ORIENTATION GUIDE

TerraSync™ and GPS Pathfinder® Office Software

Trimble®

www.trimble.com

TerraSync and GPS Pathfinder Office Software

Orientation Guide

Version 1.00
Revision A
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Trimble®

Corporate Office

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Release Notice

This is the December 2006 release (Revision A) of the *TerraSync and GPS Pathfinder Office Software Orientation Guide*. It applies to version 2.60 and later of the TerraSync software and version 3.10 and later of the GPS Pathfinder Office software.

The following limited warranties give you specific legal rights. You may have others, which vary from state/jurisdiction to state/jurisdiction.

Product Limited Warranty Information

For applicable product Limited Warranty information, please refer to Legal Notices in the *TerraSync Software Getting Started Guide* and the *GPS Pathfinder Office Software Getting Started Guide* or consult your local Trimble authorized dealer.

Contents

Introduction

Trimble Navigation Limited is committed to excellence in product training services. The training emphasis is on teaching you how to use the products. The overall goal of this training course is for you to learn how to use the Trimble® TerraSync™ software so that you can perform your work tasks with confidence.

Course objectives

The course objectives include learning to:

- associate GPS fundamentals with the criteria of a TerraSync software mapping project
- configure your data collector with data collection parameters
- record GPS data with the TerraSync software
- process your field data in GPS Pathfinder® Office software

Course materials

Material provided for the basic TerraSync software training course includes this document, the *TerraSync and GPS Pathfinder Office Software Orientation Guide*. Use it during the class as well as on the job. It provides GPS fundamentals, instruction for the classroom, and field exercises. A glossary of terms is included for your reference during and after the course.

Internet resources

The Support page on the Trimble website provides access to the newest customer support tools. To access the Support page:

- Go directly to www.trimble.com/support.html
- Click **Support & Training** on the Trimble home page
- Click **Support** in the top navigation bar on the Trimble website

On the Support page, click a product name to access support resources for that product.

Support notes and FAQs

Support notes and FAQs (Frequently Asked Questions) include product information, troubleshooting instructions, and answers to common questions. Trimble recommends that you check the support notes and FAQs before you seek direct assistance.

To view or download the available support documents for your product, go to the Support page on the Trimble website (www.trimble.com/support.html) and then click the product name.

Technical assistance

If you have a problem and cannot find the information you need in the product documentation, ***contact your local dealer***. The *Dealer Locator* page on the Trimble website (www.trimble.com/locator/sales.asp) provides contact details for your local dealer.

Dealer name ______________________________

Phone number ______________________________

Email ______________________________

Alternatively, you can purchase Priority Support.

Priority Support

If time is crucial, and your staff field need their technical GPS questions answered quickly, you can purchase Priority Support. You will receive a direct dial phone number and an email address to contact dedicated Priority Support staff to access the help you need immediately.

Note – *Priority Support is currently available only to customers who live in the USA. If you live outside of the USA, please contact your local Trimble Dealer to discuss the support options they offer.*

There are two types of Priority Support:

- ***Annual Priority Support.*** Purchase Annual Priority Support for each person who requires direct access to experienced Trimble support specialists. This option provides 12 months of unlimited technical support, covering all Trimble Mapping & GIS equipment. You will receive a free-phone number so you can communicate directly with GPS/GIS support specialists from Monday to Friday, 9am - 7pm Eastern Time and have a "High priority" status for all your enquiries, ensuring your questions get answered first.
- ***Pay as you go Priority Support***. Call 1-866-560-6200 to purchase Priority Support when you require it. You pay using a credit card when you make the call. Each call costs US$29.95.

Important GPS contacts

The following contact numbers are useful for obtaining GPS and control point information, pribmarily in the United States. For information about your region, ask your trainer.

U.S. Coast Guard

The U.S. Coast Guard is a source for current GPS and satellite information. You can obtain information on the number of operational space vehicles (SVs) and the times and dates they will be available, as well as launch dates for new and replacement SVs. You can also get information on the U.S. Coast Guard beacons.

Recorded Message: 1-703-313-5907
Live Voice: 1-703-313-5900
Internet: www.navcen.uscg.mil

National Geodetic Survey (NGS)

Call the National Geodetic Survey department for the location of control points in your geographic area (within the United States).

Information Center: 1-301-713-3242
Internet: www.ngs.noaa.gov

System components

The TerraSync software with a GPS receiver and a handheld data collector is a GIS data collection system.

There are a number of different system configurations available.

TerraSync software

The TerraSync software running on a Trimble handheld data collector of your choice is designed for collecting and updating GIS and spatial data. The TerraSync software acts as the ***controlling software***. It communicates with a GPS receiver, allowing you to set GPS parameters in the receiver, record GPS positions on the data collector, and maintain existing GIS data.

The TerraSync software can be used with a wide variety of real-time sources of differential corrections, including:

- integrated SBAS (Satellite Based Augmentation Systems) receiver
- integrated beacon receiver
- integrated satellite differential receiver
- external source connected to the GPS receiver (for example, a GeoBeacon™ receiver or a DGPS radio)

GPS Pathfinder Office software

Back in the office, you can process the information that you collected, and export it to your GIS, using the GPS Pathfinder Office software.

The GPS Pathfinder Office software provides the tools needed for effective mission planning, data dictionary creation, differential correction, and export to a Computer Aided Design (CAD) system or Geographic Information System (GIS).

With the GPS Pathfinder Office software you can:

- use mission planning software to find the best times of day to collect data (now that there is full satellite coverage, this is optional)
- create data dictionaries that describe the features you want to collect
- import data from your GIS for update
- transfer data files between a field computer and your office computer
- differentially correct your data
- edit attributes and offsets, and delete erroneous positions
- produce scaled plots of your data
- export your data to a GIS or CAD

The GPS Pathfinder Office software makes exporting GPS data to your GIS a simple process. Parameters for exporting data can be set up in the software and saved for use on future projects. The GPS Pathfinder Office software exports files to most GIS and CAD systems.

GPS hardware

For more information on using your GPS receiver and/or handheld data collector, see the user guide for the device.

MODULE

1

GPS Fundamentals

In this module:

The Global Positioning System (GPS) is a constellation of at least 24 satellites that provides worldwide accurate position coordinates. GPS uses satellites and computers to compute positions anywhere on Earth. The system is owned, operated, and controlled by the United States Department of Defense (DoD). It can be used worldwide by any civilian free of charge.

GPS segments

GPS is divided into three segments: control, space, and user.

Control

The control segment is the "brain" of GPS. A controller monitors the satellites' transmission of navigation messages and sends adjustments, if necessary. The DoD operates this segment from Falcon Air Force Base in Colorado Springs, Colorado, USA. The segment also includes four monitoring and upload stations distributed throughout the world. Each satellite passes over a monitoring station twice a day.

Space

The space segment is the NAVigation Satellite Timing And Ranging (NAVSTAR) constellation of satellites that broadcast GPS signals. When the system is at full operational capacity, there are 24 operational satellites. This number changes constantly as satellites are commissioned (put into operation) and decommissioned (removed from operation).The satellites orbit 20,200 km above the Earth and make one revolution approximately every 12 hours.

Numerous launches in the early 1990s brought the number of satellites in the NAVSTAR constellation from 10 operational satellites in 1989 to full status in December 1993.

User

Many applications use GPS to calculate positions. Civilian users currently outnumber military users worldwide. Applications include agriculture, aviation, emergency services, recreation, and vehicle tracking. For more information about GPS applications, visit the Trimble website (www.trimble.com).

Why satellites?

GPS is an effective mapping tool because:

- line of sight between the unknown and a known location is ***not*** necessary. You only need line of sight to the sky.
- when used properly, GPS satellites provide accurate positioning, user mobility, and rapid data collection.

While satellite-based positioning has revolutionized the GIS mapping data collection industry, it is important to note that GPS is only a useful tool. You cannot use it to perform every mapping task.

Satellite ranging

GPS is based on satellite ranging. This measurement is determined by timing how long it takes a radio signal to reach the GPS receiver from a satellite, and using that time to calculate the distance.

Measuring satellite distance

Two factors are involved in measuring the distance from a satellite:

- The *speed* of the radio signal, which equals the speed of light (300,000 km per second)
- The *time* it takes the signal to reach Earth

The GPS receiver compares digital codes generated at precisely the same time by a GPS satellite and the GPS receiver. Identical "pseudorandom" codes are generated by all GPS equipment (satellites and receivers) every millisecond. Time is calculated as the difference between when the satellite generated the code and when the receiver receives the code.

Trilateration refers to measuring the distance from at least three satellites to establish a position on Earth. Trigonometry requires three perfect measurements to define a point in three-dimensional space. However, the accuracy of a measurement based on three satellites may be diminished due to non-synchronization of clocks in the GPS satellites and the receiver.

Calculating an accurate position

Four imperfect measurements can eliminate timing offsets. The microprocessor in the GPS receiver recognizes timing offset when it receives a series of measurements that it cannot intersect at one point. It automatically starts subtracting the same amount of time from all of the measurements until one point is determined.

An accurate position is calculated by using four satellites. Currently, all Trimble mapping receivers have at least twelve parallel channels to receive radio transmissions from up to twelve GPS satellites simultaneously.

Almanac information

Some GPS receivers have an almanac programmed into their microprocessor's memory. The almanac specifies where each GPS satellite will be at any given moment in the future. It is a set of parameters used to calculate the ***general*** location of each satellite. Almanacs are used while planning a work project, and for quick acquisition of satellite positions by the receiver.

Ephemeris information

The orbits of all GPS satellites are measured constantly by the DoD. They determine satellite ranging and calculate the ***exact*** location of each satellite. The adjusted measurement is transmitted from the DoD to the satellites. These minor corrections are then transmitted by the satellites as ephemeris information.

The ephemeris information is a data file that contains orbit information for one particular satellite. This information is used by the GPS receivers along with their internal almanac to establish precisely the position of the satellite.

Differential GPS

Differential GPS is the precise measurement of the relative positions of two receivers tracking the same GPS signals. This requires a receiver to be placed as a base station over a known coordinate. The base station determines what errors the satellite data contains. Other receivers (rovers) then use this corrected GPS information to eliminate error in their measurements.

Differential GPS measurements are much more accurate than standard GPS measurements. When taking measurements in the differential mode, you can achieve accuracy of one meter. These measurements are based on the accuracy of the reference position (coordinate) used at the antenna of the base station.

Sources of error

Ultimately, the accuracy of a GPS position is determined by the sum of several sources of error. The contribution of each source varies depending on atmospheric and equipment conditions.

There are several sources of error that affect the results of GPS data collection. Environmental factors, such as physical objects causing obstructions and reflected signals, cause errors in data collection. Errors are minimized by applying rigorous data collection techniques to equipment setup and obtaining satellite lock.

Selective Availability

Selective Availability (SA) is intentional scrambling of the GPS signal by the DoD to degrade the accuracy of GPS positions. When SA is turned off, the horizontal accuracy of autonomous positions is approximately 10–15 meters. When SA is turned on, autonomous accuracy can be up to 100 meters.

Selective Availability was turned off in May 2000. However, it can be turned back on at any time.

Obstruction

In general, GPS signal reception is better in an open field than under tree canopy or in a natural or urban canyon. If the GPS receiver is tracking four satellites and then loses lock on a satellite that passes behind an obstruction, then you must wait for the receiver to regain that satellite before you can continue to log 3D positions.

Therefore, try to avoid obstructions caused by buildings or vegetation during data collection. If you cannot avoid them, plan to collect data at these locations when there is a maximum number of satellites in the sky. Greater sky visibility at the antenna location provides more accurate data.

Multipath

Multipath error occurs when the GPS signal is reflected off an object before it reaches the GPS antenna. Multipath error occurs without warning. The error can be minor, or can result in several meters of accuracy degradation. High multipath surfaces include urban canyons and dense foliage.

Currently, there is no way to prevent multipath from occurring. However, field techniques and receiver firmware can reduce its effects. Serious multipath errors are usually recognizable and easily edited in the office processing software.

Atmospheric delay

GPS signals bounce around when traveling through the ionosphere and troposphere. As the signal bounces, the amount of time it takes to reach the Earth is altered. This can change the calculated position.

Atmospheric delay is largest during the heat of the day when ionospheric activity is greatest. Furthermore, weather patterns in the troposphere can be different at the base and rover receivers. Although atmospheric delay is a solvable error, differences in atmospheric conditions over large distances may not be totally resolved in a differential solution.

Note – *GPS works in all weather conditions.*

MODULE

2

Equipment Setup

In this module:

TerraSync system components

A TerraSync system has three components:

- Data collector
- GPS receiver
- TerraSync software

To transfer TerraSync software files between a data collector and an office computer, you need one of the following installed on the office computer:

- version 3.10 or later of the GPS Pathfinder Office software
- the Trimble Data Transfer utility, which is available for free download from the Trimble website at www.trimble.com/datatransfer.html.

You also need Microsoft® ActiveSync® technology installed on the office computer.

Using the TerraSync software

The TerraSync software consists of five sections, as described below:.

Use this section …	to …
Map	view features, background files, and the GPS trail graphically
Data	work with data files: • create a new data file or open an existing data file • log base station data to file or broadcast real-time corrections • collect new features or maintain existing features • move, copy, delete, or rename data and background files
Navigation	navigate to features using the *Direction Dial* and *Close-up* screens, or the graphical lightbar
Status	view information about: • the satellites the TerraSync software is tracking, their relative positions in the sky, and your current position • the predicted satellite constellation and position quality over the next 12 hours • communication ports that the TerraSync software is using • your GPS receiver and real-time correction source • the current UTC time • the TerraSync software version and trademark information
Setup	configure the TerraSync software

One of these sections is always active and visible. The Section list button shows the section that is currently active. You can move between sections at any time without closing any open forms or screens. To switch to a different section, tap the Section list button and then select the section you want from the drop-down list. For example, to switch from the *Map* section to the *Data* section, tap the Section list button and then select *Data*. The button now shows Data and the *Data* section becomes the active section. When you return to the *Map* section, the screen or form that was open when you left appears again.

Configuring critical settings in the TerraSync software

There are some critical settings in the TerraSync software to configure before collecting data (for example, the GPS settings).

Tip – Trimble recommends that you review the critical settings before each data collection session and retain those settings throughout the project.

In this section, you will learn the recommended settings when working in optimal conditions and with obstructed views. An appropriate TerraSync software configuration can make your data collection session easier and your data more accurate.

