USER GUIDE

Trimble SCS900 software

Version 3.1
Revision A
February 2013

Trimble

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Legal Notices

NTP Software Copyright

Release Notice

This is the February 2013 release (Revision A) of the SPS Modular Receiver documentation. It applies to version 3.1 of the receiver firmware.

Product Limited Warranty Information

For applicable product Limited Warranty information, please refer to the Limited Warranty Card included with this Trimble product, or consult your local Trimble authorized dealer.

Safety Information

Before you use your Trimble product, make sure that you have read and understood all safety requirements.

WARNING – This alert warns of a potential hazard which, if not avoided, could result in severe injury or even death.

CAUTION – This alert warns of a potential hazard or unsafe practice that could result in minor injury or property damage or irretrievable data loss.

Note – *An absence of specific alerts does not mean that there are no safety risks involved.*

Use and care

This product is designed to withstand the rough treatment and tough environment that typically occurs in construction applications. However, the receiver is a high-precision electronic instrument and should be treated with reasonable care.

CAUTION – Operating or storing the receiver outside the specified temperature range can damage it.

Vehicle safety

Warning – When you select the Vehicle mode, the following warning message appears:

WARNING: Do not operate SCS900 while driving the vehicle. Failure to heed this warning may result in a collision causing property damage or personal injury.

Do not interact with the touch screen, keyboard, or software in any way while the vehicle is moving. While the vehicle is moving, the software provides a continuous display of position and data that can be seen at a glance. Operating the device or interacting with the software while the vehicle is moving can be a distraction for the operator, and may result in collision causing property damage or personal injury.

Servicing

Do not attempt to repair a Trimble Site Tablet or Trimble TSC3 controller. There are no user-serviceable parts inside. To arrange for a controller to be serviced, please contact your Trimble dealer.

Caution – When you select the Vehicle mode, the following warning message appears:

WARNING: Do not operate SCS900 while driving the vehicle. Failure to heed this warning may result in a collision causing property damage or personal injury.

Do not interact with the touch screen, keyboard, or software in any way while the vehicle is moving. While the vehicle is moving, the software provides a continuous display of position and data that can be seen at a glance. Operating the device or interacting with the software while the vehicle is moving can be a distraction for the operator, and may result in collision causing property damage or personal injury.

Accessories

Caution – Use only approved accessories with this equipment. In general, all cables must be high quality, shielded, correctly terminated, and normally restricted to two meters (6.56 feet) in length. AC adapters approved for this product have special provisions to avoid radio interference and must not be changed or substituted. Unapproved modifications or operations beyond, or in conflict, with these instructions for use may void authorization by the authorities to operate the equipment

Contents

CHAPTER 1

Introduction

In this chapter:

This manual provides you with the necessary information to perform measurement tasks with the Trimble® SCS900 site controller software. To perform these measurement tasks, you need the SCS900 site controller software running on a controller that is either connected to a Precision or Location GNSS system, or to a total station. You can also use the internal GPS of the device to locate objects. The SCS900 software is the field software that runs on a Trimble Site Tablet and the Trimble TSC3 controller. For presentation and training purposes, a software emulator that runs on a Windows operating system is also available.

The SCS900 software is a site measurement tool that streamlines earthworks and surface finishing operations. It enables construction contractors to measure material volumes, monitor grades and laid material thicknesses, and to perform site measurement tasks such as point, line, and surface stakeout.

Start up and set up of the sophisticated GPS and total station technology is quick and easy. The software manages data for multiple project sites, single large project sites, and large sites that have been divided into zones. When a field engineer opens a work order, the software opens all data files needed to complete that work order. Because the software delivers results immediately, informed decisions can be made in the field.

The software can also be used to check site grading operations that have been performed using a machine control system, such as a Trimble

GCS900 Grade Control System. If your organization does not have a 3D machine control system, the system provides site control, grade control, progress volumes, and stakeout capabilities to facilitate earthmoving operations.

The field engineer can quantify progress, check data, and set out the information needed to keep the machines moving. The SCS900 system tracks activities at each site and keeps a continuous record of all results. Related data is stored, together, as a permanent construction record and is also output as a TXT or DXF file. Back at the office, the software delivers comprehensive operation analysis data.

Even if you have used other GNSS or GPS products before, Trimble recommends that you spend some time reading this manual to learn about the special features of this product. If you are not familiar with GNSS or GPS, visit the Trimble website (www.trimble.com).

Related information

Sources of related information include the following:

- Release notes – The release notes describe new features of the product, information not included in the manuals, and any changes to the manuals. They can be downloaded from the Trimble website at www.trimble.com/construction/heavy-civil/site-positioning-systems/scs900.aspx?dtID=support.
- Trimble training courses – Consider a training course to help you use your GNSS system to its fullest potential. For more information, go to the Trimble website at www.trimble.com/training.html.

Technical support

If you have a problem and cannot find the information you need in the product documentation, contact your local dealer. Alternatively, go to the Support area of the Trimble website (www.trimble.com/support.shtml). Select the product you need information on. Product updates, documentation, and any support issues are available for download.

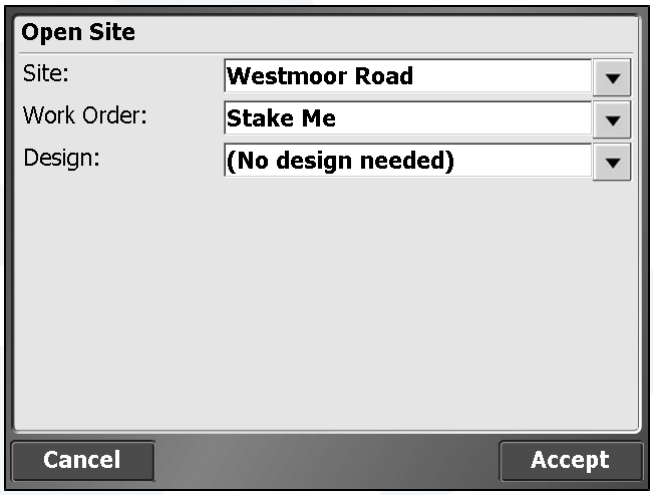
If you need to contact Trimble technical support, complete the online inquiry form at www.trimble.com/support_form.asp.

CHAPTER 2

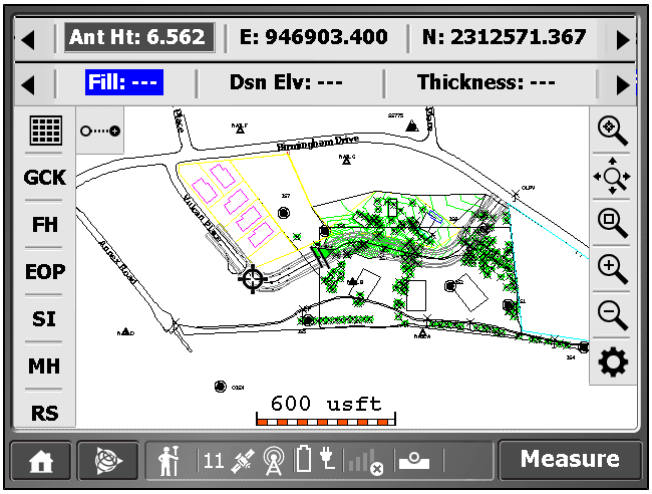
Starting the Software

In this chapter:

To start the SCS900 software on your controller, tap **Start** and then select Trimble SCS900. The SCS900 software will start in the *Open Site* dialog where you can select an existing site, design, and work order on your controller or create a new one.



After accepting the selection, the software will load your data and load the map view. If you have previously connected a rover receiver to the site base station, the software tries to automatically connect with the last used configuration.

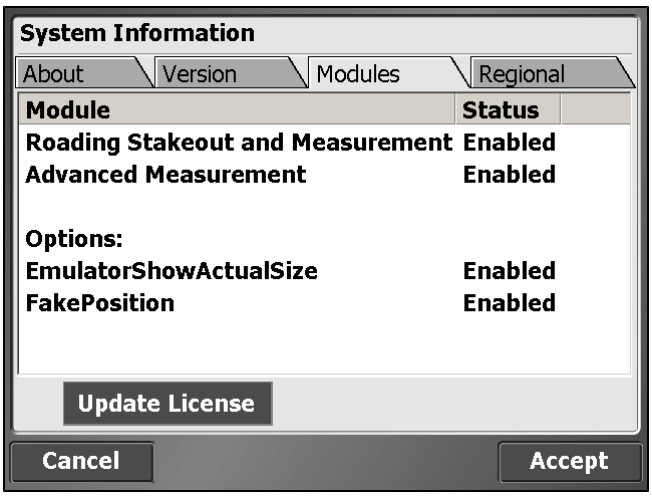


If the software is not automatically connecting to your positioning device, go to the *Home* menu and tap GPS or Total Station to start the setup.

System information

The *System Information* dialog has multiple tabs that contain information about the current version of the SCS900 software, which modules are enabled, which positioning sensors are connected and which firmware the sensors have. From the Trimble icon menu, select *System Info*.

If you have purchased a module after the controller was activated, activate the new module by tapping **Update License** in the *Modules* tab.



In the *Regional* tab, you can toggle between different supported languages:

CHAPTER 3

Menus

In this chapter:

The software is a menu-driven system. From the *Map* screen you can access the main menu through the **Home** button at the bottom left of the screen. The Trimble icon menu next to it contains related functions to the mode currently in use.

The Home menu

The *Home* menu is the main menu of the SCS900 software. It contains the following buttons:

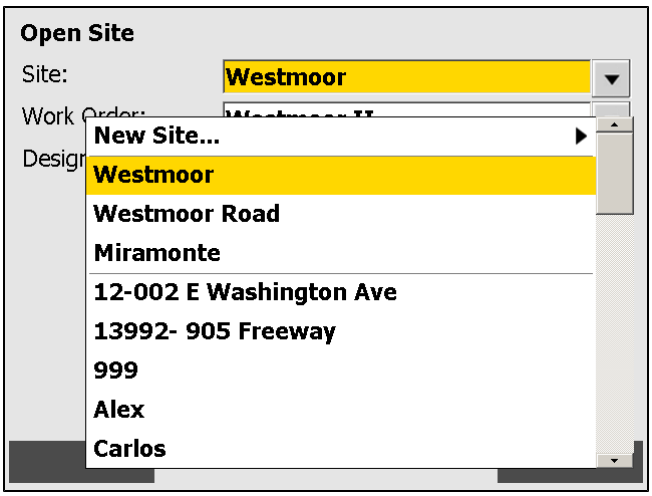
To access it, tap  .

The Site menu

The *Site* menu contains the tools to create, open, and complete sites, designs, and work orders. You can also change the design referenced by the current work order, and create new designs.

From the *Home* menu, tap **Site**.

You can create a new site, design, and work order. At the top of each list, the software displays the last three items that have been used and then all remaining data on the controller:



The GPS menu

The *GPS* menu contains the control and system setup functions for GNSS operation. Use this menu to start the rover receiver, carry out a site calibration, or select a predefined coordinate system. You can also enter and edit control point information, measure new control points for the project, and recheck the system setup on a control point.

From the *Home* menu, tap **GPS**.

The following commands are available from this menu:

Command	Description
	Set up and start a GNSS base station, rover receiver, configure static measurements, or start the internal GPS of the controller.
	Perform or resume a single-point, two-point, or multi-point site calibration.
	Select a predefined coordinate system from the coordinate system library.
	Check an existing site calibration on a known control point.
	Edit and enter control point coordinates.
	Measure new control points.

The Total Station menu

The *Total Station* menu contains the control and system setup functions for total station operation. Use this menu to connect the instrument and carry out total station setup to establish the position and orientation of the instrument. The menu provides access to all total station control functions. General functions include being able to enter and edit control point information, measure new control points for the project, and recheck the system setup on a control point.

From the *Home* menu, tap **Total Station**.

The following commands are available from this menu:

Command	Description
	Connect to the total station using either a cable, Bluetooth® wireless technology, or a radio for robotic operation.
	Set up the total station and establish its position and orientation on the site using the known point or arbitrary location (also known as free station or resection) methods.
	Check an existing site calibration on a known control point.
	Edit and enter control point coordinates.
	Measure new control points.

The Import/Export menu

Use this menu to export measured information or selected design information to an external memory device such as a USB flash drive. It also includes export functions for data use in the GCS900 Grade Control System or the Accugrade machine control systems.

From the *Home* menu, tap **Import/Export**.

The following commands are available from this menu:

Command	Description
	Write the surface data that was measured in the field to a new design surface.
	Export measured data in a CSV File or in a DXF File, write the measured data in a Record.txt file, or export data as a custom report using a stylesheet template.
	Export a design to a CompactFlash card or USB drive for use with the GCS900 Grade Control System.
	Synchronize data with the Connected Community service using the Wireless Data Sync function.
	Enter the device credentials to access the Connected Community service.

The Measure menu

The software always initially starts in the Measurement mode. Use this option to switch between stakeout and measure.

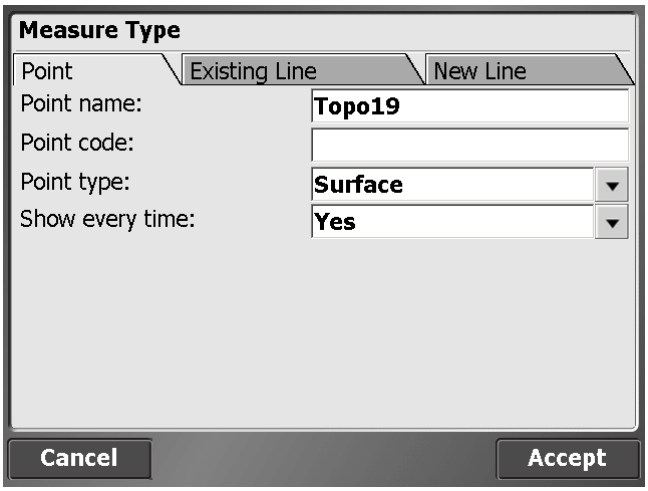
From the *Home* menu, tap **Measure**.

In this menu, you can accomplish all site measurement functions including:

- Grade checking
- Material thickness checking
- Topographic measurements to create surface models (for example, volume computations)
- Site feature measurements to record the location of non-surface features
- Real-time cut/fill information against a selected design model

Before you use this menu, set up your GPS or total station function in the *Home* menu. If you have not yet done a system setup when you select an option in this menu, the software automatically puts you through either the station establishment process for a total station, or the rover setup for GNSS.

If points or lines are stored as part of a DTM surface or only as a site feature, they can be defined in the *Measure Type* dialog to the left of the status bar. When the Advanced Measurement module is installed, the measurement type is controlled by the settings in the Feature Code Library for each feature code.



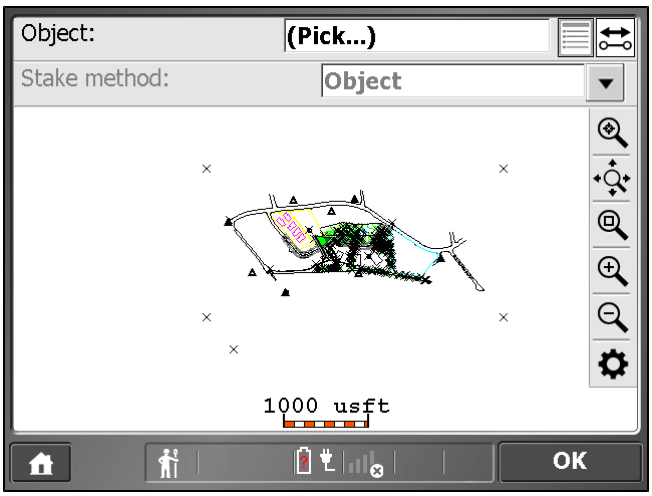
The Stake menu

The *Stake* menu contains all stakeout functions including staking points, lines and alignments, surfaces, side slopes, catch points, and road features. Before you use this menu, set up the system using the *System Setup* menu.

From the *Home* menu, tap **Stake**.

After selecting the stakeout function, the *object selection* screen appears. Select the object that you want to stake out either directly from the map or from the list in the top right corner of the screen  .

After you select an object, multiple stake methods are available that differ depending on the type of object that you selected. For more information, see Stakeout Workflow, page 57.



The COGO menu

The *Volume & COGO* menu contains a number of calculations, for example, area, distance, bearing, slope, and point generation functions that can be used to generate points for stakeout operation from CAD data in the currently loaded design. The menu also provides access to review and edit functions for editing breaklines and deleting points or lines to resolve surface modeling problems.

From the *Home* menu, tap **COGO**.

The following commands are available from this menu:

Command	Description
	View or delete point and lines, add breaklines and boundaries, and calculate surface volumes (stockpiles) or periodic progress volumes.
	Create points by a variety of methods including free point, radius, and offset to a line. To create free points, tap the screen or enter its coordinates.
	View all stakeout points of the currently selected design and edit their coordinates.

The Exit menu

This menu closes the SCS900 software, and optionally can shut down the receiver.

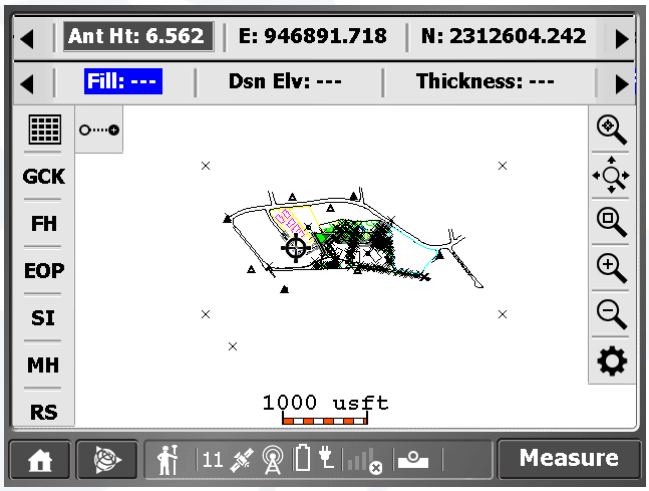
From the *Home* menu, tap **Exit SCS900**.

CHAPTER 4

Measurement screen

In this chapter:

The software is a menu-driven system. From the *Map* screen you can access the main menu through the **Home** button at the bottom left of the screen. The Trimble icon menu next to it contains related functions to the current mode in use.



