SGS PRIME COGO

Version 1.8.1 - Reference Manual

SIMPLE
Geospatial Solutions

March 1, 2020

https://sgss.ca/

Table of Contents

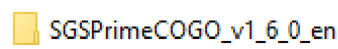
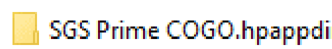
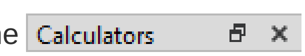
1 Installation

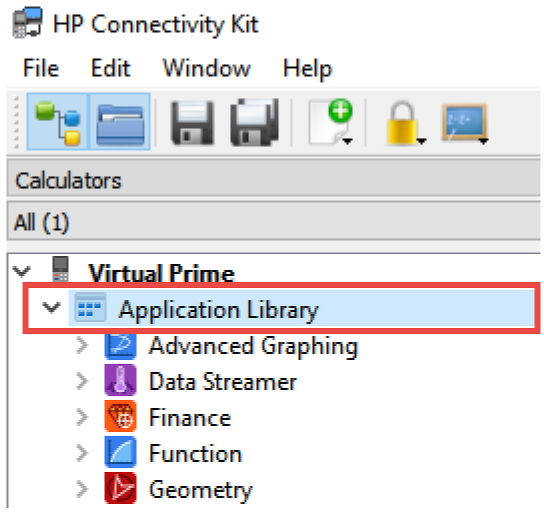
Install the **SGS Prime COGO** application for HP Prime on any of the following devices:

- Physical HP Prime Graphing Calculators
- Virtual Calculators for Windows or Mac
- Windows UWP HP Prime Pro app
- Android HP Prime Pro app
- iOS HP Prime Pro app

Required: Installation requires the Connectivity Kit for Windows or Mac.

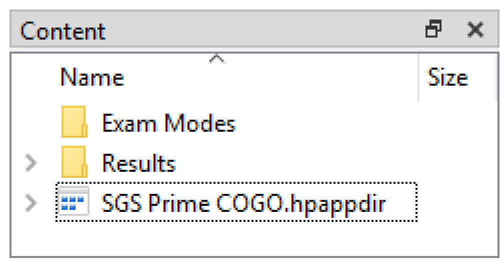
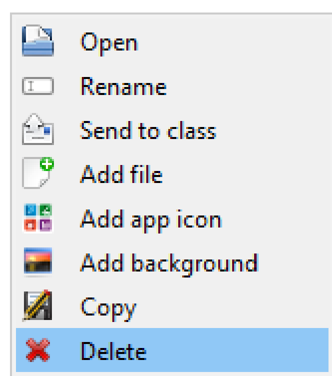
1.1 New Installation

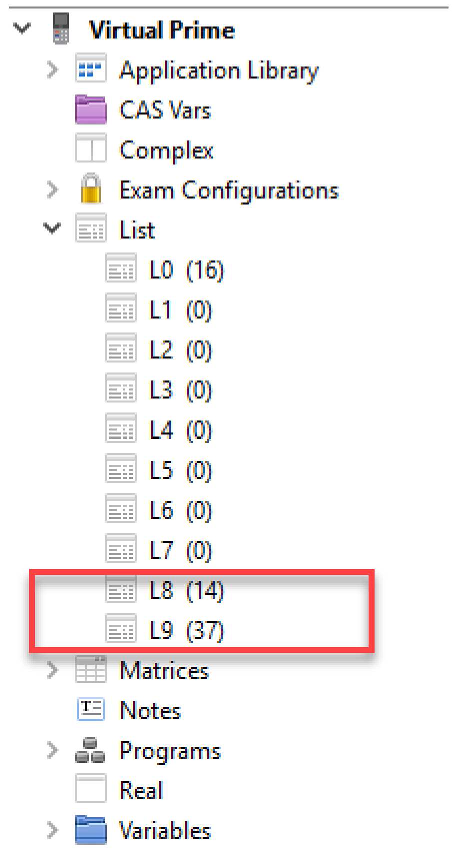
Step	Action
1	Download the installation files from https://sgss.ca/hpprime.html.
2	Unzip/extract the installation files.
3	Navigate into the folder where the files were extracted, a folder with the version number of the app will be found. 
4	Open the folder to reveal a sub-folder with a **.hpappdir** extension inside. 
5	Open the Connectivity Kit on your PC or Mac.
6	A. For physical HP Prime calculators; plug in the USB cable to connect. B. For HP Prime Pro apps; open the app on the device that is on the same Wi-Fi network as the PC or Mac running the Connectivity Kit.
7	Confirm your calculator connection, it will be visible in the  pane of the Connectivity Kit once connected.

8	Expand the connected calculator in the Connectivity Kit. Drag and Drop the SGS Prime COGO.hpappdir folder from Step 4 onto the Application Library folder of your calculator. It may take a few seconds to complete the transfer. Close the Connectivity Kit.	

1.2 Upgrade to new Version

To preserve application variables and files, it is best to overwrite only the program code of the app when upgrading to a newer version. It is currently not possible to overwrite just the program code of an app directly in the **Application Library**; therefore, a workaround step is required to accomplish the upgrade.

Step	Action
1	Download the installation files from https://sgss.ca/hpprime.html.
2	Unzip/extract the installation files.
3	Navigate into the folder where the files were extracted, a folder with the version number of the app will be found. SGSPrimeCOGO_v1_6_0_en
4	Open the folder to reveal a sub-folder with a **.hpappdir** extension inside. SGS Prime COGO.hpappdir
5	Open the Connectivity Kit on your PC or Mac.
6	A. For physical HP Prime calculators; plug in the USB cable to connect. B. For HP Prime Pro apps; open the app on the device that is on the same Wi-Fi network as the PC or Mac running the Connectivity Kit.
7	Confirm your calculator connection, it will be visible in the Calculators pane of the Connectivity Kit once connected.
8	Expand the Application Library folder and locate the SGS Prime COGO app. Drag and drop the app into the Content pane of the Connectivity Kit. This will create an **SGS Prime COGO.hpappdir** folder in the ***Content*** pane as shown. 
10	Right-click on the SGS Prime COGO app in the Application Library and choose **Delete**. 

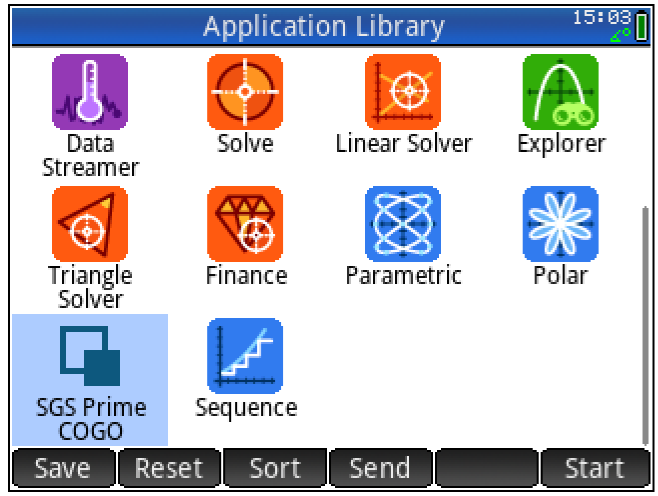
11	Using your PC or Mac File Explorer, open the SGS Prime COGO.hpappdir folder from Step 4. Inside you will find a SGS Prime COGO.hpappprgm file, drag and drop this file onto the SGS Prime COGO.hpappdir folder in the Content pane. At the prompt choose **Yes** to replace the file. This updates the program code of the app in the ***Content*** pane.
12	Drag and Drop the SGS Prime COGO.hpappdir folder from the Content pane to the Application Library folder. It may take a few seconds to complete the transfer. Close the Connectivity Kit.
13	NOTE: If you are upgrading from Version 1.5.x, you can delete the L8 and L9 lists that were installed with that version. Right-click on the L8 and L9 list objects and choose “Delete”. 

NOTE: If you encounter an Insufficient Memory error when trying to connect with the Connectivity Kit, try:

1. Reboot the calculator by holding down On/Off and then pressing Symb/Setup. Try again.
2. If you have Version 1.5.1 or later installed, try the Unload option prior to connecting to the Connectivity Kit, then use the Reload option after upgrade is complete.

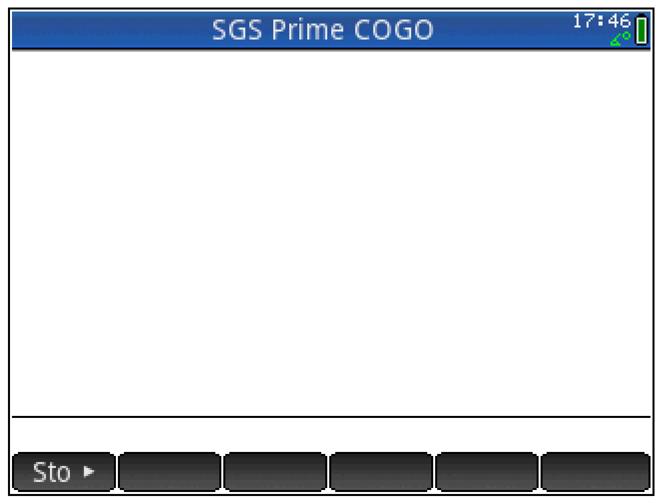
1.3 Running SGS Prime COGO

Once installed, run **SGS Prime COGO** by one of the following methods:



1. Open the Application Library on your calculator by using the Apps Info key. Locate the **SGS Prime COGO** app and tap the icon or **Start** on the menu to open the application.

or Start

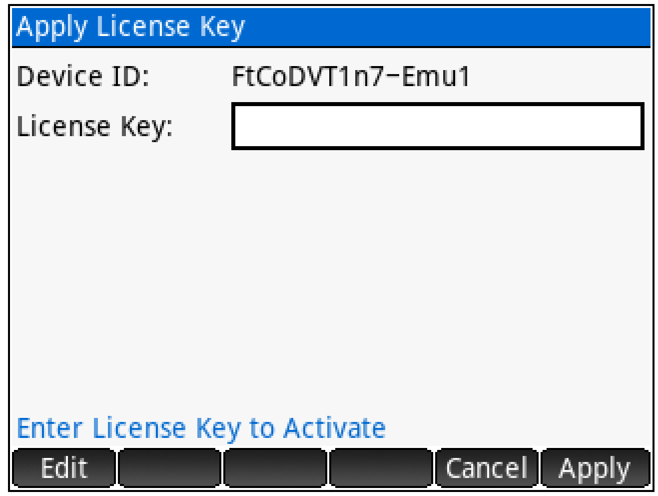


2. From the Home or CAS screen, if **SGS Prime COGO** is the active application with the title visible at the top of the screen, use the Num Setup key to start the application.

Other shortcut keys available from the Home or CAS screen:

- Symb Setup starts the RPN Calculator.
- Plot Setup opens the Plot Points program.
- Shift and Symb Setup / Plot Setup / Num Setup opens the User Settings options.

1.4 License Key



A valid **License Key** enables the functionality of the software.

License Keys are bound to the Device ID of the calculator or app that the SGS Prime COGO application is installed on.

You must supply the Device ID of your calculator or app when requesting a License Key.

The Device ID should match the calculator serial number followed by a few characters to help identify the type of device and the version of the app.

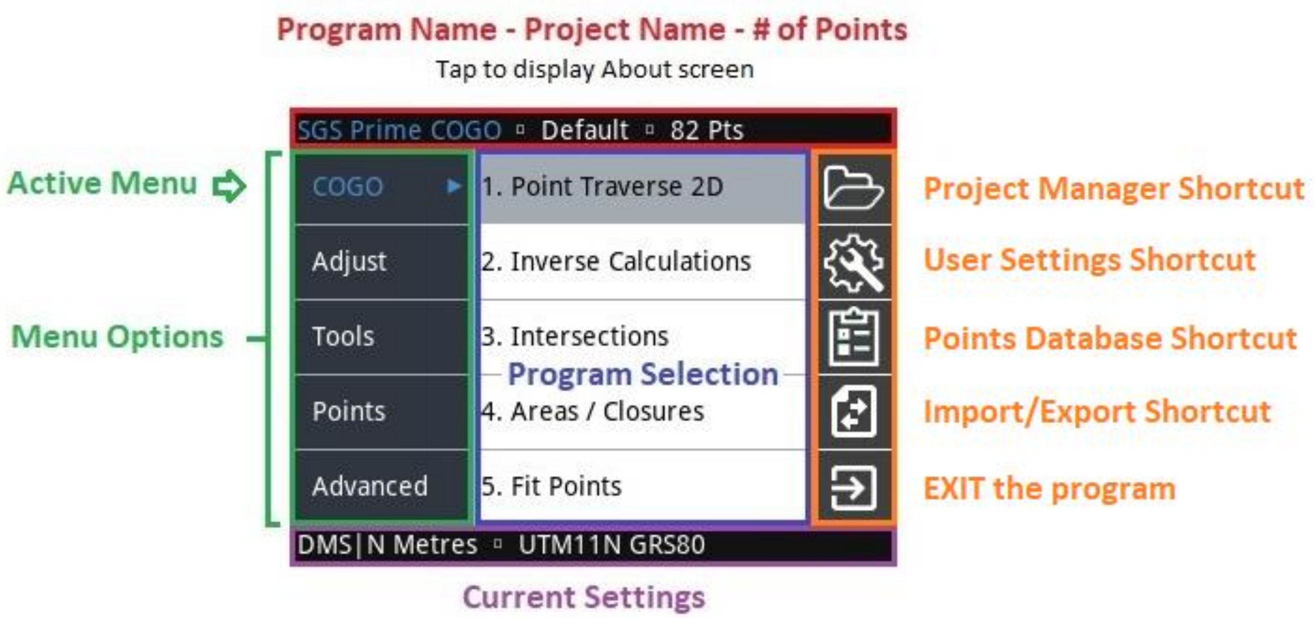
Contact sales@sgss.ca for more information about licensing.

2 Main Menu and User Interface

SGS Prime COGO is designed for touch and keyboard navigation.

2.1 Main Menu Screen

The user interface displays program settings and provides access to all program functions. The diagram below illustrates the screen layout.



See the next two pages for descriptions of the various components.