Configure these settings in the office, or in the field. You can also set other (non-critical) settings to suit your application or preferences.

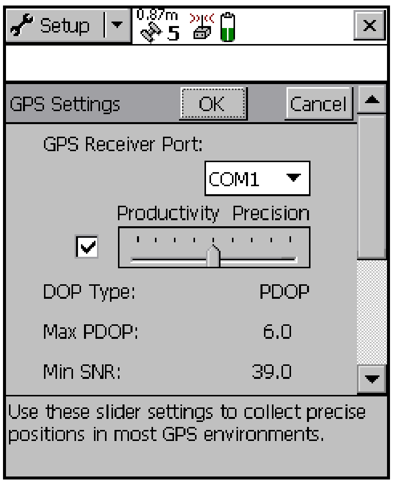
Configuring GPS settings

You can adjust the GPS slider bar to best suit your environment.

In an open area, with few tall buildings, trees, or other obstructions, you can adjust the GPS slider bar to allow better positions to be recorded. You will record fewer positions because you will restrict logging to when there is good satellite geometry, but the positions you record will have higher quality.

***Note** – By default, the GPS slider bar is set at the middle setting. When you adjust the GPS slider bar to the left, you can obtain positions in less favorable conditions though the positions are less precise.*

To open the *GPS Settings* form, tap **GPS Settings** in the *Setup* screen. Use this form to control the precision you require for GPS positions:



When you select the Slider check box, the editable fields in the form change to display text and the GPS slider control appears on the slider. The GPS slider makes it easy for you to change the level of accuracy without needing to know the best values for each precision setting.

The GPS slider is a scale from Low to High. Drag the slider control to the ***left*** to ***decrease*** the GPS precision. Drag it to the ***right*** to ***increase*** the GPS precision and exclude positions that do not meet the precision requirements.

When you clear the *Slider* check box, the GPS slider disappears and the remaining fields change to editable numeric fields. Enter values in these fields to set the GPS precision you require. These fields are available on the *GPS Settings* form in Custom mode:

- DOP Type
- Max PDOP or Max HDOP
- Min SNR
- Min Elevation
- Velocity Filter

Note – *Velocity filtering is available with supported receivers only.*

The following are general recommendations for configuring the TerraSync software. Configuration settings may vary based on project specifications and/or the environment of the data collection site:

- Max PDOP – set to 6.0. Satellite constellations with PDOP values greater than the specified number are not used.
- Max HDOP – if vertical precision is not important, set a maximum HDOP of 4.0 instead of a maximum PDOP.
- Min SNR – set to 39. This field specifies the minimum signal-to-noise ratio, or signal strength. The stronger the signal, the better. Values lower than 39 are not used.

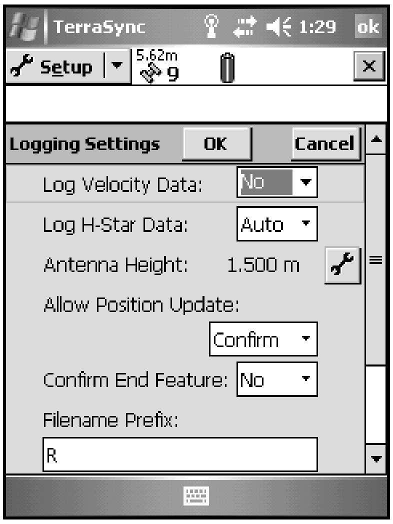
Note – *The GPS settings for a Trimble GPS Pathfinder XB or XC receiver can not be configured.*

- Min Elevation – set to 15°. Elevation above the horizon where satellites are used to calculate a position.

Note – *For more information on GPS settings, refer to the TerraSync Software Reference Manual.*

Configuring logging settings

To open the *Logging Settings* form, tap **Logging Settings** in the *Setup* screen. Use this form to configure settings that control what data is stored, and how.



Use the *Logging Settings* form to configure how additional data is collected:

- Log Velocity Data – specify whether to log velocity records as well as GPS position records. If you log velocity records, you can use velocity filtering in the GPS Pathfinder Office software to reduce "spikes" in your data caused by poor GPS conditions.
- Log H-Star Data - specify whether to log H-Star™ data as well as GPS position records. If you log H-Star data you can perform postprocessing for improved accuracy.

Note – *H-Star data will be logged only if you have a GPS receiver capable of logging it.*

- Antenna Height – enter the height of the antenna. This is the height of the GPS antenna above the feature you are collecting.
- Allow Position Update – specify whether or not positional data can be updated or replaced.
- Confirm End Feature – specify whether to display a confirmation message when you close an updated feature.
- Filename Prefix – specify a single letter to identify the files you record. This is the first letter of the name of each automatically generated file.

Note – *SuperCorrect™ records are always logged to enable improved processing options in the GPS Pathfinder Office software.*

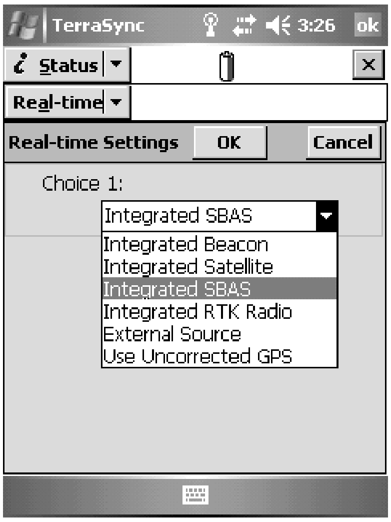
The *Style, Interval* and *Accuracy* fields appear for each feature in the current data dictionary.

- *Style* – specify the method of measurement for between feature and feature logging

- *Interval* – specify the interval between feature GPS positions when you are collecting a point feature. For example, if you set the interval to five seconds, the TerraSync software logs GPS positions once every five seconds, from when you start the feature until you end it. Either enter a number or select Off.
- *Accuracy* – specify whether to log the usual code phase data from the GPS receiver, or to log more accurate carrier phase data.

Configuring real-time settings

To open the *Real-time Settings* form, tap **Real-time Settings i**n the *Setup* screen. Use this form to configure settings that control the sources of real-time differential GPS that you use, if any, and how your system communicates with each source:



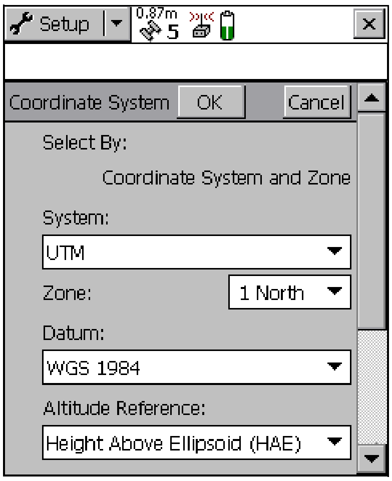
The TerraSync software always uses the highest priority real-time source available, according to your list of preferences. If the source it is currently using becomes unavailable, the TerraSync software switches to the next choice. Whenever the TerraSync software acquires a higher priority real-time source, it switches back to this source. For example, the TerraSync software will not use your second choice if your first choice is available.

Tip – To record uncorrected GPS positions only, without using any real-time corrections, select Use uncorrected GPS from the *Choice 1* field. You can correct these positions back in the office using the GPS Pathfinder Office software.

For more information on real-time settings, refer to the *TerraSync Software Reference Manual*.

Configuring coordinate settings

To open the *Coordinate System* form, tap **Coordinate System** in the *Setup* screen. Use this form to specify the coordinate system you want the TerraSync software to use to display foreground and background files:



A coordinate system is a three-dimensional frame of reference that can be used to describe the location of objects. You can choose many different coordinate systems. Each is appropriate depending upon the map projection and region in which you are collecting data.

In the TerraSync software, all GPS data is collected in the World Geodetic Datum of 1984, the latitude/longitude system, and the Height Above Ellipsoid altitude reference.

If you configure the TerraSync software in a different coordinate system for postprocessed data collection, you only affect how the coordinates appear. The data is not converted.

However, this setting is critical if you are navigating or looking for a location on a paper map. The coordinates will not match unless the TerraSync software is configured to the same coordinate system as the paper map.

Datums are fundamental to GPS. To compare GPS data with locations from an existing map, both must be referenced to the same datum. Different datums provide different coordinates for any location. GIS users choose to convert their data to a datum that matches their existing GIS database during the export process. Each datum has a unique point of origin, which is why one point displayed in two different datums yields two different sets of coordinates.

Examples of datums:

- WGS-84 – worldwide
- NAD-83 – region-wide
- EUROPEAN 1950

Examples of coordinate systems:

- Latitude, Longitude, Altitude – 3D-based
- UTM – Grid Squares – 2D-based
- State plane - each US state has created its own grid system

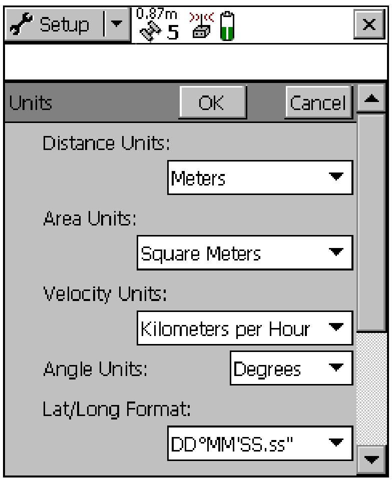
Height values can be expressed as a height above the ellipsoid (HAE) or as a height above mean sea level (MSL). GPS works in HAE, but many Geographical Information Systems are set up using MSL. You can convert between the two for display in the TerraSync software, and for map display and map export in the GPS Pathfinder Office software:

- Ellipsoid – a mathematical model of the Earth's size and shape. HAE equals the distance from the ellipsoid to the geoid (MSL) surface.
- Geoid – considers the gravitational pull to model the Earth's "true" size and shape. The Earth is not uniformly dense. Gravity is a function of mass; therefore, gravitational pull varies from place to place.

Note – *The geoid height equals the separation between the geoid and the ellipsoid. This distance approximates mean sea level (MSL).*

Configuring unit settings

To open the *Units* form, tap **Units** in the *Setup* screen. Use this form to specify the units used for measurements and display:



These fields are available in the *Units* form:

- Distance Units
- Area Units
- Velocity Units
- Angle Units

- Lat/Long Format
- Offset Format
- North Reference
- Magnetic Declination

Change the units as appropriate. Changing unit settings does not affect data quality. However, unit settings are critical when specifying an accurate antenna height, or when navigating.

Exercise 2.1: Assemble the equipment

Before going out into the field with the TerraSync software, check that you have all the necessary GPS hardware, batteries, and cables. Trimble recommends that before you leave the office you:

- Set up your entire GIS/GPS data collection system and test it to make sure that everything is connected correctly.
- Make sure all batteries, including the field computer, are charged.

For instructions on how to configure the hardware that you are using, refer to the relevant hardware guide.

CAUTION – After testing the system, remember to turn off the data collector and any other equipment (such as radios) before proceeding to the start point of your field work. Leaving equipment on wastes battery life, especially if it will be some time before you need to use the equipment.

MODULE

3

Field Session

In this module:

After you have configured the TerraSync software, you are ready for the field. This section covers two functions of the TerraSync software:

- GPS status
- Data capture

You should become familiar with these functions, as they assist you throughout field data collection.

GPS status

When you arrive at the field site, start the TerraSync software to allow it to begin satellite tracking. Before data collection, it is useful to check the status of your receiver. Make sure that the receiver is tracking at least four satellites for 3D data collection. Check that all precision standards are met.

Starting the TerraSync software

When you are outside and ready to begin, switch on your data collector and start the TerraSync software. The GPS receiver should activate automatically.

On the Microsoft Windows® or Windows Mobile® taskbar, tap and then select *Programs / TerraSync*. While the software is loading, a Trimble identification screen appears:

The *Skyplot* subsection of the *Status* section always appears after the identification screen.

Getting a clear view of the sky

Move to a location where the receiver has a clear view of the sky.

Signals can be received from any direction. Satellite signals can be blocked by people, buildings, heavy tree cover, large vehicles, or powerful transmitters. Anything that blocks light also blocks signals. GPS signals can go through leaves, plastic, and glass, but these all weaken the signal.

Checking the GPS status

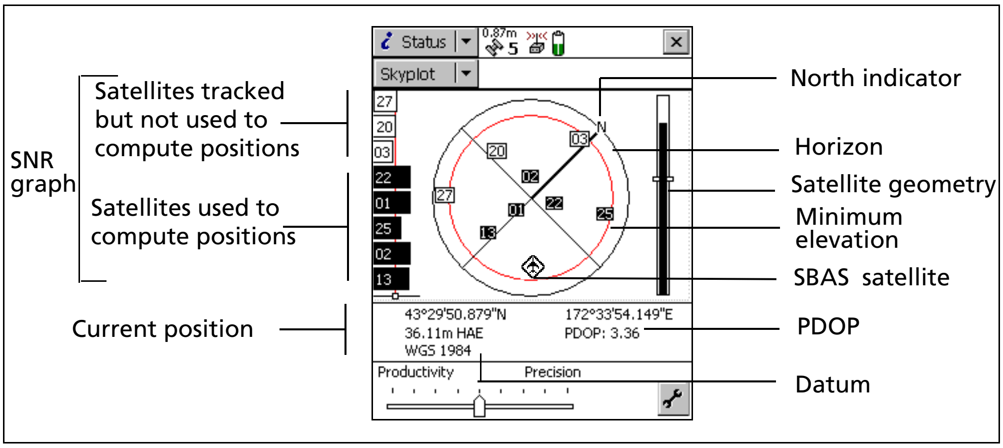
When you start the TerraSync software, it automatically connects to the GPS receiver, and begins to track visible satellites and to calculate its current position. Use the satellite icon on the status bar to check whether the receiver is computing GPS positions. The software provides information about the geometry of the satellites that are being used to compute GPS positions.

Use the *Status* section to view the satellites currently tracked and those that are being used to calculate the current position.

***Note** – For a further explanation of satellite geometry and how this can affect your GPS data collection, refer to the Mapping Systems General Reference.*

To view the GPS status:

1. The *Skyplot* screen appears when you first run the TerraSync software. If this screen is not visible, tap the Section list button, select *Status*, tap the Subsection list button and then select *Skyplot*. Figure 5.1 shows the parts of the *Skyplot* screen.



2. Use the skyplot to check the satellites that are being tracked and to see your current position.

Filled black boxes represent satellites that the receiver is using to compute its current GPS position. White boxes represent satellites that the receiver is getting signals from but is not using because the signals are too weak. The figure shows eight GPS satellites are being tracked; five of these satellites are being used to compute GPS positions.

