and a tribrach adaptor.
2. Do one of the following:
   - Connect the power source to the 4600LS receiver port labeled PORT 2, and the TSC1 data collector to the 4600LS receiver port labeled PORT 1.
   - Use the appropriate Y-cable to connect both the TSC1 and power to the 4600LS receiver port labeled PORT 1.

Warning – Never connect power to PORT 1 and PORT 2 on the 4600LS receiver at the same time.

3. Turn on the TSC1 and go to Starting a Base Survey, page 299.

Figure D.5 shows a receiver setup for a postprocessed survey using a Trimble 4600LS receiver.

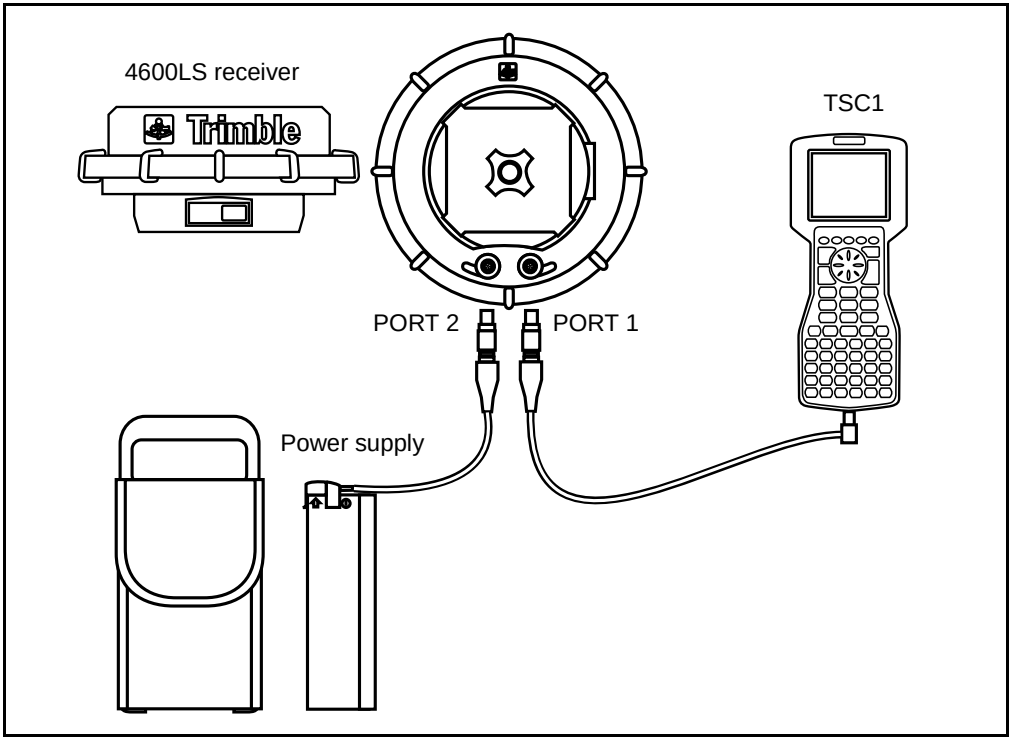


Figure D.5 Postprocessed configuration using a 4600LS receiver

Using an MS750 Receiver

To set up a base receiver for a postprocessed (PP) survey using an MS750 receiver, see Using an MS750 Receiver, page 608 but omit the radio.

Connecting the Rover Receiver for a Real-Time Survey

This section shows how to connect the rover receiver for a real-time survey.

Using a Series 4000 or Site Surveyor 4400 Receiver

To set up a rover receiver for a real-time survey using a Trimble Series 4000 or Site Surveyor 4400 receiver, see Figure D.1 on page 604. Then do the following:

1. Use a backpack to carry the GPS receiver and the radio, and mount the GPS antenna on the range pole.
2. Connect the GPS antenna to the GPS receiver port labeled ANTENNA. Use the N-type to Lemo cable.
3. Assemble the radio antenna and fix it to the outside of the backpack. Connect the radio antenna to the radio using the cable attached to the antenna. See Figure D.2 on page 605.
4. Connect the radio to the GPS receiver port labeled I/O 2. Use the appropriate cable—for a Trimble radio, this is the 7-pin Lemo to 5-pin Lemo cable.

   If using a third-party radio solution, make sure that the radio is connected to a power source.
5. Connect the power source to the GPS receiver port labeled PWR 2 & 3 and turn on the receiver.
6. Connect the TSC1 data collector to the GPS receiver port labeled PWR-I/O 1.
7. Turn on the TSC1 and go to Starting a Rover Survey, page 315.

Using a 4600LS Receiver

To set up a rover receiver for a real-time survey using a Trimble 4600LS receiver, see Figure D.3 on page 607. Then do the following:

1. Mount the 4600LS receiver on the range pole. Assemble the radio antenna and fix it to the outside of the hip pack.
2. Connect the radio antenna to the radio using the cable attached to the antenna. See Figure D.2 on page 605.
3. Connect the radio and power to the GPS receiver port labeled PORT 2. Use the appropriate Y-cable for a Trimble radio, this has three 5-pin Lemo connectors.

   If using a third-party radio solution, make sure that the radio is connected to a power source.
4. Turn on the receiver.
5. Connect the TSC1 data collector to the GPS receiver port labeled PORT 1.
6. Turn on the TSC1 and go to Starting a Rover Survey, page 315.

Using an MS750 Receiver

For information about how to set up a rover receiver for a real-time survey using an MS750 receiver, see Using an MS750 Receiver, page 608. Mount the GPS antenna on a range pole not a tripod.

Once the equipment is set up, for more information, see Starting a Rover Survey, page 315.

Connecting the Rover Receiver for a Postprocessed Survey

This section shows how to connect the rover receiver for a postprocessed survey.

Using a Series 4000 or Site Surveyor 4400 Receiver

To set up a rover receiver for a postprocessed survey using a Trimble Series 4000 or Site Surveyor 4400 receiver, see Figure D.1 on page 604. Then do the following:

1. Use a backpack to carry the GPS receiver, and mount the GPS antenna on the range pole.
2. Connect the GPS antenna to the GPS receiver port labeled ANTENNA. Use the N-type to lemo cable.
3. Connect the power source to the GPS receiver port labeled PWR 2 & 3 and turn on the receiver.
4. Connect the TSC1 data collector to the GPS receiver port labeled PWR-I/O 1.
5. Turn on the TSC1 and go to Starting a Rover Survey, page 315.

Using a 4600LS Receiver

To set up a rover receiver for a postprocessed survey using a Trimble 4600LS receiver, see Figure D.5 on page 613. Then do the following:

1. Attach the 4600LS receiver to the range pole.
2. Connect the power source to the 4600LS receiver port labeled PORT 2 and turn on the receiver.
3. Connect the TSC1 data collector to the GPS receiver port labeled PORT 1.

Warning – Never connect power to the 4600LS receiver ports labeled PORT 1 and PORT 2 at the same time.

4. Turn on the TSC1 and go to Starting a Rover Survey, page 315.

Using an MS750 Receiver

For information about how to set up a rover receiver for a postprocessed (PP) survey using an MS750 receiver, see Using an MS750 Receiver, page 608. Omit the radio and mount the GPS antenna on a range pole if required.

Once the equipment is set up, see Starting a Rover Survey, page 315 for more information.

APPENDIX

E

Conventional Instrument Settings

Introduction

This appendix lists the settings for different conventional instruments. The Trimble Survey Controller software supports the instruments listed and other instruments that are compatible.

Notes:

- The conventional instrument should always display the *Measure* screen when connected to the Trimble Survey Controller. Some instruments (for example, the Leica) cannot communicate to external devices when they are not in the measure screen.
- Before connecting the TSC1 data collector to a Leica or Geodimeter instrument, you must select an appropriate Survey Style first. This Survey Style must specify the correct type of instrument. Connect the instrument and select *Station setup*. Failure to follow this procedure will result in communication errors. If this occurs, power the instrument down and try again.