Item	Description
Project Name	Displays the current project name and the number of points stored in the current project. NOTE: Tap on this area to display the **About** screen.
Shortcuts	Often used functions are available on all main interface screens.
Current Project	Displays some of the available user settings. ▶ **DMS** (360° ‘ “) **D.d°** (360° decimal) **GON** (400 gons) indicates current Angle Unit setting. ▶ **|N** (North Bearings) **|S** (South Bearings) **|QB** (Quadrant Bearings) indicates current direction reference setting. ▶ **Metres** (Metres) **IFeet** (International Feet) **USFeet** (US Survey Feet) indicates the current Distance Unit setting. ▶ Coordinate system and associated ellipsoid.
Menu Options	Displays the titles of all menus, with the active menu name highlighted. ▶ **COGO** menu ▶ **Adjust** menu ▶ **Tools** menu ▶ **Points** menu ▶ **Advanced** menu
Program Selection	Displays the available programs within each menu, with the currently selected program name highlighted.

About Screen

Tap the top of the main menu to display the About screen. The program version and license information is shown.

Key Update License Key. This will be necessary when upgrading an existing license from Lite to Standard, or Standard to Professional.

Unload Unload app data to reduce the memory size of the app folder. **Warning:** This removes all user-created content from the app and is intended for use prior to performing an app upgrade to a new version.

Reload Reload previously unloaded app data. Intended to be used immediately after performing an app upgrade to a new version.

Project Manager Shortcut

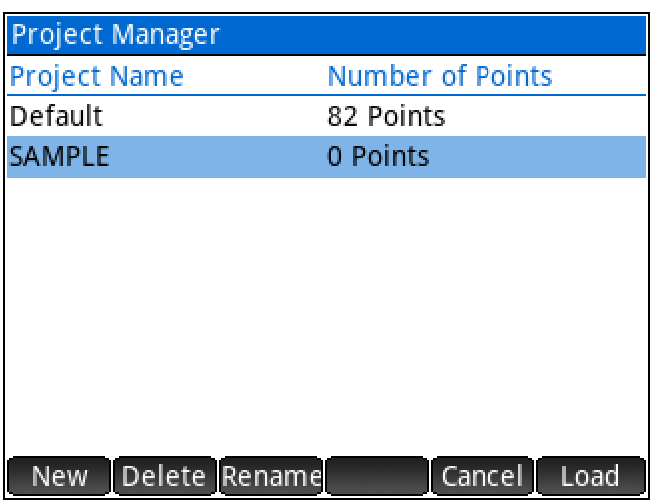
Tap to access the Project Manager. Available options:

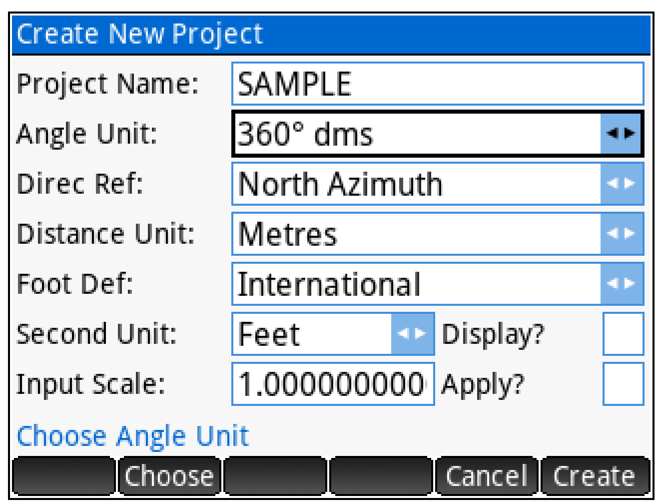
New Create a new Project. The name is entered, and common user settings are selected. Some of the User settings are stored with each project while others are applied to all projects; see the User Settings chapter for details.

Delete Delete the selected project. A confirmation prompt is displayed.

Rename Rename the selected project.

Load Load the selected project.





User Settings Shortcut

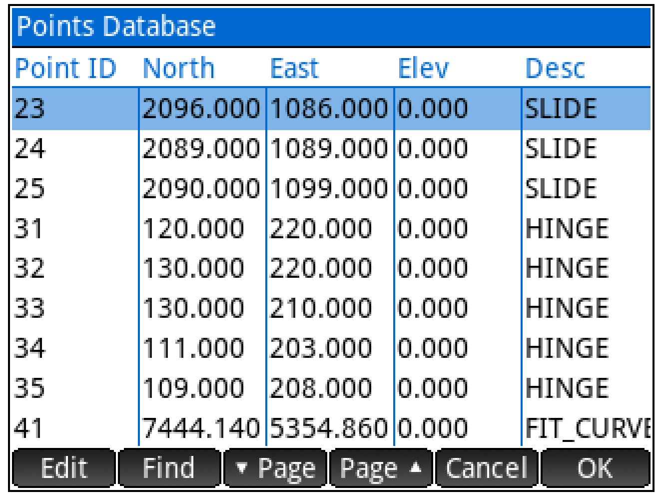
Tap to access the User Settings. See the User Settings chapter.

Points Database Shortcut

Tap to access the current project Points Database.

Points are sorted in numerical ascending order.

Available options:



Edit Edit the selected Point coordinates and description.

Find Find a point by Point ID.

▾ Page Page Down, scrolls to the next page until the end of the database is reached.

Page ▴ Page Up, scrolls to the previous page until the start of the database is reached.

Find Points

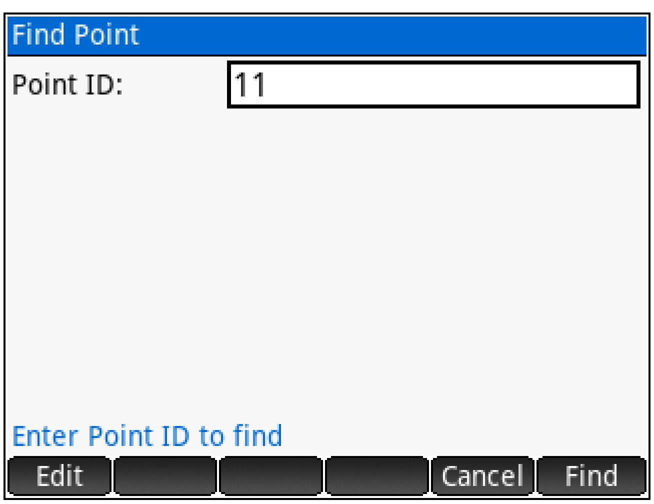
Enter a Point ID to display the coordinates and description of the Point ID. Scroll to view information of the adjacent points, as sorted numerically.

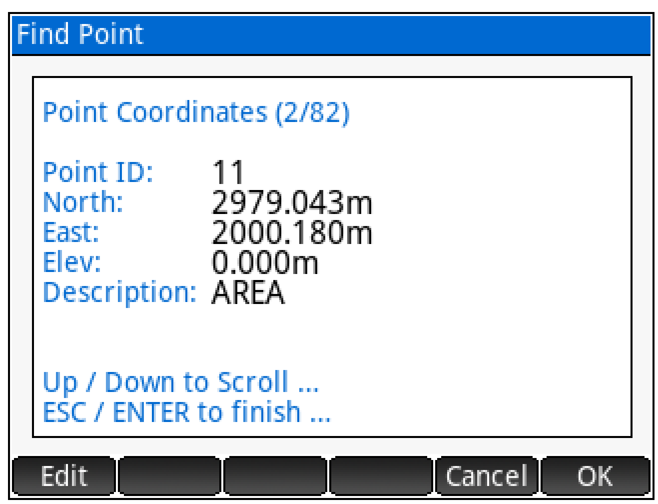
While viewing point information:

Edit Edit the currently displayed point.

Cancel Exit the Find Points program and return to the Main Menu.

OK Return to the Input Form.





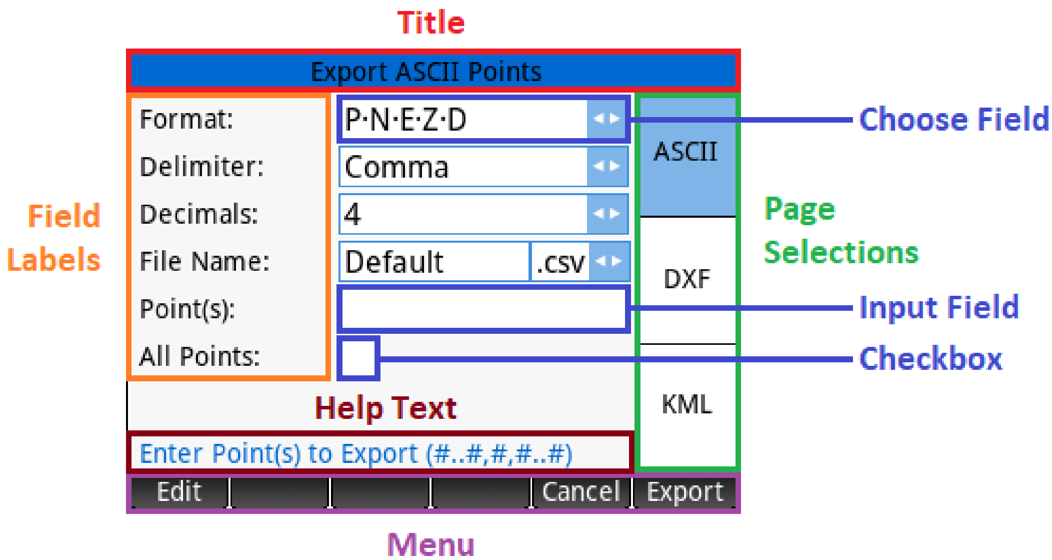
2.2 Keyboard

Navigate the main user interface by using the directional cursor keys. Use the ◀ and ▶ cursor keys to change the current menu and use the ▲ and ▼ cursor keys to change the current selection.

- [Enter] will load the currently selected program.
- [Esc Clear] or [On Off] will exit ***SGS Prime COGO***.
- Numeric keys [1 Program Y] through [5 [ ] V] can be used to run the corresponding program from each menu.
- [Symb Setup] launches the RPN Calculator app from the Main Menu or from any Input Form.
- [Plot Setup] opens the Plot Points program.
- [View Copy] opens the Points Database.

2.3 Input Forms

Input forms are used throughout the program to accept multiple different types of input. Some common input types are: **Point IDs** / **Point Ranges** / **Directions** / **Angles** / **Distances** / **Coordinates** / **Stations** / **Grades** / **Text** / **Choose Lists** / **Checkboxes**



Each input form will have some of the same basic elements, such as the Title, Field Labels, Input Fields, Help Text and a Menu. Some input forms feature more than one page, the page selections can be made on the right edge of the screen. The touch screen and keyboard can be used to select fields.

Current display settings control the appearance of each field.

NOTE: The RPN Calculator app can be launched from any input form by using the Symb Setup key.

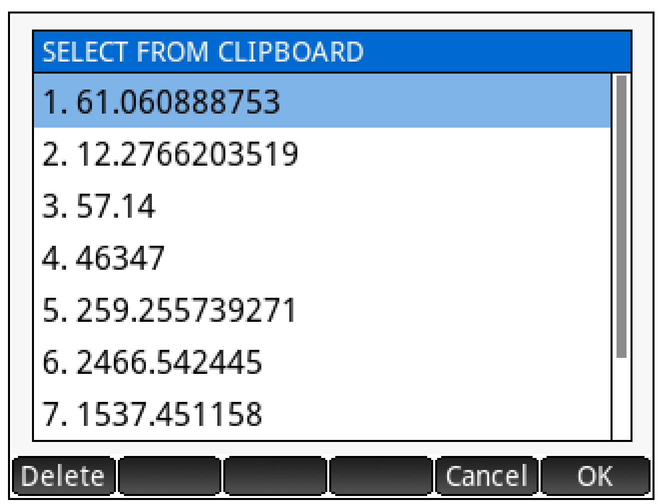
Copy and Paste

The clipboard can hold multiple items, which are stored as strings as would be entered into an input field.

Shift and View Copy can be used to copy the value inside the selected field, or the value being edited.

Shift and Menu Paste can also be used to paste from the clipboard.

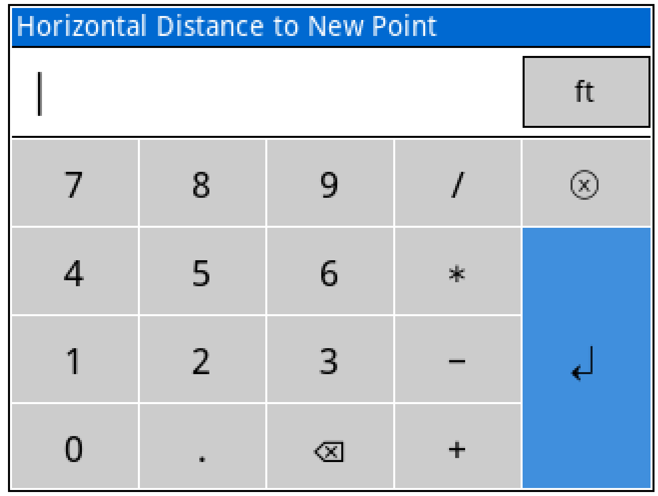
The Copy/Paste functionality is a good method to transfer calculated values to/from an Input Form and the RPN Calculator.



Touchscreen keypads

When any editable input field is selected, tap on the field to open the touchscreen keypad to enter a value. There are two types of keypads, numeric and alpha-numeric.

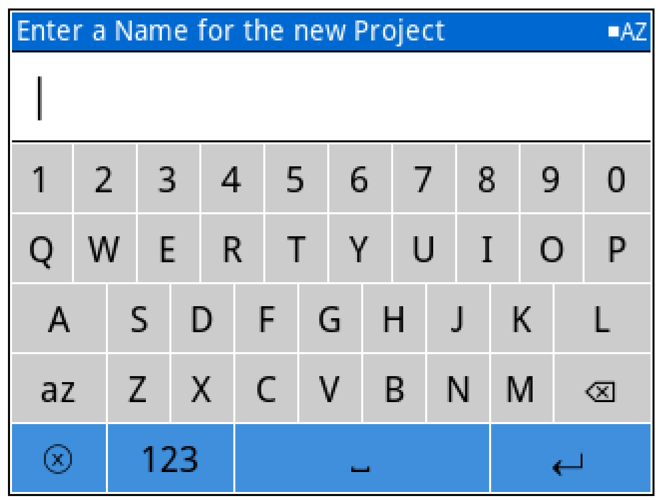
Numeric keypad



Any time a numeric field is edited, the numeric keypad opens. The title of the keypad is the help text of the field being edited, and a “helper” button is to the right of the edit line, which can vary depending on the type of input field you’re editing. The example shows a distance field being edited, as a result the helper button shows the secondary distance unit to convert from secondary to primary distance units.