If an SBAS satellite is being tracked, its location is indicated by this icon:

***Note** – Numbers without a box represent that there are satellites available, but that the TerraSync software is not receiving signals from them.*

Your current GPS position is displayed at the bottom of the screen.

Tip – For detailed information on satellite positions and signal strengths, use the *Satellite Info* subsection of the *Status* section.

You need a minimum of four satellites, with good geometry, to compute a 3D GPS position. When you turn on the GPS receiver, it automatically starts to track visible satellites and to calculate its current position. Use the satellite icon in the status bar to check whether the receiver is computing satellite positions. If the satellite icon and the number below it are solid (not flashing), the receiver is computing GPS positions.

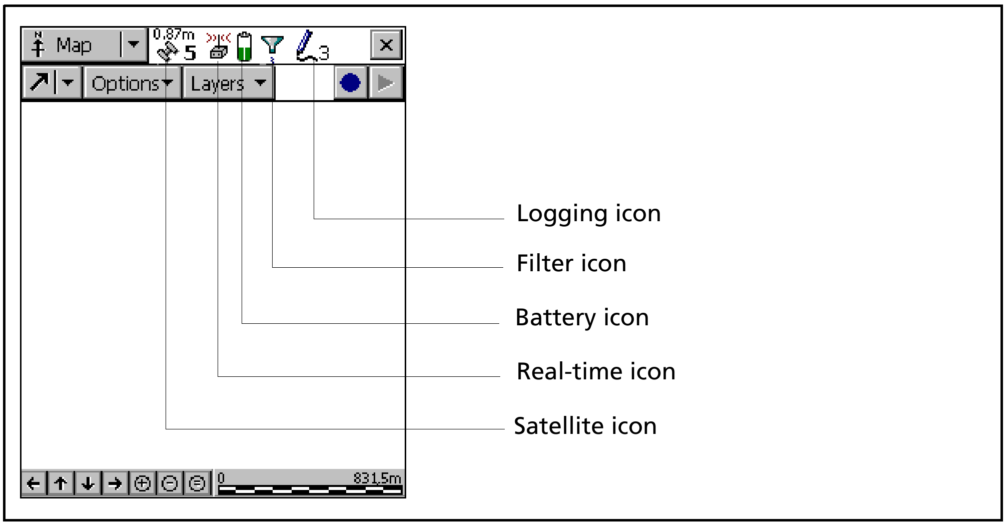
- CEA (Current Estimated Accuracy) - The number above the satellite icon shows the CEA. This is displayed in the currently configured units. The CEA is an indication of the horizontal accuracy (RMS) of the current GPS position. It depends on several factors, including satellite geometry, and the type of GPS receiver that is connected.

- PPA (Predicted Postprocessed Accuracy) - The number above the logging icon shows the PPA. This is displayed in the currently configured units. The PPA is an indication of the predicted postprocessed horizontal accuracy (RMS) of the current GPS position. The PPA appears only if the connected GPS receiver is H-Star capable, and H-Star logging is set to Auto in the *Logging Settings* form.

If the satellite geometry is poor or there are too few satellites available to compute GPS positions, adjust the GPS slider or wait until conditions are more favorable.

Status bar

The status bar appears in the top row of the TerraSync screen. It is always visible, but the icons displayed depend on the current status of the system. The status bar provides basic information about the status of the TerraSync software. The figure below shows the icons in the status bar.



Data collection guidelines

If you observe a few simple practices in the field, you can save time and effort in the long run. To get good results first time, Trimble recommends that you do the following when using the TerraSync software in the field:

- If you are using a Trimble GeoExplorer® handheld, make sure that it is clear of your body. As with any GPS receiver, the antenna requires a clear view of the sky.
- Use the Log Now / Log Later function to pause and resume logging when appropriate. To do this, select the function from the Data section, under Collect screen / options.

  Log Now / Log Later is useful to control GPS logging to prevent unwanted positions being logged to the feature. For example, you can pause to go around an obstacle when logging a line, then resume once you are back on track. Pausing when stationary, at traffic lights for example, will prevent a small drift from being recorded as part of the feature.
- Minimize constellation changes. Each constellation of satellites gives a slightly different position solution. Provided the PDOP values fall within the default values, then no solution is significantly more accurate than any other. However, there is often a relative shift between one constellation and another. Therefore, within a feature, try to avoid objects that block the view of the sky intermittently and cause constellation changes.

Basic data collection

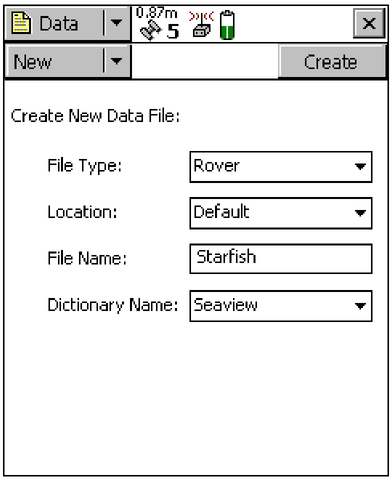
The primary objective of this exercise is to become familiar with basic data collection techniques. You will revisit the field and perform these techniques a second time for practice and perfection. During this exercise, just concentrate on logging point, line, and area features, using a data dictionary.

This exercise shows you how to collect point, line, and area features

Creating a new data file

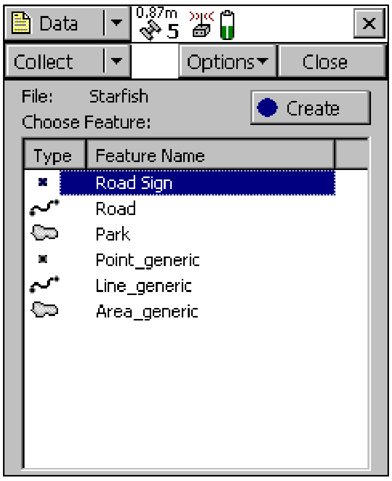
Before starting the data collection session, you need to create a new data file to store the new features and attributes you collect. Use the *Data* section to do this.

1. Tap the Section list button and then select *Data*.
2. Tap the Subsection list button and then select *New*. The *New File* screen appears:



   The TerraSync software automatically enters a default name in the *File Name* field.

3. In the *Dictionary Name* field, select a data dictionary.
4. Tap **Create**. The *Collect Features* screen appears:



   This screen shows a list of all the features in the data dictionary.

You have created a new data file, so you can now start collecting features.

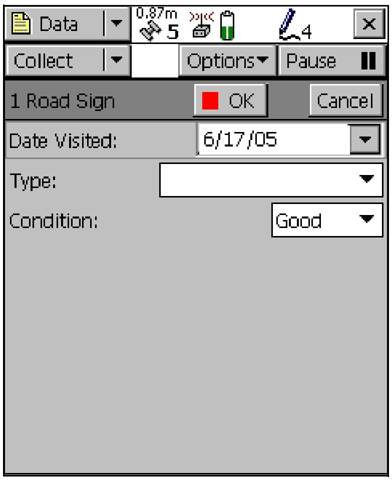
Collecting a point feature

When you record a point feature, you remain stationary for some time. The TerraSync software logs a number of GPS positions during this time. These positions are averaged together to compute the final GPS position of the point feature.

When the TerraSync software is logging GPS positions, the logging icon appears in the status bar. The number beside the icon indicates how many positions have been logged for the selected feature.

To record a point feature:

1. Make sure the *Collect Features* screen is open. If it is not, tap the Section list button, select *Data,* tap the Subsection list button and then select *Collect Features*.
2. In the *Choose Feature* list, highlight an appropriate point feature and then tap **Create**. The attribute entry form for the feature type appears:



3. Fill in the attribute fields with appropriate values.

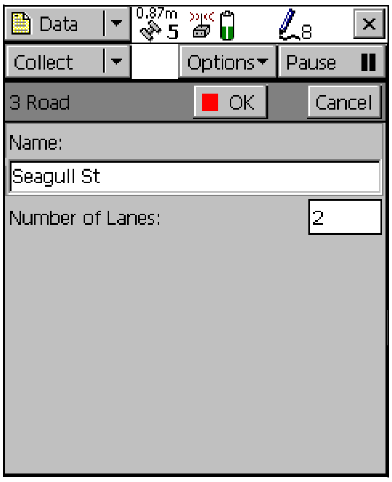
   As the software logs GPS positions, the counter beside the logging icon increments.
4. When you have finished entering the attributes, tap **OK** to close the road sign feature.

   The attribute entry form closes and you are returned to the *Collect Features* screen.

Collecting a line feature

To record a line feature, you need to travel along the line. As you do so, the TerraSync software records a GPS position at the configured interval, which was set when the feature was created in the data dictionary. These positions are joined together to form a line.

1. Make sure the *Collect Features* screen is open. If it is not, tap the Section list button and select *Data*, tap the Subsection list button and then select *Collect Features*.
2. In the *Choose Feature* list, highlight an appropriate line feature.
3. Tap **Create**. The attribute entry form for the feature appears:



4. Continue along the line feature. When you reach the end of the line you are logging, tap **OK** to close the road feature.

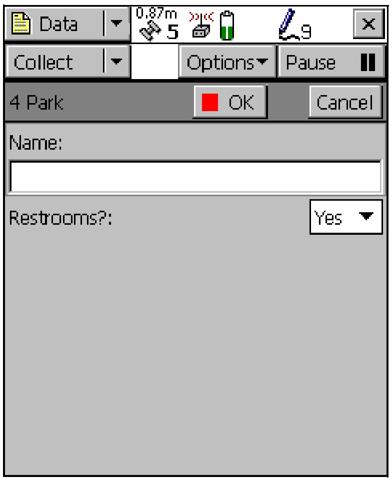
Collecting an area feature

To record an area feature, you need to travel around the perimeter of the area. As you do so, the TerraSync software logs GPS positions at the logging interval set in the data dictionary. These positions are joined together to form the perimeter of the area.

The first and last GPS positions are joined together to close the area, so there is no need to return to the exact start point.

1. Make sure the *Collect Features* screen is open. If it is not, tap the Section list button, select *Data*, tap the Subsection list button and then select *Collect Features*.
2. Tap **Options** and then select Log Now.
3. In the *Choose Feature* list, highlight an appropriate area feature.
4. Tap **Create**.

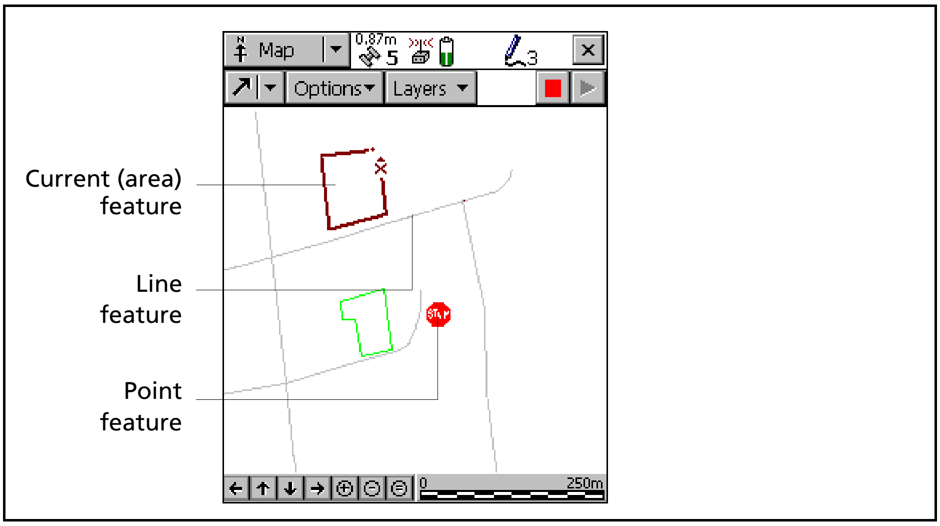
The attribute entry form for the area feature opens, and the TerraSync software starts to log positions:



You can pause logging at any time. For example, if you are driving around the perimeter of the park and you want to stop and examine a sign some distance from the park, you would stop logging positions for the park boundary. You can also pause logging if you want some time to enter attribute values.

5. To pause logging, tap **Pause**. The TerraSync software stops logging positions and a pause icon flashes in the status bar. To continue collecting the park feature, tap **Resume** to resume logging. The pause icon disappears.

6. You can view the map while collecting features. To do this, tap the Section list button and then select *Map*. The features that you have collected appear on the map, along with the park perimeter that you are currently collecting.



You can view the map at different scales. To do this, tap the *Zoom In* or *Zoom Out* button on the command bar.

Alternatively, tap the *Map Tools* list button, select Zoom In or Zoom Out, and select the point on the map that you want to zoom in or out from.

7. To go back to the *Data* section, tap the Section list button and select *Data*. The attribute entry form is still active and the TerraSync software is still logging positions for the park.
8. When you have walked around the perimeter of the area, tap **OK** to close the feature.

Ending the data collection session

When the data collection session is complete, close the data file and then exit the TerraSync software.

1. In the *Collect Features* screen, tap **Close**.

   A message appears, asking you to confirm that you want to close the open file.
2. To close the current data file and return to the *New File* screen, tap **Yes**.
3. Tap the × button in the top right corner of the screen.

   A message appears, asking you to confirm that you want to exit the TerraSync software.
4. Tap **Yes**.

Logging H-Star data

If you connect the TerraSync software to a receiver with H-Star technology, you can collect high-accuracy GPS data. With H-Star processing in GPS Pathfinder Office software, you can achieve horizontal accuracies (RMS) of 30 cm (1 ft) or better. Positions logged while stationary using an external dual-frequency (L1/L2) antenna, can achieve horizontal accuracies (RMS) of 20 cm (8 inches) or better after H-Star postprocessing.

***Note –** Accuracy estimates for GPS positions logged while moving may be larger than 20 cm (dual frequency) or 30 cm (single frequency).*

Status information

When collecting H-Star data, the TerraSync software provides additional status information:

- A Predicted Postprocessed Accuracy (PPA) value for the feature is displayed in the status bar.
- If carrier lock is lost, a tooltip appears warning of the loss of lock, and showing the last PPA value. A warning sound is also given to indicate loss of lock.

***Note –** The PPA value is only an indicator of accuracy that can be achieved with H-Star postprocessing. The accuracy indicated by the PPA is not guaranteed.*

Configuring the TerraSync software to collect H-Star data

If you have an H-Star capable receiver, configure the TerraSync software to collect H-Star data. To do this:

1. Tap the Section list button and then select *Setup* to open the *Setup* section.
2. Tap **Logging Settings**. The *Logging Settings* form appears.
3. Verify that the *Log H-Star Data* field is set to Auto.