This is not a problem with robotic instruments connected remotely through a radio modem.

- When using a Leica instrument in reflectorless mode, set the EDM precision to *Instrument default* in the Survey Style.
- The Nikon cable looks identical to the Topcon and Sokkia cables, but the pin outputs are different. These cables are not interchangeable.
- Most Nikon instruments support the Set (Basic) commands, so in addition to using the Nikon instrument type you can also specify Set (Basic) as the instrument in the Survey Style for use with Nikon instruments.
- When measuring a point using a Geodimeter 420 instrument, press A/M on the instrument then Measure on the Trimble Survey Controller.
- To use the Trimble Survey Controller software with a Geodimeter 600 instrument in Robotic mode, you must have the third party interface option turned on in the instrument. Please see your Spectra/Geodimeter service center for more details on how to obtain the third party interface password.
- Do not use the following units when using a Pentax instrument: Mils and Feet/inches.
- The Trimble Survey Controller software automatically sets the data bits based on the parity. When the parity is None the data bits is 8. When the data bits is Odd or Even, the data bits is 7.

For additional information on using a conventional instrument with the Trimble Survey Controller software, see the *Trimble Survey Controller Release Notes*

If you are using an instrument that is not listed, try using the Survey Style for a similar instrument, and configure the appropriate settings on the instrument, as specified in Table E-1.

Table E.1 Conventional Instrument Settings

Make and Model	Trimble Survey Controller configuration	Cable connected to TSC1 DB9 cable	Conventional instrument setting
Sokkia			
SET 3B SET 3C II SET 5W SET 5F Power set 3100	Baud 1200 Parity None HA VA status rate Never	Hirose to DB9 / TSC1 Lemo	Setting the Checksum to Yes is recommended.
Topcon			
GTS-500	Baud 1200 Parity Even HA VA status rate Never	Hirose to DB9 / TSC1 Lemo	Set minimum distance to OFF.
GTS-700 GTS-701 GTS-711D			No special settings.
GMT-100			Select Parameters / Comms and set the CR/LF option to OFF. Turn off the minimum distance setting.
GTS-311 GTS-312			Select Parameters / Comms and set the CR/LF option to OFF.
GTS-211D			No special settings.

Table E.1 Conventional Instrument Settings (Continued)

Make and Model	Trimble Survey Controller configuration	Cable connected to TSC1 DB9 cable	Conventional instrument setting
Zeiss			
Elta 2 Elta 3	Baud 1200 Parity Odd HA VA status rate Never	Zeiss 5P connector to DB9 / TSC1 Lemo	No special settings.
Elta 4			Do not use Mils as the angular units.
Rec Elta 15	Baud 4800 Parity Odd HA VA status rate 1s	Zeiss 8P connector to DB9 / TSC1 Lemo	Set data record format to Rec 500.
R Series	Baud 9600 Parity None HA VA status rate 1s		Set the protocol to REC E and turn off recording.
S Series	Not supported		

Table E.1 Conventional Instrument Settings (Continued)

Make and Model	Trimble Survey Controller configuration	Cable connected to TSC1 DB9 cable	Conventional instrument setting
Leica			
TC300	Baud 19200 Parity Even HA VA status rate 2s	Leica 5-pin zero-shell Lemo to DB9 / TSC1 Lemo	No special settings.
TC500 TC800 TC805	Baud 2400 Parity Even HA VA status rate 2s		
T1000 (6 button)	Baud 2400 Parity Even HA VA status rate Never		Set the instrument communications format to T1000 and output to GRE.
T1000 (14 button) TC1100	Baud 2400 Parity Even HA VA status rate 2s		Set the RCS communications mode to off. Ensure that the instrument is in Measurement mode.
TC1100 Servo (GSI)	Baud 9600 Parity Even HA VA status rate 2s		
TC1100 Servo (Geocom)	Baud 19200 Parity None HA VA status rate Never		Set the RCS communications mode to on. Ensure that the instrument is in Measurement mode.
TC1100 Robotics (Geocom)		Leica Y-Cable with power supply to DB9 / TSC1 Lemo	
TC1600 TC2000	Baud 2400 Parity Even HA VA status rate 2s	Leica 5-pin zero-shell Lemo to DB9 / TSC1 Lemo	No special settings. On the instrument select SET MODE, then 75.
TC2002			No special settings.

Table E.1 Conventional Instrument Settings (Continued)

Make and Model	Trimble Survey Controller configuration	Cable connected to TSC1 DB9 cable	Conventional instrument setting
Spectra Precision (Geotronics)			
420	Baud 1200 Parity Even HA VA status rate Never	Geotronics DB9 Y-cable with power supply to DB9 / TSC1 Lemo	Select the Standard table (table number 0). Set F79 to 62.
520 610 620 640	Baud 1200 Parity None HA VA status rate Never	Geotronics Hirose to DB9 / TSC1 Lemo	
500/600 Servo	Baud 9600 Parity None HA VA status rate Never	Geotronics Y-cable with power supply to DB9 / TSC1 Lemo	Select the Standard table (table number 0). Set F79 to 62. Select RPU Manual or Automatic.
600 Robotics			Select the Standard table (table number 0). Set F79 to 62. Select PRU Remote.
4000 Servo			Select the Standard table (table number 0). Set F79 to 62.

Table E.1 Conventional Instrument Settings (Continued)

Make and Model	Trimble Survey Controller configuration	Cable connected to TSC1 DB9 cable	Conventional instrument setting
Nikon			
DTM-310 DTM-420 DTM-450 DTM-520 DTM-530	Baud 1200 Parity None HA VA status rate 2s	Hirose to DB9 / TSC1 Lemo	No special settings.
DTM-800	Baud 1200 Parity None HA VA status rate Never		Use Instrument type Set (Basic). The 800's do not support the Nikon format.
Pentax			
PCS-325	Baud 1200 Parity None HA VA status rate 1s	Hirose to DB9 / TSC1 Lemo	Configure the port parameters as follows: Xon/Xoff = No Command set = Nil

APPENDIX

F

Working with Road Templates

In this chapter:

- Introduction
- Interpolating between templates
- Applying superelevation values
- Pivots

Introduction

This appendix describes how the Trimble Survey Controller software:

- interpolates between templates
- applies superelevation values to elements in a template
- works with pivots

It provides some background to Key In Roads, page 543.

Interpolating Between Templates

This section shows how the Trimble Survey Controller software interpolates between templates when consecutive templates have:

- an equal number of design elements
- a different number of design elements
- different side slopes

When Templates Have an Equal Number of Design Elements

If consecutive templates have an equal number of design line elements, the Trimble Survey Controller software interpolates from each element in the first template to its equivalent in the next template.

In Figure F.1, for example, the first element of the template at station 0+100 has a cross fall of –2% and an offset of 4.0 m. The next assigned template is at station 0+400, where the equivalent element has a cross fall of –5% and an offset of 7.0 m. The values for stations 0+200 and 0+300 are interpolated as shown to provide an even grading from station 0+100 to 0+400.