Copy and paste is functional here too, as are the keys on the keyboard of the calculator.

Alpha-numeric keypad



Any time an alpha-numeric field is edited, the alpha-numeric keypad opens. The title of the keypad is the help text of the field being edited.

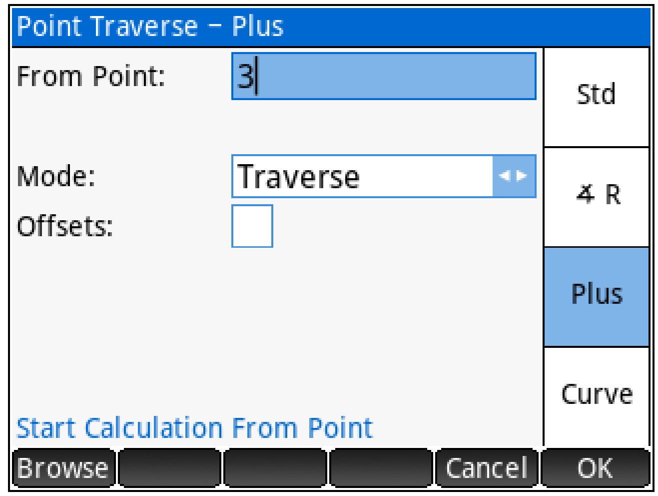
This keypad can have three different sets of characters:

- Uppercase alphabetic (with top row of numbers)
- Lowercase alphabetic (with top row of numbers)
- Numbers and special characters

The ALPHA alpha and Shift keys can be used to switch between modes.

Depending on the language of the installed app, the keypad may respond to long presses on certain keys to show accent characters where applicable.

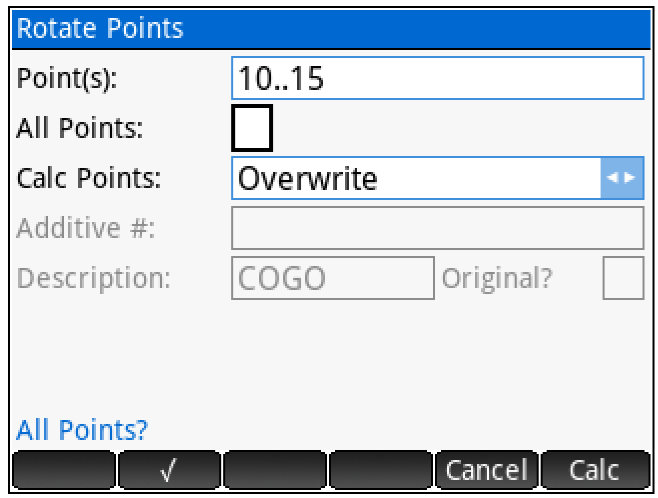
Point IDs



A single Point ID can be input by simply entering the number. Depending on the context of where the input is requested, there may be requirements that the point exists or does not exist.

While editing a Point ID field where an existing Point is required, the menu will change to display **Browse** on the first menu label. Pick this option to open the Point Database browser where a Point can be selected from the database.

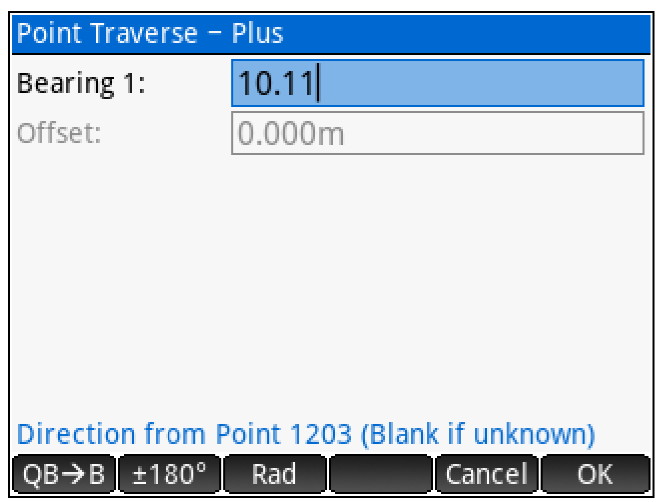
Point Ranges



To input a range of points:

- Enter a range of points in the format "From..To", for example ***1..5***, to input a range of point numbers.
- Enter a combination of point ranges and individual points, for example ***1..5 7 9..15***, where each range or individual point is separated by a space or comma.
- Often a checkbox labeled ***All Points*** is available to select all points in the current project.

Directions



A direction input can be a full circle bearing or a quadrant bearing. The prompt will depend on the direction reference user setting.

- Enter a 360°'" full circle bearing input in the DDD.mmss format. For example, 123°45'12" is entered as ***123.4512***.
- Enter a quadrant bearing input in the QDD.mmss format, where Q is the quadrant (1 to 4). For example, N24°34'55"W is entered as ***424.3455***.
- Enter two points in the "From..To" format to inverse the direction between two existing points in the job database. For example, enter ***1..2*** to inverse the direction from Point 1 to Point 2.

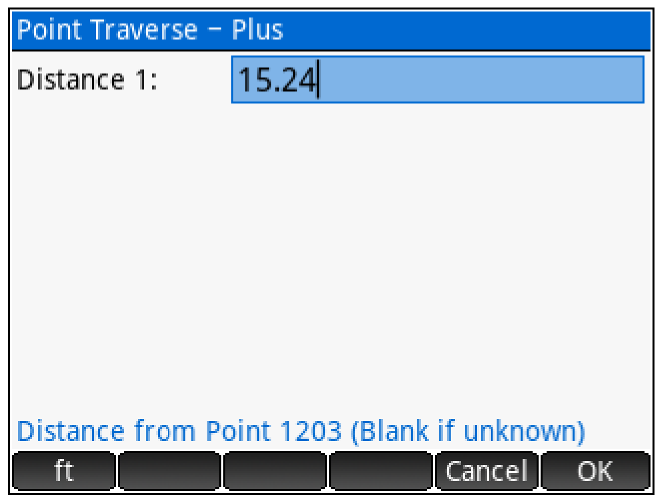
- ► Subtract or add angles to/from a line direction by entering “From..To+Angle” or “From..To-Angle”. For example, ***1..2+30.3055*** will inverse the direction from Point 1 to Point 2 and add 30°30’55” to it.
- ► Perform complex calculations using standard algebraic entry with current angle unit settings. For example, ***1..2+30.17-2.35-1.44*** will inverse the direction from Point 1 to Point 2, then add 30°17’, then subtract 2°35’, and then subtract another 1°44’.
- ► Repeat the last entry by entering **++** as input.
- ► QB→B While editing a direction field, pick this option to convert between quadrant bearings and full circle bearings.
- ► ±180° While editing a direction field, pick this option to reverse the direction.
- ► Rad While editing a direction field, pick this option to enter a value in radians.

Angles

Angles work in a similar fashion as directions except that the input MUST be a real number or a complex calculation involving only real numbers.

Distances

Distance input is like direction input:



- ► Enter two points in the “From..To” format to inverse the distance between two existing points in the job database. For example, enter ***1..2*** to inverse the distance from Point 1 to Point 2.
- ► Subtract or add a distance from a line distance by entering “From..To+Distance” or “From..To-Distance”. For example, ***1..2+30.1*** will inverse the distance from Point 1 to Point 2 and add 30.1 units to it.
- ► Divide or multiply a line distance by a factor by entering “From..To*Factor” or “From..To/Factor”. For example, ***1..2/5*** will inverse the distance from Point 1 to Point 2 and divide the result by 5.
- ► Perform complex calculations using standard algebraic entry. For example, ***1..2+(30.214/3)-5*** will inverse the distance from Point 1 to Point 2, then add one third of 30.214, then subtract 5.
- ► Repeat the last entry by entering **++** as input.
- ► ft While editing a distance field, pick the first menu button to convert a distance entered from the secondary distance unit to the primary distance unit.

Feet, Inches, Fractions

Feet, Inches and fractions may be input into any distance fields by delimiting each part by a comma character. This input type will always convert to the current unit setting once entered. The tables below show example use cases to illustrate how this entry method is implemented.

Project Distance Unit set to Metres

User Entered Value	Interpreted As	Displayed As (3 decimal places)
10	10m	10.000m
10,	10’	3.048m
10,6	10’-6”	3.200m
10,6,1/2	10’-6 1/2”	3.213m
10,6,15/32	10’-6 15/32”	3.212m
10,6,7	10’-6 7/16”	3.212m

Project Distance Unit set to Feet

User Entered Value	Interpreted As	Displayed As (1/16 precision)
10	10’	10’
10,	10’	10’
10,6	10’-6”	10’-6”
10,6,1/2	10’-6 1/2”	10’-6 1/2”
10,6,15/32	10’-6 15/32”	10’-6 1/2”
10,6,7	10’-6 7/16”	10’-6 7/16”

Coordinates

Coordinate values must be entered as real numbers, or as complex calculation involving real numbers. Coordinates are displayed with current unit suffix once entered.

Stations

Station values must be entered as real numbers, or as complex calculation involving real numbers. Stations are displayed with current station format once entered, 0+00 / 0+000 / No Format.

Grades

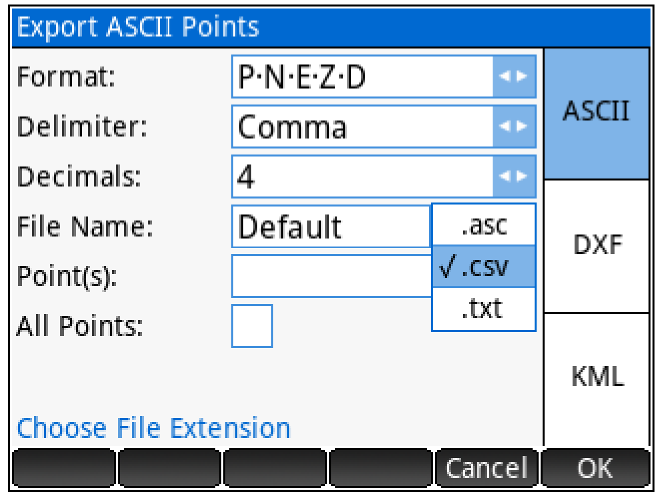
Grade values must be entered as real numbers, or as complex calculation involving real numbers. Grades are displayed with grades format once entered, % (V/H*100) / Ratio V:H / Ratio H:V.

Text

Text fields will accept a certain range of characters as valid input. Use ALPHA alpha and Shift to enter the characters required. Available characters include (see next page):

Default	1 2 3 4 5 6 7 8 9 0 . , + - * /
ALPHA alpha enabled:	A B C D E F G H I J K L M N O P Q R S T U V W X Y Z # : . ;
ALPHA alpha and Shift enabled:	a b c d e f g h i j k l m n o p q r s t u v w x y z # : = _ ;

Choose Lists



Choose lists contain a pre-defined set of options to choose from. Selections can be made by:

- Tapping on the field to open the list of possible selections to pick.
- Tapping Choose once the field is selected.
- Cycling through available options using the keyboard ◀ and ▶ buttons.

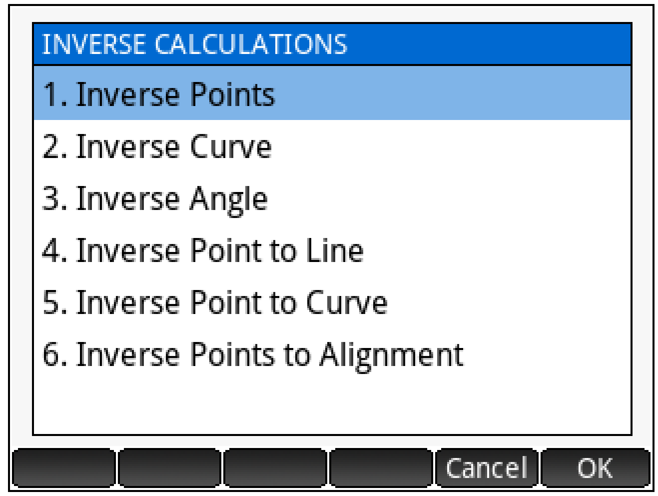
The current selection is displayed with a checkmark when the list is expanded.

Checkboxes

Checkboxes are toggles to set a flag True or False. In some cases, the state of the checkbox may disable or enable other fields in the input forms. Checkboxes can be toggled by:

- Tapping on the field.
- Tapping √ once the field is selected.
- Using the keyboard ◀ and ▶ buttons.

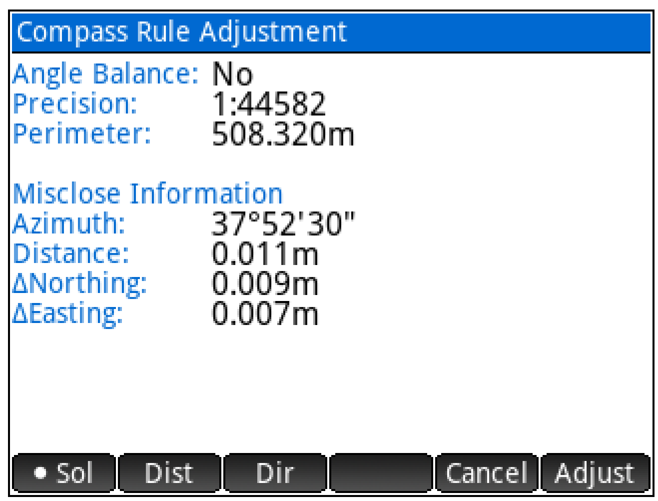
2.4 Choose Boxes



Choose boxes present a list of multiple options from which to choose. Selections can be made by:

- Tapping on the option row selects the option, and when already selected will complete the selection and advance to the next step.
- Use the keyboard shortcut keys 1 to 9 to make a seleciton. This action will also complete the selection and advance to the next step.
- Cycling through available options using the keyboard ▲ and ▼ buttons. Use OK to advance to the next step.
- When a list is longer than 7 items, a scrollbar is shown and the list can be scrolled with the touchscreen.