Measure modes

The Measure mode controls a number of functions for the GPS receiver and total station. There are multiple modes available, which you can switch between by tapping the Measure Mode icon on the left side of the status bar or in the Trimble icon menu in the Measure Mode option.

GPS measure mode

GPS measure mode	Name	Description
	Standing	Walk to a point and then take a single measurement.
	Walking	Walk the site and continuously take measurements. Points are stored based on a setting for horizontal distance and elevation change, which can be set by tapping the Measure mode icon either in the status bar or in the Trimble icon menu.
	Vehicle	Drive the site in a vehicle. Points are stored based on a setting for horizontal distance and elevation change, which can be set by tapping the Measure mode icon either in the status bar or in the Trimble icon menu.
	Static	Measure a point for a longer period and to achieve a greater accuracy.

Total Station measure mode

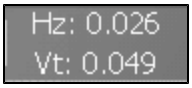
Total Station measure mode	Name	Description
	Standing	Walk to a point and then take a single measurement.
	Walking	Walk the site and take continuously measurements. Points are stored based on a setting for horizontal distance and elevation change, which can be set by tapping the Measure mode icon either in the status bar or in the Trimble icon menu.
	Vehicle	Drive the site in a vehicle. Points are stored based on a setting for horizontal distance and elevation change, which can be set by tapping the Measure mode icon either in the status bar or in the Trimble icon menu.

Total Station measure mode	Name	Description
	Averaging	Measure a point in multiple faces/rounds.
	DR	Measure a point using a DR reflectorless total station.

Status bar

The status bar at the bottom of the screen contains relevant information about the current status of the positioning system, battery status, measure mode, and measurement type. The icons change slightly depending on the positioning device. The following icons are typically available:

GPS mode

Icon	Description
	Indicates the current measure mode in use. See Measure modes, page 23
	The number of satellites being tracked and radio connection status to the base station.
	The horizontal and vertical precision of the GPS position solution.
	The battery level of the controller and externally connected GNSS receiver.
	Cell signal reception for the internal cell modem.
	Measurement type (Point, Line, Surface Feature).
	Random/Fixed Station Mode Staking.
	Stake Method.

Total Station mode

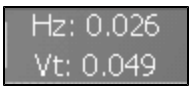
Icon	Description
	Indicates the current measure mode in use. Please read the chapter about measure mode for a more detailed description.
	Target Tracking Status and access to the control panel.
	Shows the battery level of the controller and total station.
	Cell signal reception for the internal cell modem.
	Measurement type (Point, Line, Surface Feature).
	Random/Fixed Station Mode Staking.
	Stake Method.

Precision GNSS control icons

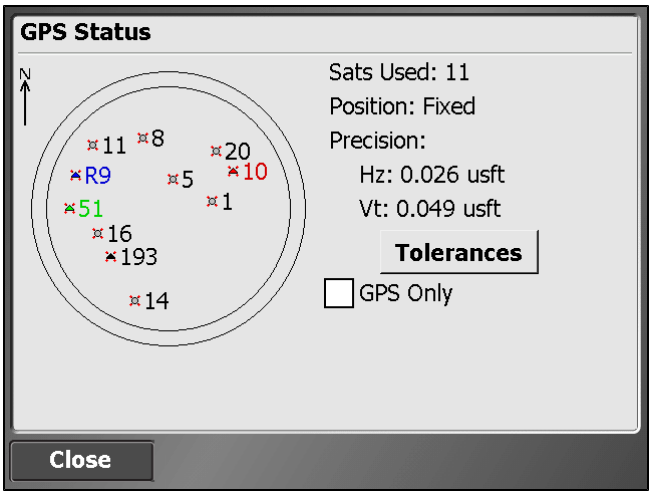
When using the internal GPS or while connected to an external SPS receiver, an icon panel appears at the bottom of the screen. The display swaps permanently between the following two panels:

GPS mode

This icon...	Shows...
	how many satellites are being tracked.
	the radio connection status.

This icon...	Shows...
	the battery level of the controller.
	the battery level of the GNSS receiver.
	the horizontal and vertical precision of the GPS position solution.

Tap one of these icons to show more detailed information. To access the sky plot of the current satellite constellation, tap the Satellite icon:



The **Tolerances** button, which appears when the controller is connected to an SPS receiver, is a shortcut to the RTK Precision option. The *GPS Only* check box enables you to toggle between using GPS and GNSS.

Map options

Map options enables you to customize what you see on the map. You can choose the information that you want to view for the task rather than cluttering the screen with too much information.

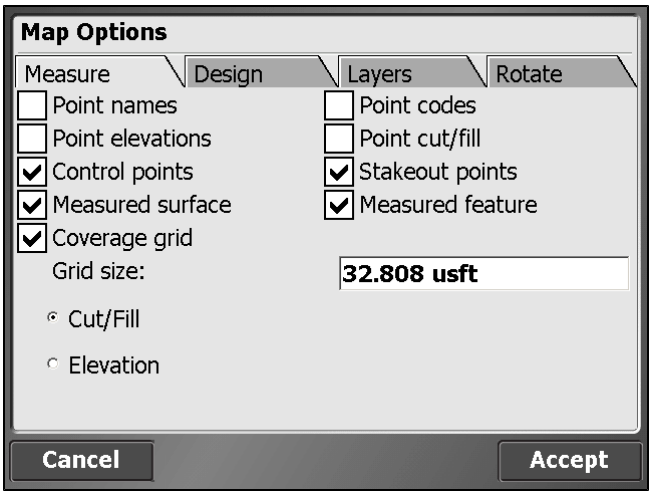
Map control

The icons on the right of the screen enable you to move around the screen and toggle information on and off to improve readability when there is a lot of information shown on the screen.

Icon	Description
	Center the map on the current location.
	Zoom to the extents of the file.
	Zoom to a user-defined box (use a stylus to draw a box on the screen).
	Zoom in.
	Zoom out.
	View the display options.
	Toggle between the Plan and Cross Section view when staking lines and roads.

Measure tab

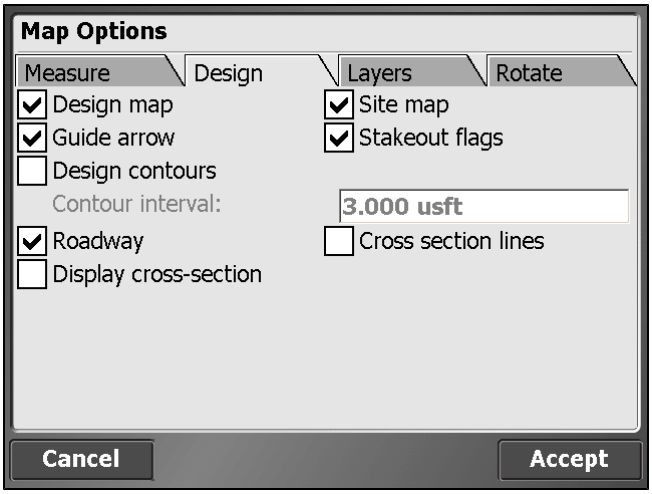
Use the *Measure* tab to filter the different measured data that is being displayed:



Select this option...	to display...
Point names	the point names of every point on the map view.
Point elevations	the point elevations of every point on the map view.
Control points	control points on the map view.
Measured surface	measurements that were recorded as a surface.
Coverage grid	a coverage map that shows cut/fill in tolerance values as red/blue/green or different shades of blue to represent elevation changes depending on the setting of the radio button.
Point codes	the point codes of every point on the map view.
Point cut/fill	the cut/fill information for every point on the map view.
Stakeout points	stakeout points on the map view.
Measured feature	measurements that were recorded as a site feature.

Design tab

Use the *Design* tab to filter the different design data types that are displayed:

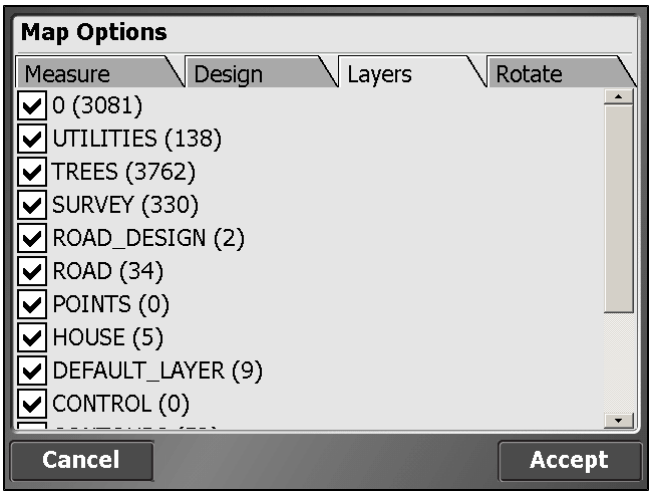


Select this option...	to display...
Design map	the design map on the map view.
Guide arrow	the guidance arrow to navigate to points of interest.
Design contours	contours on the map view, if a design is loaded.
Roadway	the center line of any roadway design.

Select this option...	to display...
Display cross-section	display the slope values for each segment of a road cross section.
Site maps	the site map on the map view.
Stakeout flags	stakeout flags on the map view.
Cross section lines	the cross sections of any loaded roadway design.

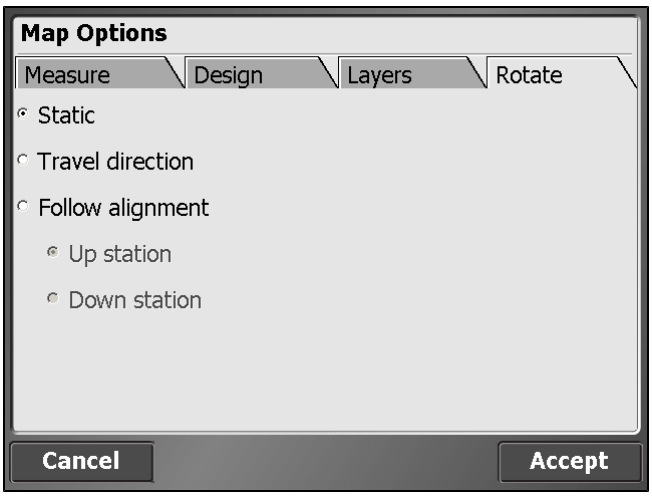
Layers tab

If there is a lot of data displayed, use the *Layers* tab to turn layers on and off in the design map to improve readability.



Rotate tab

Use the *Rotate* tab to control the map rotation of the *Measurement* screen:

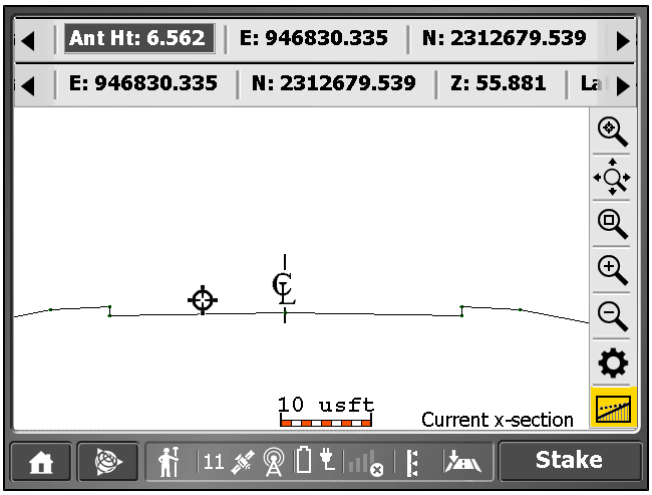


Select this option...	to orientate...
Static	the map view to North.
Travel direction	the map view to your direction of travel/walking.
Follow alignment	(This option is only available when an alignment is selected.)
Up station	the screen up station.
Down station	the screen down station.

Note – *When any option other than Static is selected, a North arrow automatically appears on the screen.*

Toggling between Plan and Cross Section view

If road or alignment data is loaded in the current design, a button on the bottom right of the screen enables you to toggle between Plan and Cross Section view. A highlighted button shows that the Cross Section view is enabled.



Info bars

At the top of the screen there are two bars that show readings and values related to the current operation:

Use the arrows on the right and on the left to scroll through the different values which are currently enabled. You can also tap on the bar and "flick" through the different values. For each function, a predefined set of values is shown. You can modify the settings in the Trimble icon menu with the *Configure Info Bars* option.

Some fields (for example, Antenna & Target Height, Stakeout line offset, and Surface offset) are "active" fields. By tapping on it, you can change the settings and shortcut in the *Settings* dialog of this value.

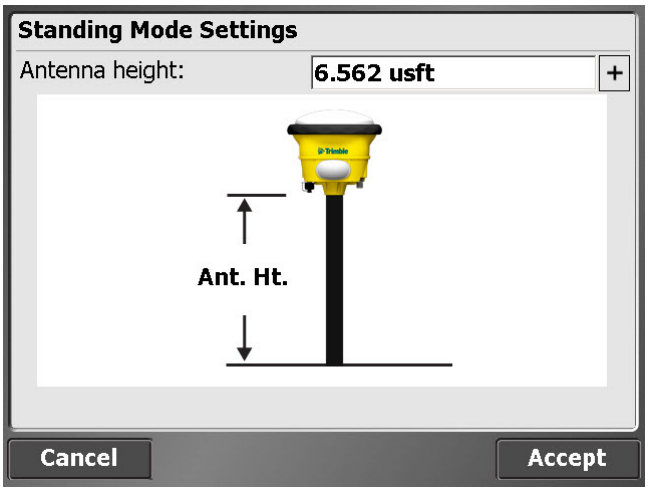
The following values are available:

This value	Shows the...
Ant Ht	currently applied antenna height.
Tar. Ht	currently applied target height.
E	current Easting in the selected/applied coordinate system.
N	current Northing in the selected/applied coordinate system.
Elv	current Elevation in the selected/applied coordinate system.
Horizontal angle	current horizontal angle the instrument is shooting.
Vertical angle	current vertical angle the instrument is shooting.
Slope distance	current slope distance the instrument is shooting.
Lat	current latitude in WGS-84.
Long	current longitude in WGS-84.
Ht	current height in WGS-84.
Sta	current station to a selected road or alignment.
Off	current offset from a selected road or alignment.
Go	distance and direction guidance to a selected point or object.
Cut/Fill	cut/fill value to a selected point, line, road, or alignment.
Dsn Elv	design elevation of a selected point, line, road, or alignment. An arrow next to the value indicates if a surface offset has been applied.
Thickness	current thickness of a layer vertical on the last layer.

This value	Shows the...
R. Sta	current station to the selected reference alignment.
R. Off	current offset to the selected reference alignment.
dE	difference in East to a selected point or object.
dN	difference in North to a selected point or object.
dElv	difference in Elevation to a selected point or object.
Ahead/Back	difference in station to a selected point along the selected alignment.
Inward/Outward	difference in offset to a selected point relative to the selected alignment.
Feature 2 cut/fill	Cut/Fill 1–2 when using a primary and underlying surface.
Feature 2 design elevation	design elevation of a selected point, line, road, or alignment.
Dsn Sta	station to a selected point per design.
Stakeout line offset H	Currently-applied horizontal line offset.
Stakeout line offset V	Currently-applied vertical line offset.
Surface offset	Currently-applied surface offset.

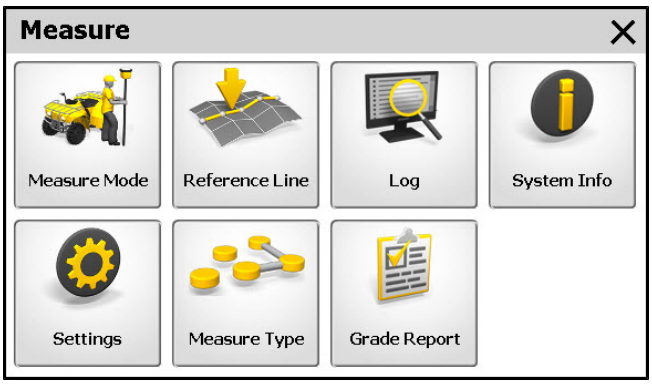
Antenna Height / Target Height

To change the antenna or target height, tap on the value in the info bar. This value is subtracted from each GPS elevation or elevation measured with a total station. If the antenna/target height is currently not displayed in the info bar, turn it on in the Trimble icon menu using the *Configure Info Bars* option.



Trimble icon menu

Tap the Trimble button  to directly access functions related to the current operation. A menu similar to the one shown below appears:



The content alters with the current function and available data.

Measure menu

Icon	Description
	Toggle between Standing, Walking, Vehicle, Static, and Averaging Mode.
	Select a reference line or alignment to get station and offset in addition to the current function in use.
	View the log file of the current work order.
	System information about the software including any modules installed.

Icon	Description
	Configure the info bar or adjust the stakeout settings like settings for the stakewriter tool, the Line settings, or the Road settings.
	Toggle between measuring points, lines, surface, and site features.
	Generate a statistic about the quality of a surface grade check.

Stakeout menu

Icon	Description
	Toggle between Standing, Walking, Vehicle, Static, and Averaging mode.
	Select a reference line or alignment to get station and offset in addition to the current function in use.
	View the log file of the current work order.
	System information about the software including any modules installed.

Icon	Description
	Change the settings for the stake writer tool, for example, the dimensions of your stake and the stake marking method.
	Configure the info bar or adjust the stakeout settings like settings for the stakewriter tool, the Line settings, or the Road settings.
	Stake a different object.
	Stake a point with a different design elevation.
	Stake a different station.
	Stake a feature with an offset.

CHAPTER 5

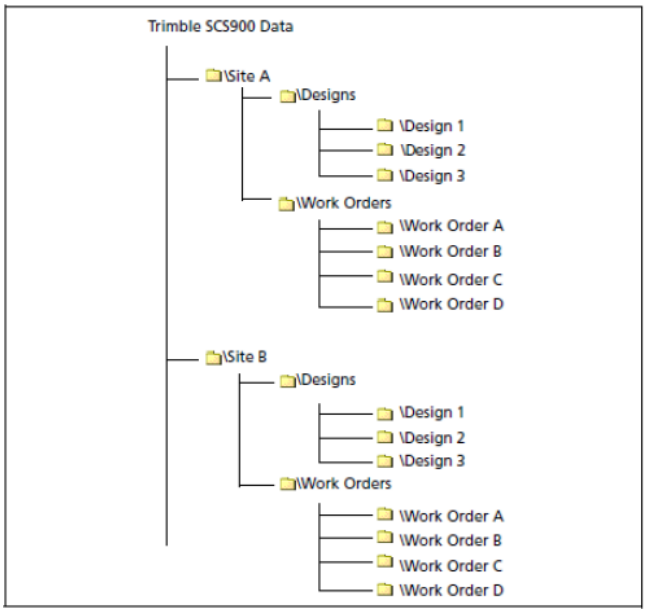
Data Management

In this chapter:

Trimble recommends that you use the latest version of the Business Center – HCE software to prepare the data that should be used with the SCS900 software. The Business Center – HCE software incorporates the capabilities of the SCS Data Manager and Report Utility for multiple jobsite/controller management and generating work order reports. The correct file folder structure is automatically created and quality assurance tools are available to ensure that all controllers are using the most recent data.