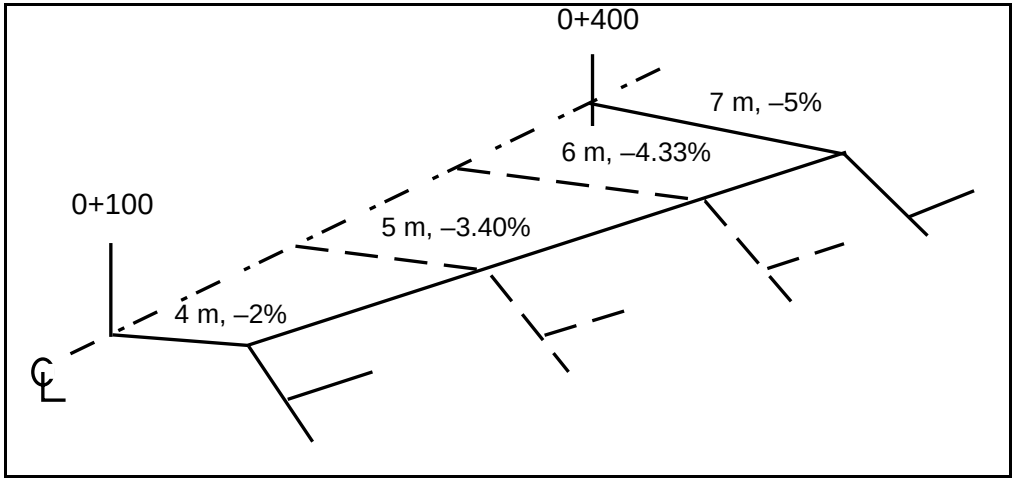


Figure F.1 Interpolating between templates – equal number of design line elements

Note – *Interpolation will only take place if the offset being staked is selected from the list or selected using the* Offs>> *softkey. For more information, see Chapter 18, Roading, page 428.*

When Templates Have a Different Number of Design Elements

If one template has more design line elements than the next template, the Trimble Survey Controller software adds an appropriate number of zero-length elements to the template with fewer elements. These zero-length elements are added to the end of the last element, before the side slope element begins. This creates an equal number of elements, and the Trimble Survey Controller software then interpolates as described in When Templates Have an Equal Number of Design Elements, page 629.

In Figure F.2, for example, the Trimble Survey Controller software added the zero-length element ‘3’.

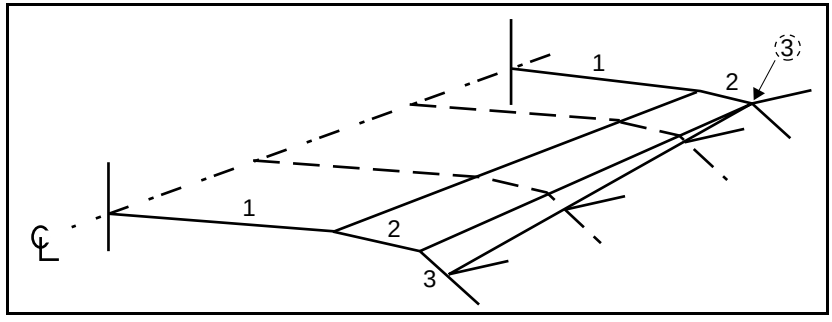


Figure F.2 Interpolating between templates – different number of design line elements

Template Application

The following section explains how placement and transition between templates control the road definition.

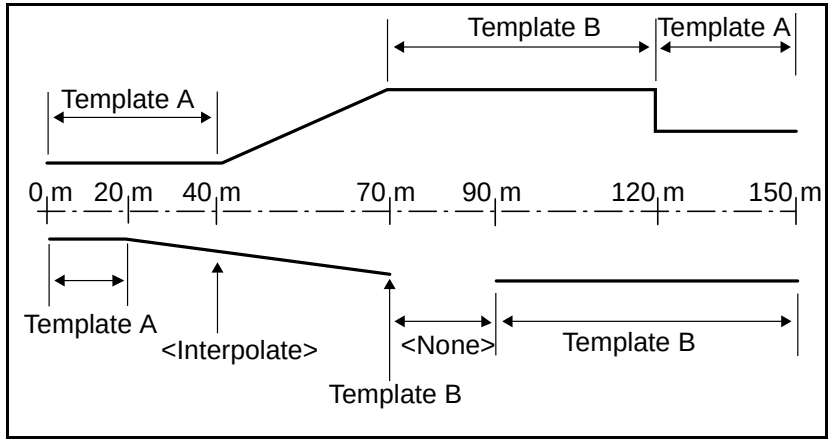


Figure F.3 Applying templates

Right-hand side of the road

Template A is assigned to stations 0 to 20 m. The road makes a transition from Template A at station 20 m to Template B at station 70 m.

Because a template must be assigned at station 40 m on the left-hand side, to maintain correct interpolation the system template <Interpolate> must be assigned to the right-hand side of the road at station 40 m.

To correctly represent the gap between stations 70 to 90 m, the system template <None> is assigned at a nominal distance after station 70 m (for example, 70.005 m). To complete the right-hand side of the road, Template B is assigned from station 90 to 150 m.

Left-hand side of the road

Template A is assigned from station 0 to 40 m. The road makes a transition from Template A at station 40 m to Template B at station 70 m. To correctly represent the design, Template A is assigned a nominal distance after station 120 m (for example, 120.005 m) to 150 m.

Assign the templates at the specified stations as shown in table F–1.

Table F.1 Assigning Templates

Station	Left template	Right template
0.000	Template A	Template A
20.000	Template A	Template A
40.000	Template A	<Interpolate>
70.000	Template B	Template B
70.005	Template B	<None>
90.000	Template B	Template B
120.000	Template B	Template B
120.005	Template A	Template B

Notes

- To best represent the road design, you can add zero length template elements yourself. Do this when you construct the template. For more information, see Keying In Elements, page 556.
- No interpolation occurs between a <None> template and a user-defined template.
- Superelevation and widening are applied before interpolation between templates occurs.
- The <Interpolate> template can only be assigned between valid user-defined templates

When Side Slopes are Different

If consecutive templates have side slopes of different values, the Trimble Survey Controller software bases the interpolation on the difference between the slope values.

For example, if the side slope at station 6+000 is 1:2 and at station 10+000 it is 1:4, the side slope at station 8+000 will be 1:3.

Applying Superelevation Values

This section shows how the Trimble Survey Controller software applies superelevation values to elements in a template.

The first element with the *Apply superelevation* field set to Yes determines the superelevation applied to each element to be superelevated.

The amount of superelevation that the Trimble Survey Controller software applies is determined by the difference between the first template element and the superelevation value that you specify. The same amount of superelevation is applied to each element that has the *Superelevation* field set to Yes.

For example, if the first element that superelevation is applied to in a template has a cross fall of –2%, and the superelevation value specifies that the superelevation at that station is to be +6%, then 8% is added to the cross fall of each superelevated element in that template.

Figure F.4 shows, in cross-section, elements of a template before and after superelevation values are applied.