2.5 Output Screens



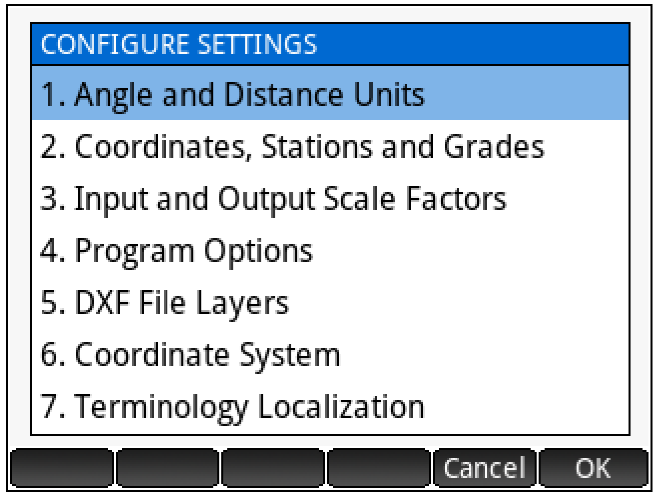
Output screens display the results of calculations and do not accept input. Some output screens feature a menu to provide access to further calculations related to the data, while other output screens will only feature a OK menu option.

Some output screens consist of multiple pages; the active page is differentiated with a filled circle character preceding the menu label, for example • Sol.

Many output screens also feature a COPY menu button. This allows the user to select one of the solved values to copy to the clipboard.

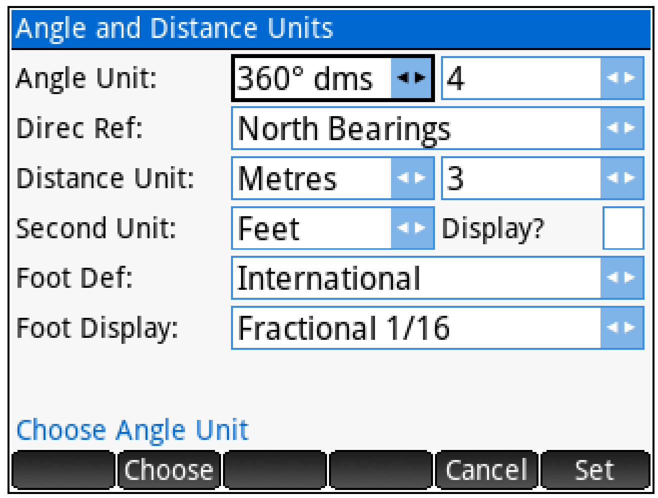
Many output screens also feature a STOV menu button. This allows the user to select one of the solved values to store to a named variable.

3 User Settings



Various settings allow the user to configure the software to function to his/her preference. It is important to review all the settings prior to using the software to ensure they are set to produce the desired results.

3.1 Angle and Distance Units



Unit settings affect input interpretation and representation.

Angle Unit

The angle unit may be set to **360°'" dms**, **360° dec** or **400 gon**. Angular and directional input and output will honour this setting for all functions.

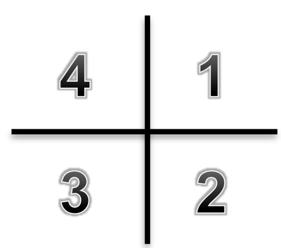
Angle Precision

Angles and directions are displayed with the specified number of decimals.

Direction Reference

Direction reference may be set to **North Bearings**, **South Bearings**, or **Quadrant Bearings**.

- **North bearings** are defined by declaring north to be 0° (or 0g) while **south bearings** are defined by declaring south to be 0° (or 0g), and then measuring the full circle in a clockwise direction. Direction input and output are subject to both angle unit and direction reference settings.
- **Quadrant bearings** split the circle into NE, SE, SW, and NW quadrants, always measuring angles from north or south towards east or west. Quadrants are numbered 1-4 to facilitate fast input of quadrant bearings. For example, to enter a bearing of N36°43'15"W; the user would enter ***436.4315*** because the NW quadrant = quadrant 4.



Distance Unit

The distance unit may be set to **metres** or **feet** for display and conversion purposes.

> The distance unit setting DOES NOT AFFECT JOB COORDINATES. The distance unit is for input/output display only. To convert a project from metric to imperial, or vice versa, use the Scale Points option. This behaviour is consistent with how a CAD drawing operates. The coordinates are essentially unit-less, and this setting determines input and output display/calculations.

Distance Precision

Distances are displayed with the specified number of decimals.

Secondary Unit

The secondary unit may be set to **metres**, **feet**, **links** or **chains**. This setting determines the unit that can be used for quick conversions (to the primary unit) within distance input fields.

Display Secondary Unit

This toggle determines if calculated distance results will be displayed in the primary unit only, or both primary and secondary units.

Foot Definition

The foot definition setting may be set to **US Survey Foot** or **International Foot** for use with all conversions between metric and imperial.

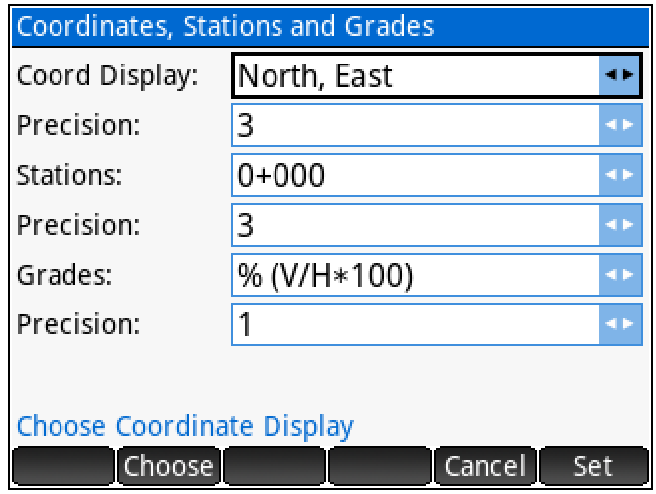
- The definition of a **US Survey** Foot is exactly 1200⁄3937 metres, approximately 0.304800609601 metres.
- The definition of the **International Foot** is exactly 0.3048 metres.

Foot Display

The foot display setting may be set to **Decimal** or **Fractional 1/16** for displaying distances in feet units.

3.2 Coordinates, Stations and Grades

Modify the display of coordinates, stations and grades.



Coordinate Display

The coordinate display format may be set to display coordinates in the order of **Northing, Easting**, **Easting, Northing** or **X,Y**. This setting changes the order and labels for most cases where coordinates are input and/or displayed.

Coordinate Precision

Coordinates are displayed with the specified number of decimals.

Stationing Display

The stationing display format may be set to display stations in the format **0+00**, **0+000** or without any formatting.

Stationing Precision

Stations are displayed with the specified number of decimals.

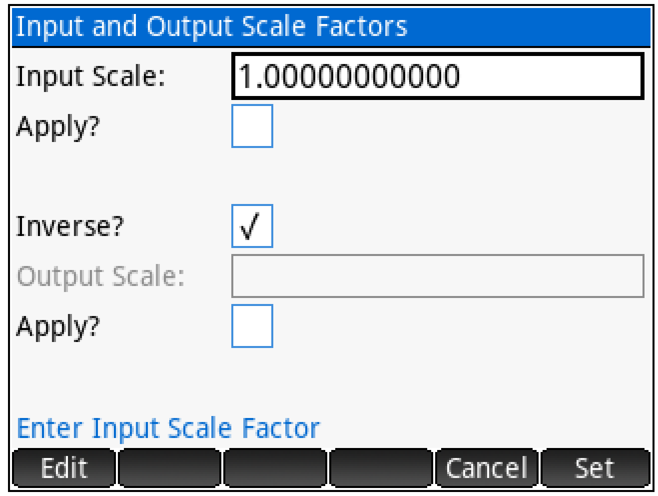
Grade Display

The grade display format may be set to display grades as percentage grades **% (V/H*100)**, ratio **V:H**, or ratio **H:V**. This setting applies to input and output of grades.

Grade Precision

Grades are displayed with the specified number of decimals.

3.3 Input and Output Scale Factors



The Input Scale Factor, when enabled, is applied to all distance entries to automatically scale the distance by the specified scale factor. The Output Scale Factor, when enabled, is applied to all calculated distances to automatically scale the calculated distance. The primary use of these settings is to calculate grid coordinates by entering ground distances. The settings can also be used to work with alternate units, such as entering feet dimension in a metric project.

Input Scale Factor

The Input Scale Factor will be applied to any entered distance values when the toggle is set.

Apply Input Scale Factor

Toggle the application of the Input Scale Factor.

NOTE: When the Input Scale Factor is being applied, all distance input fields will display an asterisk after the distance value once the input has been entered and parsed, for example **30.000m *.**

Inverse?

Toggle the automatic calculation of the Inverse of the Input Scale Factor to set the Output Scale Factor.

Output Scale Factor

The Output Scale Factor will be applied to all calculated distances when the toggle is set.

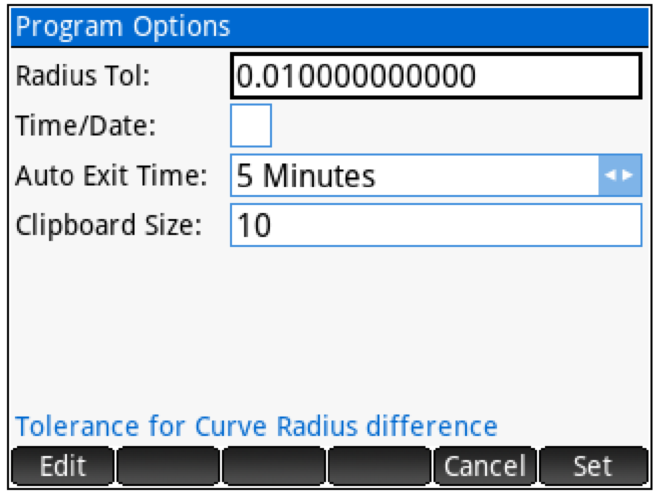
Apply Output Scale Factor

Toggle the application of the Output Scale Factor.

NOTE: When the Output Scale Factor is being applied, all calculated distance values will be scaled by this factor, and the resulting value will be displayed with an asterisk, for example **30.000m *.**

.

3.4 Program Options



Program Options are settings that affect how the program will handle certain situations.

Radius Tolerance

Enter a value to set the radius tolerance, used primarily by **Inverse Curve** and **Area by Points**. The distance from the BC point to the Radius point and the distance from the EC point to the Radius point cannot differ by more than this value, otherwise the points will not define a valid curve. The average of the two values ((BC..CC+EC..CC)/2) is used as the radius for a curve.

Time/Date

Toggle the display of the time and date in the header of the program.

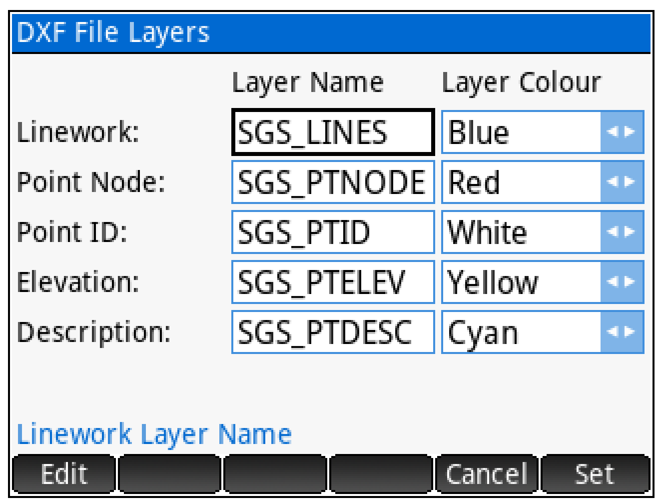
Auto Exit Time

Set the timeout duration for inactivity. After the specified time limit the app will start a close sequence that will see the app completely exit out. This is done to allow the calculator to go to sleep to save battery life.

Clipboard Size

Set the maximum number of items that the clipboard will hold, must be a number in range of 1 to 100.

3.5 DXF File Layers



DXF File Exports are available for some routines, and the DXF File Layers settings are used when exporting the entities.

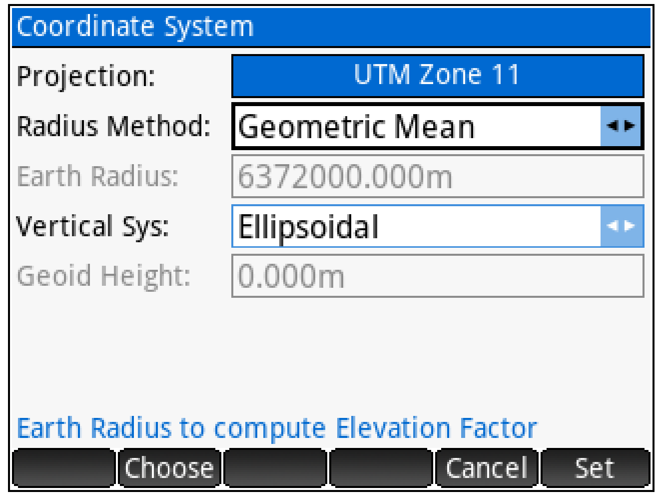
Default layer names and colours will be used until the user changes the name or colour settings.

3.6 Coordinate System

Coordinate System Settings are used for Coordinate Conversions and Ellipsoid Calculations.

Projection

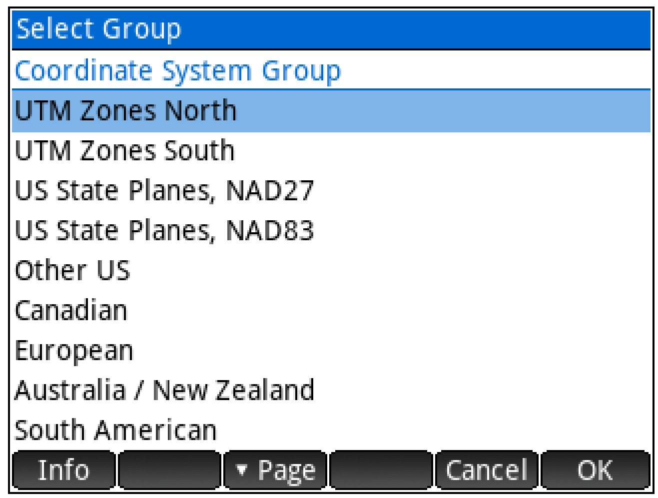
Various pre-defined projections are included. Coordinate systems are grouped by region and projection type. Available reference ellipsoids vary depending on the coordinate system selected. Touch the button displaying the currently set projection to change it.