***Note –** If your GPS receiver is not H-Star capable, the Auto setting corresponds to No. If you have a GPS receiver that is H-Star capable but you do not want to log H-Star data select No.*

4. Tap **OK** to close this form and confirm the changes you have made.

H-Star data logging is now enabled.

Collecting features

To log H-Star data, the receiver requires a clear view of the sky at all times, so avoid obstacles such as trees, bridges, and tall buildings. As you log a feature, the Predicted Post-processed Accuracy (PPA) value appears in the status bar. The PPA predicts the accuracy that will be achieved for the position after H-Star postprocessing. The value of the PPA correlates directly with the length of time that you have continuously collected H-Star data. To collect H-Star data you must:

- be connected to a receiver that has H-Star technology
- maintain lock on the required number of satellites
- maintain a maximum PDOP of 6 or less

When logging…	maintain lock on at least…
Point features or averaged vertices	four satellites
Line and area features	five satellites

When the PPA value reaches the accuracy you require for a point feature or vertex, you can stop logging. For example, to collect a point feature with an estimated accuracy of 20 cm, you will need to maintain lock on at least 4 satellites with a PDOP of 6 or less until the PPA indicator shows 20 cm. After H-Star postprocessing, the accuracy of the feature should be close to the value shown by the PPA (20 cm). The PPA indicates a 63–68% confidence level for the positions you collect.

Note – *If you lose lock while collecting a feature, the PPA value increases, and you will need to reacquire satellites and remain at the feature until the PPA value decreases to the required accuracy.*

Advanced H-Star data collection

The TerraSync software does not stop logging automatically when the required accuracy is achieved, and it does not prevent you from closing a feature before the required accuracy is achieved, or before the lock period is complete.

You do not have to remain at the same feature until the PPA value is reached. If you are collecting a series of features and you have a clear view of the sky and so are unlikely to lose lock, you can move to the next feature before the required PPA is reached. Provided that the PPA shows the accuracy you require for the features, all of the features collected while lock was maintained will have the same accuracy value after H-Star postprocessing.

CAUTION – This data collection method is recommended only if you are unlikely to lose lock on the required number of satellites. If you lose lock while collecting a series of features, you will need to re-collect all of the features to obtain features with the accuracy you require.

Exercise 3.1: Field data collection

You can now go out into the field to collect data with the TerraSync software.

Make sure that you have the required GPS hardware, batteries, and cables.

MODULE

4

Data Processing with the GPS Pathfinder Office Software

In this module:

Postprocessed differential correction in the GPS Pathfinder Office software is the most accurate way to process GPS data. In the field, you collected autonomous and/or real-time corrected data, while base data was stored at the base station nearby. The two data sets are loaded into the GPS Pathfinder Office software where corrections are applied. (Any real-time data that has been collected can be “recorrected” in the GPS Pathfinder Office software to achieve the best possible results.) After you display your corrected data file, you can:

- Edit any unwanted positions
- Verify that the feature information is correct, and edit any attributes
- Export your data to a GIS or CAD format

Exercise 4.1: Transfer field data

Use this exercise to practice transferring field data to the GPS Pathfinder Office software. You can transfer:

- data files
- base data
- data dictionaries
- almanacs

This exercise shows you how to:

- transfer a field data file to the GPS Pathfinder Office software

Connect the data collector to the office computer

1. Switch on your data collector and your office computer and connect the two computers.

   The Microsoft ActiveSync technology should automatically establish a connection with the data collector. When ActiveSync technology is connected to a data collector, the message Connected appears in the main *ActiveSync* window, and its taskbar icon is green.

2. If ActiveSync technology does not connect automatically, connect to the data collector manually. For more information, refer to the ActiveSync Help.

Transfer rover file to the office computer

1. In the GPS Pathfinder Office software, select *Utilities* / *Data Transfer*.

   The *Data Transfer* dialog appears.

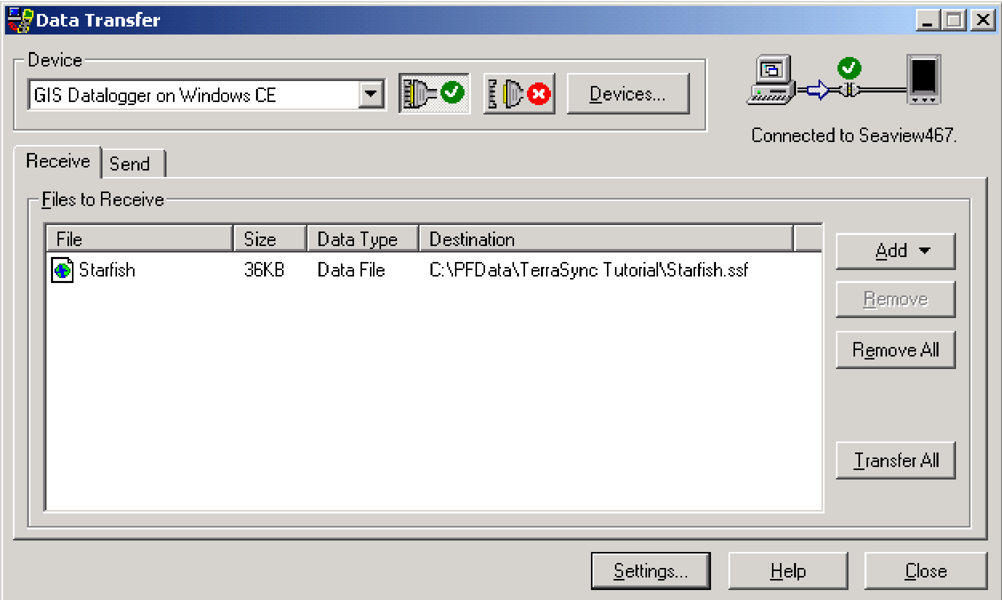
2. From the *Device* list, select the device called GIS Datalogger on the Microsoft Windows CE operating system. Alternatively, if you have set up a device definition for your data collector, select that device name from the list.

   The Data Transfer utility automatically connects to the data collector.

3. Select the *Receive* tab.
4. Click **Add** and then select Data File from the drop-down list. The *Open* dialog appears.

Note – *The files that appear are those in the TerraSync software data folder on the data collector.*

5. Highlight the rover file and then click **Open**. The *Open* dialog disappears and the selected file appears in the *Files to Receive* list:



6. Click **Transfer All**.

   The data file is transferred to the office computer.

7. A message showing summary information about the transfer appears. Click **Close**.

8. To exit the Data Transfer utility, click **Close**.

For more information, refer to the *GPS Pathfinder Office Help*.

Differential correction

Differential correction reduces atmospheric errors; therefore, it is necessary for achieving submeter accuracy for a C/A code position and subfoot accuracy for a H-Star processed position. Differential correction can be performed in real time, or back in the office with the GPS Pathfinder Office software. For optimal results, you can use both.

For a differential correction to be performed, a base station must be running at the same time as a rover in the same vicinity. Both base and rover must track the same satellites at the same time and therefore record the same errors from regional atmospheric conditions. The base station is set up over a known reference position and can compare positions computed with errors to "truth". Differential correction then adjusts for errors in the rover file, based on a time tag for each position.

You can use real-time differential corrections from the following sources:

- integrated SBAS receiver

- integrated beacon receiver
- integrated satellite differential receiver
- external source connected to the GPS receiver (for example, a GeoBeacon receiver or a DGPS radio)

For ***postprocessing***, corrections are logged in a base file that is transferred when you return from the field.

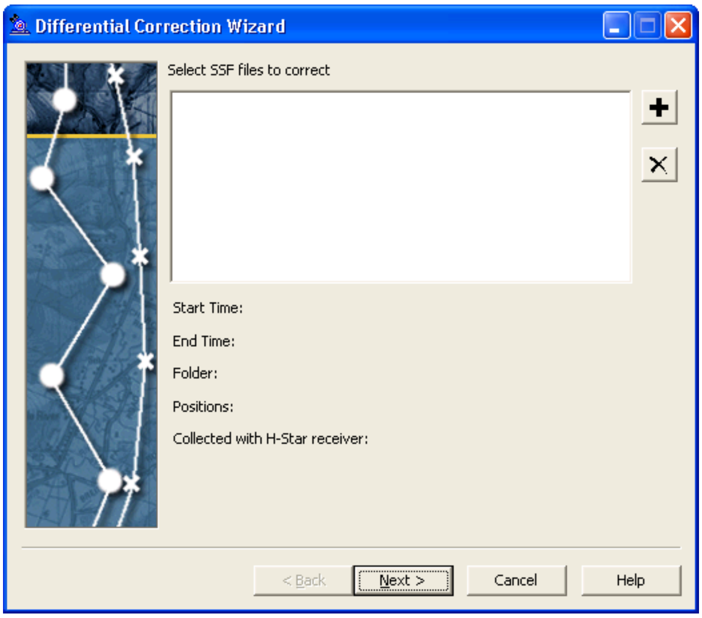
In the GPS Pathfinder Office software there are two options for differentially correcting your data. The Differential Correction Wizard, which you would use in most cases, and the Differential Correction Classic utility, that you will use if you are carrier phase processing data using a single-frequency base station.

The following exercises explain both options.

Exercise 4.2: Differential Correction Wizard

To start the Differential Correction Wizard from the main GPS Pathfinder Office menu bar, select *Utilities / Differential Correction*.

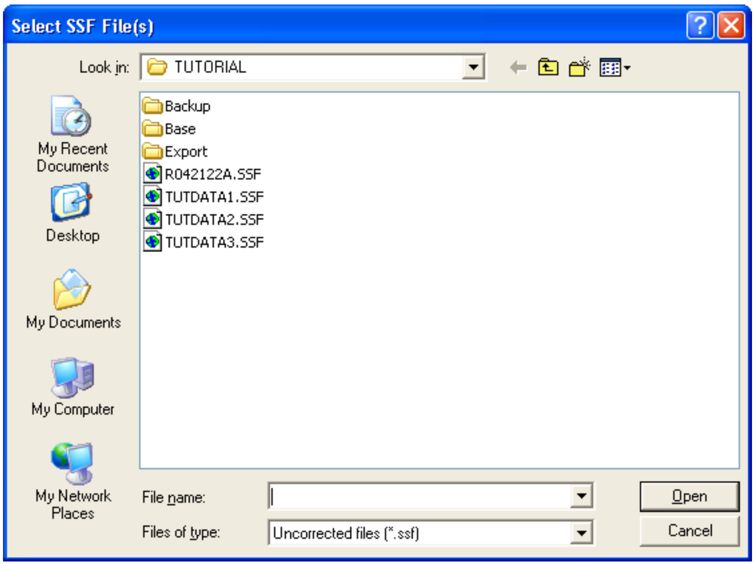
The *Differential Correction Wizard* appears:



Select rover files

The *Select SSF files to correct* list will be empty, or it will show the SSF files that were created the last time you downloaded rover files.

1. To remove any SSF files that are listed, select them and then click .
2. To select the SSF files you want to differentially correct:
   a. Click . The *Select SSF Files* dialog appears:

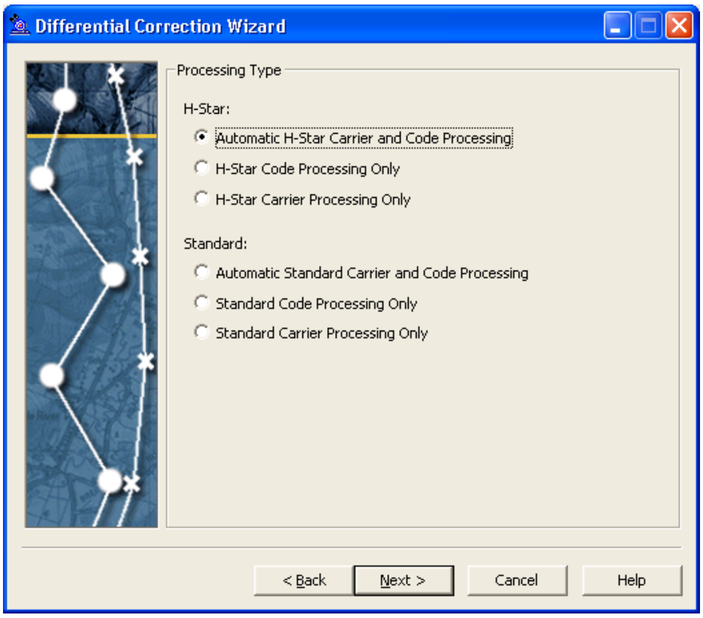


   Select the rover file, or hold down the **Shift** key to select a block of files or hold down the **Ctrl** key to select multiple individual files to be corrected. By default the uncorrected files (.ssf) are shown.

   b. Click **Open**.

   In the dialog that appears, the fields below the selection list display information about the selected file. The *Collected with H-Star receiver* field indicates whether the rover file contains data collected using a receiver with H-Star technology. The options displayed in the rest of the Differential Correction Wizard are dynamic: H-Star processing options are only displayed if the value for this field is Yes.

3. Click **Next**. The *Processing Type* page of the wizard appears:



This screen displays the processing options available for processing the GPS data in the selected rover files.

Select type of processing

Use the *Processing Type* step of the Differential Correction Wizard to specify the type of processing you want to use for the selected SSF files. There are three standard processing options. If the receiver that is used to collect the data uses H-Star technology, an additional three H-Star processing options are available.

H-Star processing types

H-Star processing corrects the GPS data in the selected SSF files using data from a group of base stations. The files are corrected using data from each base station in the group and then the results are averaged to produce a single corrected position for each original position. The averaging calculation gives more weight to base stations that are closer to where the original GPS positions were collected. The options are:

- *Automatic H-Star Carrier and Code Processing* – The GPS data is both H-Star code processed and H-Star carrier processed using data from multiple base stations. The results give one averaged code-corrected position and one averaged carrier-corrected position for each original GPS position; the best position of the two corrected positions is used as the corrected position. This option gives the best results for every position. It is especially useful if you have some positions that were logged while you were not locked onto the number of satellites required for logging H-Star data.

- *H-Star Code Processing Only* – The GPS data is code processed using data from multiple base stations. This option gives better results than standard code processing. Use this option if a receiver with H-Star technology was used to collect the data, but no H-Star carrier data was collected.
- *H-Star Carrier Processing Only* - The GPS data in the session is H-Star carrier processed using data from multiple base stations to produce a carrier float solution. Any GPS positions logged while you were not locked onto the required number of satellites, or when the PDOP value was higher than 6, will not be corrected.