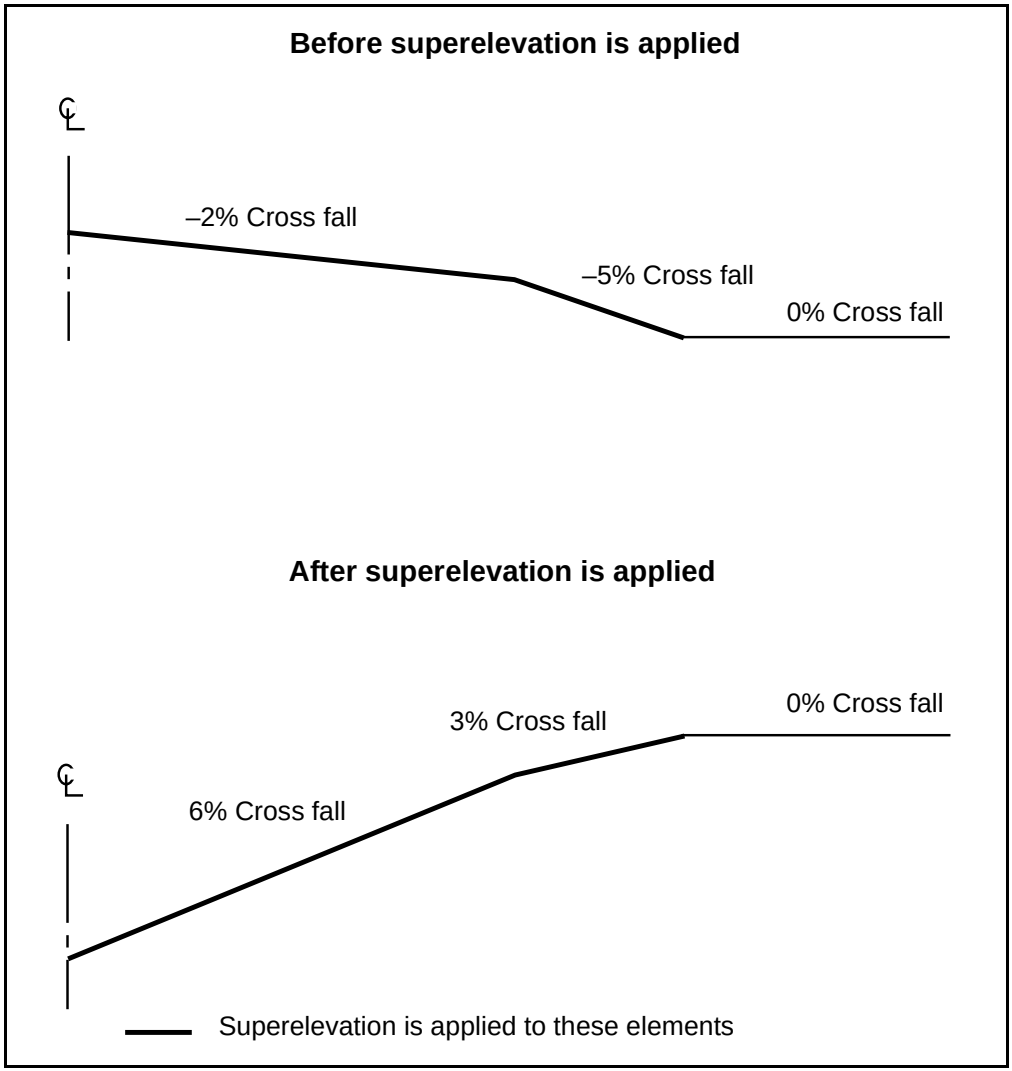


Figure F.4 Applying superelevation

Pivots

This section shows the three pivot settings (Crown, Right, and Left) that are available in the Trimble Survey Controller software.

Figure F.5 shows a Crown pivot.

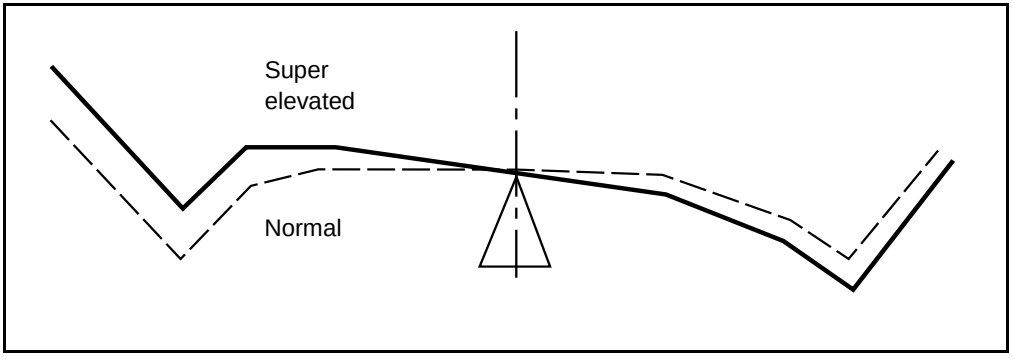


Figure F.5 Pivot crown option

Figure F.6 shows a Right pivot.

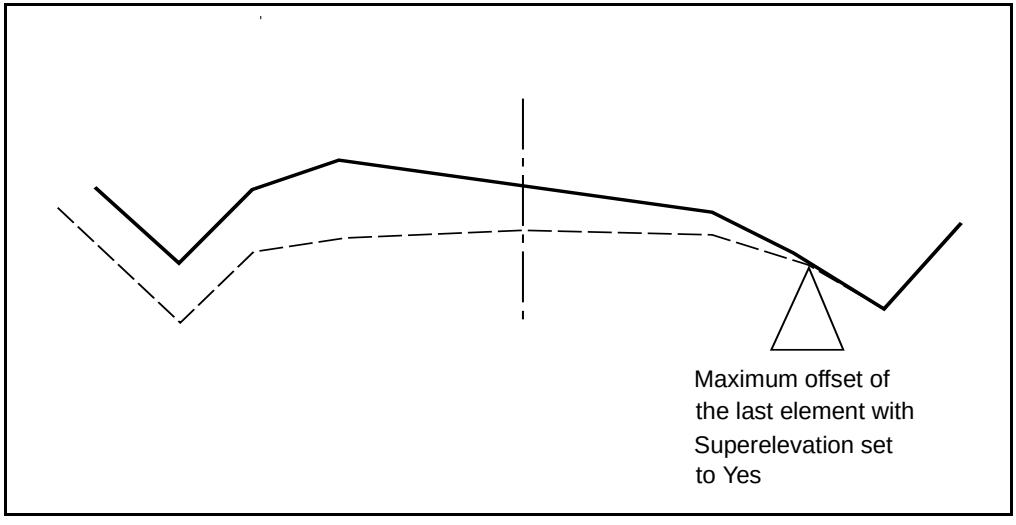


Figure F.6 Pivot right option

Figure F.7 shows a Left pivot.

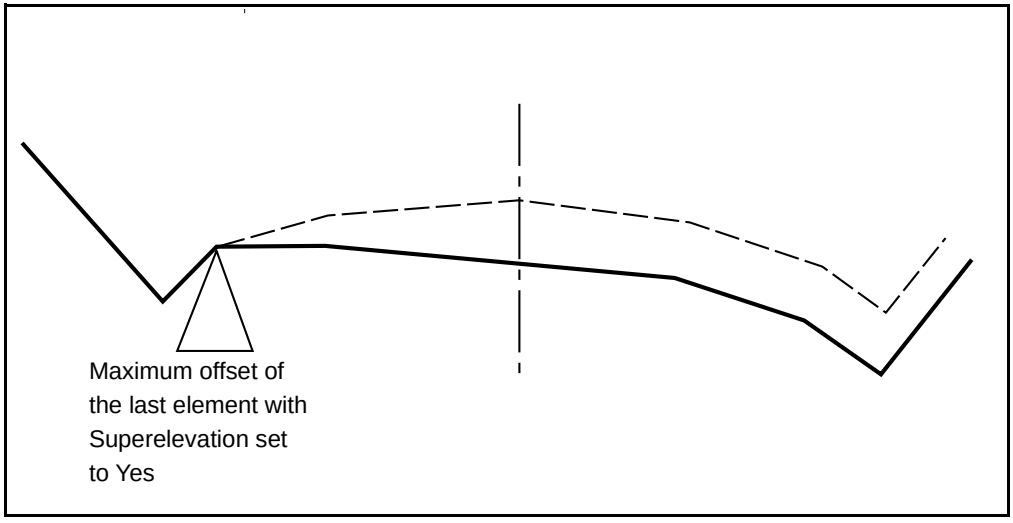


Figure F.7 Pivot left option

APPENDIX

G

Messages

In this chapter:

- Introduction
- Error messages
- Warning messages
- Status line messages
- Field error messages
- Other messages

Introduction

This appendix lists the messages that can appear on a TSC1 data collector. It provides an alphabetic list for each of the following:

- Error messages
- Warning messages
- Status line messages
- Field error messages
- Other messages

Error Messages

An error message appears when the Trimble Survey Controller software cannot proceed with a function. To acknowledge an error message, press OK, Enter, Esc, or the key that is indicated. Then correct the problem.

Abnormal shutdown

You did not end the previous survey correctly before turning off the Trimble Survey Controller software.

Area calculation has failed. Check Cogo settings

The area calculation has failed. Make sure that the value in the *Distances* field in the *Cogo settings* screen is correct.

Area perimeter crosses over. Calculation is invalid

The area calculation includes a set of points for which the perimeter lines cross.

At least three points are required to calculate an area

You have selected less than three points for area computation.

Calculator expression too complex

You have entered more than ten nested functions when using the Trimble Survey Controller software's in-field calculator.

Calculator syntax error

You have entered an invalid formula when using the Trimble Survey Controller software's in-field calculator. Check the order of the numbers and the operators.