Sites, Designs, and Work Orders

All data for the software is stored in a top-level folder called Trimble SCS900 Data, and is organized in a precise structure. The file folder structure that you create on the office computer exactly mirrors the file folder structure on the controllers, which makes it easy to manage and archive data between the computer and the controllers. Data is organized by site. Within each site, data is divided into designs and work orders.

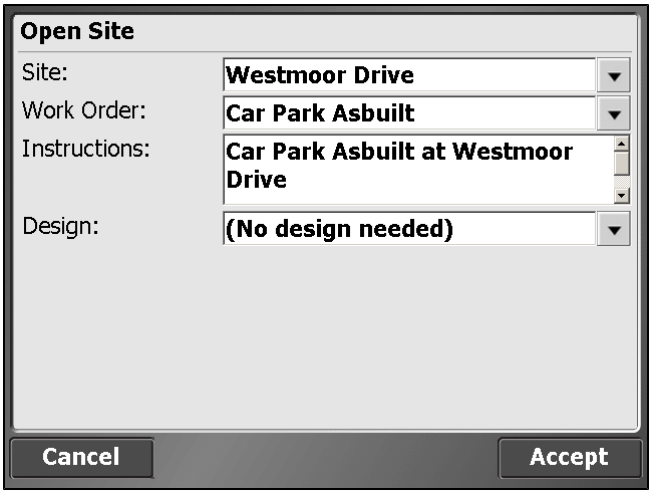


Information on a controller is arranged in the following levels:

Level	Description
Global	Global information is used at all sites. It includes lists of feature codes, Code lists, and Geoid files.
Site	Site information relates to all activities at the specified site. It includes control points, site calibration results, and background maps. Site information is always available.
Design	Inside each site, a main Designs folder holds individual design folders that contain design data pertaining to the site. Design data relates to a particular phase of construction. Data stored at this level includes foreground maps, stakeout data, and a design surface model.
Work Order	Inside each site, a main Work Orders folder holds individual work order folders.

Creating and opening a work order in the field

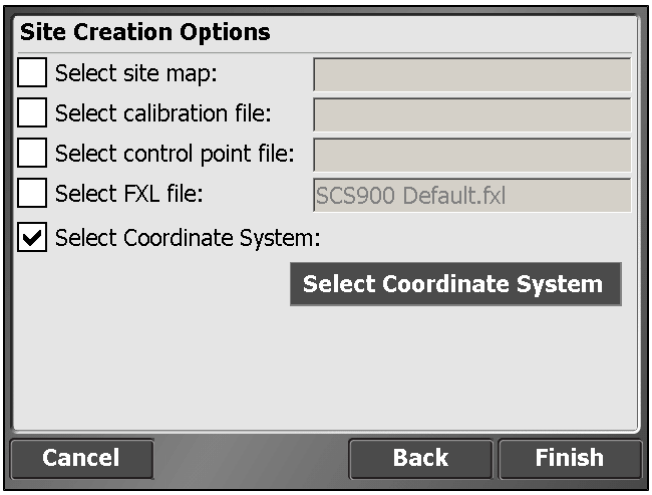
From the *Home* menu, tap **Site**. After starting the software, you can select a site and work order to start with:



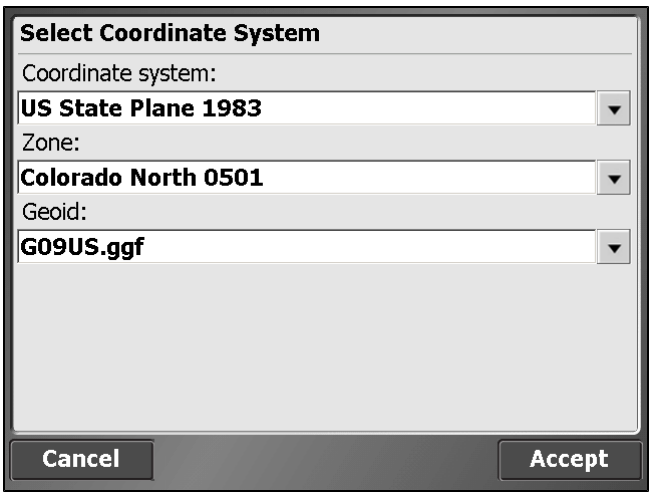
For each of these options, you can either decide to open an existing site, design, and work order, or create a new one. The *New* option opens a screen with a number of fields where you can define the settings and add data files from a USB drive or from data already stored on the controller.

CAUTION – Before taking a measurement or associating a design with the site, ensure that the distance units are correctly set. All files that relate to a single site must be stored and operated with the same units. Once a measurement is taken, or a design is selected, you cannot change the units.

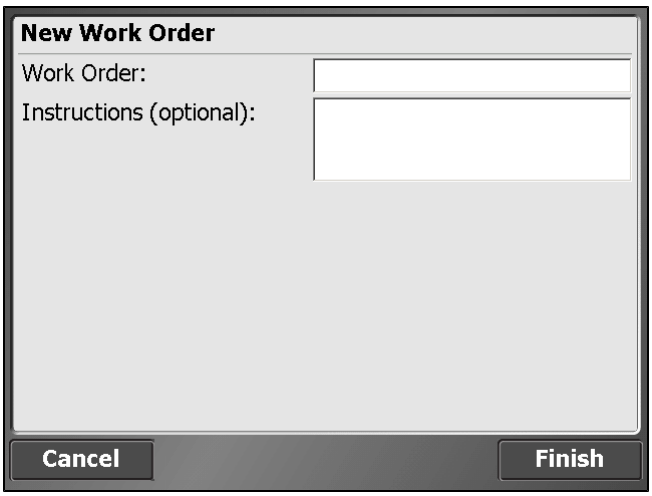
When creating a site on the controller, you can import or measure a site calibration or use a published coordinate system from the coordinate system manager. After you select the *Select coordinate system* option and tap **Select coordinate system**, the software will list all supported coordinate systems.



If you need to use a geoid, you must export it from the Business Center - HCE software the first time, and store it in the Trimble GeoData folder.



A work order can include instructions for the person in the field explaining what tasks to carry out. Work order instructions entered in the office will appear in this screen when selecting the work order. When creating a work order in the field, instructions can be entered in the instruction box too:



Work orders should have a meaningful name to make it easy to identify them when multiple work orders are created for a particular project.

Connected Community service

The Connected Community service includes the following services:

- Wireless Data Synchronization to synchronize SCS900 data with the data stored in the Connected Community website
- IBSS (Internet Base Station Service) web service to receive base station corrections from the local base station through the Internet
- Remote Assistant to remotely connect to a field controller for Trimble Support purposes.

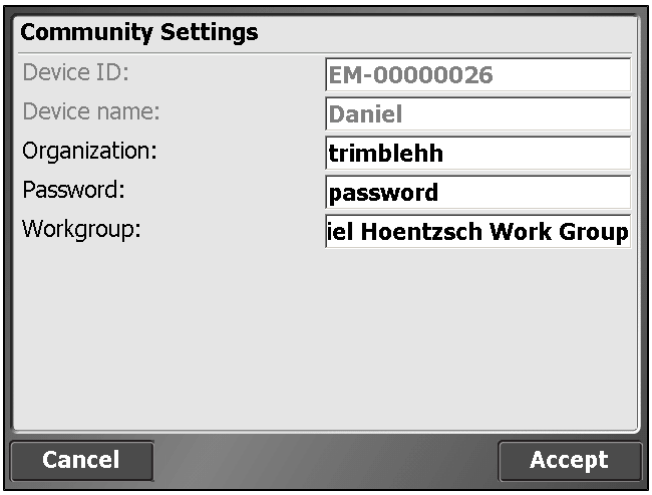
All these service are tied to the device ID that you need to purchase for the controller with a monthly TCC subscription.

Registering the controller

To use the controller with the Connected Community services, you must register the controller in the Connected Community Device Manager of the user organization.

1. In the SCS900 software, select *Import / Export*.
2. Tap **Community Settings** 

.
3. Enter the credentials and then tap **Accept**.



You only need to do this once. You can also enter a work group for Wireless Data Sync to group multiple controllers of a company in a certain structure.

Wireless Data Sync

The Wireless Data Sync option enables your SCS900 data to be synchronized with your data stored in the Connected Community website, which eliminates the requirement to move data to and from the field, but uploads design updates and work order results to the Connected Community website.

To manage the synchronization process, the following set of rules controls the dataflow to, and from, the Connected Community website.

File Type	Currently on the Connected Community	Currently on the controller	Action
Work Order	✓	✗	Download to the controller
	✗	✓	Upload to the Trimble Connected Community service
	✓	✓	Upload to the Trimble Connected Community service
Design Data	✓	✗	Download to the controller
	✗	✓	Upload to the Trimble Connected Community service
	✓	✓	Download if file size is different
Site	✓	✗	Download to the controller
	✗	✓	Upload to the Trimble Connected Community service
	✓	✓	Download if file size is different
Calibration File (*.DC & *.CAL)	✓	✗	Download to the controller
	✗	✓	Upload to the Trimble Connected Community service
	✓	✓	Do nothing

File Type	Currently on the Connected Community	Currently on the controller	Action
Control Point File (*.csv)	✓	✗	Download to the controller
	✗	✓	Upload to the Trimble Connected Community service
	✓	✓	Do nothing
FXL File	✓	✗	Download to the controller
	✗	✓	Upload to the Trimble Connected Community service
	✓	✓	Do nothing
Report.txt Tasklog.txt	✓	✗	Download to the controller
	✗	✓	Upload to the Trimble Connected Community service
	✓	✓	Upload if file size is different
Site.ini - Site.xml - Site.xml.schema	✓	✗	Download to the controller
	✗	✓	Upload to the Trimble Connected Community service
	✓	✓	Do nothing
Trimble GeoData	✓	✗	Download to the controller
	✗	✓	Upload to the Trimble Connected Community service
	✓	✓	Download if file size is different

Remote Assistant

The Trimble Remote Assistant is a service that establishes a remote connection to the field controller for Trimble Support purposes. The controller must be registered in the Connected Community

Device Manager of the user organization. To do this, see Registering the controller, page 40.

To start the Remote Assistant service:

1. From the Trimble icon menu, tap **System Info**.
2. Tap **Start Trimble Remote Assistant** to establish the connection to the office. A small icon in the status bar shows that the connection is successful.

Note – *Trimble Remote Assistant is available only on Trimble TSC3 controllers.*

CHAPTER 6

Measurement Workflows

In this chapter:

The SCS900 software is a site measurement tool that enables you to monitor earthworks and surface finishing operations. It enables construction contractors to measure material volumes, monitor grades and laid material thicknesses, and to perform site measurement tasks such as points, lines, and surfaces.

Displaying cut/fill

If the software is not in Measure mode, tap the **Home** button and then tap **Measure**. Walk anywhere on the design surface and view the current cut/fill on the Info bars, page 31. The lightbar on the left side of the screen indicates whether the surface is in cut, fill, or on grade.

Checking a grade/elevation

Measure a surface point at a location where you want to view and record the difference in elevation between the design surface and the actual ground.

1. If not in Measure mode, tap the **Home** button and then tap **Measure**.
2. Tap **Measure** to record a surface point and the cut/fill value at that location.

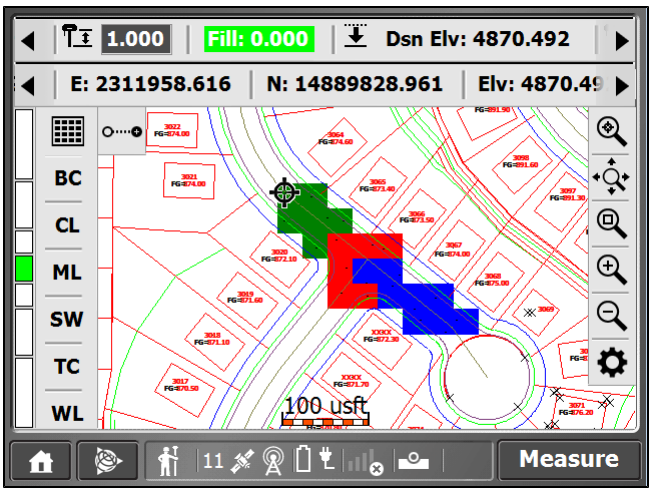
The software draws a box of the size that you specify around every recorded point so you can easily view where data is missing.

As you move around, the values in the boxes at the top of the screen update.

Once a point is recorded, a colored box appears around it, showing it as in tolerance (green), cut required (red), or fill required (blue).

To change the cut/fill tolerances:

1. Tap the Trimble icon menu and then tap *Settings* / *Measure Settings*.
2. Enter the required tolerances and then tap **Accept**.



Tip – If a gray box appears, tap the zoom window icon and draw a box around the area of the gray box. Gray boxes appear when the map is zoomed out too far to see the colored boxes at the specified resolution.

If no boxes appear, tap  from the toolbar on the right. Ensure that the *Coverage Grid* check box and the *Cut/Fill* option are selected. You can also change the grid size.

Checking material thickness

The typical procedure for checking a material thickness is:

1. Measure the existing surface before laying the material.
2. Save the measured surface as a design.
3. Create a new work order and then select the saved design as the design.
4. Lay the new material.
5. Check the material thickness.

If the current material thickness is too thin, a blue square appears to show that more “fill” material is required. If the current material thickness is too thick, a red square appears to show that material is required to be “cut” away. If the current material thickness is within a specified tolerance, a green square appears to show that no action is required.

1. If not in Measure mode, tap the **Home** button and then tap **Measure**.
2. Tap the Trimble icon menu and then select *Settings* / *Measure Settings*.
3. Enter the required thickness as a surface offset (you can change tolerances here too).
4. Tap **Measure** to record a point and the cut/fill value at that location.

As you move around, the values in the boxes at the top of the screen update; the thickness of the material is shown in the Thickness box.

Once a point is recorded, a colored box appears around it showing whether it is within the tolerance range or whether more or less material is required.

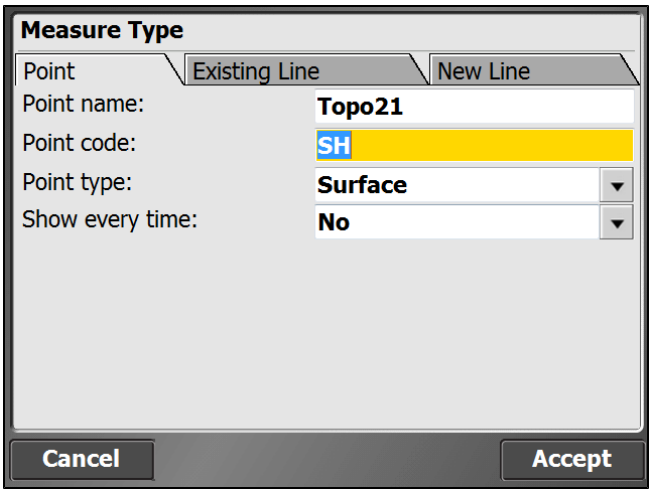
> **Tip –** If a gray box appears, tap the zoom window icon and draw a box around the area of the gray box. Gray boxes appear when the map is zoomed out too far to see the colored boxes at the specified resolution.

If no boxes appear, tap  from the toolbar on the right. Ensure that the *Coverage Grid* check box and the *Cut/Fill* option are selected. You can also change the grid size.

Measuring a surface or a feature

1. If the software is not in Measure mode, tap the Home menu and then tap **Measure**.

2. Tap the icon highlighted above to choose between point and line and surface and non-surface feature to be measured:



3. You can also enter a point name (will be automatically incremented) and point code. The status bar icon changes depending on what kind of point or line you choose to measure:

Icon		Definition
	Surface Point	Elevation is used to create a terrain model.
	Feature Point	Elevation is not used to create a terrain model.
	Feature Line or Area	Elevation is not used to create terrain model.
	Breakline, Volume Boundary, or Outer Boundary	Elevation is used to create a terrain model.

To create an outer boundary, volume boundary, or surface points to add to an existing line, select the correct line type. Once a surface is measured, you can save the surface as a design and then perform a material thickness check.

To save the surface as a design:

1. From the *Home* menu, tap **Import/Export**.
2. Tap **Surface as Design**.

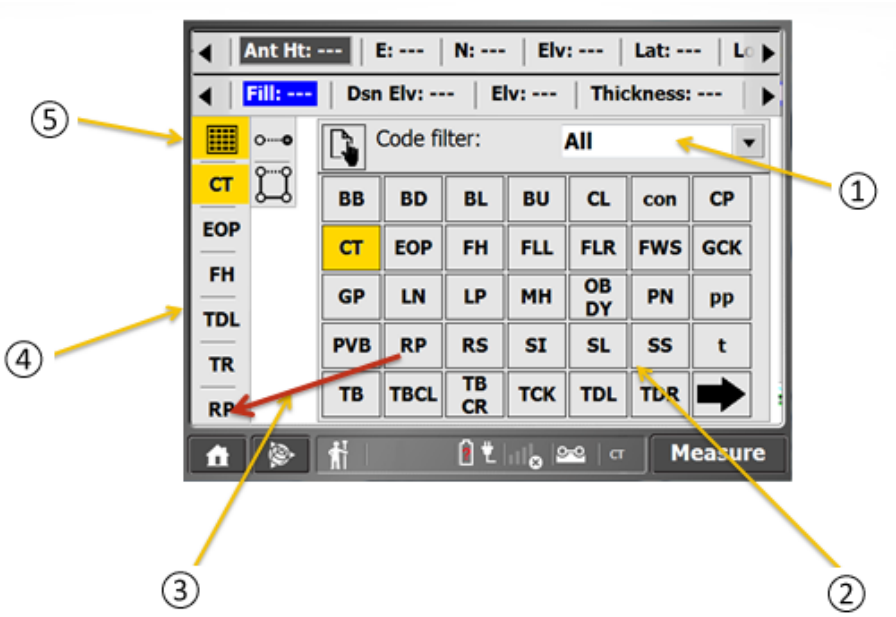
Measuring with feature codes – Advanced Measurement module required

The software can use feature codes to record data on site. Create and customize the feature code library using the Feature Definition Manager of the Business Center - HCE software.