Standard processing types

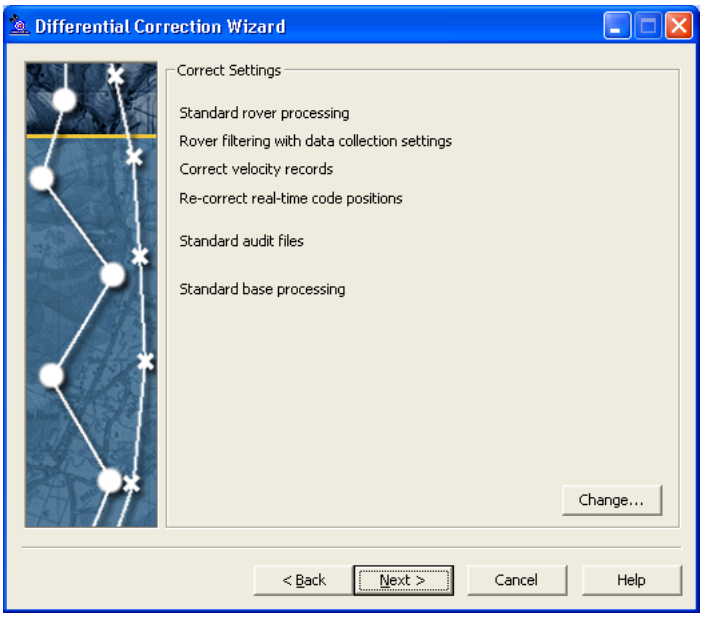
Standard processing corrects the GPS data in the selected SSF files using data from a single base station. The standard processing options are always available whether or not the selected files were collected using an H-Star receiver or not. The options are:

- *Automatic Standard Carrier and Code Processing* - The GPS data is both code processed and carrier processed using data from a single base station. The results give one averaged code-corrected position and one averaged carrier position for each original GPS position; the best position of the two corrected positions is used as the corrected position.
- *Standard Code Processing Only* - The GPS data is code processed using data from a single base station.
- *Standard Carrier Processing Only* - The GPS data in the session is carrier processed using data from a single base station to produce a carrier float solution.

Note – *The Differential Correction Wizard provides a carrier floating solution for data that is differentially corrected using H-Star carrier processing. If you require a carrier fixed solution for carrier data that was not collected using a receiver with H-Star technology, or if you require a carrier solution and your base station is single frequency, correct the data using the Differential Correction Classic utility. To start the Differential Correction Classic utility, select Utilities / Other / Differential Correction Classic from the menu bar.*

To select the type of processing:

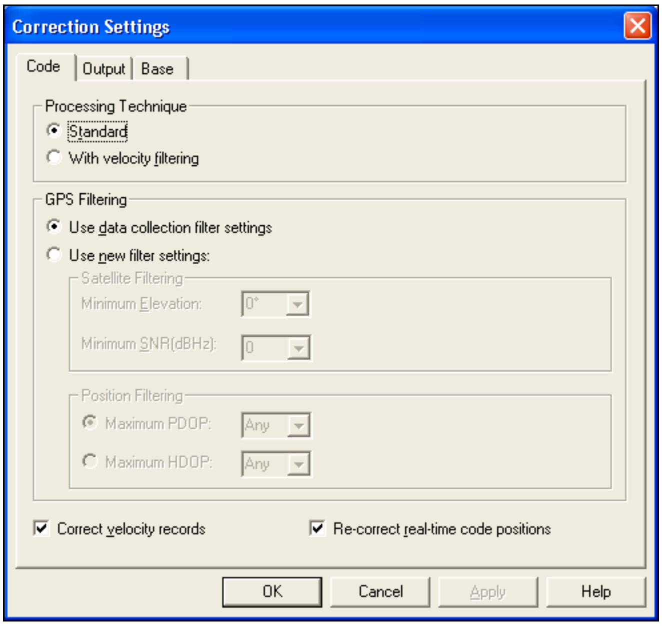
1. Select one of the processing types for differential correction. The options are explained in the previous sections.
2. Click **Next**. The *Correction Settings* page of the wizard appears:



Select appropriate settings

Use the options in the *Correct Settings* dialog to customize differential corrections.

1. Click **Change** to open the *Correction Settings* dialog:



2. Select the *Code* tab and then select an option from the *Processing Technique* group:
   - *Standard* – the quickest method of processing rover data. No velocity filtering is applied.
   - *With velocity filtering* – velocity records are used to filter large leaps or multipath spikes in the data.

3. Choose which filters will be applied to the data as it is differentially corrected. You can apply either the elevation, SNR, and DOP settings that were set in the TerraSync software, or the new settings that you select in the accompanying fields.
   - Select the *Use data collection filter setting* option and process files using the masks and DOP filters that were set in the TerraSync software.
   - Select the *Use new filter settings* option to process files using the settings specified in this tab.

   The system uses files containing pseudorange data to increase the accuracy of positional calculations. This means that you can use data collection techniques such as velocity filtering to increase accuracy in the field, and also differentially correct the data in the office. Data collected using real-time correction sources such as SBAS can be postprocessed, as can data from rover positions using satellites not seen by the base station. (Rover data is recomputed using the satellites common to both rover and base station.)

4. Select the *Correct velocity records* check box to correct velocity records. Clear this check box to leave velocity records uncorrected.

Note – *To use velocity records, the TerraSync software must record velocity records.*

5. Select the *Re-correct realtime code positions* check box to improve the accuracy of real-time corrected positions. Clear this check box to leave real-time corrected positions unprocessed.
6. In the *Output* tab, select an option from the *Output Positions* group, which determines the data to be sent:
   - *Corrected only* – stores only corrected positions and velocity records.
   - *Corrected and uncorrected* – stores corrected and uncorrected positions and velocity records.
7. Select an option from the *Audit File Contents* group, which specifies what is written to the audit file:
   - *None* – no audit file is created.
   - *Standard* – creates an audit file that shows basic information about the differential correction session.
   - *Expanded* – creates an audit file that shows epoch-by-epoch information about the corrected file.
8. In the *Base* tab, select an option from the *Base Data Processing Technique* group:
   - *Standard* – the quickest method of differential correction. No filtering or smoothing is applied.
   - *With filtering* – filters the base data to provide slightly better corrections.
   - *With filtering and smoothing* – an advanced option that further reduces errors.

Note – *Filtering and smoothing operations increase the time to perform corrections. However, the base audit files will contain more detailed statistics on measurement residuals and rejected outliers.*

9. Select options in the *Base Data Filtering* group:
   - *Minimum elevation* – base station data from any satellite that is below the specific elevation is not used for differential correction.
   - *Minimum SNR (dBHz)* – specifies the minimum SNR value to be used. Base station data from any satellite that has an SNR below the specified value is not used.

Note – *These filters are controlled by the GPS slider bar in the TerraSync software.*

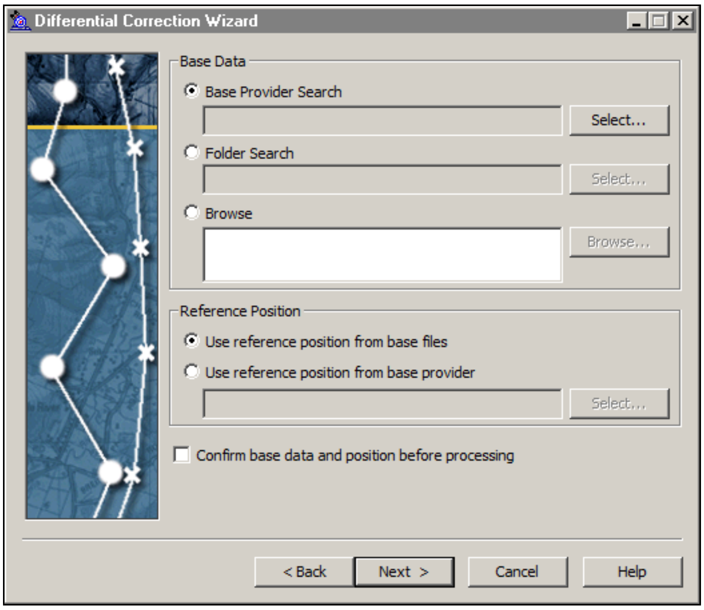
10. Click **OK** to save differential correction settings.
11. Click **Next.** The *Select Base Data* page of the wizard appears.

Select base files

The interface that appears will depend on whether or not your rover files contain H-star data.

Rover files without H-star data

If your rover files do not contain H-star data, the following page appears:

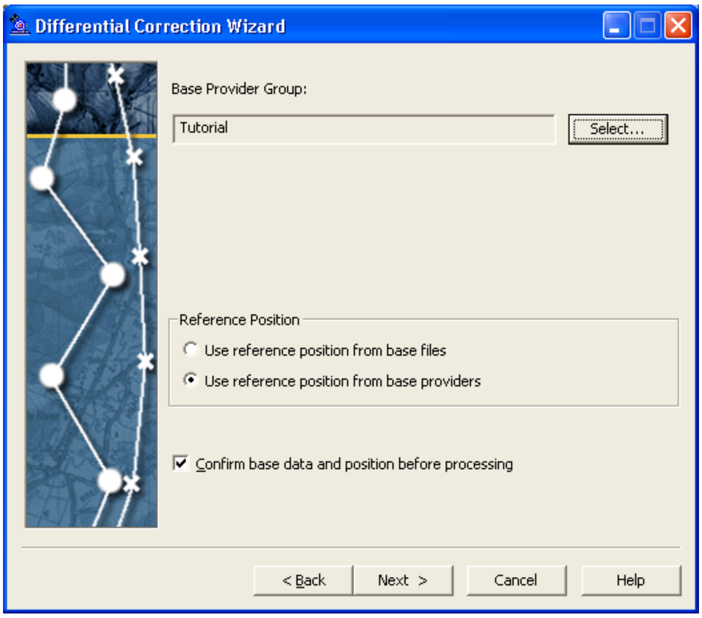


Do one of the following:

- If you are going to download files from the Internet select the *Base Provider Search* option and then click **Select**.
- If the base files are in the base folder for the current project select the *Folder Search* option. If the wrong folder is displayed and then click **Select** and choose the correct folder.
- If you want to manually select the base files, select the *Browse* option and then click **Browse**.
  In the *Open* dialog, navigate to the folder where the base files are stored, select the files you want to use and then click **OK** to return to the Differential Correction Wizard.

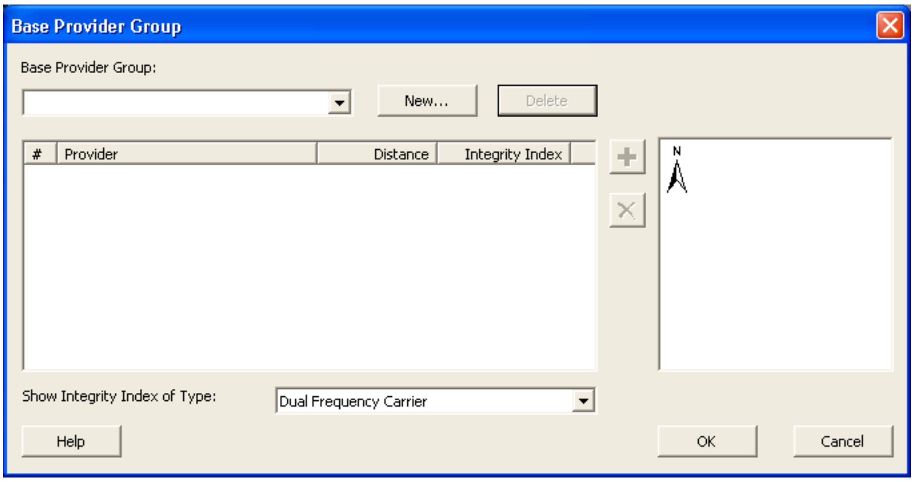
Rover files with H-star data

If your rover files contain H-star data the following page appears:



With H-star processing you can select more than one base station with which to correct your data. To do this, select a number of base stations and then save them as a group:

1. Click the **Select** button next to the *Base Provider Group* field. The *Base Provider Group* dialog appears:



The *Base Provider Group* dialog displays information about the selected base provider group. Each member of the group appears in the group member list, which displays the distance and integrity index records for the base provider. These details are the same as those in the parent *Base Provider* list displayed in the *Select Base Provider* dialog. The type of integrity index shown in the group member list depends on the type of data contained in the GPS sessions currently selected for differential correction. To display integrity index values of a different type, select a different type from the drop-down list.

Note – *The Integrity Index value is an indicator of the quality of the data provided by the base station. A poor Integrity Index value can indicate that the base provider is unreliable or often off line.*

2. Click **New** to open the *New Base Provider Group* dialog and create a new base provider group.
3. Click  to open the *Select Base Provider* dialog and select a base provider to add to the group. Repeat this process until you have added all the required base stations to your group.

   Next to the list of base provider group members, a map displays the approximate positions of the base providers, in relation to the rover. The reference position is the center coordinate of the current map view, projected into the WGS-84 geographic coordinate system.
4. Click **OK** to return to the Differential Correction Wizard.

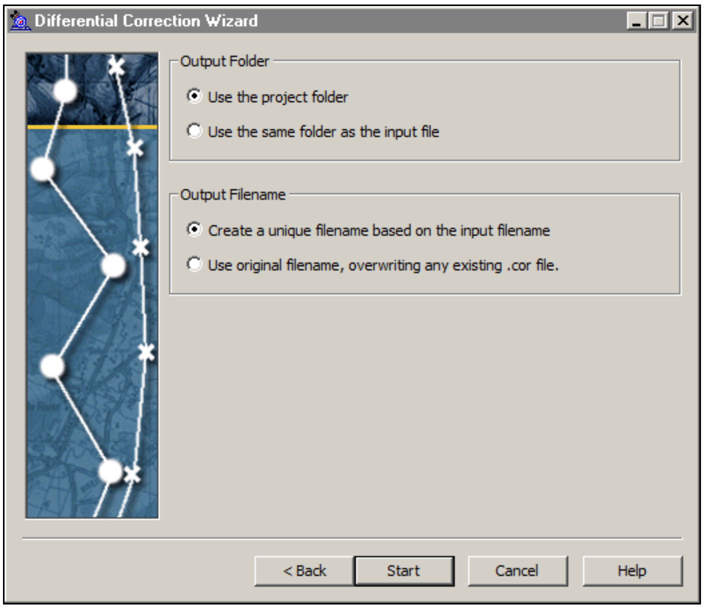
Reference Position settings

1. Select what you want to use as the source of the base station reference position. From the *Reference Position* option select one of the following:
   - *Use reference position from base files* - If you know the reference position for the base provider is incorrect, select this option to use the reference position specified in the selected base files. By default, these coordinates are taken from the first selected base file.
   - *Use reference position from base provider* - Select this option to use the recorded reference position of a selected base provider. This option is recommended, as the reference position recorded for a base provider is generally more accurate than the reference position provided in base files.