Cannot copy roads while receiver is in use

You have attempted to copy a road while the Trimble Survey Controller software is communicating with the receiver. Close the windows that are communicating with the receiver and try again.

Cannot go static until 1 epoch has elapsed

The receiver must be allowed to go into roving mode before it can go static again.

Cannot perform this operation. End the survey first

You have attempted to change the current job while a survey is running. End the survey and try again.

Cannot perform this operation. Job currently in use

You have attempted to change the current job while the Trimble Survey Controller software is doing another operation.

Cannot perform this operation. Use the NEXT key to close other job windows

You have attempted to change the current job while other windows that need it are open. Close the other windows and try again.

Cannot perform this operation. Receiver is currently measuring

You have attempted to measure points while some other window is doing this.

Cannot perform this operation. The comms port is being used

You have attempted to start a survey, configure a radio, or do data transfer while one of these is operational already.

Communications error

A general communications error has occurred. Check cables, connections, and switches. Check that the output on the receiver port has not been disabled.

Connection failed. Receiver is transmitting on external port.

You are trying to configure a radio that is attached to a receiver set up as a base. Select *End survey* from the *Survey* menu and try again.

File cannot be modified

You have tried to delete or edit a system file.

File information not available from this receiver type

GPS file listings are only provided by 4600LS receivers and GPS Total Station 4800 or 4700 receivers.

GPS receiver card not supported

You have inserted a GPS receiver PC card, such as the Pathfinder Card™.

Insufficient memory in the controller

You are logging data to the TSC1 data collector, and there is less than 20 KB of logging space available. You cannot start the survey.

Insufficient memory in the receiver

You are logging data to the receiver, and there is less than six minutes of logging space available. You cannot start the survey.

Insufficient memory to perform the operation

There is not enough memory left to perform the operation. Close some windows and try again.

Invalid geoid file. No vertical adjustment will be installed

You have selected a geoid model that is not in a valid format.

Need at least one 3D point to perform a calibration

If no projection or datum transformation is specified, define at least one grid point with defined horizontal and vertical coordinates before calculating a calibration.

No result for defined intersection

A Cogo intersection calculation has failed due to limitations in the standard ellipsoid formulas. For example, the intersection fails if two azimuths only converge by a small amount or if two points are too far apart on the ellipsoid.

No DTM selected

You are staking out a point, line, or curve. The *Display Cut/Fill to DTM* field in *Stakeout* options is set to Yes but no DTM is selected.

Number of rounds: Out of range 1 to 20

You have entered a number outside the range of 1 to 20 in the *Number of rounds* field. Enter the number of rounds to be observed, between 1 and 20.

Observation does not exist. Field cannot be changed

You are trying to set the *Use* field to Yes for an observation that was skipped in a rounds survey.

One circle is contained within the other

A Cogo Dist-dist intersection calculation has failed. The two arcs do not intersect because of containment.

Out of memory. Close down some windows and try again

Too many next-window windows are open. The current operation needs memory before it can start.

Parallels are equal

When you key in a Lambert 2 Parallel projection, the orientation values must be different.

PC Card: <error number>

A PC card has a hardware or software error, with the number <*error number*>. Report this number to your local dealer.

PC Card needs formatting

You have inserted an unformatted PC card. Format it on the office computer and reinsert it.

Radio configuration specifies an invalid receiver port

The configuration specifies a non-existent port on the receiver.

Radio configuration specifies receiver port currently used by controller

The TSC1 data collector is using the port set for the radio. Select the *Radios* option in the Survey Style and change the port setting.

Receiver does not support the Clarion radio

The receiver does not have a Clarion radio driver installed.

Receiver does not support data logging

The receiver does not have internal memory.

Receiver does not support data logging to the controller

The receiver does not have the real-time data output option installed. It cannot store data while it is doing an RTK survey.

Receiver does not support RTCM

The receiver does not have RTCM capability, or it does not have the necessary options installed.

Receiver does not support RTK

The receiver does not have the RTK option installed.

Receiver is in an unknown state

This message should clear after a few seconds. If it does not, press Abort to end the survey, then start another survey.

Receiver is not responding. Attempting to reconnect

A general communications error has occurred. Check cables, connections, and switches. When the receiver reconnects, the message disappears. Otherwise press Abort to end the survey.

Resection calculation has failed. Check the target point data and geometry

The resection calculation has failed and coordinates may not be displayed. Change the setting in the *Use* field in the *Resection point* screen and check the coordinates of the point observed to. Alternatively, check the geometry of the observed points. They should not lie on a circle.

Start station: Station does not exist

You are trying to compute a traverse and the point name you have entered for the start station does not exist, or has no observations from it.

Station setup not defined

You are trying to turn a servo or robotic instrument to a point where the station setup has not been defined.

The two azimuths are parallel

You are using the Cogo function with the Brng-brng intersection method. Where two azimuths cannot intersect because they are parallel.

The two circles are concentric

You are using the Cogo function with the Dist-dist intersection method. The two distances emanate from the same point.

Too close to equator

When you key in a Lambert 1 Parallel or Lambert 2 Parallel projection, the orientation values must be greater than 10° north or south of the equator.

Too many calibration points

A calibration can be calculated with up to 20 points. This message appears when point 21 is added.

Too many files already exist. Cannot create file

The Trimble Survey Controller software lets you use 100 files of any one type. You can have up to 100 job files and 100 language files, for example. (This figure includes recoverable deleted files.)

Too many observations for a resection calculation

There are more than forty observations in the resection calculation. Delete some.

Total station is not responding. Attempting to reconnect

The Trimble Survey Controller software has lost communications with the instrument. Check cables, connections and the power supply to the instrument. When the instrument reconnects, the message disappears.

Unable to connect to radio

You selected *Survey Style* / *Radio* and pressed Connect to connect to a radio, but timeout occurred. Check the cables, connections, and the selected radio type.

Unable to connect to receiver

Connection was not successful when the survey was started. Check the cables, connections, and switches. Make sure that the receiver is turned on.

Unable to store point. No corrected positions available

You are measuring a point and pressed Enter before enough time elapsed. Press OK and wait until the Store key appears.

Unrecognized receiver type

An incompatible receiver is connected to the Trimble Survey Controller software.

Unsupported or faulty PC Card

The PC card that is inserted is not supported by the Trimble Survey Controller software or is faulty.

Unsupported receiver firmware version

The software has detected old receiver firmware that is not supported. Upgrade the receiver firmware.

Warning Messages

A warning message appears when the Trimble Survey Controller software cannot proceed. Most of these messages are for information only, but with some you must press Yes or No to continue.

A new station setup is required

You have selected *Measure rounds* from the *Survey* menu after performing a survey with the current station setup. A new station setup is required before rounds can be measured.

An L1 antenna is being used with an L2-capable receiver

You are using a single-frequency antenna. It is better to use a dual-frequency antenna with a dual-frequency system.

Curvature and refraction applied in instrument and controller

This message appears when *Station setup* is selected in a conventional survey. It means that the Trimble Survey Controller software has determined that the correction for curvature and refraction is being applied by both the instrument and the Trimble Survey Controller software. Change the setting in the instrument or the Trimble Survey Controller software to None.

Datum grid required. Select Datum transformation and specify a datum grid or the datum transformation will be invalid

You have selected an uploaded job that uses a datum grid but the Trimble Survey Controller software cannot locate the file. Select the file now or upload it and open the job again.

DTM is not valid

You are staking out a point, line, or curve. The *Display Cut/Fill to DTM* field in *Stakeout options* is set to Yes but the DTM is no longer available. (This occurs if the DTM is stored on a PC card, for example, and the card is removed).

Geoid model and Datum grid required. Specify geoid model and datum grid, or elevations will be nulled and datum transformation invalid

You have selected an uploaded job that uses a geoid model and a datum grid but the Trimble Survey Controller software cannot locate the files. Select the files now or upload them and open the job again.

Geoid model required. Select Vertical adjustment and specify a model, or elevations will be nulled

You have selected an uploaded job that uses a geoid model in the height adjustment but the Trimble Survey Controller software cannot locate the file. Select the file now or upload it and open the job again.