The feature code defines if a point, line, or breakline is measured. The following classes of feature codes are available:

Feature code class	Definition
	Point feature, but no surface feature.
	Line feature, but no surface feature.
	Point feature and surface point.
	Line feature and breakline.
	Feature contains optional or compulsory attributes.

The currently selected feature code and its class can be identified in the status bar. To select and manage feature codes in the field, tap  .



Select this option...	to...
①	filter by group or category.
②	toggle to the Grid view.
③	drag code to the Quick Select list.
④	select from the Quick Select list.
⑤	select a feature code.

To select a feature code, either tap on one of the buttons in the Quick Select list or select a feature code from the Grid view. The Grid view enables you to measure data without seeing the map. Instead you have up to 34 codes to choose from with a single tap.

Both the Grid view and the Quick Select list selection enable you access feature codes quicker by filtering feature codes by group and category. Groups and categories must be defined in the Feature Definition Manager in the office.

A category is a class of related feature codes, for example, vegetation. For certain measurements or tasks, you might want to group feature codes from different categories into a group for faster access.

With each feature code, different attributes can be stored, which enables you to describe a recorded point or line with more information. Attributes need to be set up in the Feature Definition Manager and cannot be changed or created in the field.

Different properties can be applied to each attribute, for example, if it is optional or compulsory to fill out this attribute, which values are required for this attribute, the permitted length of the text string that you can enter, or available items in a drop-down list.

Photos

Photos can be attached as an attribute using the internal camera of your site controller.

The pictures are geotagged using the position of the internal GPS of the device or the position of an external SPS GPS receiver, if available. Photo attributes are set up in the Feature Definition Manager.

CHAPTER 7

Volume and COGO

In this chapter:

When collecting data in the field, it is useful to be able to review and edit your data. This section covers reviewing and editing any surface data you have measured, calculate new points and lines in the field, and calculate the volume from measured data.

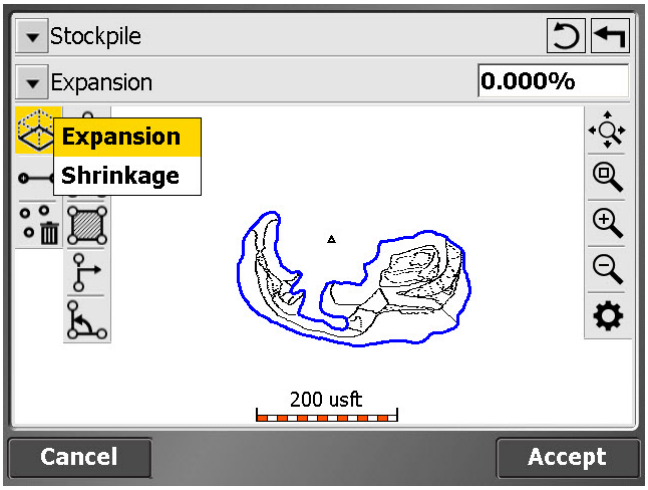
Compute Volumes

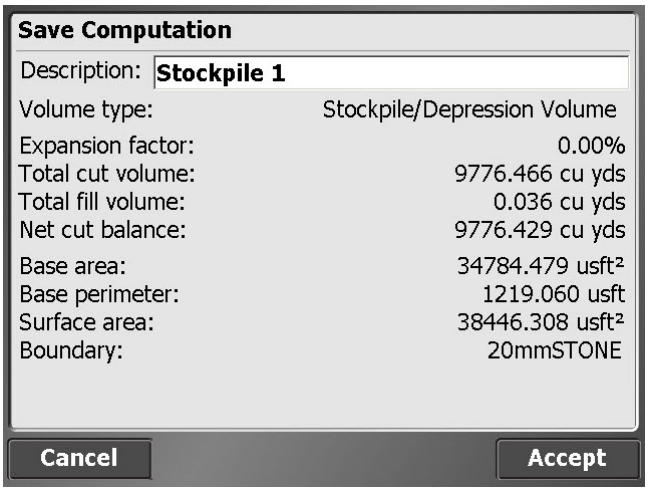
Use the *Compute Volume* option to calculate a volume from the data you have measured. Three types of volumes can be calculated:

- To a design surface
- To an entered elevation
- To a surface created by the volume boundary (stockpile/excavation volume)

From the *Review & Edit Data* menu, (see page 53), tap **Contour Measured Surface**  to view contours based on the surface you have measured. This is a useful tool to check for any major errors. The contours highlight any elevation errors in the data.

1. In the *Elv. Interval* field, enter a contour interval and then press **Enter**.
2. Tap the **Compute Volume** icon  .
3. Tap on the boundary of the area for which you want to calculate the volume and then tap **OK**.
4. Select the type of volume to compute:
   a. The volume from the surface you have measured to the design surface.
   b. The volume to a user-defined elevation.
   c. The volume of a stockpile/depression.
5. The following screen shows the result of the volume calculation. A depression or shrinkage factor can be entered to accommodate for material expansion or shrinkage.





The results of the calculation are stored in the site report using the name of the volume boundary.

Review & Edit Data

Use this feature to delete points you may have incorrectly measured. You can also use this feature to calculate volumes of any surfaces that you have measured.

It also enables you to display contours of the surface, which serves as a quick check that you have correctly collected data.

From the *COGO* menu, tap **Review & Edit Data** 

.

The *Review and Edit Surface* screen has a list of icons on the left side, which represents all the available functions:

Icon	Description
	Compute Volumes
	Create Line/Boundary
	Delete Point/Line
	Generate Measured Contours
	Delete Measured Points and Lines
	Compute Distance
	Compute Total Distance
	Compute Area

Icon	Description
	Compute Down and Out from Line
	Compute Angle
	Icon Help

To undo an action, tap  .

Create Points/Arcs

Use the *Create Points/Arcs* option to create design data in the field. You can create new points relative to other points and lines in the work order or in the current loaded design.

From the *COGO* menu, tap **Create Points/Arcs** 
.

A variety of functions is available in the bar on the left:

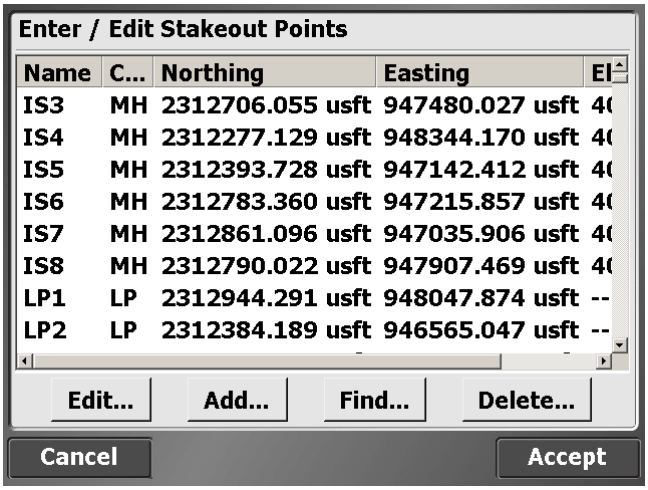
Icon	Description
	Create a Radius Point for an arc.
	Create Offset Points from a line.
	Create an offset point at a certain station.
	Create a mid-point of a line or arc.

Icon	Description
	Subdivide a line or arc in segments.
	Create a point at a distance and bearing.
	Enter the coordinates of a stakeout point.
	Create points at the end of a line or arc.
	Free Point Pick.
	Toggle display bar.
	Create a point at the intersection of a line.
	Tells you In and Out of a point from the Line.
	Delete Points and Lines.
	Create an arc from three points or two points and radius.
	Create a new line from two points.
	Icon help.

The points can be stored as stakeout points or as measured points. A surface can be generated from measured points, which you can export to the GCS900/Accugrade Grade Control Systems for machine guidance.

Enter/Edit Stakeout Points

Use this feature to retrieve a list of all stakeout points in the currently loaded design. Tap **Edit**, **Add**, or **Find** to make changes or to completely delete the point.



CHAPTER 8

Stakeout Workflow

In this chapter:

The SCS900 software enables stakeout points, lines, surfaces and roads stored in a design. You can access the *Stakeout* menu either through the *Home* menu, or tap and hold on items in the *Measurement* screen.

Points

Before you can stake out points, the points must be part of the currently loaded design. There are a number of ways to get points into a design:

- Enter the coordinates of the point in the SCS900 software using the Enter/Edit Stakeout Points functions.
- Use the Create Stakeout Points COGO functions.

1. From the *Measurement* screen, tap the **Home** button and then tap **Stake**.
2. Select a point using the list at the top right of the screen and then select a stakeout point in the *Points* tab. Alternatively, select the point directly from the map. If there is more than one object available in this area, a list of different objects appears that you can select from.

   The following symbols distinguish the different stakeout items:

Icon	Description
	Points
	Lines
	Roads
	Surfaces

3. If you need to calculate a stakeout point from design data, tap the **Home** button and use the functions in the *COGO* menu.
4. Multiple stake methods (point, side slope, and catch point) are available. For information about slope staking, see page 62.
5. Use the values in the info bar (for example, GO) to navigate to the point. A small green arrow between your current position and the stakeout point provides you with guidance. In addition, a large arrow on the top right of the screen turns in the correct walking direction after the software recognizes in which direction you are currently moving. When using a map rotation in travel direction or following a selected alignment, an additional North Arrow on the top left indicates North so that the values in the info bar can be used to navigate to the point.
6. When you are close to the stakeout point, the software switches into the Fine Stake mode. Additional guidance arrows appear on the top right corner of the map to indicate the remaining distance in each direction. The screen is orientated to the last moving direction before the Fine Stake mode was selected.
7. Once you are within tolerance, the dot in the circle of the stake guidance turns yellow. After tapping **Stake**, a stakeout report for this point appears. The software remembers which tab of the stakeout report was last viewed and opens the same tab after staking the next point.
8. Select the *Edit stakeout name* check box to store the staked point using a different point name and point code.

9. In another tab, a graphical diagram shows how to put an elevation mark on the stake. The software does all the calculations for you. The way that the software calculates the elevation mark and cut/fill depends on the stakeout settings in the Trimble icon menu.
10. After staking out the point has been completed, the software returns to the *Stakeout Selection* screen. If during the stakeout process a different point is selected, tap the Trimble icon menu and then tap **Change Stake Object** 

.
11. To change the stakeout elevation to a different value, tap the Trimble icon menu and then tap **Stakeout Elevation** 

.

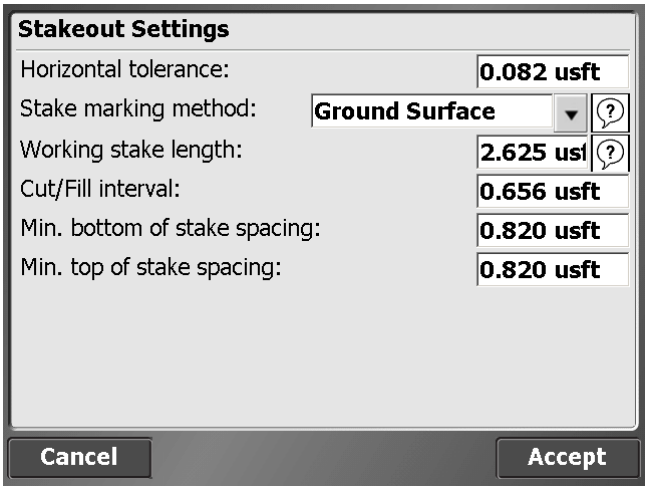
Stakeout Settings

To access these settings, from the main menu, select the Trimble icon menu in Stakeout mode and tap **Stakeout Settings**. The software supports three elevation reference methods used to mark cut depths or fill heights on a grade stake or location/grade stake:

- Measuring the cut/fill reference mark from the ground surface
- Measuring the cut/fill reference mark from the top of the stake
- Cut/fill reference from the measured point

These methods help you to establish a cut/fill reference mark on the stake at a specified cut/fill measurement interval, such as at one-foot increments. If you choose to place a cut/fill reference mark on the grade stake, a Stake Marking report helps you establish the position of the reference mark on the stake and helps you correctly label it.

Typically, you will use one of the above methods consistently. Usually, you use only one method. When you first receive the software, switch to the correct setting. The software then uses that setting for all stakeout operations. When you tap **Stake** during a stakeout operation, the software converts the measured elevation, design elevation, and computed cut depth or fill height into information that you can then write on the stake. It also informs you where to mark the stake based on the settings that you enter in this dialog:



The stakeout tolerance is also entered in this dialog.

Note – *You can only stake a point or location when you get close to the point to stake, at which time the* **Stake** *button appears on the map view.*

Measured Point

This method enables you to label a grade stake with the required cut depth or fill height as measured from the measured point, which can be either the top of stake or the current ground surface. If you choose to mark the stake with the cut depth or fill height as referenced to the measured point, the software simply informs you of the cut or fill measurement. In this case, you can mark that measurement on the stake, using your normal convention to indicate from where the measurement is referenced.

Ground Surface

With this method, the software guides you to the horizontal location of the stakeout point. The software generates a Stake Marking report that shows the distance from the ground up to where you must mark the stake. It also shows the value of cut or fill to mark on the stake.

Top of stake

With this method, the software guides you to the horizontal location of the stakeout point. You then hammer the stake into the ground and measure the top of the stake. You can change the antenna height for this measurement in case you want to take the receiver off the pole and place it directly on the stake. The software shows the distance from the top of the stake down to where you must mark the stake. It also shows the value of cut or fill to mark on the stake.

Lines

The lines you want to stake out must be part of a design map in the currently loaded design. There are multiple ways to get lines into a design:

- From a DXF foreground map with lines created in the Business Center - HCE Software.
- By creating lines from points using the COGO functions

1. From the *Measurement* screen, tap the **Home** button and then tap **Stake**.
2. Select a line using the list at the top right of the screen and then select a stakeout line in the *Line* tab. Alternatively, select a line directly from the map. If there is more than one object available in this area, a list of different objects appear where you can specify your selection. When using the Business Center - HCE software, names can be assigned to lines, which improves the orientation.

3. If necessary, before confirming the selection, change the line direction using the button on the top right of the screen.
4. Different stake methods (side slope and catch point) are available. See Slope staking, page 62.
5. Enter the station to be staked out or tap on the line where you want to stake it and then tap **OK**.
6. The map view then guides you to the point. To help you find the point, the guide arrow needs to point up the screen to show that you are traveling directly toward the point. You can turn the guide arrow off and on. The information bars at the top of the screen can be customized using the *Customize Info Bars* option in the Trimble icon menu. The display shows the design elevation for the point, the amount of cut or fill required to get to that elevation, and how far and in what direction you need to travel to get to the point.

7. The default map view has the direction north pointing up. You can change this so that the guide arrow is pointing in the direction you are walking by changing the map rotation in the *Map Options* dialog. A cut/fill lightbar on the left graphically shows cut and fill.
8. When you are close to the selected line point, the software switches into the Fine Stake mode. Additional guidance arrows appear on the top right corner of the map to indicate the remaining distance in each direction. The screen is orientated to the last moving direction before the Fine Stake mode was selected. When you are within tolerance, the dot in the circle of the stake guidance turns yellow.

   After tapping **Stake**, a stakeout report appears. The software creates a Stake Marker report. A graphical diagram shows how to put an elevation mark on the stake. The software does all the calculations for you. The way the software calculates the elevation mark and cut/fill depends on the stakeout settings in the Trimble icon menu. The software remembers which tab of the stakeout report was last viewed and opens the same tab after staking the next point.

   Instead of staking a certain station it is also possible to stake a line at random stations using the buttons on the bottom right in the status bar:

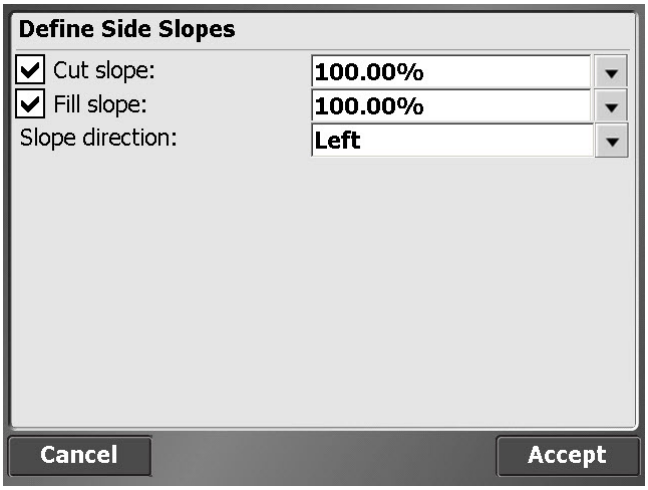
Tap	to
	stake at fixed intervals starting at a certain station
	stake at random intervals somewhere along the line

9. Enter a horizontal and vertical offset for the stakeout line. The line elevation can be defined using different methods and the start station, station interval (increment distance), and whether or not to automatically advance to the next station can also be determined. If a horizontal offset is applied and the *Generate tangent/corner points* check box is selected, three stakeout points are created at each corner to help you stake out the lines. Access these settings from the Trimble Icon menu under *Settings* / *Line settings*.

Slope staking

For both stakeout point and stakeout lines, side slope and catch point stakeout modes are available that enable staking out the slope or the catch point between this slope and the existing ground. This function can be applied to any earthwork operation that involves a tie to the current ground surface. Examples include staking earthworks for pad placement, earth dams, site drainage, ponds, lagoons, embankments, and keyways.

The tie-slope can be projected from a 3D point using a bearing or from a 3D Line. After defining either one of those, the stakeout process is very much alike. Use the *Define Side Slope* dialog to select the direction of the slope and whether you define a cut and/or fill side slope to the left or right of the reference line. To select what the slope designation is to be based on, alter the selection in the *Slope direction* field.



The software computes the elevation of the reference line at that point, and projects the designated cut and/or fill side slope magnitudes from that reference point, through your position, along a line referred to as the slope indicator. The slope indicator line is shown in the map view, extending from the reference line to the currently predicted catch point location. In predicting the location of the catch point, if you have defined both cut and fill slope magnitudes, the software determines whether the cut slope or fill slope is applicable at the reference point.