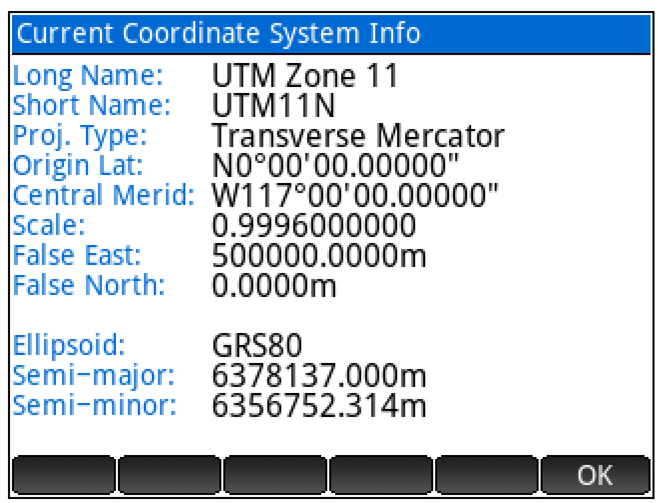
Coordinate System Groups

The available coordinate system groups are:

1. UTM Zones North
2. UTM Zones South
3. US State Planes, NAD27
4. US State Planes, NAD83
5. Other US
6. Canadian
7. European
8. Australia / New Zealand
9. South American
10. Central American
11. African
12. Middle East
13. User Defined



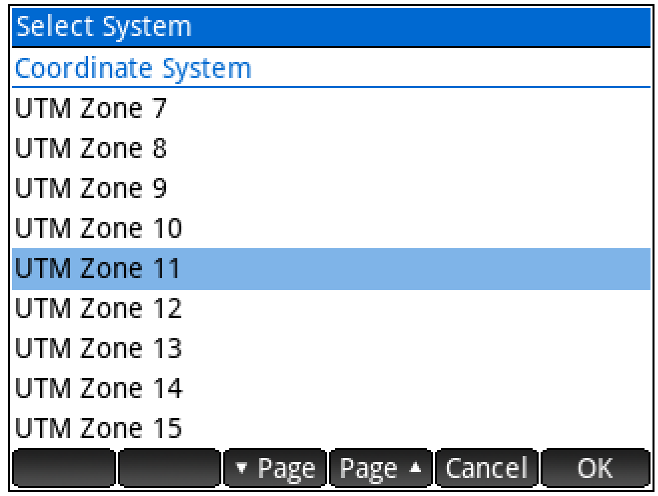
On the menu use the Info option to display the parameters of the currently set coordinate system.



Select a group to display the available coordinate systems.

Coordinate Systems

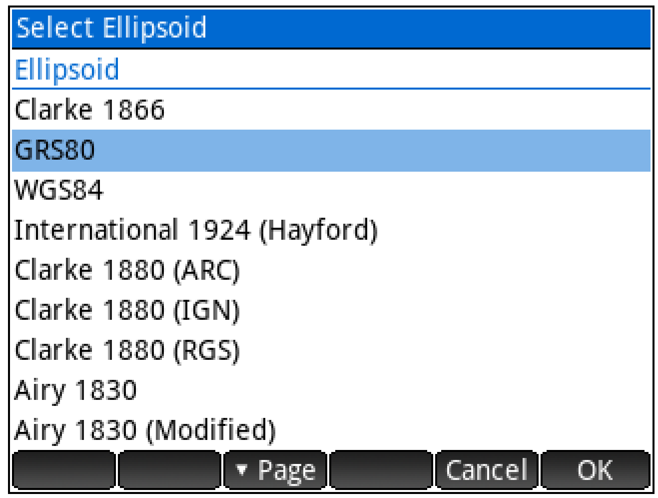
The available coordinates systems for the selected group are displayed, choose the coordinate system.



Reference Ellipsoid

Depending on your chosen coordinate system; you may be presented with a list of options to select the reference ellipsoid. A reduced list, or automatic selection is made for those coordinate systems that are specifically based on a certain ellipsoid.

Various commonly used ellipsoid definitions are included. Available options are:



1. Clarke 1866 (NAD27)
2. GRS80 (NAD83)
3. WGS84
4. International 1924 (Hayford)
5. Clarke 1880 (ARC)
6. Clarke 1880 (IGN)
7. Clarke 1880 (RGS)
8. Airy 1830
9. Airy 1830 (Modified)
10. Australian National Spheroid
11. Krassovsky 1940
12. Bessel 1841
13. Parametry Zemli 1990 (PZ-90)
14. User Defined

Radius Method

Choose the method to determine the earth radius to use for elevation factor calculations. Options include:

- ***Geometric Mean*** – Calculates the geometric mean earth radius for each point, using the formula:

  $r = \frac{a \times \sqrt{1-e^2}}{1-e^2 \times (\sin \emptyset)^2}$ where a = semi-major axis (radius at equator) e^2 = eccentricity squared and ∅ = geodetic latitude. This is the most accurate method.
- ***6372000m*** – Commonly used mean earth radius, may not be ideally suitable for all regions.
- ***User Entered*** – Some regions have adopted a mean earth radius that best fits their region.

Earth Radius

When the **Radius Method** is set to ***User Entered***, enter the appropriate value for the coordinate system.

Vertical System

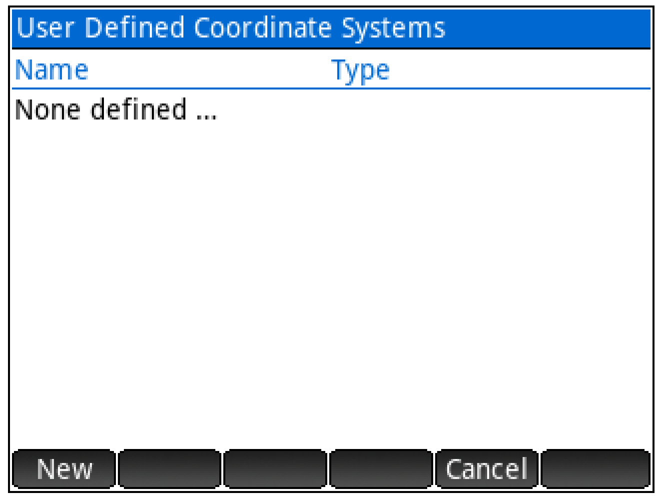
Choose the vertical system that will be used to arrive at ellipsoid heights for various calculations. The options are ***Ellipsoidal*** (requires no conversion) or ***Average Geoid Height*** (applies average geoid separation to obtain ellipsoid heights). Geoid file support is planned for a future release.

Average Geoid Height

The average geoid height for your project area. Ellipsoid heights (h) are calculated by adding the orthometric height (H) and the ***geoid height*** (N). $h = H + N$ therefore $N = h - H$

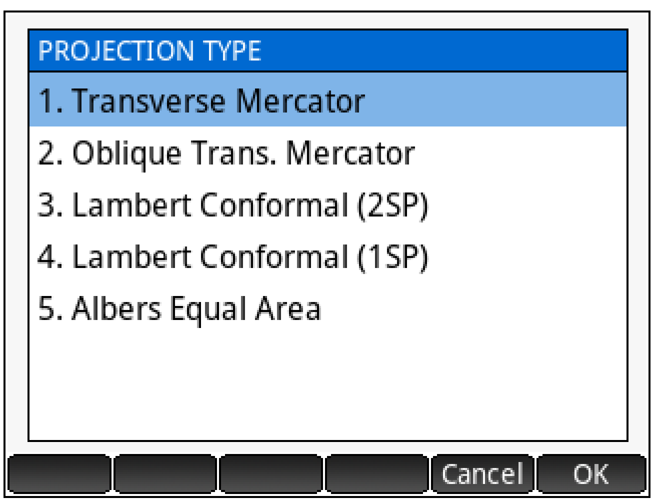
User Defined Coordinate Systems

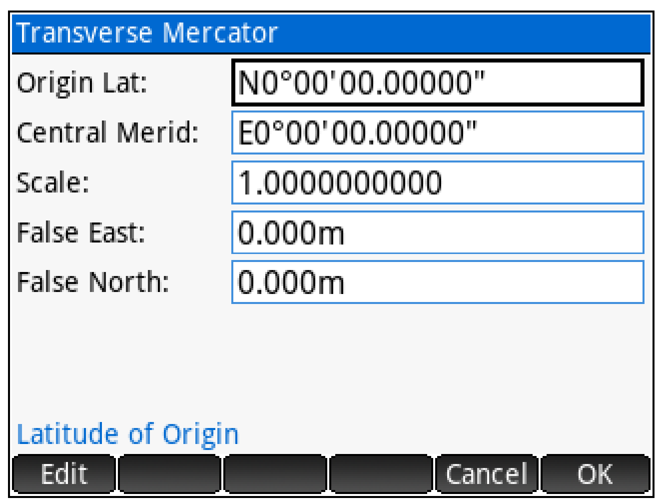
When selecting ***User Defined*** as the **Coordinate System Group**, a list of user-created coordinate systems is displayed.



Use the New option on the menu to create a new coordinate system. The user can choose the projection type to create the new coordinate system. The input form that follows will prompt for the appropriate parameters required to define the coordinate system.

A final input form accepts a long and short name for the coordinate system and the Hemisphere & Orientation selections.



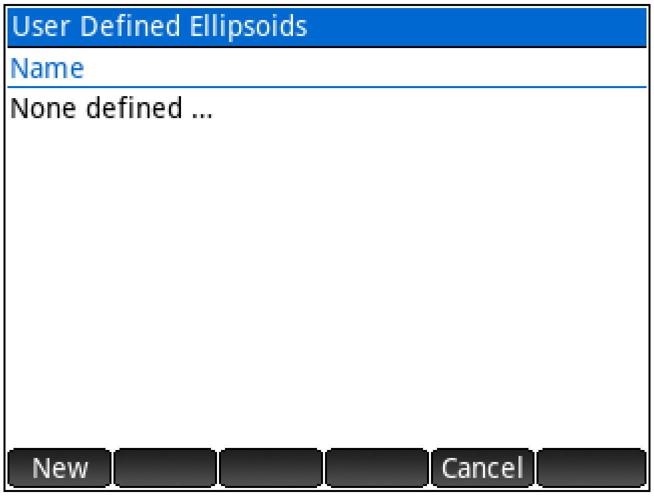


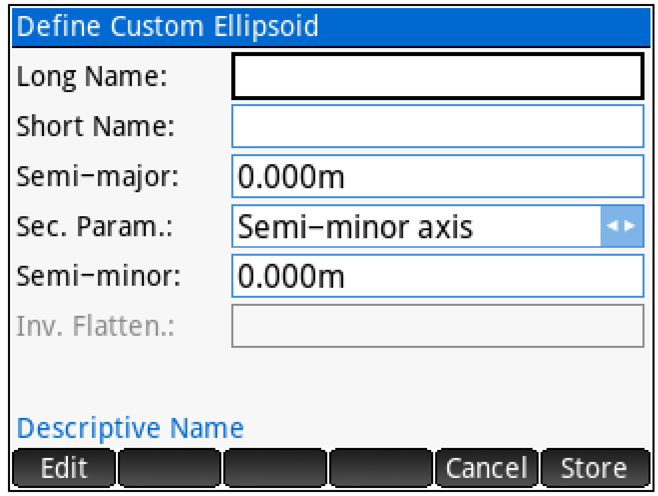
Once created; the custom coordinate system may be selected as the chosen coordinate system or edited if required.

User Defined Ellipsoids

When selecting ***User Defined*** as the **Ellipsoid**, a list of user-created ellipsoids is displayed.

Use the New option on the menu to create a new ellipsoid. The input form accepts all the required information. The second parameter of the ellipsoid can be either the ***Semi-minor axis*** or the ***Inverse Flattening*** parameter.



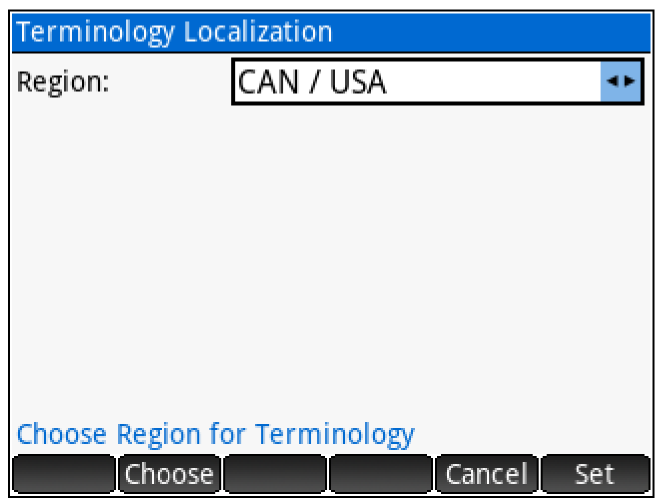


Once created; the custom ellipsoid may be selected as the chosen ellipsoid or edited if required.

3.7 Terminology Localization

Terminology localization allows the user to control some of the terminology used throughout the program. Standard terminology differs between regions. When the calculator settings are set to English language, then this option will be available in the **SGS Prime COGO** settings. The available region selections are:

- CAN / USA (Canada / USA)
- AUS / NZL / ZAF (Australia, New Zealand, South Africa)

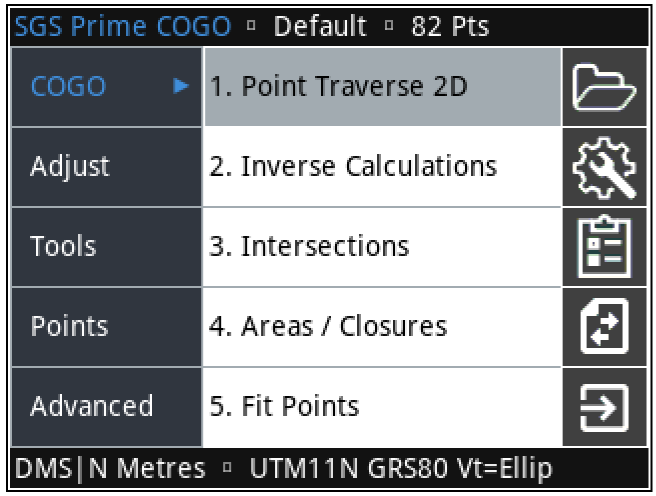


3.8 Settings Use and Application

The table below outlines which settings are specific to the current project, and which ones are constant until changed explicitly. When creating a new project, the current project's 'project specific' settings will be the default suggested values.