Initialization has been lost. Initialize now?

This message can only appear during an L1 postprocessed or real-time kinematic (PPK or RTK) survey. Perform a manual initialization now or dismiss the message and initialize later.

Insufficient SVs being tracked.

Lock has been lost during initialization in a postprocessed survey. (The number of satellites being tracked has fallen below the minimum.) The PP init time will be reset and initialization will resume when a minimum of four satellites are being tracked.

Measure catch point without construction offsets?

When staking out a catch point on a road, you navigated to a catch point with construction offsets. Then you pressed Measure with the range pole on the catch point instead of on the offset point.

To stake out the offset point, press No and navigate to it.

Memory nearly full

The TSC1 memory is almost full. End the survey or current operation or the Trimble Survey Controller software will do so shortly.

New base station detected, recommend the survey is restarted

During an RTK survey, radio corrections are received from a base station different from the one that the survey was started with. Any points subsequently measured or staked out will be in a different network. Trimble recommends that you restart the survey and check that corrections are being received from the original base station. To do this select *Files* / *Review current job*.

No projection. Some features will not be displayed

You have chosen to display the Current job map but have not defined a projection for the job. As a result, WGS-84 points such as the base station cannot be displayed on the map. Only grid points, or points that can be converted into grid points, can be displayed.

No DTM selected

You are staking out a point, line, or curve. The *Display cut/fill to DTM* field in the *Stakeout* options is set to Yes but no DTM is selected.

Please confirm: Not all points have been observed. End observations on this face?

You pressed End face during a rounds survey before all points have been observed on the current face. Press Yes to confirm that you want to end observations for that face.

Observation is on the wrong face

You are trying to make an observation in a rounds survey on the wrong face. Change the face on the instrument and observe again.

Please confirm: Remove all points from list

You pressed Del all from the Stakeout list. Press Yes to confirm that you want to remove all the points.

Point does not exist. Provide coordinates at processing time

You have started the base receiver in a postprocessed survey and the point name is not in the database. Provide the coordinates of this point when postprocessing the data.

Poor geometry

You are performing an initialized RTK survey using a Series 4000 receiver as a rover. The PDOP value exceeds the PDOP mask and although another satellite is available, it is not yet in the solution. (This can be a new satellite or one that the receiver has not tracked for a short period.) High PDOP means that the receiver cannot use the new satellite in the solution.

You see the following options, depending on the equipment: Go static, Static initialize, Roving initialize, Continue anyway.

If you select Go static, the system attempts to use the extra satellite to make a better estimate of its position. When the system is static, it uses RDOP instead of PDOP. RDOP decreases with time: if the system takes longer than 30-45 seconds, the PDOP of the initialized satellites is so high that it cannot include the extra satellite. Wait until the constellation improves.

If you select Static initialize, you can reinitialize using a known point, new point, or initializer plate / bar, depending on the equipment.

If your receiver has On-The-Fly capability and you select Roving initialize, an OTF initialization is performed.

If you select Continue anyway, you can continue to survey with the high PDOP. The system will not use the extra satellites (that are being tracked but that are not in the solution) until the PDOP of the initialized satellites drops below six, or until you go static by recording a point at a later time.

Point name error. Some points have not been transferred

You are transferring points to a TDS device using the Unchanged option for the point names and some of the points have not been transferred. A point will only be transferred if the point name is less than eight characters long and contains numeric characters only.

PPM applied in instrument and controller

This message appears when *Station setup* is selected in a conventional survey. It means that the Trimble Survey Controller software has determined that the correction for PPM is being applied by both the instrument and the Trimble Survey Controller software. Change the setting in the instrument or the Trimble Survey Controller software to null.

Prism constant applied in instrument and controller

This message appears when *Station setup* is selected in a conventional survey. It means that the Trimble Survey Controller software has determined that the prism constant correction is being applied by both the instrument and the Trimble Survey Controller software. Change the setting in the instrument or the Trimble Survey Controller software to zero.

Receiver has stopped logging data

A GPS data logging survey (to the receiver) was running and the receiver has unexpectedly stopped logging.

Receiver is currently busy

Part of the system, for example Radio configuration, is communicating with the receiver. Exit the screen that is communicating with the receiver.

Receiver is still initialized. Discard current initialization?

Press Yes to confirm that you want to discard the initialization.

Receiver port cannot be used. Update stakeout external display settings

You are trying to start a survey with the external display option enabled and have specified an invalid receiver port. Select *Stakeout* in your Survey Style and set the External display fields correctly.

Specified number of rounds have not been completed. Continue?

You have ended a rounds survey before the number of rounds specified in the *Options* screen have been completed. Press Yes to confirm that you want to end the current rounds session, or press No to continue observing rounds.

Style changes will not apply to current survey

You have chosen a Survey Style that is the same as the one used by the survey that is running.

Survey has been stopped. Receiver memory is full

This message can occur when GPS data is being logged to the receiver. The receiver memory is so full that the survey has been ended.

Survey has ended. Controller memory is full

This message can occur when GPS data is being logged to the TSC1 data collector. The TSC1 memory is so full that the survey has been ended.

Turn to zero selected. Do not use Next or Menu in stakeout, communication errors will occur.

You are configuring a SET (Extended) conventional Survey Style and the *Stakeout turn to zero* field is set to Yes. This option puts the SET instrument into a special mode where standard commands do not work. When staking out, do not use the Next and Menu keys to access other menus—communication errors will result. Exit the stakeout screen by pressing Esc before using the Next and Menu keys.

Unused observations have been deleted

You exited out of the *Point* details screen after setting the *Use* field to No for one or more observations.

Status Line Messages

A status line message alerts you to information that requires attention. A status line message generally remains on the screen until you or the Trimble Survey Controller software resolve the situation.

Cannot check corrections

This message appears when *Station setup* is selected in a conventional survey. It means that the Trimble Survey Controller software cannot determine whether the corrections for prism constant, PPM, and curvature and refraction are being applied by both the instrument and the Trimble Survey Controller software. Check that the corrections are only applied once.

Cannot check curvature & refraction

This message appears when *Station setup* is selected in a conventional survey. It means that the Trimble Survey Controller software cannot check if the correction for curvature and refraction is being applied by both the instrument and the Trimble Survey Controller software. Check that the correction is only applied once.

Cannot check PPM

This message appears when *Station setup* is selected in a conventional survey. It means that the Trimble Survey Controller software cannot determine whether the correction for PPM is being applied by both the instrument and the Trimble Survey Controller software. Check that the correction is only applied once.

Cannot check prism constant

This message appears when *Station setup* is selected in a conventional survey. It means that the Trimble Survey Controller software cannot determine if the prism constant correction is being applied by both the instrument and the Trimble Survey Controller software. Check that the correction is only applied once.

Computing position, please wait

The Trimble Survey Controller software is starting a survey. It cannot continue until the receiver has computed a position based on the satellites it is tracking. This can take up to 30 seconds.

Continuous topo: poor precisions

The precisions set under *Continuous topo* in the Survey Style cannot be met. No points are stored while this message is flashing.

Controller battery is dead

The internal battery of the TSC1 data collector is flat. There is just enough power left to display this message. Recharge the battery.

Corrections checked

This message appears when *Station setup* is selected in a conventional survey. It means that the Trimble Survey Controller software has checked that the corrections for prism constant, PPM, and curvature and refraction are not being applied by both the instrument and the Trimble Survey Controller software.

EDM error

The EDM signal is not strong enough to give a distance measurement. Make sure that the target is not obstructed and that the conventional instrument is functioning correctly.

First face completed

You have completed observations on the first face during a rounds survey.

High RMS

RMS is an indicator of the quality of GPS phase measurements. This message appears during an RTK survey. If measuring a point, you probably wobbled the pole during the observation. If roving, you could be in a high multipath environment or the last initialization could be bad.

Initialization in 30s

This message can appear during a Real-Time Kinematic (RTK) or Postprocessed Kinematic survey. It is an estimate only.