Note – *If there is no H-star data in the selected rover files, the name of the base provider selected to provide the reference position appears in the text box below this option. Click* ***Select*** *to select a different base provider.*

2. Confirm base data and position before postprocessing. Select the check box to confirm the co-ordinates of the reference position and the availability of the base files to be used. This information appears in the *Differential Correction Processing* window on the last page of the wizard before you start the correction process. If the check box is not selected, when you click **Start** on the last page of the Differential Correction Wizardm the correction process starts automatically without first checking that base data is available.

3. Click **Next.** The *Output* page of the wizard appears:



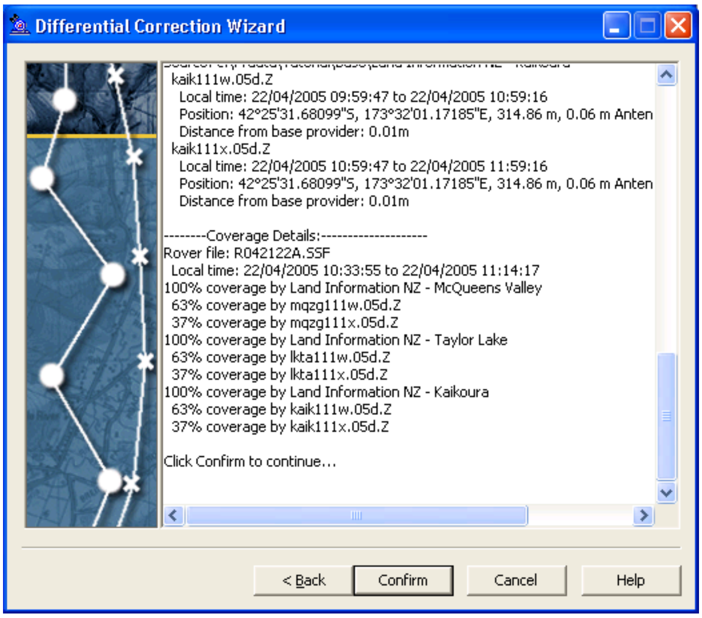
Select output options

1. Select the folder that you want to store the output files in from the following options:
   - *Use the project folder* - All output files will be stored in the same folder. By default, this is the current project folder.
   - *Use the same folder as the input file* - Output files will be stored in the same folder as the input folder. This allows you to select rover files from different folders, process them, and to store the corrected files with their corresponding input files.
2. Select how you want the output files named from the following options:
   - *Create a unique filename based on the input filename* - Automatically creates a unique filename, based on the input filename. The format for automatically created names is <input rover file>_<n>.cor, where n denotes the number of subsequent processing of the same rover file.
   - *Use original filename, overwriting any existing .cor file* - The output file has the same name as the input rover file, with a .cor extension. Subsequent processing of the same input file results in previous output files being overwritten.

Differentially correct your data

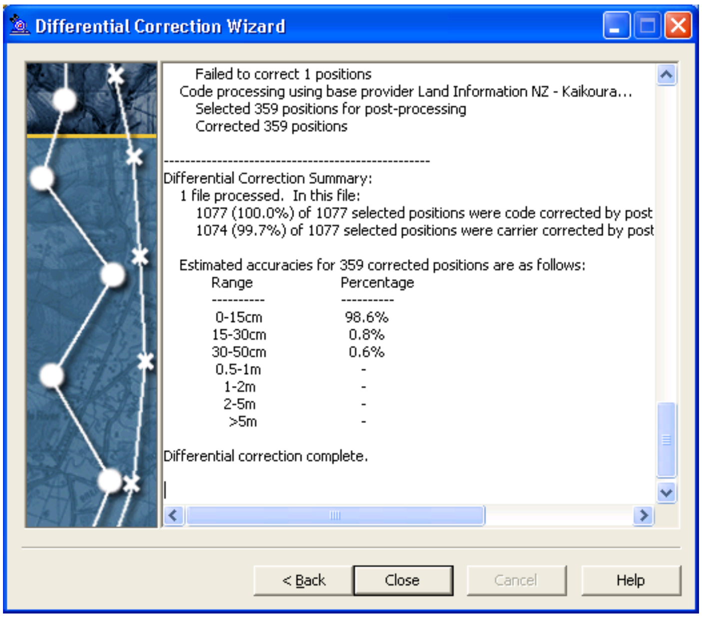
1. Select **Start**. The differential correction process starts.

   If you have chosen to *Confirm base data and position before processing*, a dialog similar to the following appears:



2. If the base data coverage and reference positions are correct, click **Confirm**. The data is processed.

   As the GPS Pathfinder Office software begins differentially correcting the selected SSF files, the *Correct processing* page of the wizard appears:



It displays details about the status of the differential correction process. The SSF files are processed sequentially. The Correct Processing page displays the number of corrected positions for each SSF file.

When the last SSF has been processed, the message Differential correction complete and a summary of the estimated accuracy values gained for the corrected GPS positions appears at the bottom of the Correct Processing page.

This summary provides immediate feedback on the quality of the corrected GPS positions. For example, if too few base providers were selected for multi-base processing, the results indicate this by showing large estimated accuracy values.

3. Click **Close**.

Note – *The most common reason for differential correction failure is choosing the wrong base files.*

View differential correction reports

View generated reports in a text editor such as Microsoft Notepad. There are two types of reports:

- Summary - Correct_DATE_TIME.txt - These are created upon conclusion of processing. These reports detail processing settings, files used, files created, and include a processing summary.
- Audit
  - Rover - RoverAudit_ROVERNAME_DATE_TIME.txt - Rover audit files contain a variety of information that can be used to trace the problems with differential correction. They list processing parameters, available ephemeris data, and the number of position and velocity records processed in each satellite constellation tracked. The files also contain the final warning and/or error messages that can indicate why a differential correction failed. Rover audit files are created in the same folder as the corrected rover files. One audit file is created per input rover file.
  - Base - BaseAudit_BASENAME.txt - Base audits files contain processing parameters, ephemeris data, and pseudo-range corrections for each satellite at the base logging interval. They are created in the same folder as the base file(s).

Exercise 4.3: Create a GIS export setup

This exercise:

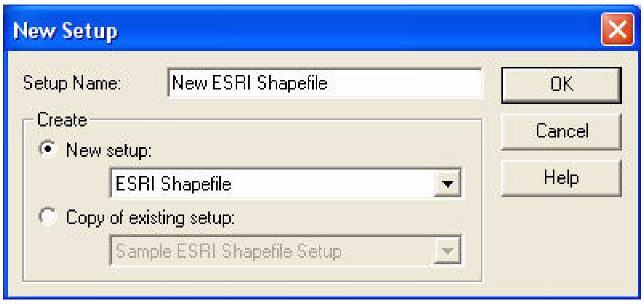
- Shows you how to use the Export utility to match GPS data to your GIS database.
- Defines options to convert this information to a format that matches an existing GIS or CAD database.

Many types of GPS data can be exported to a GIS, including features, attributes, not in feature positions, notes, velocity records, and external sensor records.

In this exercise, you will create a customized export setup, configure the format setup options, and export your corrected data file. Make sure you clearly understand the options offered to perform a GIS export. After completing this exercise, create an export setup that meets the requirements of your company's GIS.

Create your own GIS export setup

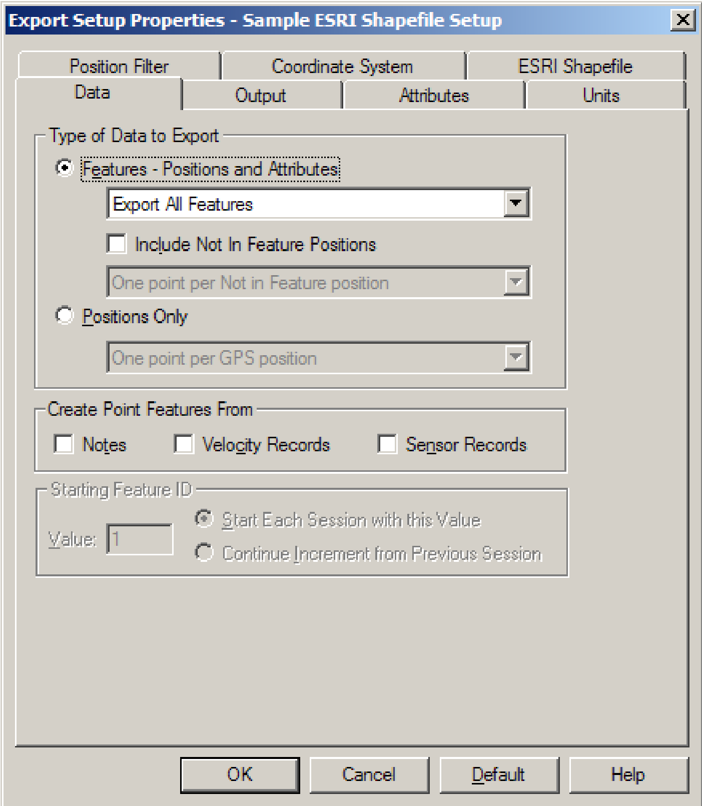
1. Select *Utilities* / *Export*.
2. In the *Export* dialog, click **New**. The *New Setup* dialog appears:



3. Enter a name for the new setup.
4. In the *Create* group, select the *New setup* option and then select ESRI Shapefile from the list.
5. Click **OK**.

Configure the format

1. Select the *Data* tab.



2. In the *Type of Data to Export* group, select the *Features / Positions and Attributes* option:

   – *Features - Positions and Attributes* – exports features and attribute information.

   – *Include Not in Feature Positions* – exports not in feature positions as either *one point per Not in Feature position* or as *one line per group of Not in Feature positions*.

   – *Positions Only* – exports positions as either one point per GPS position, one point per file (mean position), one line per input file, or one area per input file.

3. In the *Create Point Features From* group, you can export the following as point features:

   – Notes

   – Velocity records

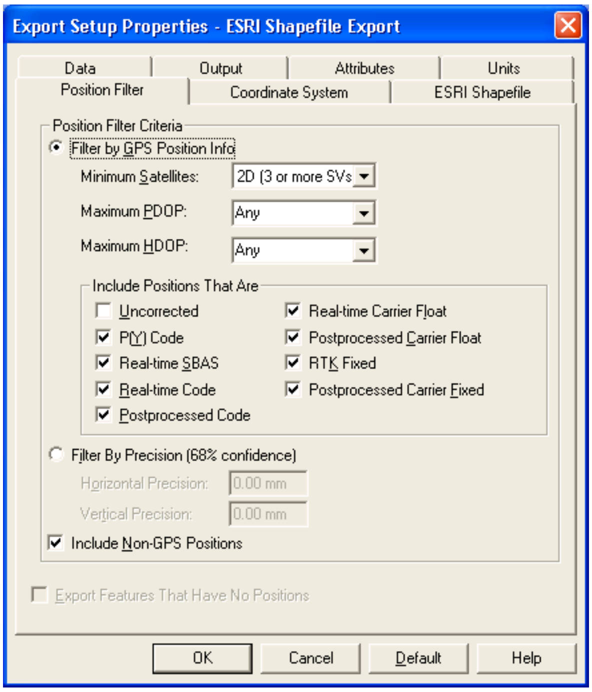
   – Sensor records

   A position for each note, velocity record, or sensor record is interpolated from GPS positions within the input file.

4. The *Starting Feature ID* group is only available for export formats that require a unique ID. The *Value* field specifies the starting feature ID for the session:
   - *Start Each Session with this Value* – specifies that the starting feature ID always starts at the value shown.
   - *Continue Increment from Previous Session* – the value field defaults to 1 plus the last feature ID exported in the previous session.

Include position filters

1. Select the *Position Filter* tab:



2. Select the *Filter by GPS Position Info* option.
   a. From the *Minimum Satellites* list, select 3D (4 or more SVs). This option exports only positions collected with a specified number of satellites. It does not filter out positions created manually (without GPS).
   b. From the *Maximum PDOP* list, select 6. This option filters out positions above a particular PDOP. Only positions with a PDOP less than or equal to this value are exported.
   c. From the *Maximum HDOP* list, select 12. This option filters out positions above a particular HDOP. Only positions with an HDOP less than or equal to this value are exported.
   d. In the *Include Positions That Are* group, select one or more of the following:
      – *Uncorrected* – the uncorrected positions are exported.

CAUTION – If you have uncorrected data in your GIS, you may compromise the accuracy standards of your existing GIS database.

– *P(Y) Code* – positions collected using P- or Y-code are exported. Only military receivers can log positions using these codes.
– *Real-time SBAS* – positions collected using SBAS real-time DGPS are exported.
– *Real-time Code* – positions collected using real-time differential GPS and computed using a code phase solution are exported.
– *Postprocessed Code* – positions corrected in the Differential Correction utility using the Code Processing options are exported.
– *Real-time Carrier Float* – (for RTK systems only.) Positions collected using real-time differential GPS and computed using a carrier float solution are exported.
– *Postprocessed Carrier Float* – positions that have a carrier float position. These positions were corrected using either the *H-Star processing* option in the Differential Correction Wizard, or using the *Smart Code and Carried Phase Processing* option or the *Carrier Phase Processing* option in the Differential Correction utility.
– *RTK Fixed* – (for RTK systems only.) Positions collected using real-time kinematic techniques and computed using a carrier fixed solution are exported.
– *Postprocessed Carrier Fixed* – positions corrected in the Differential Correction utility using the Centimeter Processing option, and having a carrier fixed solution, are exported.

e. Select the *Include Non-GPS Positions* check box to export positions that were collected manually, were originally imported from a GIS or CAD system using the *Import* utility, or were created with the *Create Feature* tool in the GPS Pathfinder Office software.