Setting	Project Specific or Constant
Angle Unit	Project Specific
Angle Unit Precision	Constant
Direction Reference	Project Specific
Distance Unit	Project Specific
Distance Unit Precision	Constant
Foot Definition	Project Specific
Secondary Distance Unit	Project Specific
Display Secondary Unit	Project Specific
Coordinate Display Format	Constant
Coordinate Precision	Constant
Station Display Format	Constant
Station Precision	Constant
Grades Display Format	Constant
Grades Precision	Constant
Input Scale Factor	Project Specific
Input Scale Toggle	Project Specific
Inverse Calculation toggle for Output	Project Specific
Output Scale Factor	Project Specific
Output Scale Toggle	Project Specific
Radius Tolerance Value	Constant
Point Traverse App	Constant
Header Time and Date	Constant
DXF File Layers	Constant
Coordinate System	Project Specific

4 COGO Menu



- Point Traverse 2D – The primary COGO routine used to calculate point coordinates.
- Inverse Calculations – **Inverse Points**, **Inverse Curve**, **Inverse Angle**, **Inverse Point to Line**, **Inverse Point to Curve**, and **Inverse Point to Alignment**.
- Intersections – **Bearing-Bearing**, **Distance-Distance**, **Bearing-Distance** and **Distance-Interior Angle**.
- Areas / Closures – **Area by Points**, **Subdivide by Sliding Bearing**, **Subdivide by Hinge Point**, and **Closures**.
- Fit Points – **Fit to Straight Line** (Linear Regression), **Fit to Circular Curve**, **Double Proportion, Irregular Boundary** and **Grant Boundary**.

4.1 Point Traverse 2D

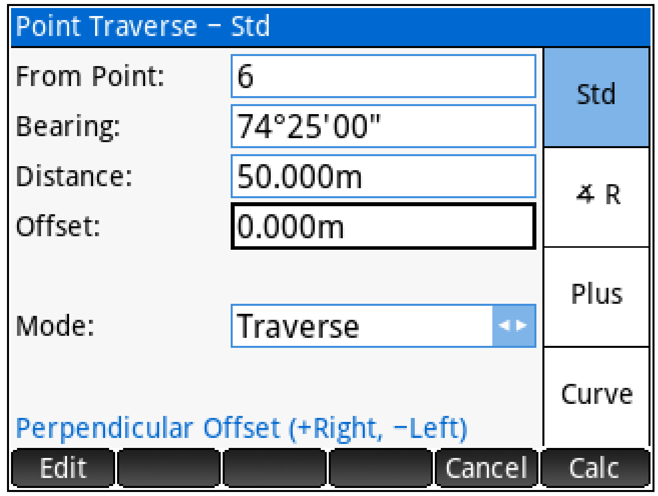
Point Traverse 2D is the main COGO application and is available in three configurations: **Standard**, **Angle Right** and **Plus**. The **Curve Traverse** option is used to calculate points from curve information.

Each of the three configurations will have a Mode option which controls automatic Point ID updating while calculating:

- **Traverse** – Traverse Mode will always advance the From Point to the new Point ID that gets stored when completing a calculation. This is ideal if calculating the perimeter of a parcel, for example.
- **Sideshot** – Sideshot Mode does not advance the From Point when a calculation is completed. This is ideal for calculating numerous points from the same base point.

Point Traverse - Standard

Point Traverse – Std is a COGO application that accepts all input within a single input form.



‘From Point’ Field

This field requires an existing point number to use as the starting point, or station. Entering a point number that does not exist in the job will result in the option to create a new point.

All the Inverse Calculations as described under the Point Traverse - Plus section are also accepted.

‘Bearing’ Field

This field requires the direction to the new point from the FROM POINT. Input types accepted:

1. Bearing – The real number entered is interpreted based on the current angle unit and direction reference user settings.
2. Any of the standard directions input options.

‘Distance’ Field

This field requires the distance to the new point from the FROM POINT. Input types accepted:

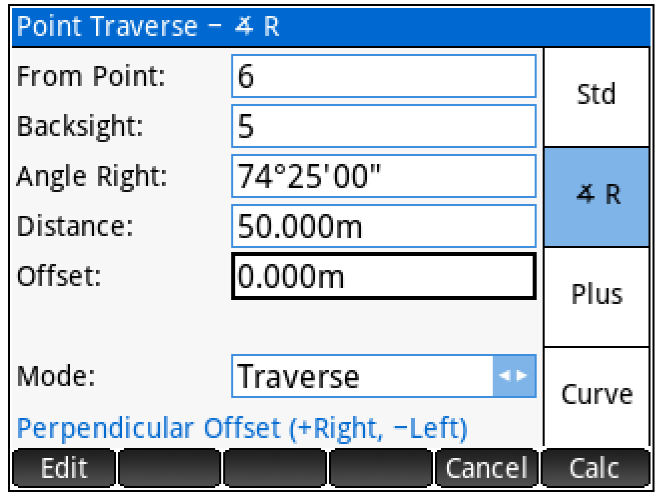
1. A distance – The number entered is used as the distance.
2. Any of the standard distances input options.

‘Offset’ Field

This field accepts a perpendicular offset value from the line of direction. A positive offset is to the right while a negative offset is to the left. This field accepts the same types of inputs as the ***Distance*** field.

Point Traverse – Angle Right

Point Traverse – Angle Right is like Point Traverse - Standard with differences as noted below.



'Backsight' Field

This field requires an existing point number to use as the backsight point.

'Angle Right' Field

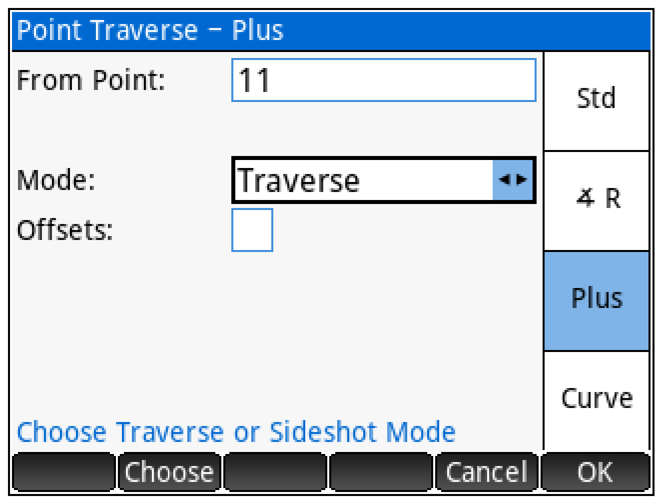
This field requires a real number angle turned right (clockwise) from the Backsight.

Point Traverse – Plus

Point Traverse - Plus is a complete COGO solution with **Inverse** and **Intersection** capabilities.

'From Point' Screen

The ***From Point*** input screen prompts the user to input a point number to use as a starting point for further calculations. Input types accepted:



1. An existing point number – The program ensures the point exists.
2. A non-existing point number – The user may enter a point number that has not yet been stored in the database. An option to create the point will be presented.
3. Two point numbers in the format "From..To" – Calculate a point inverse between two points in the job. The ***From Point*** input screen is re-displayed after this input type is processed. For example, input ***1..2*** to calculate the inverse from Point 1 to Point 2.
4. Three point numbers in the format "Start..End..Offset" – Calculate a point to line inverse by entering the baseline start and end points and the offset point. The ***From Point*** input screen is re-displayed after this input type is processed. For example, input ***1..2..3*** to calculate the offset of Point 3 from the line defined by points 1 and 2.
5. Three point numbers in the format "BC+CC+EC" – Calculate a curve inverse, direction 'right', by entering the beginning of curve, curve center and end of curve points separated by the '+' character.

The ***From Point*** input screen is re-displayed after this input type is processed. For example, input ***1+2+3*** to inverse a curve connecting Point 1 and Point 3 in a clockwise direction with curve center (radius point) at Point 2.

6. Three point numbers in the format "BC-CC-EC" – Calculate a curve inverse, direction 'left', by entering the beginning of curve, curve center and end of curve points separated by the '-' character. The ***From Point*** input screen is re-displayed after this input type is processed. For example, input ***1-2-3*** to inverse a curve connecting Point 1 and Point 3 in a counter clockwise direction with curve center (radius point) at Point 2.

The Menu

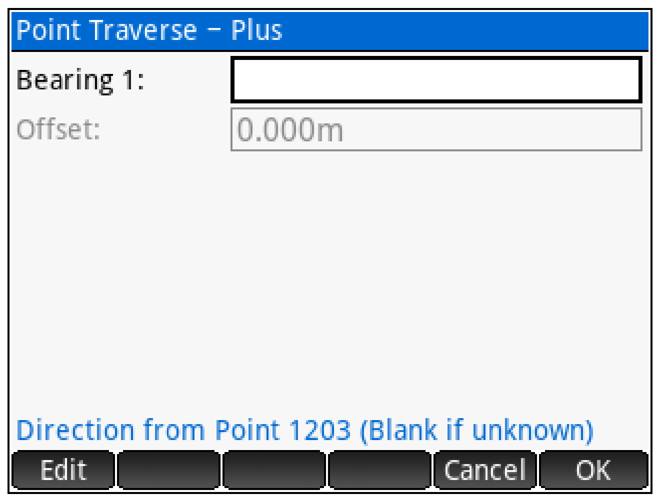
While editing the From Point, the menu updates to show these options:

Browse Opens the Point Database browser where the user can select a point from the list.

Offsets

Toggle to enable offset fields in the Direction Input screens.

'Bearing 1' Screen



This screen prompts the user to input the bearing to the new point from the FROM POINT. Input types accepted:

1. Bearing – The real number entered is interpreted based on the current angle unit and direction reference user settings and the next screen is displayed.
2. Any of the standard directions input options.
3. Leave blank, no input – Signals that the bearing to the new point is unknown, which leaves the possibility of a Distance-Bearing, or Distance-Distance intersection.

The Menu

While editing the Direction, the menu updates to show these options:

QB→B B→QB Converts the input between quadrant bearings and full circle bearings. The appearance and action of this menu option varies depending on your direction reference setting.

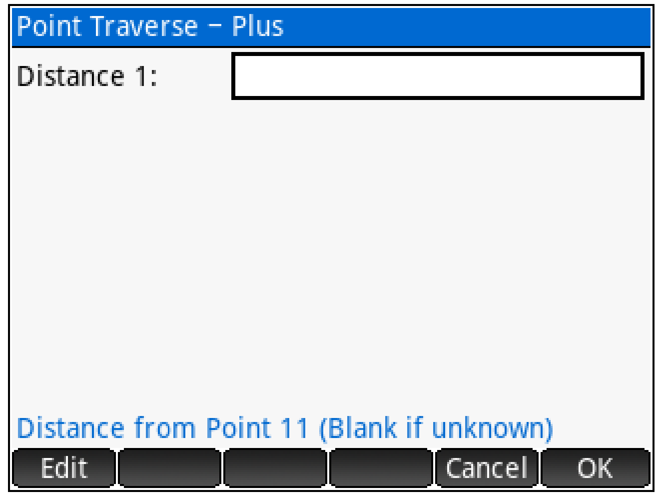
±180° Reverse direction of the number in the command line by adding/subtracting 180° / 200g.

Offset

When enabled, the offset field accepts a perpendicular offset distance from the FROM POINT.

'Distance 1' Screen

This screen prompts the user to input the distance to the new point from the FROM POINT. Input types accepted:



1. A distance – The number entered is used as the distance and the next screen is displayed.
2. Any of the standard distances input options.
3. Leave blank, no input – Signals that the distance to the new point is unknown, which leaves the possibility of a Bearing-Bearing or a Bearing-Distance intersection, provided that the ***Bearing 1*** input was given.

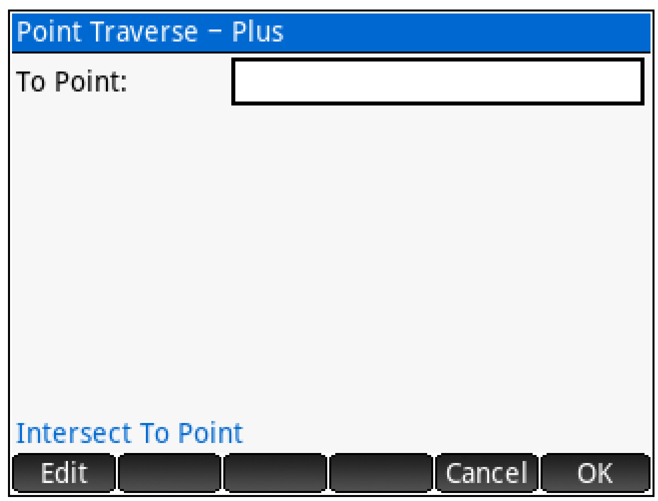
The Menu

While editing the Distance, the menu updates to show these options:

ft→m or m→ft convert the input between metric and imperial units. The menu key varies depending on your primary distance unit setting.

'To Point' Screen

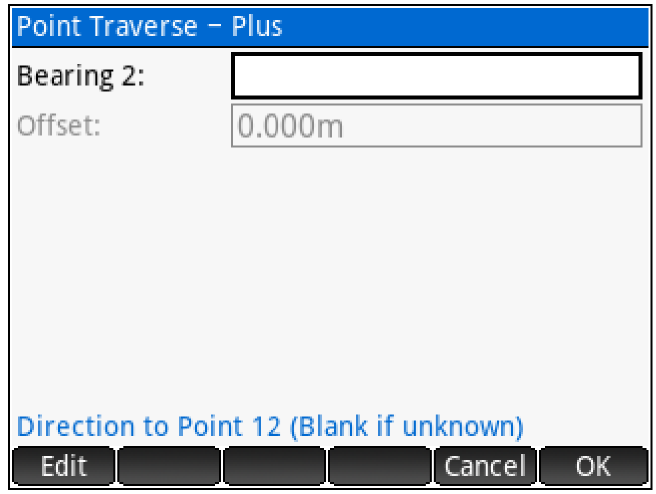
This screen accepts the point number of a second known point that an intersection calculation connects **to**.



This screen appears when either the ***Bearing 1*** or ***Distance 1*** inputs are unknown and left blank.