When staking building pad side slopes, the building pad has both internal and external right-angled corners. If you are staking external corner points, then the software automatically calculates the side slope as projected radially from the corner point. At an internal corner, the software calculates the catch point at a bisectional angle.

The Catch point option enables you to stake out points where the side slope intersects the ground surface as it is found to exist. As you stake catch points at fixed intervals, you should adapt to the existing terrain and be aware of the effect that it may have on the location of the daylight line. You can freely switch between the Stake at fixed intervals mode and Stake at randomly chosen interval modes.

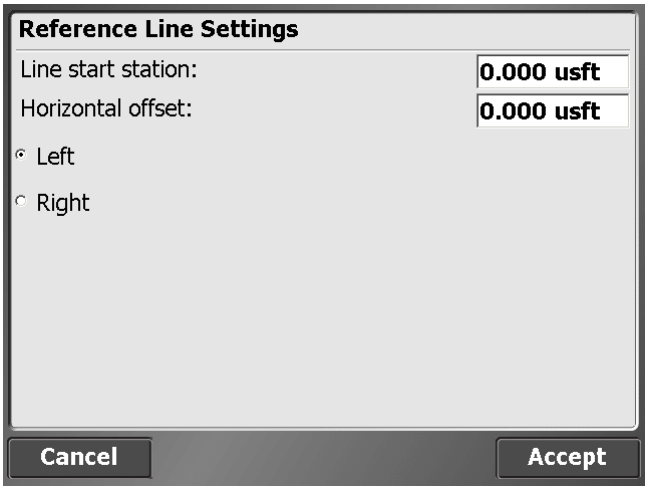
The Line option enables you to stake out the side slope's reference line. The software guides you to the line at the nearest point to where you currently are, or to a specific station. The Side Slope option enables you to place a grade stake at any required location on the side slope between the reference line and the catch point. You can toggle between the different stakeout methods using the button at the right of the status bar. Tap on the icon on the right of the status bar:

Icon	Description
	Stake catch point
	Stake side slope
	Stake line

Reference Line

While staking out different objects like a point, line, surface or road another line or alignment can be selected and referenced. To select a reference line or alignment, select the Reference Line option in the Trimble icon menu after defining the primary stakeout object. Select the reference line from the map.

When a line is used as a reference line, an optional horizontal offset and a line start station can be applied.



The station and offset to this reference line can be displayed in the info bar as reference station (R. Sta) and reference offset (R. Off) while staking the actual object.

Surfaces

Use the *Stake Surface* feature to put grade stakes over a design surface indicating the cut/fill to it. The surface you want to stake out must be part of the currently loaded design. There are multiple ways to get a surface into a design:

- From a TTM surface file (this can be created in the Business Center - HCE software).
- By creating a surface design from an existing SCS900 work order using the Import/Export feature.

1. From the *Measurement* screen, tap the **Home** button and then tap **Stake**.
2. Select the surface using the list on the top right of the screen and then in the *Surface* tab select a stakeout surface.
3. Use the values in the display bar to indicate the current cut/fill.
4. After tapping **Stake**, the software creates a Stake marker report. A graphical diagram shows how to put an elevation mark on the stake. The method that the software uses to calculate the elevation mark and cut/fill depends on the Stakeout Settings in the Trimble icon menu.

Roads

The road or alignment that you want to stake out must be part of the currently loaded design. There are multiple ways to get a road into a design:

- From a road corridor created in the Business Center – HCE software and exported through the *Field Data* menu.
- Convert LandXML files with the SCS Data Manager.
- Export a road from the Terramodel® software.

If you have the Road module installed and a Road design loaded, you can select a road/alignment from the map or from the list in the *Stake* menu and select one of the three road staking methods that are available:

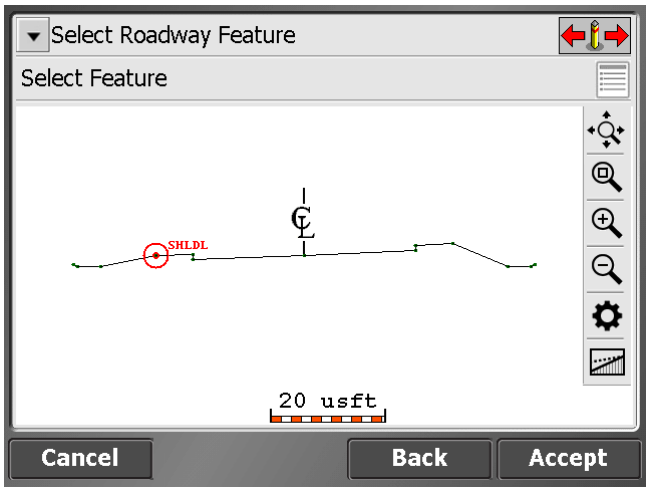
- Roadway feature staking(see page 66)
- Catch point staking(see page 70)
- Location on Surface(see page 71)

If no Roading option is installed on the controller, a warning appears.

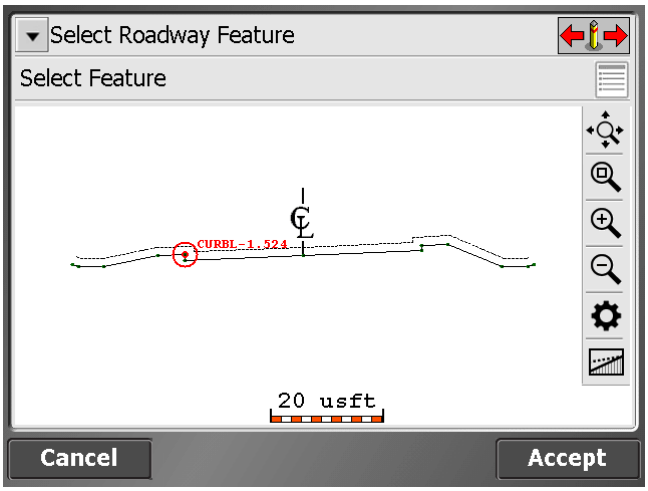
The grade stake marking preferences in the *Stakeout Settings* also apply to staking roadways. Staking methods for catch point staking can be set in the Trimble icon menu under *Settings* / *Catch Point Marking* while in the Catch Point staking mode.

Roadway feature staking

1. From the *Measurement* screen, tap the **Home** button and then tap **Stake**.
2. Select a road or alignment using the list at the top right of the screen and then select an alignment in the *Road* tab. Alternatively, select an alignment directly from the map. If there is more than one object available in this area, a list of different objects appear where you can specify a selection.
3. Enter a station or select one from the map at which to stake out the road feature. A cross section of the roadway appears. It notes the location of each roadway feature as a node on that cross section. The *Select Roadway Feature* screen appears.
4. Select the roadway feature node that represents the roadway feature that you want to stake out. To select a node, do one of the following:
   - Select from a node list (tap in the top right corner).
   - Tap the required node.



If the node is on the finished grade model, the name of the node would be SHLD, for example. If the node being selected is on the subgrade adjusted surface, it would be named SHLD-0.250; meaning it is the SHLD node, but it has a -0.250 m. A subgrade can be entered by accessing Road Settings through the Trimble icon menu while in Road Stakeout mode.



If you are navigating up station, the normal cross section view is displayed left to right as expected. If however, you are navigating down station, then the cross section would normally be back to front. To reverse the view of the section, make sure Road Stakeout mode is selected, then select the Trimble icon menu / Road Settings, and change the view setting to up station or down station.

5. Let the software guide you to the point to be staked on the selected feature using the values in the info bar. To help you find the point, the guide arrow needs to point up the screen to show that you are traveling directly toward the point. You can turn the guide arrow off and on. The information bars at the top of the screen can be customized using the *Customize Info Bars* option in the Trimble icon menu. By default, the info bar shows the design elevation for the point, the amount of cut or fill required to get to that elevation, and how far and in what direction you need to travel to get to the point. You can scroll through the different values using the black arrows on either side of the info bar. The default map view has the direction north pointing up. To change this so that the direction you are walking is pointing at you, change the map rotation in Map Options. A cut/fill lightbar on the left graphically shows cut and fill.
6. When you are close to the selected node, the software switches into the Fine Stake mode. Additional guidance arrows appear on the top right corner of the map to indicate the remaining distance in each direction. The screen is orientated to the last moving direction before the Fine Stake mode was selected.
7. After tapping **Stake**, a stakeout report appears. The software creates a Stake Marker report. A graphical diagram shows how to put an elevation mark on the stake. The software does all the calculations for you. The way that the software calculates the elevation mark and cut/fill depends on the stakeout settings in the Trimble icon menu. The software remembers which tab of the stakeout report was last viewed and opens the same tab after staking the next point.

   Instead of staking a certain station, you can also stake an alignment at random stations using these buttons on the bottom right of the status bar:

Tap...	to...
	stake at fixed intervals starting at a certain station.
	stake at random intervals somewhere along the line.

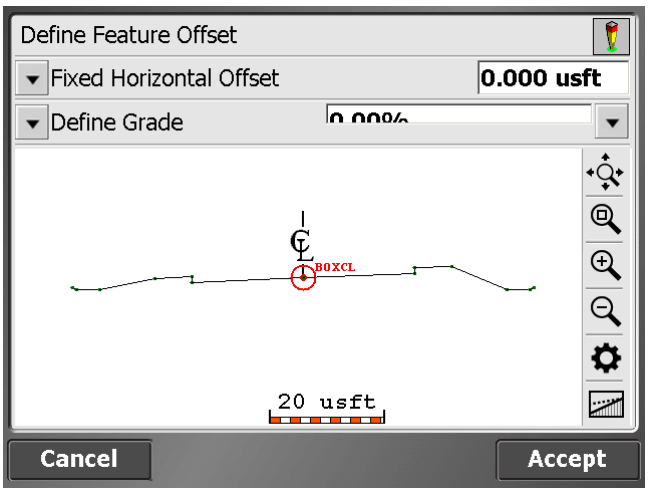
8. Set the *Auto advance option* field to one of the following options using the *Road Settings* dialog in the Trimble icon menu:

To move to the...	select...
next station	automatically advance to the next station.
previous station	automatically advance to the previous station. Do not automatically advance. This option maintains the current station between points, and enables you to increase or decrease the station when you are ready.
No (not move a station)	Depending on the settings for Station Interval, SCS900 will or will not advance to the next station.

Simple feature offset

When staking a feature, an offset is usually applied. The software is extremely flexible in the way that it enables you to specify an offset.

After selecting roadway feature node (Step 4 above) tap the button with the stake and the two red arrows on the top right of the screen. The *Define Feature Offset* screen appears. The second line enables you to specify the fixed horizontal offset or select a random horizontal offset. When specifying a fixed offset, a red line and a circle shows you where that offset point is. When specifying a random offset, you can stake anywhere along the cross section; the software displays the results to the point you are at:

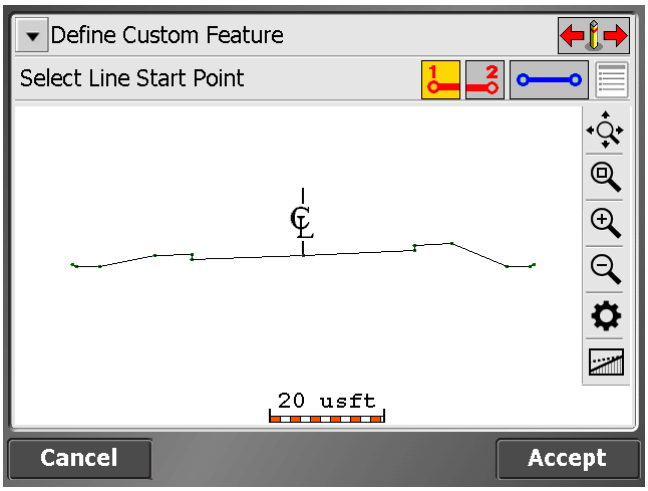


- The third line enables you to specify the kind of offset you want to use. Define Grade enables you to specify a slope for the offset. A grade of 0.000% is horizontal.
- The red, yellow, green stake on the top right of the screen enables you to apply the offset from a different feature node instead of the selected feature node itself.

Custom feature staking

Instead of staking a roadway feature node, you can define your own custom feature on a cross section. One example could be where the subgrade intersects with the tie slope. Follow these steps:

1. While in the *Roadway Feature Selection* screen, select the *Define Custom Feature* option:



2. Select two feature nodes that will form the subgrade. You can access subgrade adjustments of the finished grade from the map view during stakeout (access the *Road* menu through the Trimble icon menu, and then enter the amount and direction for the offset).
3. Select a segment (e.g., the tie slope). If required, enter a vertical offset for this segment and if you want to apply the offset vertical or perpendicular.
4. A stake appears where this subgrade intersects the tie slope. Stake out this point as usual. You can also specify a horizontal offset for the stake the same way as a normal roadway feature.

Custom segment staking

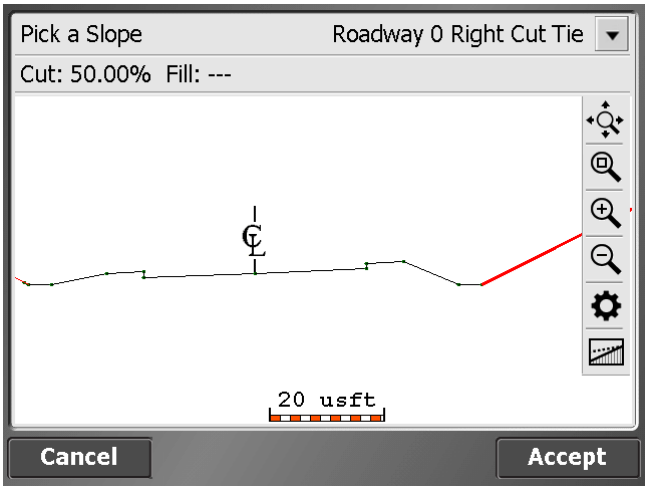
Instead of staking a roadway feature node, you can define a custom segment on a cross section. A segment is defined as the surface between two roadway feature nodes with an optional offset to reflect a subgrade. One example could be where a dam of a road gets build in multiple layers without having the complete shape of the finished grade. With this layered lift function, you can do the following:

1. While in the *Roadway Feature Selection* screen, select the *Define Custom Segment* option.
2. Select two feature nodes that will form the subgrade. If required, enter a vertical offset for this segment and if you want to apply a vertical or perpendicular offset.
3. You will get guidance to the first point you have selected. Stake out this point as usual. You can also specify a horizontal offset for the stake the same way like a normal roadway feature. It is also possible to enter a random offset and apply the grade of the roadway and then stake this layer infinite to the left or to the right and get the cut/fill to this segment.

Catch point staking

Catch point staking from the *Road* menu operates in an almost identical way to the catch point staking associated with the side slope function. The only difference is that the tie slopes are defined in the road model itself, and are automatically displayed. In a typical road model, there are at least two tie slopes; one for the right and one for the left side of the road. In the case of a divided highway, it is common to find four tie slopes, one for the left and right of each of the two traveled ways.

1. From the *Measurement* screen, tap the **Home** button and then tap **Stake**.
2. Select a road using the list at the top right of the screen and then select an alignment in the *Road* tab. Alternatively, select the road alignment directly from the map. If there is more than one object available in this area, a list of different objects will appear where you can specify a selection.
3. Select a stake method catch point.
4. Enter a station or select one from the map at which to stake out the road feature. A cross section of the roadway appears unless no tie slopes where defined for this cross section. You can then choose to extend the outer segments of the road and use them as tie slope instead.
5. Select if you want to stake the tie slope of left or the right side of the road by tapping on the tie slope itself or using down arrow on the top right. The selected tie slopes as defined in the road model (a cut slope shows in red and a fill slope shows in blue) will be highlighted.



In the top line of the display, the roadway that the tie slope is associated with is displayed. In the example above, there is only one roadway in the selected road job, and that was not named—hence Roadway 0 is displayed.

6. Navigate to the correct station using the Ahead/Backward values in the info bar. Then toggle the cross section view using the bottom icon in the map control bar and walk toward the tie-slope you are going to stake.
7. The software calculates the intersection between this recreated surface and the tie-slope and provides you with guidance to this point by extending this surface toward the slope. This point is dynamic and changes depending on the way you walk and how the terrain is formed. Use inward/outward to find the actual catch point, but also keep an eye on the station.

   Once you are in proximity of the point where the tie-slope intersects with the existing ground, tap **Stake**.

   The software creates a Stake Marker report. A graphical diagram shows how to put an elevation mark on the stake. Depending on the settings for catch point marking in the Trimble icon menu, you will get guidance to one or two more stakes which mark the point. Single Stake, Dual Stake, and Batter Rail methods are available. The placement and marking of these stakes is completely guided. The software remembers which tab of the stakeout report was last viewed and opens the same tab after staking the next point.
8. Instead of staking a certain station it is also possible to stake a line at random stations using these buttons on the bottom right in the status bar:

Tap…	to…
	stake at fixed intervals starting at a certain station
	stake at random intervals somewhere along the line

Location on Surface

Location on Surface is a very basic method of staking a road. You can walk over the road surface and have the display showing station, offset, and cut/fill to this road surface or navigate to a certain station and offset of this road.

1. From the *Measurement* screen, tap the **Home** button and then tap **Stake**.
2. Select a road using the list at the top right of the screen and then select an alignment in the *Road* tab. Alternatively, select the road alignment directly from the map. If there is more than one object available in this area, a list of different objects will appear where you can specify the selection.
3. Select a stake method location.
4. Enter a station and offset or select one from the screen. You can also overwrite the design elevation at this station.

5. The map view then guides you to the point. To help you find the point, the guide arrow needs to point up the screen to show that you are traveling directly toward the point. You can turn the guide arrow off and on. The information bars at the top of the screen can be customized using the *Configure Info Bars* option in the Trimble icon menu. The display below shows the design elevation for the point, the amount of cut or fill required to get to that elevation, and how far and in what direction you need to travel to get to the point. The default map view has the direction north pointing up. You can change this so that the direction you are walking is pointing up by changing the map rotation in map options. A cut/fill light bar on the left graphically shows cut and fill.
6. When you are close to the selected line, the software switches into the Fine Stake mode. Additional guidance arrows appear on the top right corner of the map to indicate the remaining distance in each direction. The screen is orientated to the last moving direction before the Fine Stake mode was selected.
7. After tapping **Stake**, a stakeout report appears. The software creates a Stake Marker report. A graphical diagram indicates how to put an elevation mark on the stake. The software does all the calculations for you. The way the software calculates the elevation mark and cut/fill depends on the stakeout settings in the Trimble icon menu. The software remembers which tab of the stakeout report was last viewed and opens the same tab after staking the next point.
8. Instead of staking a certain station, you can stake a line at random stations using these buttons on the bottom right of the status bar:

Tap...	to...
	stake at fixed intervals starting at a certain station.
	stake at random intervals somewhere along the line.