Initialization requires 5 L2 SVs

This message can appear during a Real-Time Kinematic (RTK) or Postprocessed Kinematic survey with OTF initialization capabilities. Wait until there are enough satellites being tracked on both the L1and the L2 frequencies to continue, or move to a place where there is a better view of the sky.

Initializing survey, please wait

RTK survey with OTF initialization. This is displayed only when no estimate of time to init is available.

Instrument error

The Trimble Survey Controller is unable to communicate with the instrument.

Low base battery

The base receiver battery is low.

This message appears at the rover receiver when it is in RTK mode during a real-time survey, a real-time and infill survey, or a real-time and datalogging survey.

Low base memory

The available memory in the base receiver is getting low.

This message appears at the rover receiver when it is in RTK mode during a real-time survey, a real-time and infill survey, or a real-time and datalogging survey.

Low Controller battery

The internal battery of the TSC1 data collector is getting low. Remove and recharge it.

Low receiver battery

The batteries in the rover receiver are getting low.

Low receiver memory

The rover receiver is logging GPS data and its available memory is getting low. End the survey soon.

Main memory nearly full

The internal memory of the TSC1 data collector is getting full. Less than 30 KB of data space remains. End the survey soon.

Measuring point: poor precisions

The precisions set under *Point measurement* in the Survey Style cannot be met. No automatic measurement takes place while this message is flashing.

No target

The target was not located during the search. Re-point the instrument and try the search again.

PC card memory nearly full

The PC card memory is getting full. Less than 30 KB of data space remains. End the survey soon.

Poor PDOP

The current PDOP is greater than the PDOP mask set under *Rover options* in the Survey Style.

Radio link down

Radio corrections have stopped being received during a real-time survey.

Radio link up

Radio corrections have returned after being down during a real-time and infill survey. Select *Stop pp infill* and continue with a real-time survey.

Setting clock, please wait

Starting a survey. The survey cannot start until the receiver has set its time from the SVs that it is tracking. This can take up to 30 seconds.

Target detected

The target has been located (when the instrument is in servo mode).

Target locked

The target has been located and tracking has been locked (when the instrument is in robotic mode).

The first point in the resection was unable to be used as the backsight

The first point observed in the resection could not be used as the backsight because there are no horizontal coordinates for it. Alternatively, you changed the *Use* field in the *Resection point* screen to V or Off.

Tilt error

The conventional instrument is not level and is beyond the range of its compensators. Level the instrument and perform a station setup.

Waiting for info from base

The Trimble Survey Controller software is starting a real-time survey, and is waiting for details of the base station across the radio link. If this persists for more than ten seconds, check radio settings, cabling, and base output.

Waiting for radio link

The Trimble Survey Controller software is starting a real-time survey, and is waiting for CMR or RTCM corrections from the base receiver across the radio link. If this persists, check radio settings, cabling, and base output.

It is possible that you are trying to start a rover survey while connected to a receiver that is operating as a base (and broadcasting corrections). End the survey and try again.

Waiting for satellites

Starting a survey or during a survey. The survey cannot continue until the receiver has got lock on four or more satellites.

Field Error Messages

A field error message tells you that there is an invalid entry in a field. Press OK or Esc and then enter a correct value.

<Field name>: A value is required for this field

This field requires a value before continuing. You left it as null (?).

<Field name>: Out of range <low value> to <high value>

This fields requires numerical input within the displayed ranges.

<Field name>: Invalid time

The value entered into a time field is not in the correct time format (for example, MM:HH:SS or 10m5s).

<Field name>: Invalid date

The value entered into a date field is not in the correct date format (for example, MM/DD/YY).

<Field name>: Invalid units

The units entered in this field do not correspond to any in the system.

Other Messages

These messages appear when you try to delete a job that has not been downloaded or the status of the receiver has changed.

Confirm deletion: Job has not been exported

When you attempt to delete a job, this message warns that the job has not been downloaded. If you delete the job, it goes on to the *Undelete job* list and will eventually be completely deleted.

Error: Total station is not responding. Attempting to reconnect

The Trimble Survey Controller software is trying to connect to the instrument. It should do this within a few seconds. If it does not, check all cables and connections.

Initialization change: Initialization has been gained

Initialization has been gained. This applies to an RTK, RTK & infill, or PP kinematic survey.

Initialization change: Initialization has been lost

Initialization has been lost. This applies to an RTK, RTK & infill, or PP kinematic survey.

Please wait. Connecting to receiver

The Trimble Survey Controller software is trying to connect to a receiver. It should do this within a few seconds. If it does not, check all cables, connections, and switches.

Please wait. Instrument turning

Indicates that the instrument is about to change face. Only applies to servo and robotic instruments when the Chg face softkey is selected.

Searching...

Indicates that the instrument is conducting a search for the target.

Glossary

This section explains some of the terms used in this manual.

almanac

Data, transmitted by a GPS satellite, that includes orbit information on all the satellites, clock correction, and atmospheric delay parameters. The almanac facilitates rapid SV acquisition. The orbit information is a subset of the ephemeris data with reduced precision.

Anti-Spoofing (AS)

A feature that allows the U.S. Department of Defense to transmit an encrypted Y-code in place of P-code. Y-code is intended to be useful only to authorized (primarily military) users. Anti-Spoofing is used with Selective Availability to deny the full precision of GPS to civilian users.

autonomous positioning

The least precise form of positioning that a GPS receiver can produce. The position fix is calculated by one receiver from satellite data alone.

base station

In a GPS survey, you observe and compute baselines (the position of one receiver relative to another). The base station acts as the position from which all unknown positions are derived.

A base station is an antenna and receiver set up on a known location specifically to collect data to be used in differentially correcting rover files. Trimble GPS Community Base Station and a receiver in base station mode are examples of base stations.

baud — A unit of data transfer speed (from one binary digital device to another) used in describing serial communications; generally one bit per second.

C/A code — See **Coarse Acquisition code**.

CMR — Compact Measurement Record. A satellite measurement message that is broadcast by the base receiver and used by RTK surveys to calculate an accurate baseline vector from the base to the rover.

Coarse Acquisition (C/A) code — A pseudorandom noise (PRN) code modulated onto an L1 signal. This code helps the receiver compute the distance from the satellite.

constellation — A specific set of satellites used in calculating positions: three satellites for 2D fixes, four satellites for 3D fixes.

All satellites visible to a GPS receiver at one time. The optimum constellation is the constellation with the lowest PDOP. See also **PDOP**.

data logging — The process of recording satellite data in a file stored in the receiver, the TSC1 memory, or on a PC card.

data message — A message, included in the GPS signal, that reports on the location and health of the satellites as well as any clock correction. It includes information about the health of other satellites as well as their approximate position.

datum — See **geodetic datum**.

Differential Positioning — Precise measurement of the relative position of two receivers tracking the same satellites simultaneously.

DOP

Dilution of Precision, an indicator of the quality of a GPS position. DOP takes into account the location of each satellite relative to other satellites in the constellation, as well as their geometry relative to the GPS receiver. A low DOP value indicates a higher probability of accuracy.

Standard DOPs for GPS applications are:

- PDOP – Position (three coordinates)
- RDOP – Relative (Position, averaged over time)
- HDOP – Horizontal (two horizontal coordinates)
- VDOP – Vertical (height only)
- TDOP – Time (clock offset only)

Doppler shift

The apparent change in frequency of a signal caused by the relative motion of satellites and the receiver.

DTM

Digital Terrain Model. An electronic representation of terrain in three dimensions.

dual-frequency

A type of receiver that uses both L1 and L2 signals from GPS satellites. A dual-frequency receiver can compute more precise position fixes over longer distances and under more adverse conditions because it compensates for ionospheric delays.