3. Select the *Filter by Precision (68% confidence)* option to filter a data set based on horizontal and vertical precision tolerances.
4. Select the *Export Features That Have No Positions* check box to include features that have no positions in the GIS or CAD output. This is useful when attribute information about a feature is gathered but GPS positions were unavailable.

Reference graphic data

1. Select the *Coordinate System* tab.
2. Select the *Use Export Coordinate System* option to export data in the coordinate system and zone configured in this tab.

   The *Use Current Display Coordinate System* option exports data as specified under *Options* / *Coordinate System* in the main GPS Pathfinder Office program.
3. Click **Change** to set the appropriate datum, coordinate system, and altitude reference.
4. Click **OK**.

Note – *The options in the Export Coordinates As group are available for formats that accept either two-dimensional or three-dimensional coordinates.*
XY – exports two-dimensional coordinates.
XYZ – exports three-dimensional coordinates.

Choose the output options

1. Select the *Output* tab.
2. From the *Output Files* group, select one of the following:
   - *Combine all input files and output to the project export folder* – a single output file (or set of output files) is created in the export folder.
   - *Combine all input files and output to an auto-generated subfolder* – a single output file (or set of output files) is created in a subfolder of the export folder.
   - *For each input file create output file(s) of the same name* – for each input file, an output file (or set of output files) with the same filename as the input file is created in the export folder.
   - *For each input file create output subfolder(s) of the same name* – For each input file, an output file (or set of output files) is created in a subfolder of the export folder.

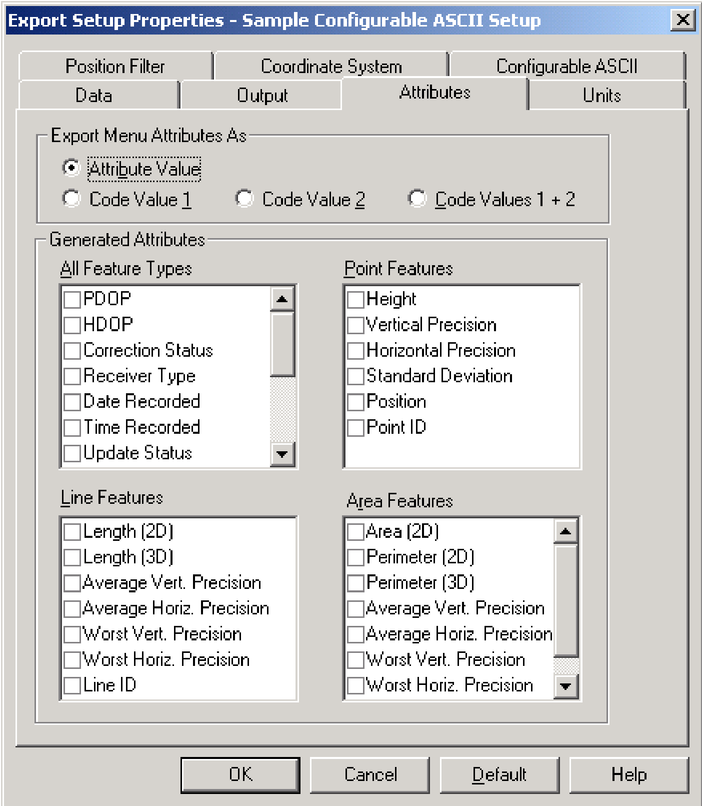
3. From the *System File Format* group, select the operating system of the computer for your GIS or CAD program.

Configure the units

1. Select the *Units* tab.
2. In the *Units* group, select *Use Export Units*. Data is exported in the units set in this tab. Click **Change** to reset the export units.
3. Choose the *Distance*, *Area*, and *Velocity Units* and then click **OK**.
4. Set the Decimal Places. These fields control the number of decimal places exported. The decimal places fields apply only to data exported in ASCII formats.
5. Select the *Latitude/Longitude Options*, if they are available:
   - *Format* – controls the style of exported Latitude and Longitude coordinates.
   - *Quadrant* – determines how the quadrant or hemisphere component of a Latitude/Longitude coordinate is exported. Select +/– to export Northern hemisphere latitudes and Eastern hemisphere longitudes as positive numbers, and Southern hemisphere latitudes and Western hemisphere longitudes as negative numbers. Select NS/EW to export hemisphere letters.
6. Choose from the following *Date/Time Options*, if available:
   - Time Format
   - Date Format

Include attributes

1. Select the *Attributes* tab:



2. In the *Export Menu Attributes As* group, select the *Attribute Value* option.

   – *Attribute Value* – exports the attribute value that was entered while collecting data.

   – *Code Value 1* – exports the first predefined code in the data dictionary.

   – *Code Value 2* – exports the second predefined code in the data dictionary.

   – *Code Values 1 + 2* – exports both predefined codes.

3. The *Generated Attributes* group includes additional attributes for documentation. Select any for your output file.

Group	Type	Exported attribute name
All Feature Types	PDOP	MAX_PDOP
	Correction Status	CORR TYPE
	Receiver Type	RCVR_TYPE
	Date Recorded	GPS_DATE
	Time Recorded	GPS_TIME
	Feature Name	FEAT_NAME
	Data File Name	DATAFILE
	Total Positions	UNFIL_POS Total number of positions of the feature in the SSF file.
	Filtered Positions	FILT_POS. Total number of positions of the feature after position editing.
Point Features	Height	GPS_CALC_HEIGHT Elevation of the point features. Use this attribute if your GIS or CAD system does not accept three-dimensional coordinates. Do not select this if your GIS or CAD system stores three-dimensional positions.
	Standard Deviation	STD_DEV The spread of positions averaged for the point feature. Standard deviation is not a measure of accuracy of a point feature's position. It indicates the spread of positions from the mean.
	Horizontal Precision	HORZ_PREC
	Vertical Precision	VER_PREC
Line Features	Length	GPS_LENGTH If your GIS or CAD system computes lengths internally, results may vary due to algorithmic processing.
	Average Horizontal Precision	AVG_HORZ_P
	Average Vertical Precision	AVG_VERT_P
	Worst Horizontal Precision	WORST_HORZ
	Worst Vertical Precision	WORST_VERT
Area Features	Area	GPS_AREA
	Perimeter	GPS_PERIMETER If your GIS or CAD system computes area and perimeter internally, results may vary due to algorithmic processing.
	Average Horizontal Precision	AVG_HORZ_P
	Average Vertical Precision	AVG_VERT_P
	Worst Horizontal Precision	WORST_HORZ
	Worst Vertical Precision	WORST_VERT

4. Click **OK** to save settings and return to the main *Export* dialog.

Export data

1. In the *Input Files* group, click **Browse**.
2. Select the corrected file to be exported (if it does not appear in the *Select Data Files* dialog) and then click **Open**.

   You can export multiple files that use the same data dictionary.
3. In the *Choose an Export Setup* group, verify that the newly created export setup is selected and then click **OK**.

   Processing begins.

   An *Export Completed* dialog informs you of the number of positions and features exported.
4. Click **More Details** to view the text file created from the export.
5. Click **Close** to exit the Export utility.

When you return to the office, create an export setup to match your company's GIS. If you are unsure of the settings that your GIS requires, write down the settings here and speak to your GIS specialist.

Glossary

This section defines technical terms and abbreviations used in this manual.

Accuracy
An indication of how closely a measurement is to the true value.

Almanac
Data transmitted by a GPS satellite, which includes orbit information on all the satellites, clock correction, and atmospheric delay parameters. The almanac is used to facilitate rapid SV acquisition. The orbit information is a subset of the ephemeris data with reduced precision.

Attribute
Characteristics of features in a Geographic Information System (GIS) or COordinate GeOmetry (COGO) package. Every identifiable feature has attributes. One common attribute of all survey features is geographic position. Other attributes depend on the type of feature. For example, a road has a name or designation number, surface type, width, number of lanes, and so on. Each attribute has a range of possible values, called a domain. The value chosen to describe a particular feature is called the attribute value.

Attribute value
A particular value for a feature, chosen from the domain of an attribute. For example, road is the feature, surface type is an attribute, gravel is an attribute value chosen from the domain of bitumen, gravel, and concrete.

Autonomous positioning
The least precise form of positioning that a GPS receiver can produce. The position fix is calculated in real time from satellite data alone. Autonomous positions are generally accurate to within 10–15 meters.

Base station
A base station is a GPS antenna and receiver positioned on a known location specifically to collect data for differential correction. Base data needs to be collected at the same time as you collect data on a rover unit. A base station can be a permanent station that collects base data for provision to multiple users, or a rover unit that you locate on known coordinates for the duration of the datalogging session.

Baud
A unit of data transfer speed (from one digital device to another) used in describing serial communications—generally one bit per second.

Bearing The direction from one point to another, usually measured clockwise from north. In the TerraSync software, the bearing indicates the direction from your current position to the target.

Broadcast server An Internet server that manages authentication and password control for a network of VRS™ servers, and relays VRS corrections from the VRS server that you select in the TerraSync software.

Carrier phase The difference between the carrier signal generated by the internal oscillator of a receiver and the carrier signal coming from the satellite.

Windows Mobile device A small, usually palm-size or handheld, computer that is capable of running the Microsoft Windows CE operating system. A Windows Mobile device usually has a small screen, and limited memory and storage space.

Centroid The calculated center of an area feature.

Coarse/Acquisition (C/A) Code A pseudorandom noise code (PRN) modulated onto a L1 signal. This code helps the receiver compute the distance from the satellite.

Code phase (also known as Coarse Acquisition code, or C/A code) The difference between the pseudorandom number code generated by the TerraSync software and the pseudorandom number code coming in from the satellite. The code phase data is used to quickly compute the distance to a satellite and therefore calculate your position.

Compact Measurement Record type 2 (CMR) A correction message that is broadcast by the base receiver and used in RTK surveys to calculate an accurate vector from the base to the rover.

Cross-track error The amount and direction by which your current heading differs from the cross-track line.

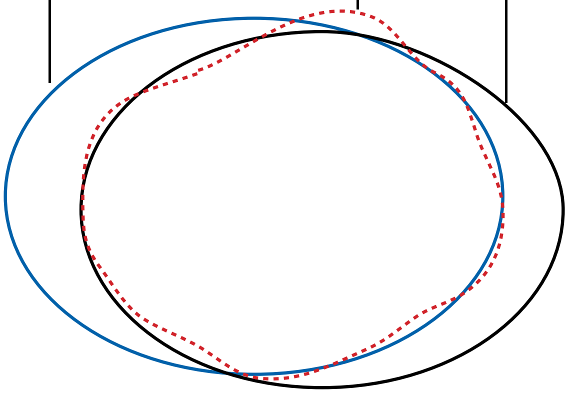
Cross-track line The shortest direct path from the navigation start to the navigation target.

Data collector In TerraSync documentation, a data collector is any computer that has the TerraSync software installed. The computer must either be a PC running a supported Microsoft Windows desktop operating system (for example, a tablet PC, laptop, or notebook computer running Windows 2000), or be a supported CE device.

Data dictionary Information that describes features that will be located in the field. This description includes feature names, data type classification (point, line, or area), attribute names, attribute types, and attribute values. After being created on a PC, a data dictionary is transferred to a datalogger and used when collecting data in the field.

Data message A message included in the GPS signal, which reports the satellite's location, clock correction, and health. It includes information on other satellites' health and their approximate positions.

Datum



A mathematical model of the earth's surface. World geodetic datums are typically defined by the size and shape of an ellipsoid and the relationship between the center of the ellipsoid and the center of the earth.

Because the earth is not a perfect ellipsoid, any single datum will provide a better model in some locations than others. Therefore, various datums have been established to suit particular regions.

For example, maps in Europe are often based on the European datum of 1950 (ED-50). Maps in the United States are often based on the North American datum of 1927 (NAD-27) or 1983 (NAD-83).

All GPS coordinates are based on the WGS-84 datum surface.

Datum transformation

Converts the coordinates of a position in one datum to coordinates in terms of another datum. The two types supported by the TerraSync software are three-parameter and seven-parameter. A datum transformation is used when the GPS results are required in terms of a local datum.

Declination

See magnetic declination.

Differential correction

Differential correction is the process of correcting GPS data collected on a rover with data collected simultaneously at a base station. Because it is on a known location, any errors in data collected at the base station can be measured, and the necessary corrections applied to the rover data.

Differential correction can be done in real time, or after the data has been collected by postprocessing.

Digitizing

The process of creating positions manually by selecting a point on a map.

Dilution of Precision (DOP)

An indicator of the quality of a GPS position, which takes account of each satellite's location relative to the other satellites in the constellation, and their geometry in relation 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)

HDOP – Horizontal (two horizontal coordinates)

VDOP – Vertical (height only)

TDOP – Time (clock offset only)

GDOP – Geometric

Dual-frequency receiver

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 by compensating for ionospheric delays.

Earth Centered, Earth Fixed (ECEF)

A cartesian coordinate system used by the WGS-84 reference frame. 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, the *x* axis passes through 0×N and 0×E, the *y* axis is perpendicular to the plane of the *x* and *z* axes.

EGNOS

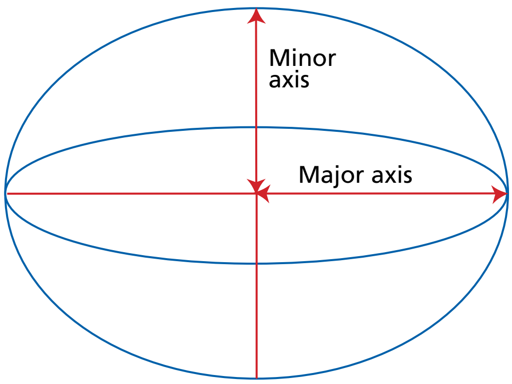
(European Geostationary Navigation Overlay Service)

A satellite-based augmentation system (SBAS) that provides a free-to-air differential correction service for GPS. EGNOS is the European equivalent of WAAS, which is available in the United States.

Elevation mask

See Minimum elevation.

Ellipsoid



The three-dimensional shape that is used as the basis for mathematically modeling the earth's surface. The ellipsoid is defined by the lengths of the minor and major axes. The earth's minor axis is the polar axis and the major axis is the equatorial axis.

Ephemeris The current satellite position predictions that are transmitted in the NAVDATA message.

Epoch The measurement interval of a GPS receiver.

Feature A physical object or location of an event. A feature can be a point (a tree or traffic accident), a line (a road or river), or an area (a forest or parking lot).

Fixed solution Indicates that the integer ambiguities have been resolved and that a survey is initialized.