To toggle between Feature, Location, and Catch point staking, tap the right button in the status bar. Tap the icon on the top right of the status bar:

Icon	Description
	Feature
	Location on Road Surface
	Catch point

CHAPTER 9

Measuring with GPS

In this chapter:

To perform these measurement tasks, you need the SCS900 site controller software running on a controller that is either connected to a positioning device like a GNSS system or a total station. This chapter explains how to set up and use the different components of a GNSS RTK system.

Setting up the GPS base station

For Precision RTK (Real-Time Kinematic) GPS operations, two main components are generally required, a base station and a rover receiver. The two components are connected by radio (450 MHz or 900 MHz frequency bands) over which RTK corrections are transmitted from the base station to the rover receiver. The base station is set up in a fixed location where it tracks the satellites of the GPS and, optionally, the GLONASS and QZSS constellations. The rover receiver moves around the jobsite on a pole, backpack, vehicle, or earthmoving machine.

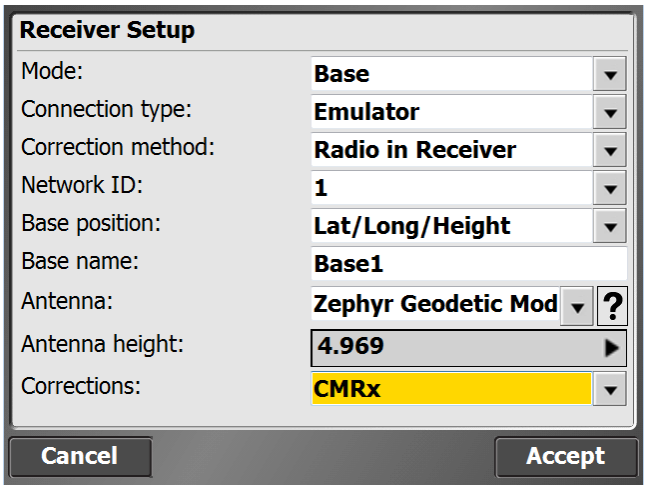
The first time that the base station is used on a project, it can be located at a known or unknown point. Once the base station is set up, turn it on. The SPS Modular GPS receivers have a front panel and keypad that enables the receiver to be initialized and set up without needing a controller; however, this guide focuses on using the software to set up the base station.

The base station setup process remembers how the previous setup was made. It automatically reconnects the components, selects the appropriate radio channel or network number, and then automatically starts to transmit GPS positions. If the base station has never been previously established on this site, or if on the last base station setup a cellphone was used to broadcast corrections, you must completely set up the base station again using the options in the *Select Connection Method* dialog. In these situations, the Setup radio only option is not available.

When using the SPS Smart GPS antenna or the SPS Modular GPS receivers, which use the AutoBase™ technology, once a base station has been established the first time, if nothing is changing between setups, you can simply set up the receiver at the base station location and then switch it on. Using AutoBase technology, the receiver reloads all appropriate data, makes all appropriate connections, and then starts to transmit corrections on the last used radio channel or network number. This eliminates the need to use a controller with the software to set up the base station each day. If you want the SPS GNSS receivers (SPS Smart GNSS antennas, and the SPS Modular GNSS receivers) to operate in AutoBase mode, you must name each base station with a different name, otherwise the AutoBase mode appears not to work.

To set up the base station:

1. From the *Home* menu, select GPS and then tap **Connect**.



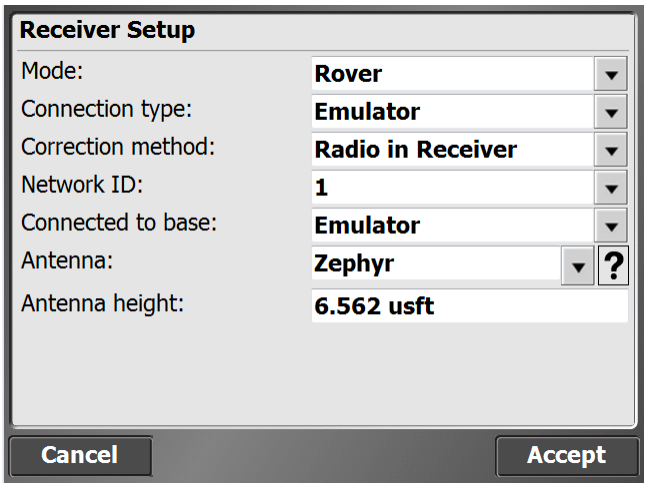
2. Set the *Mode* field to Base and then answer each question to complete the base station setup.

You only need to do this once; the software remembers your settings and prompts you to use the same ones the next time you set up the base station. You can then change any of the base station settings.

Setting up the GPS rover receiver

To set up the rover receiver:

1. From the *Home* menu, select **GPS** and then tap **Connect**.



2. Set the *Mode* option to Rover and then answer each question in turn to complete the base setup.

You only need to do this one; the software remembers your settings and prompts you to use the same ones the next time you set up the rover receiver. You can then change any of the rover settings.

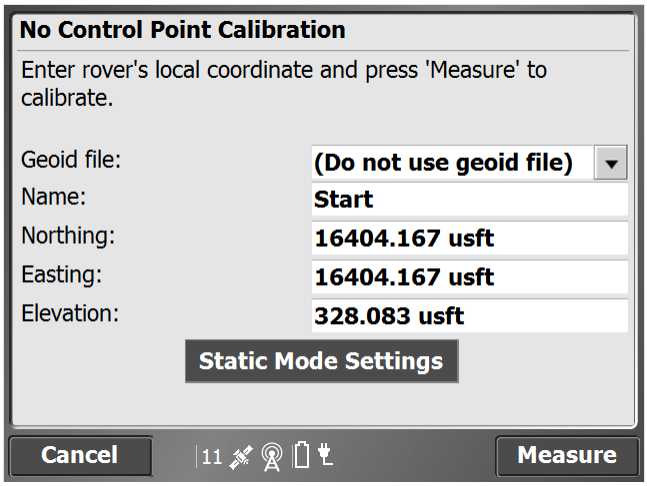
Calibrating the site

Global Positioning Systems (GPS) produce positions in latitude, longitude, and height coordinates. Construction projects are generally designed in northing, easting, and elevation (or X,Y,Z) Cartesian coordinates. A GPS site calibration ties the GPS positions to the local site coordinate system so that GPS can be used to measure or stake out on the construction site. The site calibration process involves measuring a number of known control points in the local site coordinate system using a GPS rover, allowing the software to create pairs of measured latitude, longitude, height, and known control points.

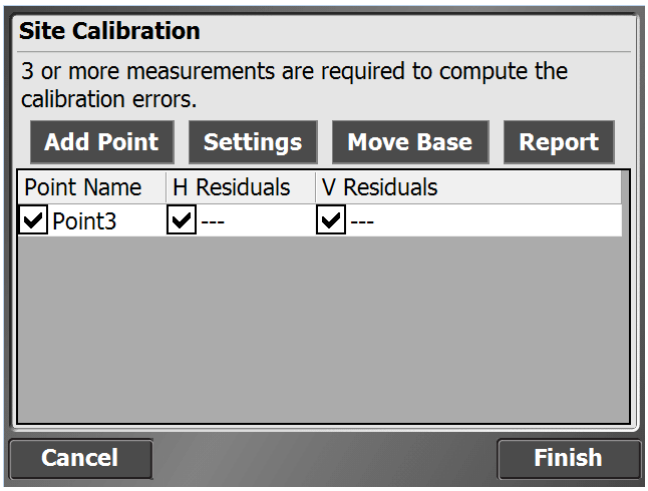
To calibrate the site:

1. From the *Home* menu, select **GPS** and then tap **Site Calibration**.
2. If you have no control points in your site, you are prompted to enter a coordinate for where

you are standing. The software computes a “one point” calibration based on this coordinate:



3. If control points exist in your site, you are prompted to select a control point and then measure the physical point on the ground with your rover receiver. To add a calibration point, tap **Add Point**:



4. When enough control points have been measured, horizontal and vertical residuals will appear on the screen.
5. If these are acceptable, tap **Finish** to end the calibration. The calibration is then used for the site.

The site calibration is stored in a DC file that can be used with other Trimble equipment working on the project. The software can also export the site calibration to a CompactFlash card as a CFG file for use with Trimble GS900 machine control systems.

The software notifies you after three points have been measured whether the calibration is in or out of tolerance with respect to the calibration tolerances. After each point you have the following options:

- measure additional points
- retake a point flagged as potentially in error
- save the partial calibration and resume later

The danger of using residuals as the only means of controlling a calibration is that the best precisions can be achieved using the wrong combination of points in the calibration solution. When an inclined plane is in use, this manipulation of residuals can result in a steeper tilt of the plane to best fit the data, resulting in better precisions and an in-tolerance calibration. Monitor the tilt of the plane closely, especially when the geometry of the control points is not strong. Widespread control that covers the entire site is good; narrow-based control around a corridor is not as good. An incorrect tilt of the plane can result in increasing errors in height as you move away from the center of the controlled area.

Performing a two-point calibration

Trimble recommends that wherever possible you use a multi-point calibration. Use the two-point calibration method in situations where a baseline of only two control points is available. In the two-point calibration, the first point establishes the position and elevation for the project; the second point establishes the project orientation.

In a two-point calibration, the heights for the project are computed using a simple block shift method that ties all heights to the first measured control point. A two-point calibration is carried out in the same way as a multi-point calibration.

Troubleshooting a site calibration

If a site calibration fails repeatedly, try the following solutions:

- Try a different combination of control points. The software cannot always identify the bad point.
- Start the calibration process again. You may have incorrectly measured a point or points.
- Check the equipment. The source of the error may be as simple as the adjustment of the rod bubble, or a bent rod.

Once the system is set up there are limited sources of error when using RTK GPS systems. The most common sources of error include:

- A poor site calibration
- Incorrect base antenna height
- Incorrect rover antenna height
- Incorrect selection of the correct antenna type at the base or rover, which causes height errors

- Incorrect location of the base station antenna
- A GPS rod bubble is out of adjustment or the rod is bent

These errors can easily be detected by rechecking the system setup. After starting the rover each day, the software prompts you to recheck the system setup. All recheck system setup operations are logged in the work order report and record files for reference and troubleshooting requirements.

Measuring a new control point

There are several reasons why you may need to measure a new control point during a project and then add the measured position to the control point file for the site. Typical cases include:

- When operating the project with a mixture of GPS and total station equipment; total stations require more control points around the project because of their line-of-sight dependence. Control points can be established very rapidly using GPS and can be used later by total station crews to establish their position and orientation.
- When operating a site, a base station often needs to be moved closer to the current working location to provide better radio coverage. The base station must be relocated to a known point in the local coordinate system. Using the Measure control point option ensures that the point is created in the correct location, with the correct coordinates, and guarantees that the site calibration remains valid after the base station is moved.
- When carrying out topographic measurements on a new site before control for the project is established, you may set the base station up in an arbitrary and convenient location and then carry out a single-point calibration. Once completed, measuring three or more control points around the project provides a common set of reference points that can be used later to transform the data measured using the single-point calibration, to the site coordinate system once it is established.

1. From the *Home* menu, select either **GPS** or **Total Statio**n and then tap **Measure Control Point**.
2. Create the control point location using a stake, a hub, or a road nail as required and then mark the stake with the name for the control point, for example, STNQ.
3. Set up the GPS rod over the point and hold it steady using a bipod. The software displays the current GPS position on the map.
4. When you are ready to take the measurement, tap **Measure**. The measurement process takes approximately 15 seconds to complete. Measuring for 15 seconds takes an average position that increases the accuracy of the computed control point.

When each control point is measured, the software stores the control point data position in the control point (Control.csv) file for the site, and also records the measurement data into the record and report files for the work order.

CHAPTER 10

Measuring with a Total Station

In this chapter:

To perform measurement or stakeout tasks, you need the SCS900 site controller software running on a controller that is connected to a positioning device. This chapter explains how to set up and use SPS Series total stations with the SCS900 software.

Connecting to a total station

When you start the software, it automatically looks for a connection to the total station through a cable connection. If the instrument is a robotic total station, the connection can also be made through the internal radio of the controller or an external 2.4 GHz radio. When the connection is made, the *Level Compensator* screen (see page 80) appears.

If you leave the controller in GPS mode, it cannot find the connection even if it is connected directly to a total station. If you are using Bluetooth wireless technology to connect to the total station (SPS700, SPSx10, SPSx20 or SPSx30), you must first turn on the total station, enable the Bluetooth connection using the face 2 display menu, and then manually force the connection to it.

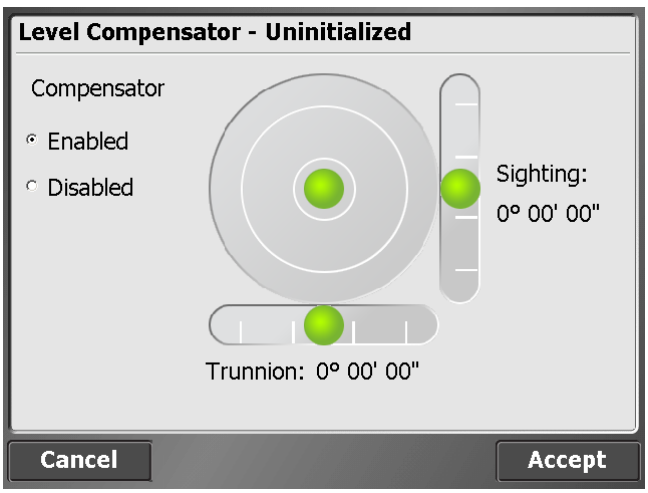
If you are using a radio to connect to the total station, you need to manually force the connection to it.

To force a connection using either a radio or Bluetooth wireless connection:

1. Go to the Trimble icon menu and select Total Station.
2. Select Trimble as a Brand.
3. Select SPS Series as instrument.
4. Select Bluetooth or Radio.
5. Select the Radio channel and Network ID.
6. Follow the instructions that appear on the screen.

Leveling the total station

The compensator inside the total station provides dual-axis correction for any mislevel of the instrument during operation, for a working range of up to 6' of arc. The display enables you to level the total station accurately using the foot-screws on the tribrach:



To level the total station:

1. Align the front face of the total station with two tribrach foot-screws.
2. Adjust the horizontal bubble in the display using those same two foot screws.
3. Adjust the vertical bubble using the third foot screw.
4. Once level, tap **OK**.

You can disable the compensator, however, ***only do this in extreme working conditions*** such as when working:

- in close proximity to a piling rig, vibratory compactor, or other source of extreme ground vibration that would continuously affect the compensation effect on the total station.
- on a mobile platform where the level is continuously changing, but where all measurements are needed in the reference frame of the platform itself, for example on a marine vessel or oil platform.
- in extremely windy conditions where wind buffet on the total station is significant, and again would continuously affect the compensation of the total station.

If the compensator is switched off, the total station stops correcting for instrument mislevel. In these situations, watch and adjust the level on a regular basis. At this point, Trimble assumes that the total station is set up accurately over a known point (see page 83) or that you have set it up in a convenient location, and will establish its position using the Arbitrary location (see page 82).

Establishing the station

The total station position and orientation is necessary if the total station is to be used for site measurement or stakeout operations where the positions computed are related to a site coordinate system. There are two methods of establishing the position and orientation of the total station:

- Arbitrary location (see page 82) (*also known as free station or resection*)
- Setting up on a known point (see page 83)

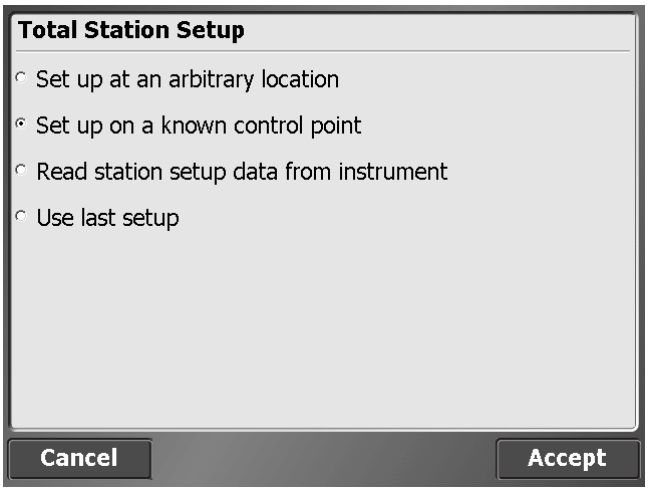
Once the station has been established, the total station can be used for measurement or stakeout operations.

If you have not established the position of the total station and you select a measurement or stakeout function, the software automatically forces you into this process when connected to a total station. If you have not entered any control point data for the site, the station establishment process only allows you to set up at a manually entered coordinate location and orientation of the angle system to 0.0000 in a chosen direction. This method is acceptable only if you are measuring a new site that has not been measured before and provided that you are not trying to measure or stake anything from a loaded design. In most cases, you should have control points available.

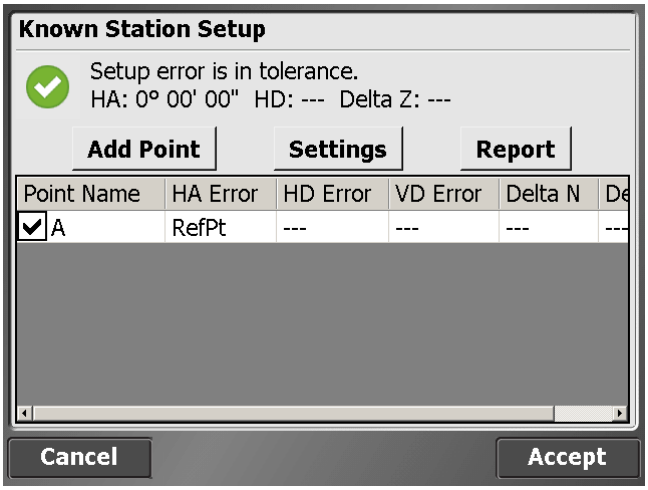
Arbitrary location

The arbitrary location setup enables you to set up the total station at a location that is convenient for the operation to be carried out (and not over a known point). It measures the angle and distance to two or more known points to determine the position and orientation of the total station.