Earth-Centered-Earth-Fixed (ECEF)

A cartesian coordinate system used by the WGS-84 reference frame. In this coordinate system, the center of the system is at the earth's center of mass. The z axis is coincident with the mean rotational axis of the earth and the x axis passes through 0° N and 0° E. The y axis is perpendicular to the plane of the x and z axes.

elevation

Height above mean sea level. Vertical distance above the geoid.

elevation mask The angle below which Trimble recommends that you do not track satellites. Normally set to 13 degrees to avoid interference from buildings and trees as well as ground multipath errors.

ellipsoid A mathematical model of the earth formed by rotating an ellipse around its minor axis. For ellipsoids that model the earth, the minor axis is the polar axis and the major axis is the equatorial axis. An ellipsoid is completely defined by specifying the lengths of both axes, or by specifying the length of the major axis and the flattening.

ephemeris The current satellite position predictions, transmitted in the data message.

epoch The measurement interval of a GPS receiver. The epoch varies according to the survey type:

- for real-time surveys it is set at one second
- for postprocessed surveys it can be set to a rate of between one second and one minute

feature codes Simple descriptive words or abbreviations that describe the features of a point. For more information see Chapter 16, Using Feature and Attribute Libraries.

fixed solution Indicates that the integer ambiguities have been resolved and a survey is initialized. This is the most precise type of solution.

float solution Indicates that the integer ambiguities have not been resolved, and that the survey is not initialized.

GDOP Geometric Dilution of Precision. The relationship between errors in user position and time, and errors in satellite range. See also **DOP**.

geodetic datum A mathematical model designed to fit part or all of the geoid (the physical earth's surface). A geodetic datum is defined by the relationship between an ellipsoid and the center of the earth. It takes into account the size and shape of the ellipsoid, and the location of the center of the ellipsoid with respect to the center of the earth (a point on the topographic surface established as the origin of the datum).

Various datums have been established to suit particular regions. For example, European maps are often based upon the European datum of 1950 (ED-50). Maps of the United States are often based upon the North American Datum of 1927 or 1983 (NAD-27, NAD-83). All GPS coordinates are based upon the WGS-84 datum surface.

geoid The surface of gravitational equipotential that closely approximates mean sea level.

GPS Global Positioning System. Based on a constellation of 24 operational satellites orbiting the earth at a high altitude.

GPS time A measure of time used by the NAVSTAR GPS system. GPS time is based on UTC but does not add periodic 'leap seconds' to correct for changes in the earth's period of rotation.

HDOP Horizontal Dilution of Precision. See also **DOP**.

integer ambiguity The whole number of cycles in a carrier phase pseudorange between the GPS satellite and the GPS receiver.

ionosphere The band of charged particles 80 to 120 miles above the earth's surface. The ionosphere affects the accuracy of GPS measurements if you measure long baselines using single-frequency receivers.

L1 The primary L-band carrier used by GPS satellites to transmit satellite data. The frequency is 1575.42 MHz. It is modulated by C/A code, P-code, or Y-code, and a 50 bit/second navigation message.

L2 The secondary L-band carrier used by GPS satellites to transmit satellite data. The frequency is 1227.6 MHz. It is modulated by P-code or Y-code, and a 50 bit/second navigation message.

local ellipsoid The ellipsoid specified by a coordinate system. The WGS-84 coordinates are first transformed onto this ellipsoid, then converted to grid coordinates.

multipath Interference, similar to ghosting on a television screen. Multipath occurs when GPS signals traverse different paths before arriving at the antenna. A signal that traverses a longer path yields a larger pseudorange estimate and increases the error. Reflections from structures near the antenna can cause the incidence of multiple paths to increase.

NAVDATA The 1500-bit navigation message broadcast by each satellite. This message contains system time, clock correction parameters, ionospheric delay model parameters, and details of the satellite's ephemeris and health. The information is used to process GPS signals to obtain user position and velocity.

NMEA A standard, established by the National Marine Electronics Association (NMEA), that defines electrical signals, data transmission protocol, timing, and sentence formats for communicating navigation data between marine navigation instruments.

parity A form of error checking used in binary digital data storage and transfer. Options for parity checking include Even, Odd, or None.

P-code The ‘precise’ code transmitted by the GPS satellites. Each satellite has a unique code that is modulated onto both the L1 and L2 carrier waves. The P-code is replaced by a Y-code when Anti-Spoofing is active.

PDOP Position Dilution of Precision, a unitless figure of merit expressing the relationship between the error in user position and the error in satellite position. Geometrically, PDOP is proportional to 1 divided by the volume of the pyramid formed by lines running from the receiver to four satellites observed. Values considered good for positioning are small (for example, 3). Values greater than 7 are considered poor. Small PDOP is associated with widely separated satellites. PDOP is related to horizontal and vertical DOP by $PDOP^2=HDOP^2+VDOP^2$. See also **DOP**.

PDOP mask The highest PDOP value at which a receiver will compute positions.

postprocess To process satellite data on a computer after it has been collected.

PRN Pseudorandom number, a sequence of digital 1’s and 0’s that appear to be randomly distributed like noise, but that can be exactly reproduced. PRN codes have a low autocorrelation value for all delays or lags except when they are exactly coincident.

Each NAVSTAR satellite can be identified by its unique C/A and P pseudorandom noise codes, so the term ‘PRN’ is sometimes used as another name for GPS satellite or SV.

projection Projections are used to create flat maps that represent the surface of the earth or parts of that surface.

QC records Quality Control records. With precise positioning applications, this receiver option lets you process RTCM-104 corrections and satellite data in real time to provide position precision statistics.

ratio During initialization, the receiver determines the integer number of wavelengths between each satellite and the GPS antenna phase center. For a particular set of integers, it works out the probability that this is the correct set. The receiver then calculates the ratio of the probability of correctness of the currently-best set of integers to the probability of correctness of the next-best set. A high ratio indicates that the best set of integers is much better than any other set. (This gives us confidence that it is correct.) The ratio must be above 5 for New Point and OTF initializations.

RDOP Relative Dilution of Precision. See also **DOP**.

reference station See **base station**.

RMS Root Mean Square. This is used to express the accuracy of point measurement. It is the radius of the error circle within which approximately 70% of position fixes are to be found. It can be expressed in distance units or in wavelength cycles.

rover Any mobile GPS receiver and field computer collecting data in the field. The position of a roving receiver can be differentially corrected relative to a stationary base GPS receiver.

RTCM Radio Technical Commission for Maritime Services, a commission established to define a differential data link for the real-time differential correction of roving GPS receivers. There are two types of RTCM differential correction messages, but all Trimble GPS receivers use the newer Type 2 RTCM protocol.

RTK Real-time kinematic, a type of GPS survey.

S/A	See **Selective Availability**.
Selective Availability (S/A)	Artificial degradation of the GPS satellite signal by the U.S. Department of Defense. The error in position caused by S/A can be up to 100 meters.
single-frequency	A type of receiver that only uses the L1 GPS signal. There is no compensation for ionospheric effects.
SNR	Signal-to-Noise Ratio, a measure of the strength of a satellite signal. SNR ranges from 0 (no signal) to around 35.
Super-trak	A Trimble proprietary method of processing the L2 signal when the P-code is encrypted.
SV	Satellite Vehicle (or Space Vehicle).
TDOP	Time Dilution of Precision. See also **DOP**.
TOW	Time of Week in seconds, from midnight Saturday night/Sunday morning GPS time.
tracking	The process of receiving and recognizing signals from a satellite.
UTC	Universal Time Coordinated. A time standard based on local solar mean time at the Greenwich meridian. See also **GPS time**.
VDOP	Vertical Dilution of Precision. See also **DOP**.
WAAS	Wide Area Augmentation System. A satellite-based system that broadcasts GPS correction information. WAAS capable GPS receivers can track WAAS satellites. WAAS is synonymous with the European Geostationary Navigation Overlay Service (EGNOS) and Japan's Multifunctional Transport Satellite Space-based Augmentation System (MSAS).

WGS-84 World Geodetic System (1984), the mathematical ellipsoid used by GPS since January 1987. See also **ellipsoid**.

Y-code An encrypted form of the information contained in the P-code. Satellites transmit Y-code in place of P-code when Anti-Spoofing is in effect.

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