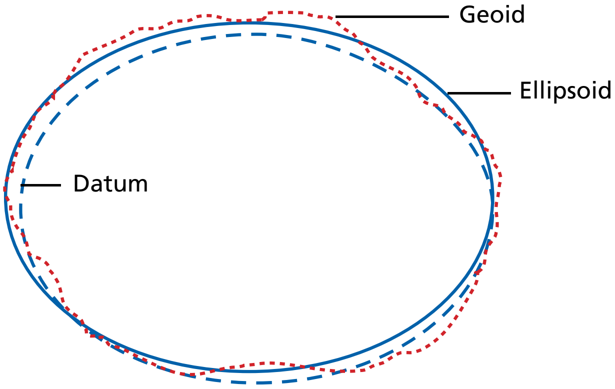
Float solution Indicates that the integer ambiguities have not been resolved and that the survey is not initialized.

Geodetic datum A mathematical model designed to fit part or all of the geoid (the physical earth's surface), which is defined by the relationship between an ellipsoid and a point on the topographic surface established as the origin of a datum.

World geodetic datums are typically defined by the size and shape of an ellipsoid and the location of the center of the ellipsoid with respect to the center of the earth.

Various datums have been established to best 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 on 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 three-dimensional shape that is used as the basis for mathematically modeling the earth's surface. The geoid is defined by the lengths of the minor and major axes. The earth's minor axis is the polar axis and the major axis is the equatorial axis.

Geometric Dilution of Precision (GDOP) The relationship between errors in user position and time and in satellite range. It is defined by the following equation:

$GDOP^2 = PDOP^2 + TDOP^2$. *See also* DOP.

Global Positioning System (GPS) Based on a constellation of 24 satellites orbiting the earth at a very high altitude.

Great-circle distance The great-circle distance is the shortest distance between two points on the surface of a sphere.

Guest A guest connection lets a Windows Mobile device exchange and share information with an office computer. You need a guest connection or a partnership to transfer data between the TerraSync software on your Windows Mobile device and the GPS Pathfinder Office software on your office computer.

When you connect as a guest, you can:

- move or copy files between the two computers
- back up files on your Windows Mobile device
- install or uninstall programs on your Windows Mobile device

However, you cannot synchronize data between the two computers when you connect as a guest. To synchronize data, you must set up a partnership.

A guest connection is temporary. When the guest Windows Mobile device is disconnected from the office computer, any settings for the guest connection are lost. The next time you connect the Windows Mobile device to the office computer, you must set the guest connection again.

Trimble recommends that you use a Microsoft ActiveSync technology partnership rather than a guest connection to connect your office computer and any Windows Mobile device running the TerraSync software.

Heading The direction you are facing or traveling, usually measured clockwise from north.

Height Above Ellipsoid (HAE) A method for referencing altitude. Altitudes expressed in HAE are actually giving the height above the datum, not the ellipsoid. GPS uses the WGS-84 datum and all heights are collected in relation to this surface. It is important to use the same datum when comparing altitudes in HAE.

Horizon The line at which the earth and sky seem to meet.

Horizontal Dilution of Precision (HDOP) *See* DOP.

H-Star H-Star data collection uses carrier phase data, but requires much shorter occupation times in the field than normal carrier phase data collection. To collect H-Star data, the TerraSync software must be connected to an H-Star capable receiver.

Initialization The technique performed in either real-time or postprocessed GPS surveying to resolve satellite integer wavelength ambiguities, therefore enabling centimeter-level positioning. Initialization types include *On-The-Fly* (*OTF*), *Known point*, *Initializer plate*, and *New point*.

Integer ambiguity The whole number of cycles in a pseudorange between the GPS satellite and the GPS receiver.

Ionospheric delay A wave propagating through the ionosphere experiences delay. The delay depends on electron content and affects carrier signals. Group delay depends on dispersion in the ionosphere as well, and affects signal modulation (codes). The phase and group delay are of the same magnitude but opposite sign.

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, 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 and a 50 bit/second navigation message.

Laser rangefinder An instrument that uses a laser beam to accurately measure the distance to a target. Some rangefinders also measure the bearing to the target. Use a laser rangefinder to measure offsets when you are unable to record positions at the exact location of the feature.

Latitude An angular measurement made from the center of the earth to north or south of the equator. It comprises the north/south component of the latitude/longitude coordinate system, which is used in GPS data collection.

Traditionally, north is considered positive, and south is considered negative.

Local ellipsoid The ellipsoid specified by a coordinate system. The WGS-84 coordinates are first transformed onto this ellipsoid before being converted to grid coordinates.

Longitude An angular measurement made from the center of the earth to the east or west of the Greenwich meridian (London, England). It comprises the east/west component of the latitude/longitude coordinate system, which is used in GPS data collection.

Traditionally, east is considered positive, and west is considered negative.

Magnetic declination The difference between magnetic north and true north. Declination is expressed as an angle and differs between locations.

Magnetic north A bearing that is relative to magnetic north uses the north magnetic pole as its north reference.

Map projection A defined method of transforming positions defined on an ellipsoid to a map grid; for example, the Transverse Mercator and Parallel Lambert projections.

Maximum PDOP The highest PDOP value at which a receiver will compute positions.

Mean Sea Level (MSL) A method of altitude reference. Altitudes expressed in relation to MSL actually give a height above the geoid.

It is important to use the same geoid when comparing altitudes in MSL.

Minimum elevation The angle below which Trimble recommends that you do not track satellites. It is normally set to 15° to avoid interference problems caused by buildings and trees and multipath errors.

MSAS (MTSAT Satellite-Based Augmentation System)

A satellite-based augmentation system (SBAS) that provides a free-to-air differential correction service for GPS. MSAS is the Japanese equivalent of WAAS, which is available in the United States.

MTSAT Satellite-Based Augmentation System See MSAS.

Multipath Interference, similar to *ghosts* on a television screen, which occurs when GPS signals arrive at an antenna after traversing different paths. The signal traversing the longer path will yield a larger pseudorange estimate and increase the error. Multiple paths may arise from reflections from structures near the antenna.

NAVDATA The Navigation Message broadcast by each GPS satellite on both the L1 and L2 beacons. This message contains system time, clock correction parameters, ionospheric delay model parameters, and the vehicle's ephemeris and health. A GPS receiver can use this information to process GPS signals and thus obtain user position and velocity.

NAVigation Satellite Timing And Ranging (NAVSTAR) The name given to GPS satellites.

Parity A form of error checking used in digital data storage and transfer. Options for parity checking include Even, Odd, and None.

Partnership

A partnership lets a Windows Mobile device exchange and share information with an office computer. You need a partnership or a guest connection to transfer data between the TerraSync software on your Windows Mobile device and the GPS Pathfinder Office software on your office computer.

A partnership stores information about:

- how to connect to the device
- what types of files you can send and receive
- what files you can synchronize
- how to manage synchronization
- how to convert files for transfer

Unlike a guest connection, a partnership is stored on the office computer and remains when the Windows Mobile device is disconnected from the office computer.

Trimble recommends that you use an ActiveSync partnership rather than a guest connection to connect your office computer and any Windows Mobile device running the TerraSync software.

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 mask

See Maximum PDOP.

Pocket PC

A lightweight personal computer, small enough to fit in your hand or pocket. Pocket PCs use the Windows Mobile version 5.0 software, which is based on the Windows operating system but is customized for computers with a limited screen size and memory.

Position Dilution of Precision (PDOP)

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, such as 3. Values greater than 7 are considered *poor*. Thus, small PDOP is associated with widely separated satellites. PDOP is related to horizontal and vertical DOP by the following formula:

$PDOP^2 = HDOP^2 + VDOP^2$. *See also* DOP.

Postprocessing

The processing of satellite data after it has been collected in order to eliminate error. This involves using office software to compare data from the rover to data collected at the base station.

Because the base station is on a known location, any errors can be determined and removed from the rover data.

Precision

A measure of the repeatability of a measurement.

Pseudorandom noise or number (PRN)
A signal that carries a code that appears to be randomly distributed like noise, but can be exactly reproduced. PRN codes have a low auto-correlation value for all delays or lags, except when they are exactly coincident. Each NAVSTAR satellite has its own unique PRN code.

Radio Technical Commission for Maritime Services (RTCM)
A commission established to define a differential data link for real-time differential correction of roving GPS receivers. There are two types of RTCM differential correction messages. All Trimble GPS receivers use the newer Type 2.2 RTCM protocol.

Raster
A raster graphic is a graphical image consisting of rows and columns of dots. The color of each dot is represented by the value of one or more data bits in the image file. A bitmap (.bmp file) is a type of raster image.

Reference station
See Base station.

Relative Dilution of Precision (RDOP)
Defined as follows:

$$\text{RDOP} = \sqrt{\sigma_{dx}{}^2 + \sigma_{dy}{}^2 + \sigma_{dz}{}^2}$$

It is usually in units of meters/cycle. Multiplying RDOP by the uncertainty of a double-difference measurement yields the spherical relative-position error. RDOP is used as a guide to the adequacy of receiver observations during real-time surveying measurements in Static mode. *See also* DOP.

Root Mean Square (RMS)
An expression of the accuracy of point measurement. It is the radius of the error circle, within which approximately 68% of position fixes are to be found. It can be expressed in distance units or in wavelength cycles.

Rover, roving receiver, roving unit, roving station
Any mobile GPS receiver and data collector collecting data in the field. A roving receiver's position can be differentially corrected relative to a stationary base GPS receiver.

Roving mode
During RTK data collection, the TerraSync software logs line and area features, and between feature positions, in roving mode. Point features and vertices are logged in static mode.

In roving mode, the TerraSync software records all RTK-corrected positions that meet the precision tolerances you have specified. All other positions are discarded.

RTK (real-time kinematic)
A real-time differential GPS method that uses carrier phase measurements for greater accuracy.

SBAS
(Satellite-Based Augmentation System)

SBAS is based on differential GPS, but applied to wide area (WAAS, EGNOS, MSAS). Networks of reference stations are used, and corrections and additional information are broadcast by geostationary satellites.

Selective Availability (SA)
Artificial degradation of the satellite signal by the United States of America Department of Defense. Selective Availability was turned off on May 10, 2000.

Signal-to-noise ratio (SNR)
(SNR)

The signal strength of a satellite is a measure of the information content of the signal, relative to the signal's noise. The typical SNR of a satellite at 30° elevation is between 47 and 50 dBHz. The quality of a GPS position is degraded if the SNR of one or more satellites in the constellation falls below 39.

The TerraSync software lets you set a minimum SNR value. This value is used to determine whether the signal strength of a satellite is sufficient for that satellite to be used by the GPS receiver. If a satellite's SNR is below the configured minimum SNR, that satellite is not used to compute positions.

SSF file (Standard Storage Format file)
A Trimble data file that stores GPS data from a mapping receiver. Usually, these files have the filename extension .ssf. A corrected SSF file has a .cor or .phs extension; an SSF file created by importing data has the extension .imp.

Static mode
During RTK data collection, the TerraSync software logs point features and vertices in static mode. Line features, area features, and between feature positions are logged in roving mode.

In static mode, the TerraSync software records only the RTK-corrected position with the best precision. All other positions are discarded.

SV
Satellite Vehicle or Space Vehicle.

Synchronization
The process where ActiveSync technology compares information on your Windows Mobile device with the corresponding information on your office computer, and then updates either computer with the latest information.

The data stored by the TerraSync software is not synchronized by ActiveSync technology. Use the Data Transfer utility in the GPS Pathfinder Office software to transfer data to and from the TerraSync software.

For more information, refer to the *ActiveSync Help*.

Time Dilution of Precision (TDOP)
See DOP.

Tropospheric delay
A wave propagating through the ionosphere experiences delay. The delay depends on electron content and affects carrier signals. Group delay depends on dispersion in the troposphere as well, and affects signal modulation (codes). The phase and group delay are of the same magnitude but opposite sign.

True north
A bearing that is relative to true north uses the north celestial pole as its north reference.

Universal Time Coordinate (UTC)
Local solar mean time at Greenwich Meridian. A uniform atomic time system maintained by the U.S. Naval Observatory and kept very close to UTC by offsets.

Vector
A vector graphic is a graphical image consisting of mathematical descriptions of lines, points, and areas.

When you transfer an SSF data file to the TerraSync software as a background file, its attribute information is removed, leaving only the vector information. You can view the features in the map, but you cannot select them, view their attributes, or edit them.

Velocity
A measure of speed that takes into account direction of travel as well as the distance traveled over a period of time.

Vertex
A point on a line or area feature where two adjacent segments of the feature join. Each position that you collect for a line or area feature is a vertex of that feature.

Vertical Dilution of Precision (VDOP)
See DOP.

VRS (Virtual Reference Station)
A system that consists of GPS hardware, software, and communication links. It uses data from a network of base stations to provide corrections to each rover that are more accurate than corrections from a single base station.

To start using VRS corrections, the rover sends its position to the VRS server. The VRS server uses the base station data to model systematic errors (such as ionospheric noise) at the rover position. It then sends RTCM correction messages back to the rover.

WAAS (Wide Area Augmentation System)

(Wide Area Augmentation System)

WAAS was established by the Federal Aviation Administration (FAA) for flight and approach navigation for civil aviation. WAAS improves the accuracy and availability of the basic GPS signals over its coverage area, which includes the continental United States and outlying parts of Canada and Mexico.

The WAAS system provides correction data for visible satellites. Corrections are computed from ground station observations and then uploaded to two geostationary satellites. This data is then broadcast on the L1 frequency, and is tracked using a channel on the GPS receiver, exactly like a GPS satellite.

Use WAAS when other correction sources are unavailable, to obtain greater accuracy than autonomous positions. For more information on WAAS, refer to the FAA website at http://gps.faa.gov.

The EGNOS service is the European equivalent and MSAS is the Japanese equivalent of WAAS.

Waypoint

A geographical point that, unlike a feature, holds no attribute information beyond a name and location. Typically, waypoints are used to denote objects whose locations are of primary interest, such as a survey mark. Waypoints are most often used for navigation.

The TerraSync software does not support waypoints explicitly. However, if you transfer a waypoint file to a Windows Mobile device running the TerraSync software, it is converted during transfer into a data file which contains only Waypoint point features. You can open this file as a data file or as a background file.

Web map server

An Internet site that lets users download GIS data, background, and other files for a specified geographical area. The TerraSync software can download raster background files from a Web map server.

WGS-84

World Geodetic System (1984). The mathematical ellipsoid used by GPS since 1984. *See also* Ellipsoid.