1. In the *Total Station* menu, select *Station Setup*. If you just connected to the total station, the software prompts you for the station establishment method. Select the *Set up on a known control point* option:



2. Select an instrument point from the list or map.
3. Enter the instrument height.
4. Add at least one control point:



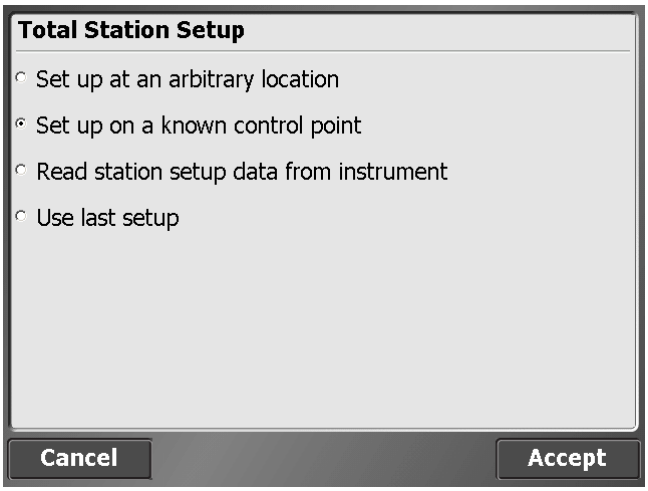
   The screen shows if the setup is within or outside the tolerance.

5. Tap **Accept** to complete the instrument setup.

Setting up on a known point

This enables you to set up the total station over a known control point location and then measure to one or more reference control points to establish its position and orientation on the jobsite. In most cases, a single reference control point may be all that is required. In other cases, where the accuracy of the work is higher, measuring more than one reference control point can provide better control over the orientation of the total station and a further check that the control point at the total station position or any of the measured reference control point locations has not moved. Unlike the arbitrary location method, once you measure a single reference control point, the information shown below appears on the screen. You can follow similar steps to those used in the arbitrary location method of station establishment. Select from one of the following options:

1. From the *Total Station* menu, select the Station Setup option. If you have just connected to the total station, the software prompts you to select the station establishment method. Select the *Set up at an arbitrary location* option.



2. Measure at least two or three control points using the **Add** button.
3. Under Settings you can modify the station set up tolerances. By tapping **Report** you get more information about the quality of your station establishment.
4. You can edit the total station components by checking and unchecking points or the horizontal and vertical component.
5. If you do not know the name of the reference point being selected when carrying out either station establishment process, simply move the target to the point that you want to measure, or point the total station at an already established target. The target indicator moves in the map to that location, making it easy to identify and select the correct point from the map view.
6. When selecting the third or subsequent point in either station establishment process, an **Aim** button appears in the display. To turn the total station to the selected point location, tap **Aim**. The total station turns directly to the selected point.
7. Tap **Accept** if the total station set up is within tolerance.

Reading station setup data from the total station

After you have performed a station establishment, the total station stores the information in its memory, so that other controllers running the software can access it. Subsequent users can save time by simply retrieving the station setup information from the total station's memory without resetting up at an arbitrary location or on a known control point.

Completing a station establishment where the height of the setup point has not been determined

If the height of the total station has not been established at the end of the station establishment process, the software prompts you to either enter a known height for the setup point or to a height from a known benchmark location defined as a 1D or 3D point. This occurs when:

- setting up at an arbitrary location, the reference control points measured were all 2D points.
- setting up a known point, the known point and reference control points selected were all defined as 2D points.

The benchmark point is measured in the same way as any other control point. It is used in combination with the target height and instrument height to determine the setup point elevation.

Working with a mechanical total station

In addition to the Trimble SPS series of total stations, the software also supports Nikon® and Trimble mechanical total stations. Most of the functions work exactly like when using a robotic total station.

1. Set up the total station over a known point and then level it using the bubble and electronic level of the instrument.
2. Enter atmospheric and other distance correction values using the instruments' on-board software.
3. Select the method of the station establishment and proceed as described in this chapter.

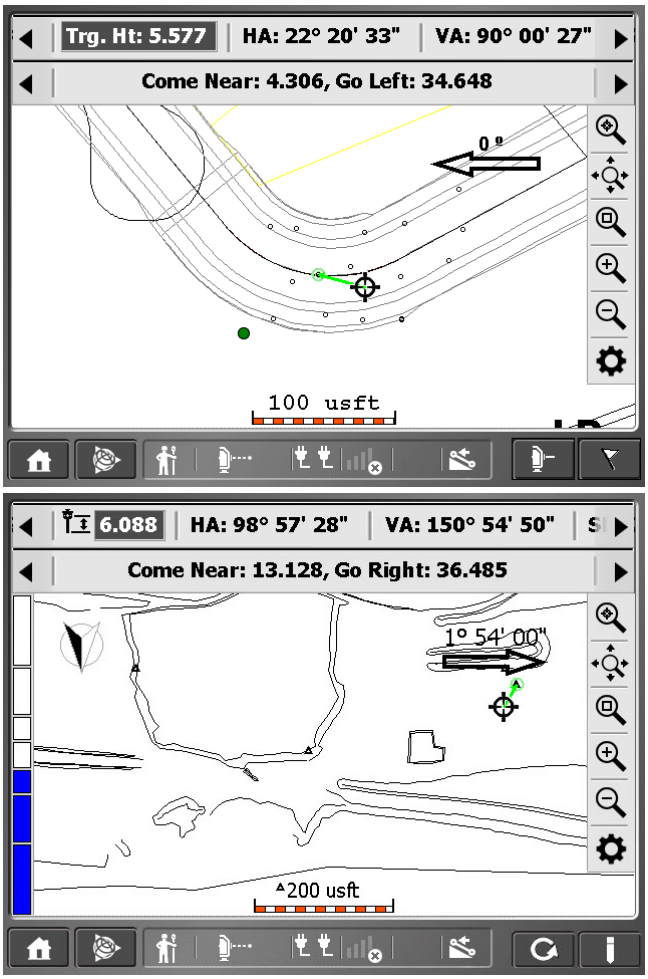
Measuring with a mechanical total station

Measuring with a mechanical total station works exactly the same as using a robotic total station. Walking and Vehicle Mode are not available with mechanical total stations.

Staking with a mechanical total station

Guidance to a stakeout point works similar to staking with a robotic total station. An additional arrow on the top right of the *Measurement* screen indicates how many degrees you need to

manually turn the total station until reaching the direction of the stakeout point.



After the person on the rod was brought in line with the total station, the total station button on the bottom right will take a measurement. The distance to the point which should be staked is indicated in the Info bars. Make sure you have GO, horizontal, and vertical angle turned on in the info bar.

Once the rod is within the stakeout tolerance, tap the button with the stakeout flag to stake the point and receive the stakeout report. The software creates a Stake Marker report. A graphical diagram shows how to put an elevation mark on the stake. The way the software calculates the elevation mark and cut/fill depends on the Stakeout Settings in the Trimble icon menu.

CHAPTER 11

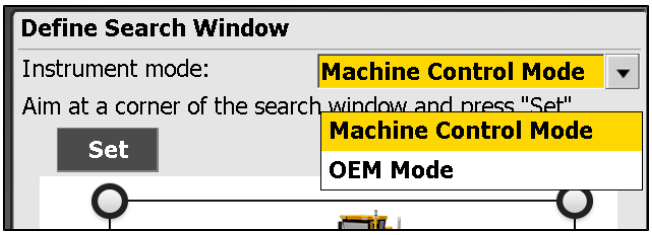
Machine Control

In this chapter:

Setting up for machine control

From the *Home* menu, tap **Total Station** / **Machine Control Setup**:

If the instrument has the OEM option installed, an OEM Mode is available. To set up the instrument for a Trimble GCS900 machine control system, select Machine Control Mode.



Defining the window for Full Search mode

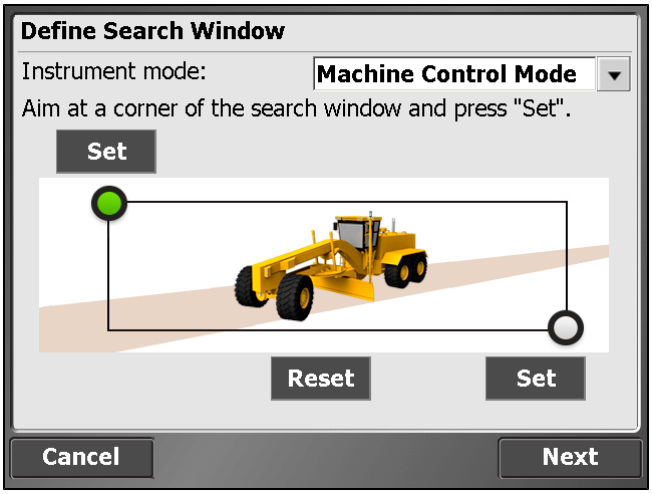
Define the window for the Full Search mode:

- Accommodate the fact that the prism can be mounted on an electric mast, and that the window of operation at close range will be higher or lower than at longer ranges.
- Ensure that you set the window of operation to cover the extents of all grading operations to be completed from that location (instrument setup).
- Ensure that if the machine is taken outside that window, to turn around or to bench on a known height point, those locations are also included in the search window.

You can define either the upper left/lower right extents of your search window or the upper right/lower left extents of your search window. Ensure that you take a good look at any high or low points in the area where you will be working and then define your search window to what most closely resembles the actual working area in front of you.

- Point the total station to an upper left location and then to a lower right location; tap the appropriate **Set** button at each pointing.
- Point the total station to an upper right location and then to a lower left location, tapping the appropriate **Set** button at each pointing.

As soon as the first corner is defined, the only option available in the software is to define the opposite corner. For example, if you define the upper right extent first, the lower left corner only is made available to define. If the lower right corner is set first, then the upper left corner only is made available to define.

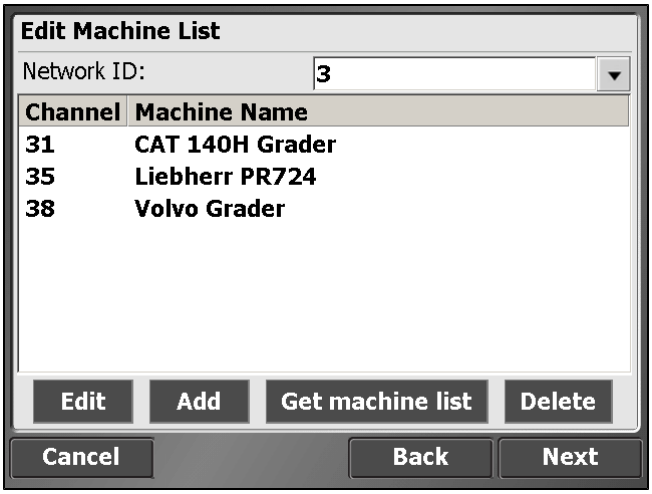


A single SPSx30 total station can be shared by multiple machines and a single SPS robotic rover pole at, for example, at a bridge structure. Only one user can use the total station at a time, but when not in use, it continually scans a predefined list of radio channels assigned to different machines and the last used site positioning system channel in sequence, looking to see if anyone needs access to the total station. When a machine or site positioning system calls the total station, it connects and provides a positioning service. When completed, the total station returns to Standby mode and becomes available to the radio channels previously loaded to the instrument. To facilitate this process, in the set up for machine control process, you can create a list of machines, each with a name and a specified radio channel, for example:

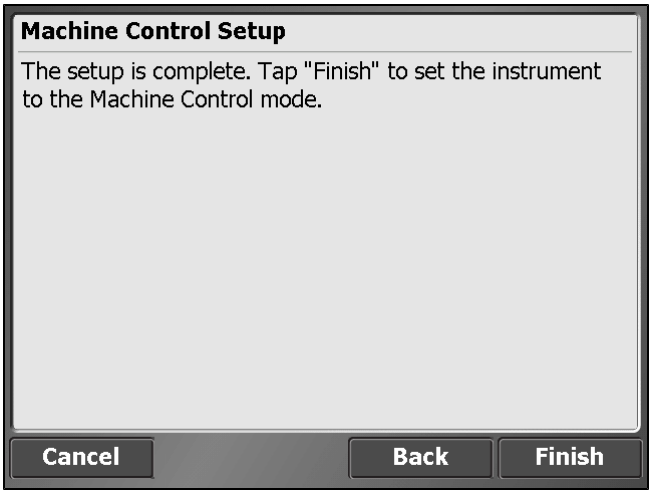
- CAT 140H Grader 1 33
- CAT D6 Dozer 1 34

The machine list is scanned sequentially whenever the total station is placed in Standby mode for machine control. The more entries in the list, the longer the scan takes to complete a full cycle and therefore the slower the initial connection will be with the total station. If you are not continually using the entries in the list in earthmoving operations, delete the entries from the list to speed up initial connection times.

Tap **Add** to create a machine in the machine list, enter a machine name and assign a network channel. Also, select a Network ID for the instrument.



This completes the instrument setup. The total station goes into Standby mode waiting for a machine to connect to it. Tap **Finish** to confirm the machine control setup:



If you are tracking a machine and the target becomes lost for any reason, the total station continues to turn at a constant horizontal and vertical speed for a short period, in the expectation that the target will appear on the same trajectory when it clears the obstruction. A line-of-sight obstruction, a passing vehicle, or simply losing the target because of movement speed can cause the total station to lose the target. When the target is 'lost', that is, the above method failed to reacquire the target, the total station searches for the target. The total station has two search modes:

Mode	Description
Quick Search	Initiated as soon as the target is 'lost'. This search is centered on the last known location, and inside a window defined by a horizontal angle width (for example, 15°) and a vertical angle width (for example, 15°). The machine control software sets the values for the search window.
Full Search	This search looks inside a larger window, defined by the dialog shown previously. When the Quick Search mode fails to locate the target, the Full Search mode is initiated.

If you are operating at the total station, point it at the MT900 target on the machine. When the machine connects to the total station, this speeds up the initial search and lock-on process for the total station as it instantly “sees” the target and locks to it. The total station goes into Standby mode for machine control and then it scans the machine list in chronological order until a machine is found calling the instrument on one of the channels. The software now disconnects from the total station. Move to the machine and initiate connection to the total station.

CHAPTER 12

Advanced Total Station Features

In this chapter:

Direct reflex (DR) technology is included in all SPSx30 Universal Total Stations as well as all SPSx20 Construction Total Stations. This technology offers many advantages such as stockpile scanning for accurate volume calculations.

The range varies depending on the total station you are using:

- The SPS620 and SPS720 total stations offer DR Standard technology, which enables you to measure reflectorless, to a maximum distance of 150 m (492 feet).
- SPSx30 total stations offer DR+ technology, allowing reflectorless measurement of objects up to 1,600 meters (5,249 feet) from the instrument.

Scanning stockpiles

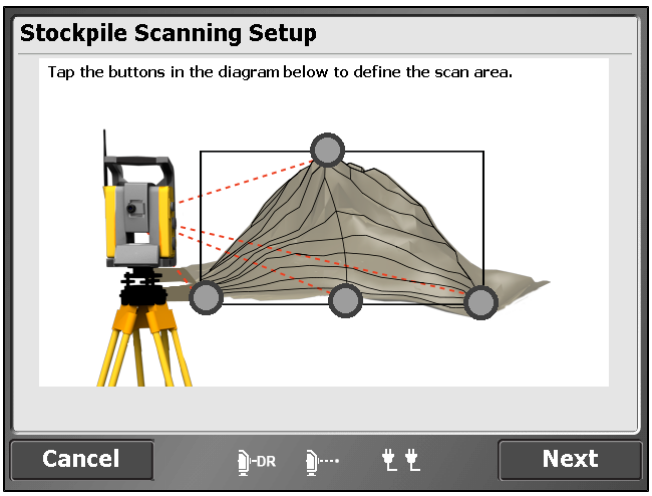
The Stockpile scan is designed to collect very accurate data for reporting on the volume of material that you have or that you have excavated. By scanning the stockpile or excavation, the need to place a worker in potentially unsafe conditions is eliminated. Reflectorless measurement technology enables you to set up the total station and measure to surfaces without using a target or prism.

Given the line-of-sight restrictions when using a total station, you need to perform a minimum of two station setups to collect all sides of the stockpile:

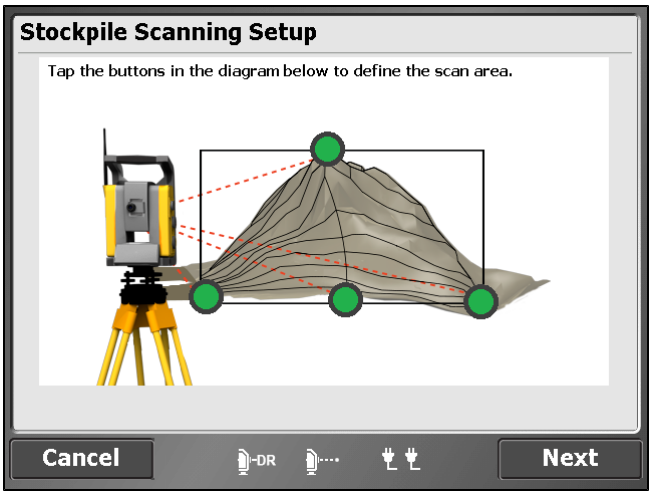
1. From your first setup, measure new control points around the stockpile in locations that will give you the fewest setups and the best vantage points to scan the largest surface area of the stockpile. This enables you to collect all sides of the stockpile and have the surface points correctly related to each other.
2. Once the whole stockpile has been scanned, define a volume boundary in the *Volume & Cogo* menu by tapping the points to be used to define the boundary, and then perform a volume calculation in the field.