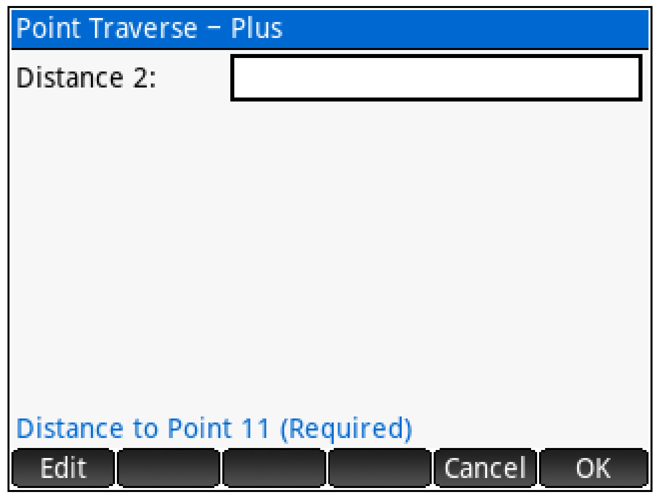
‘Bearing 2’ Screen

This screen has two possible variations depending on whether ***Bearing 1*** or ***Distance 1*** is known. In both cases the screen prompts the user to enter the direction from the new point that is being calculated TO the second known point. This screen accepts the same input types as the Bearing 1 screen.



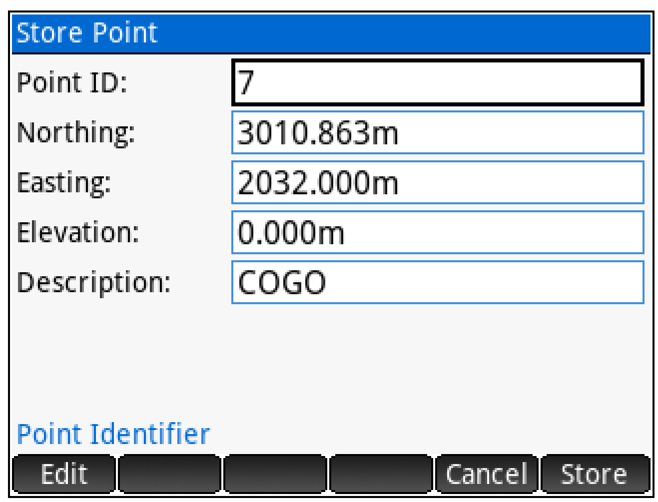
‘Distance 2’ Screen

This screen prompts the user to enter the distance from the new point that is being calculated TO the second known point. This screen accepts the same input types as the Distance 1 screen.



‘Store Point’ Screen

The screen displays the coordinates of the solved point and all the fields can be edited. The Point ID suggestion will always be next unused Point ID after the last stored point.



The Menu

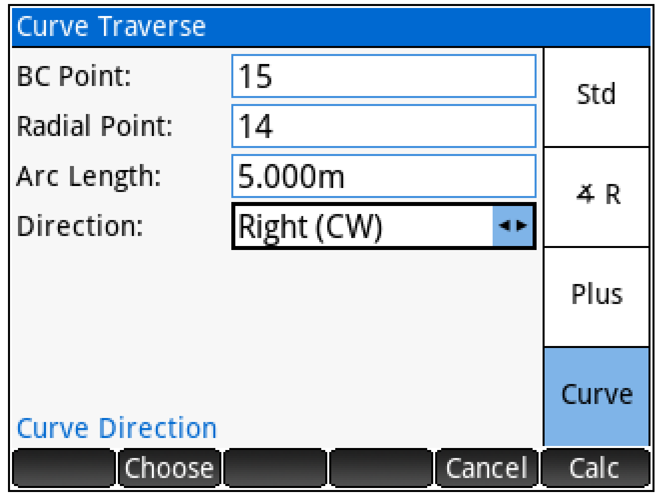
While editing the Point ID, the menu updates to show these Point ID searching options:

Low Inserts the lowest unused point number into the command line.

Next Inserts the next lowest unused point number starting from the currently entered value.

Curve Traverse

The **Curve Traverse** program allows the user to enter a beginning of curve (BC) point and a radius point, enter an arc length and choose the curve direction to solve the end of curve (EC) point.



'BC Point' Field

Enter the beginning of curve point number. A point number is automatically suggested for this input, usually the previously stored point, which can be useful when calculating multiple points along the same arc.

'Radial Point' Field

Enter the radius point number. The radius point input is remembered for the next use until the user quits the **Curve Traverse** program.

'Arc Length' Field

Enter the arc length of the curve.

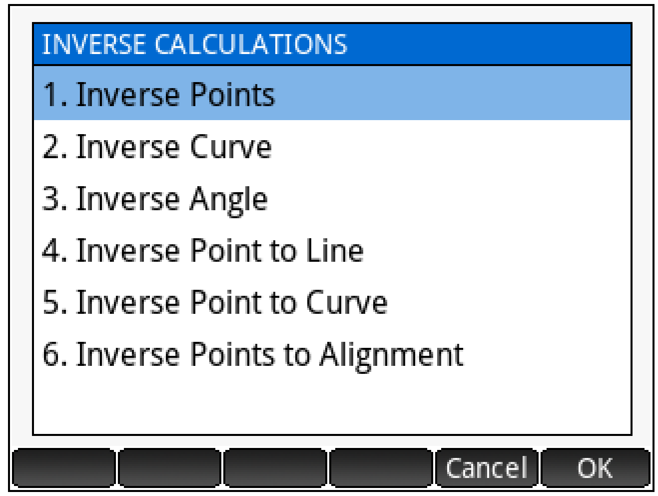
'Direction' Field

Choose the curve direction, 'Right' is clockwise, while 'Left' is counter clockwise.

The standard STORE POINT screen follows valid input to store the EC point.

4.2 Inverse Calculations

Inverse Points, **Inverse Curve**, **Inverse Angle**, **Inverse Point to Line, Inverse Point to Curve** and **Inverse Points to Alignment** are available options for inversing with point coordinates in the current project database.



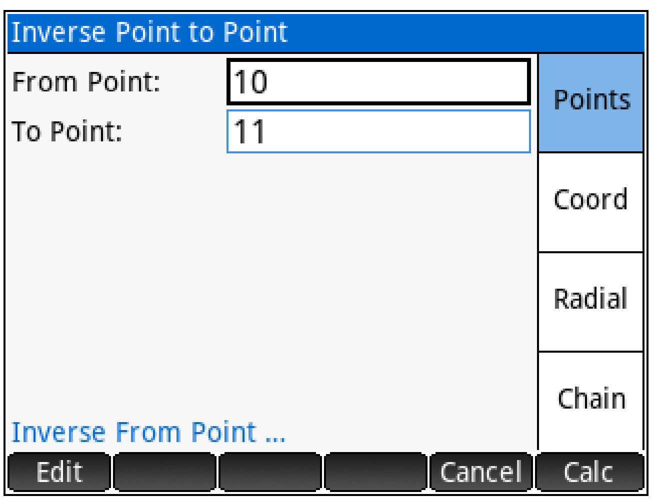
Inverse Points

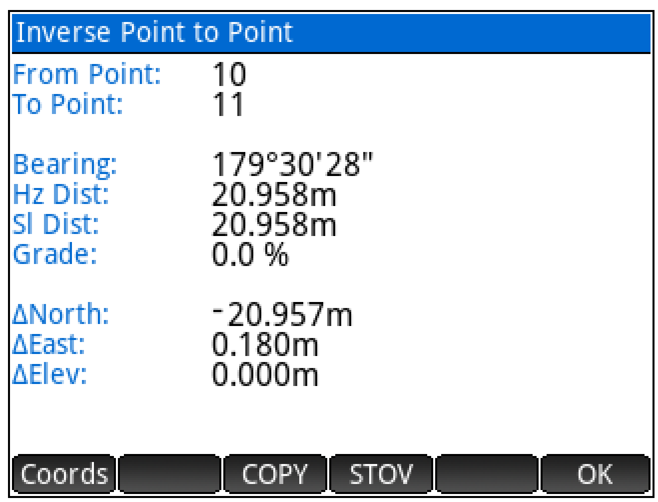
Inverse Points features four methods to inverse points: ***Point to Point***, ***Coordinates***, ***Radial Ties***, and ***Point Chain***.

Inverse Point to Point

Enter the ***From Point*** and ***To Point*** to calculate the inverse information between any two points in the job database.

The results screen displays the direction, horizontal distance, slope distance, slope grade, and coordinate differences between the two points.

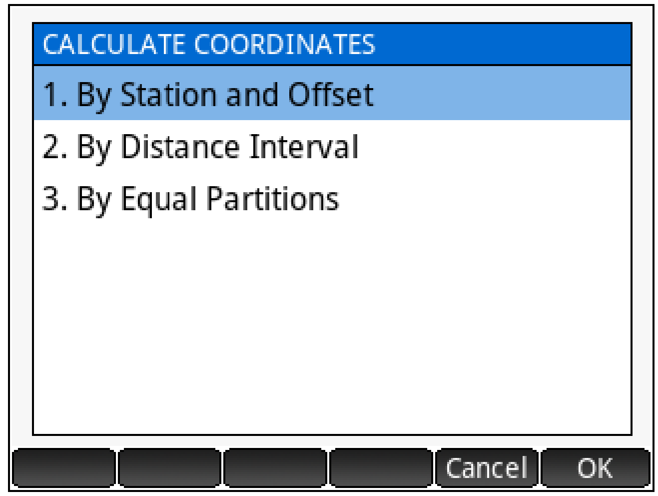




Coords Calculate Coordinates between the end points of the line (see next page for details).

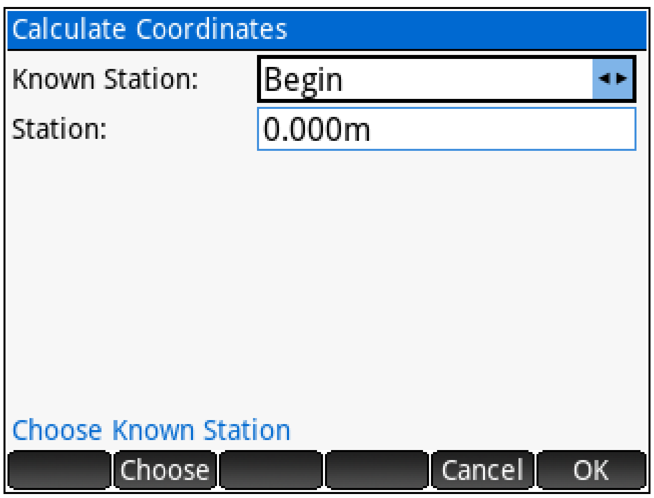
Line Coordinate Calculator

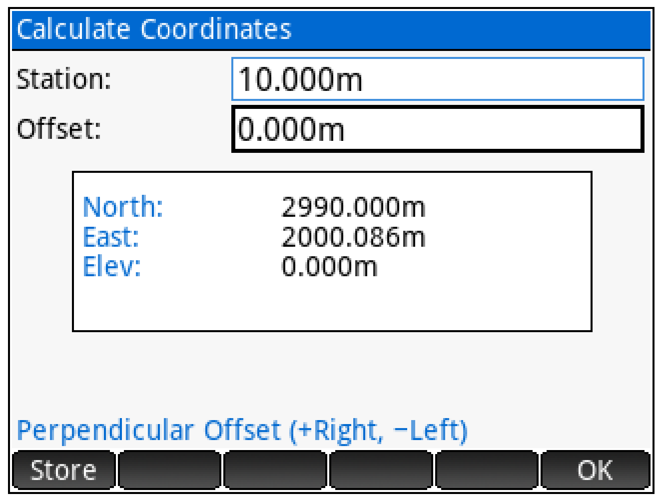
When the Point to Point Inverse is calculated, further calculations can be made between the end points of the line.



By Station and Offset

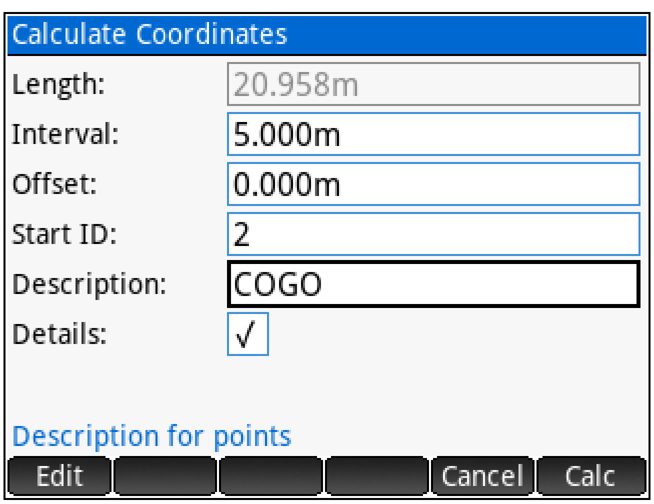
Enter any Station and Offset to solve the coordinates. The station at the beginning or end of the line is required, then 3D coordinates are calculated at the specified station and offset. The solved positions can be stored in the project database with the Store option.

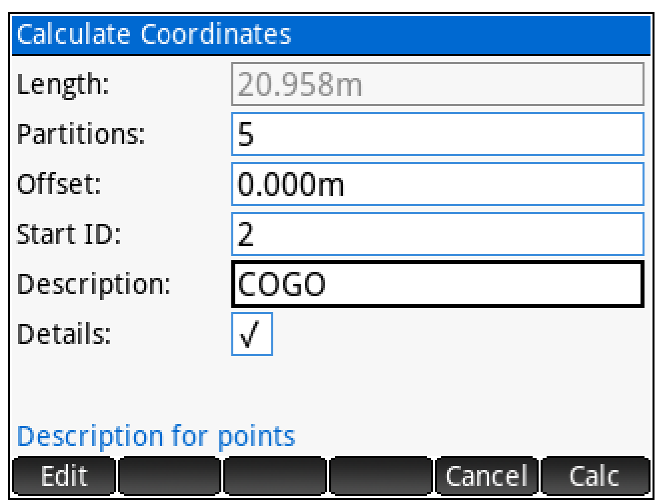




By Distance Interval or Equal Partitions

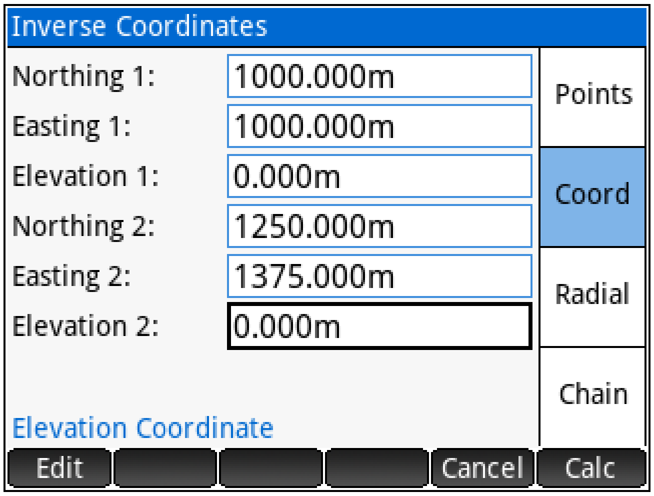
Calculate multiple points at a specific interval or by dividing the line into equal partitions.