To set up stockpile scanning:

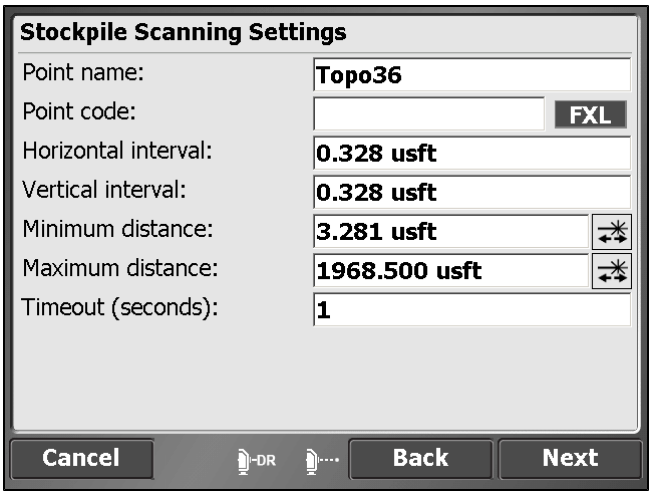
1. From the *Home* menu, tap **Total Station** and then tap **Stockpile Scanning**.
2. The software sets the instrument to DR mode, and then the following screen appears:



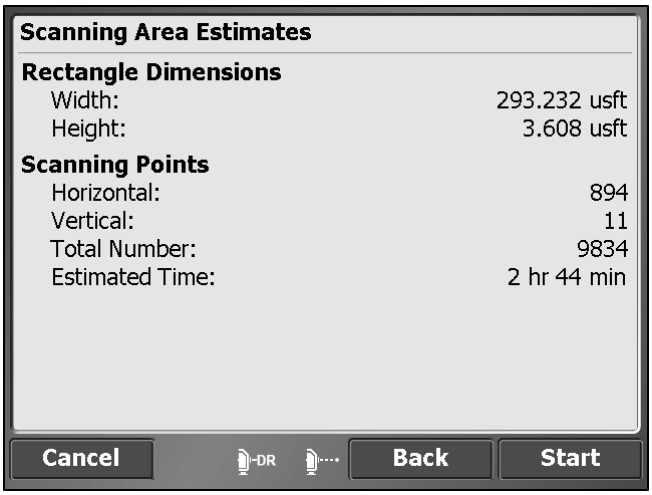
3. Define the shape of your stockpile. Start by tapping the gray dot at the highest point of the stockpile image on the screen.
4. Manually sight your instrument to the highest point of the stockpile and then tap **Measure**. The *Point Mode* dialog appears.
5. If required, enter a point code and point name and then tap **OK**. The *Stockpile Scanning Setup* dialog reappears.
6. Repeat Step 4 through Step 6 to define the bottom left, bottom right, and bottom most points of your stockpile. Once successfully measured, the points appear green:



7. Tap **Next**. The *Stockpile Scanning Settings* dialog appears:



8. Enter a point name and code and set the distance intervals. Setting the distance intervals low results in more measured points; setting the distance intervals high results in fewer measured points. When entering these values, keep the size and shape of the stockpile in mind. Define your minimum and maximum distances and then tap **Next**. Correct use of these settings helps you collect only relevant points in the field. The software will default to the recommended Timeout value depending on which instrument is being used.
9. The *Scanning Area Estimates* dialog displays the total number of points to be collected as a result of the dimension and distance intervals previously entered and an estimation of the time it will take to record the points. This time is an estimate only and the reflectivity of the material, distances involved, and the type of instrument used alters the total time once the scan has started.

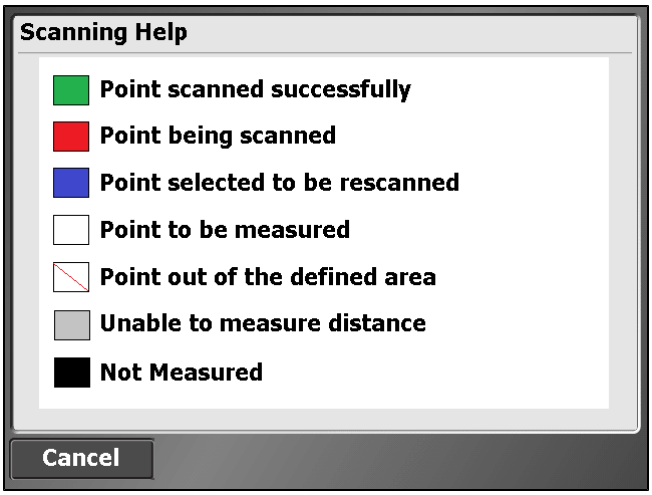


CAUTION – The values stored in Step 8 are overwritten by the minimum and maximum values set in the *DR Target Settings* dialog. Ensure that you check the values set in the *DR Target Settings* dialog to eliminate confusion by another operator when they are setting the Stockpile Scan settings. Setting the minimum distance to 2 meters (6.56 feet) and maximum distance to 1600 meters (5,249 feet) in the *DR Target Settings* dialog will eliminate any errors when setting the Stockpile Scan settings.

Tip – When working at the maximum ranges of the DR technology, increase the Timeout Setting. When adjusting the timeout settings, be aware the material being measured affects the strength of the response signal. Also, the instrument's technology affects the time it takes to record each individual point.

10. Either tap **Esc** to go back and change any settings before starting the scan or tap **Start** to start the scan.
11. A grid is displayed as the scan proceeds. Scan time remaining is displayed in the *Estimated Time Remaining* field. If you need to change the minimum and maximum distance settings, tap **Pause** and then tap  . Change the minimum and maximum settings and then tap **Next**. The scan will resume.
12. Tap  in the map control bar on the left to display the map view so you can see the points being collected.

Tip – For an explanation of the different grid sector colors, tap  in the upper right of the screen. The following screen appears:



13. To rescan any cells, tap **OK** to return to the measured cells display. Tap the associated grid sectors with your stylus. Selected sectors turn blue. Once the selection is made, tap **Rescan**. Repeat the rescan function until results are satisfactory and then tap **Finish**.

Adjusting the total station

All total stations require regular and routine checks and adjustments to deliver optimum results. All Trimble total stations allow fully accurate measurements to be made with a single pointing to a target. To achieve that, the total station stores its current adjustment values internally, and then corrects all measured data accordingly. For accurate measurements to be made, the current adjustment values need to be determined and stored in memory. Total station adjustments are required because of the optical mechanical design of the instrument. The following conditions can move the optics and mechanics out of adjustment:

- Shipping and handling
- Bumps and knocks
- Temperature and pressure changes
- Storage conditions
- General wear and tear of mechanics

To start the calibration:

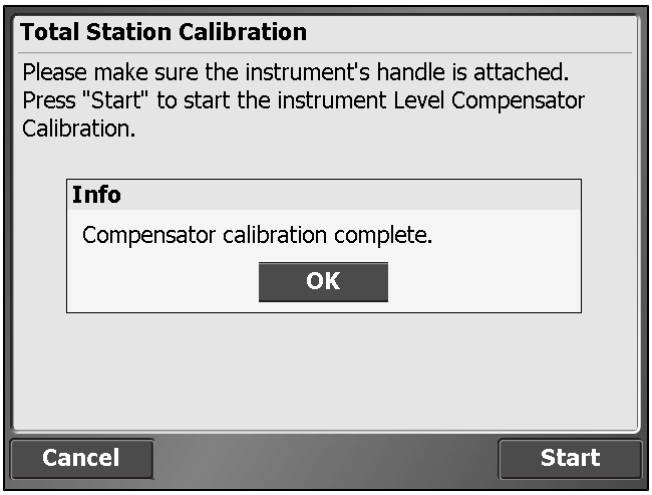
1. From the *Home* menu, select **Total Station** / **Total Station Calibration**.

Compensator Calibration

CAUTION – You must perform this calibration before the HA VA Collimation and Tracker Collimation. The compensator does not need to be calibrated every time the other collimations are performed, but if the Compensator Calibration is performed, you should immediately perform the HA VA Collimation and Tracker Collimation. Performing the Compensator Calibration negates the validity of the values of the errors found from previous HA VA Collimations and Tracker Collimations.

The SPS family of motorized total stations is all equipped with a dual-axis compensator. The compensator is active when the total station is switched on. You should periodically calibrate the compensator to adjust for any minor changes in the total station caused by normal wear and tear, as well as shipping or temperature variations. It is extremely important to perform this calibration when you are working within a very tight tolerance range. You should also perform this calibration whenever the highest accuracies are needed.

2. Tap **Start** to initiate the instrument Level Compensator Calibration:



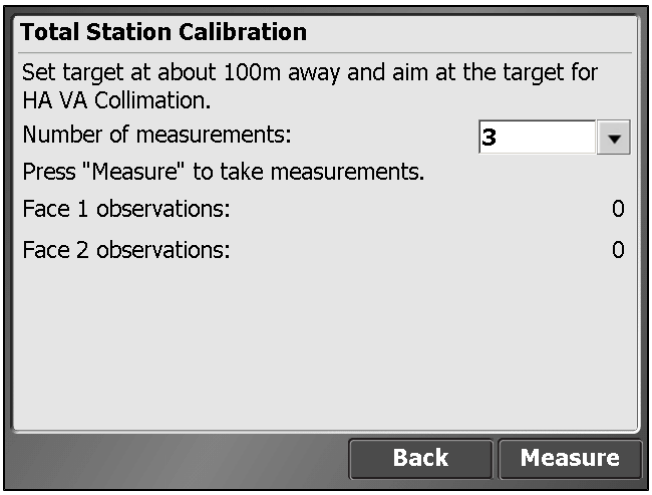
3. Tap **OK**.

HA VA Collimation test

You should perform this test to a target that can be easily bisected with both the horizontal and vertical cross-hair, placed at a location at least 100 m (328 feet) from the total station, and at approximately the same elevation as the total station telescope. The target can be any object including a road sign, window frame, or an adhesive prism target. The test involves taking a series of HA VA measurements to the target in both instrument faces, to generate a mean or averaged pointing in face 1 and face 2, from which the difference between face 1 and face 2 readings can be determined. The difference between the two face readings is known as the collimation error. In the horizontal axis, the collimation error has little effect on

measurements. However in the vertical axis, if not corrected for, the collimation error will result in erroneous elevation values for all measured points.

4. Enter the number of measurements, aim at the target and then tap **Measure**:



The collimation test computes the collimation error, stores the error inside the total station and then corrects all subsequent measurements for that error before displaying them on the screen or storing them in memory.

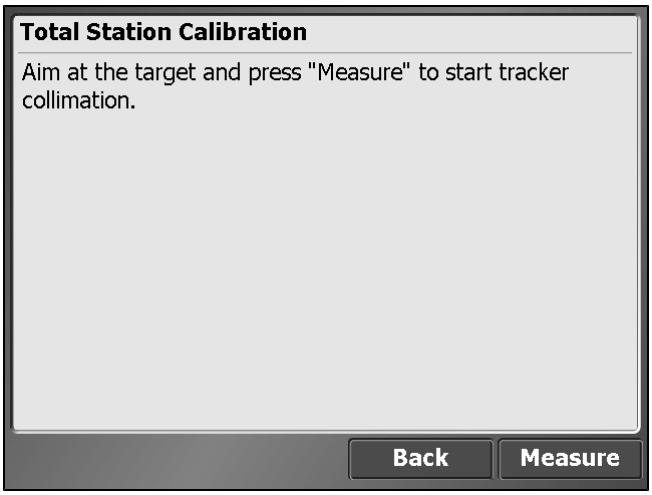
5. Tap **Next**.

Tracker Collimation test

You should perform this test towards a prism or active target set up at a distance of around 100 m and at approximately the same elevation as the total station telescope. Ideally, perform the test at the approximate range that subsequent measurements will be made.

The test involves the total station locking onto and measuring an average position over a period of time in both faces to determine any misalignment of the tracker in relationship to the telescope cross-hair. If not corrected for, this error results in erroneous position determination in both horizontal and vertical axes, and also between measurements made with and without Autolock technology. Once measured, the error is stored in the total station, and is used to correct all subsequently measured positions.

6. Aim at the target and tap **Measure**:



Note – *There can be two reasons for significant change between old and new values: The total station has received a knock or bump in transit that may need a service correction. There has been an observation error.*

If you suspect an observation error, repeat the process. If the values are repeated, you may want to contact an authorized Trimble Service Center for advice. When the values exceed a certain level, you will be advised to send the total station to an approved Trimble Service Center for recalibration.

Note – *The values displayed when new will be close to zero, but over time these are expected to change. Non-zero values are no cause for concern; however, sudden large changes should be cause for concern because they indicate misuse, abuse, or transportation problems. For full details of the instrumentation errors, refer to your instrument manual.*

7. Tap **Finish**.

Glossary

benching	Benching is a process of aligning your GPS position (latitude, longitude, and height) to a benchmark that has been added as a reference point. The calibration offsets your GPS position to that of the benchmark, improving accuracy and providing a point that you can return to later.
AutoBase	AutoBase technology uses the position of the receiver to automatically select the correct base station; allowing for one button press operation of a base station. It shortens setup time associated with repeated daily base station setups at the same location on jobsites.
base station	Also called *reference station*. In construction, a base station is a receiver placed at a known point on a jobsite that tracks the same satellites as an RTK rover, and provides a real-time differential correction message stream through radio to the rover, to obtain centimeter level positions on a continuous real-time basis. A base station can also be a part of a virtual reference station network, or a location at which GNSS observations are collected over a period of time, for subsequent postprocessing to obtain the most accurate position for the location.
DGPS	See real-time differential GPS.
design map	The map that provides live linework within a design for stakeout operations. The design map is a DXF file.
differential correction	Differential correction is the process of correcting GNSS data collected on a rover with data collected simultaneously at a base station. Because the base station 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 is collected by postprocessing.
differential GPS	See real-time differential GPS.
elevation (elev, elv)	(1) Vertical distance (height) above or below mean sea level. (2) Vertical distance above or below the geoid. (3) Distance above or below Local Datum.
elevation mask	The angle below which the receiver will not track satellites. Normally set to 10 degrees to avoid interference problems caused by buildings and trees, atmospheric issues, and multipath errors.
feature	A feature is a physical object or event that has a location in the real world, which you want to collect position and/or descriptive information (attributes) about. Features can be classified as surface or non-surface features, and again as points, lines/breaklines, or boundaries/areas.
GLONASS	Global Orbiting Navigation Satellite System. GLONASS is a Soviet space-based

	navigation system comparable to the American GPS system. The operational system consists of 21 operational and 3 non-operational satellites in 3 orbit planes.
GNSS	Global Navigation Satellite System.
GPS	Global Positioning System. GPS is a space-based satellite navigation system consisting of multiple satellites in six orbit planes.
height	It can mean a target height or antenna height (for example, 2 m of rod height).
Here position	An autonomous instantaneous position derived from the GPS receiver's uncorrected latitude, longitude, and height.
IBSS	Internet Base Station Service. This Trimble service makes the setup of an Internet-capable receiver as simple as possible. The base station can be connected to the Internet (cable or wirelessly). To access the distribution server, the user enter a password into the receiver. To use the server, the user must have a Trimble Connected Community site license.
Location GPS	Location GPS covers decimeter to submeter GPS positioning techniques including Satellite Based Augmentation Systems (SBAS) such as WAAS, EGNOS, and MSAS), DGPS (reference station and rover operations), OmniSTAR VBS/HP/XP services, and Location RTK (decimeter-level RTK positioning).
Location RTK	Some applications such as vehicular-mounted site supervisor systems do not require Precision RTK accuracy. Location RTK is a mode in which, once initialized, the receiver will operate either in 10 cm horizontal and 10 cm vertical accuracy, or in 10 cm horizontal and 2 cm vertical accuracy.
Precision GPS	GPS positioning provided by techniques that typically deliver centimeter-level accuracy. These include RTK (Real-Time Kinematic) techniques and signals obtained from a VRS (Virtual Reference Station) system.
postprocessing	Postprocessing is the processing of satellite data after it is collected, in order to eliminate error. This involves using computer software to compare data from the rover with data collected at the base station.
real-time differential GPS	Also known as *real-time differential correction* or *DGPS*. Real-time differential GPS is the process of correcting GPS data as you collect it. Corrections are calculated at a base station and then sent to the receiver through a radio link. As the rover receives the position it applies the corrections to give you a very accurate position in the field. Most real-time differential correction methods apply corrections to code phase positions. While DGPS is a generic term, its common interpretation is that it entails the use of single-frequency code phase data sent from a GNSS base station to a rover GNSS receiver to provide sub-meter position accuracy. The rover receiver can be at a long range (greater than 100 kms (62 miles)) from the base station.

Road job	A road job is the term that defines a complete road model within the Terramodel and SCS700 software. It is a collection of roadway information that is expected to function together to define a roadway or a portion of a roadway between specific stationing limits. A road job contains the main alignment and all sub alignments, the road templates, and all the information used to define widening and super elevation for the road. A single project can contain multiple road jobs for different roads also contained within that single construction project.
road model	The road model used by the SCS700 software is a Trimble Terramodel PRO file. This file can be used for both staking and grade checking operations. The Road model is a template based model that provides full accuracy anywhere within the roadway surface.
rover receiver	A rover is any mobile GNSS receiver that is used to collect or update data in the field, typically at an unknown location.
Roving mode	Roving mode applies to the use of a rover receiver to collect data, stakeout, or control earthmoving machinery in real time using RTK techniques.
RTK	real-time kinematic. A real-time differential GPS method that uses carrier phase measurements for greater accuracy.
site	A project that is to be worked on for a significant period of time. A site stores all design data and all executed work orders so you can easily find data whether you are in the office or in the field.
site map	The site map within the SCS900 software is stored as a part of the site data. The site map provides linework as a reference only and is not live, which is why you cannot select it for stakeout purposes.
station	A station is the running distance along the centerline or road that starts at 0.0 and increments as you proceed along the route. This term is used primarily in the US, whereas the equivalent term chainage is used throughout many other areas of the world, such as Australia, Asia, Europe, and New Zealand.
surface model	The surface model used by the SCS700 software is a Trimble Terrain Model file (TTM file). It provides a 3D surface model that can be used for stakeout or grade checking operations.
work order	A work order covers a task to be performed by a crew on a single jobsite. A work order contains the reference to the appropriate design, required settings and tolerances for the task, and a record and report of all the data measured or staked out in the process of completing the task. A work order can cover a short-term task (such as the stakeout of a specific building pad) or a task that will last the duration of the project (such as the stakeout of storm water drainage) and that will be executed periodically as required during the project. When the project is complete, all the information regarding the task is stored in a single file that is easy to recall.