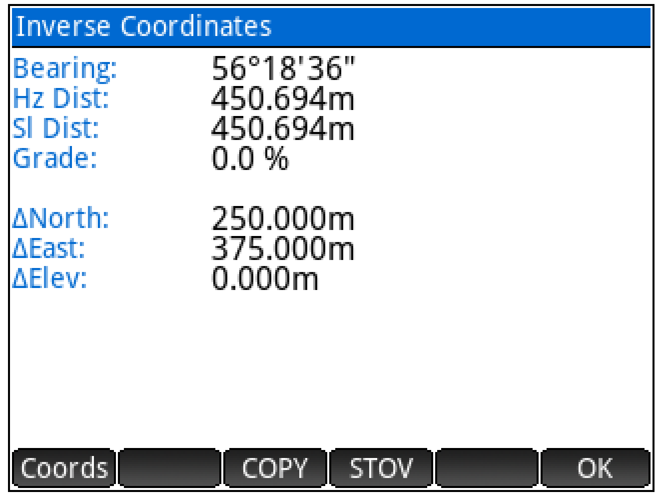




Inverse Coordinates

Enter the coordinates for two points to calculate the inverse.





Inverse Radial Ties

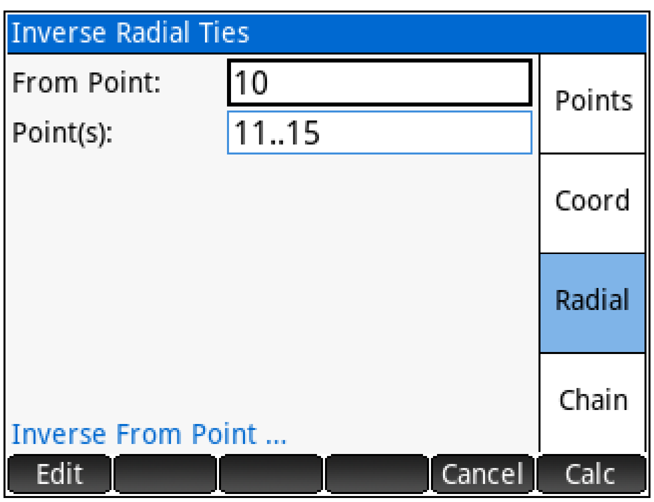
Enter the ***From Point*** and a ***Range of Points*** to calculate radial ties to that range of points.

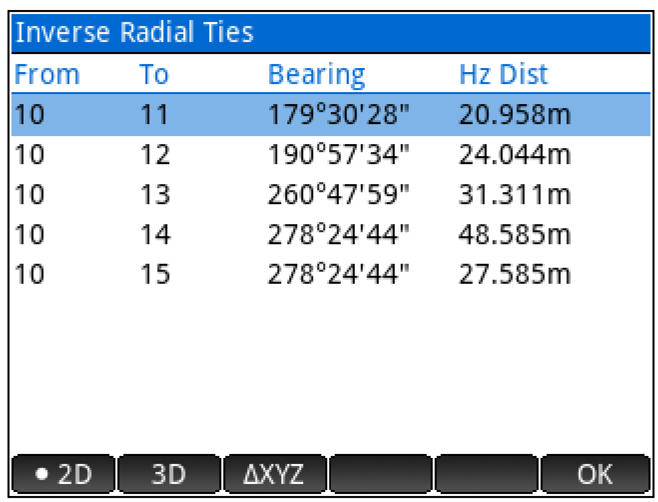
Three pages of results are available.

• 2D Displays directions and horizontal distances.

• 3D Displays slope distances and grades.

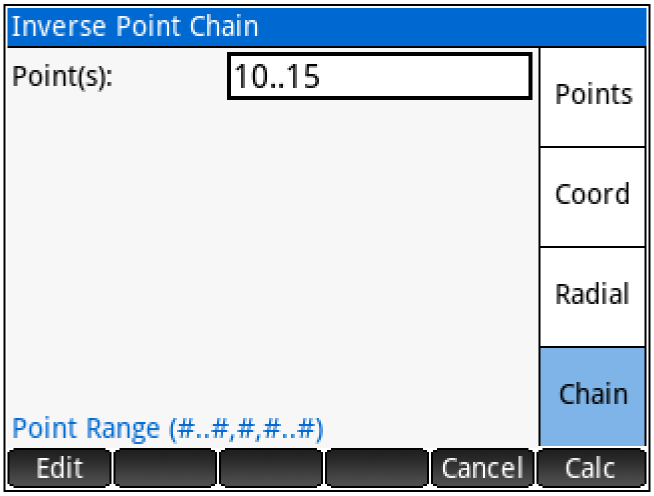
• ΔXYZ Displays differences in coordinates.

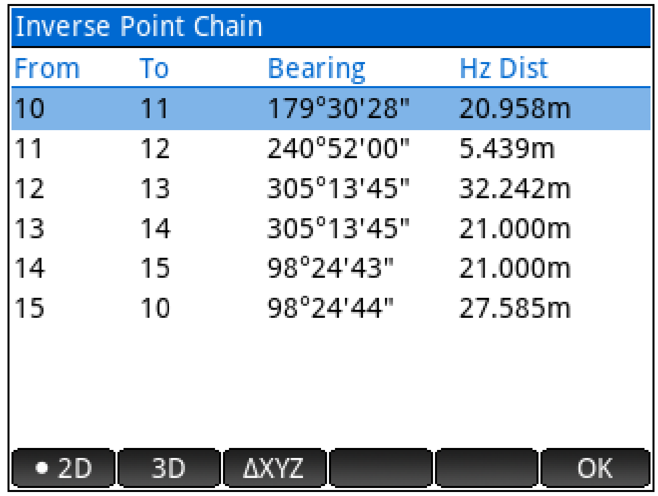




Inverse Point Chain

Enter a ***Range of Points*** to calculate a series of Point to Point inverses, as a chain connecting the points.





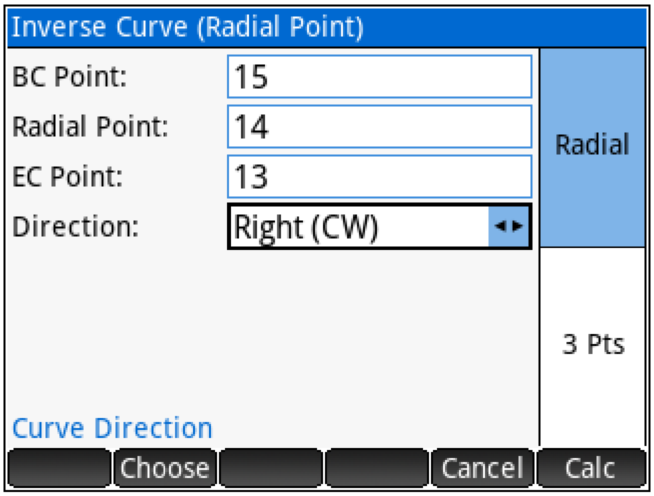
Inverse Curve

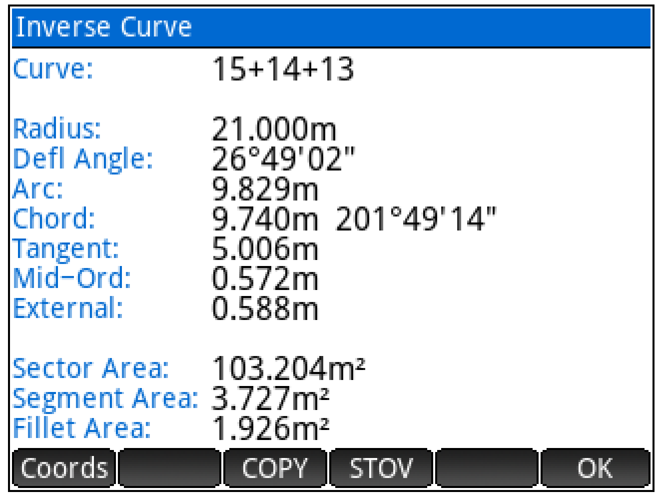
Inverse a Curve using a Radial Point or Three Points on the curve.

Inverse Curve (Radial Point)

Enter the ***Beginning of Curve Point***, the ***Radius Point*** and the ***End of Curve Point***, and choose the ***Curve Direction*** to calculate the curve information.

The results screen displays the radius, deflection angle, arc length, chord length, tangent length, mid-ordinate length, external length, sector area, segment area and fillet area of the curve.

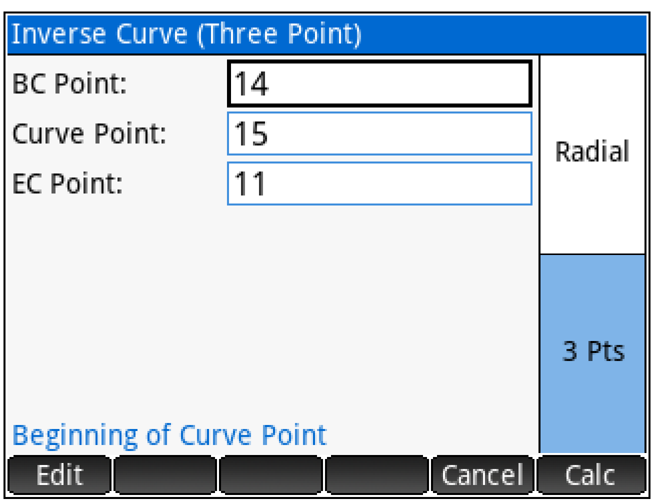


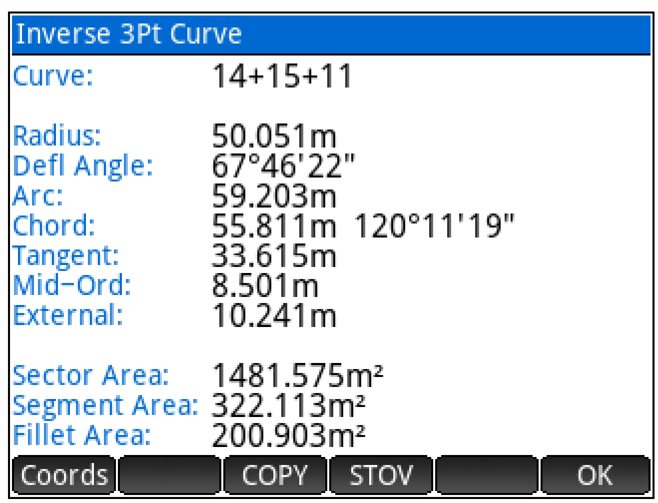


Inverse Curve (Three Point)

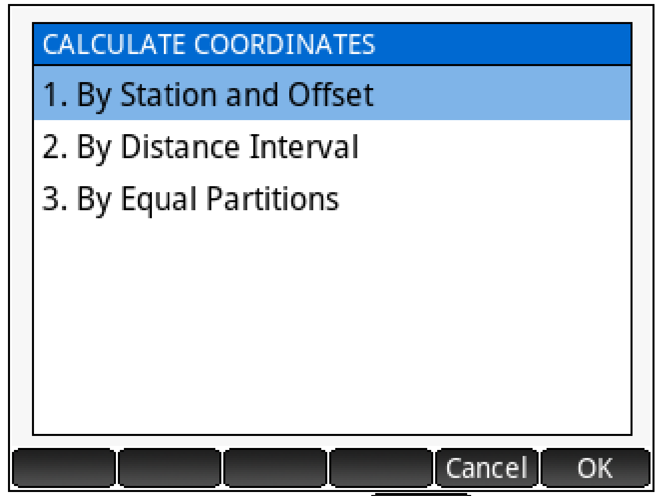
Enter the ***Beginning of Curve Point***, a ***Curve Point*** and the ***End of Curve Point*** to calculate the curve information.

The program can determine if the curve direction is right or left. Following the result screen, an option is presented to store the radius point.





Coords Calculate Coordinates on the curve.

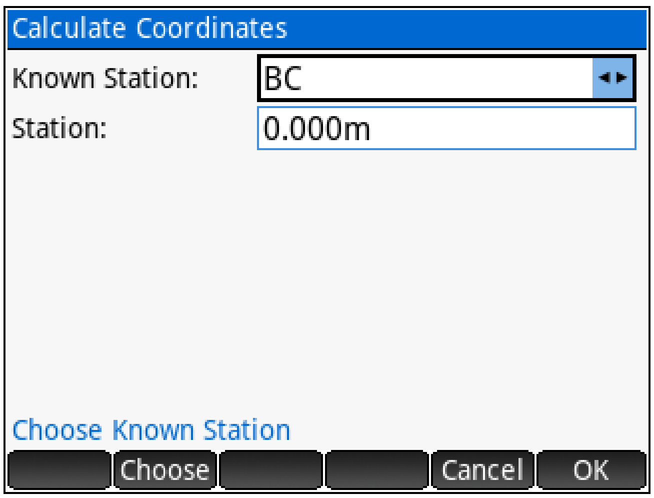


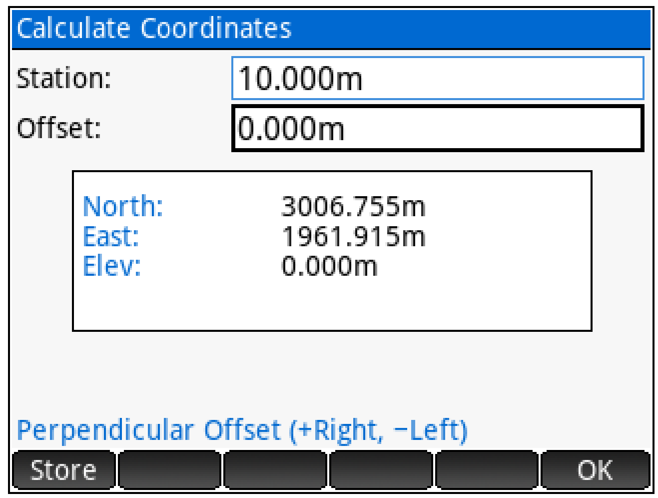
Curve Coordinate Calculator

When the Point to Point Inverse is calculated, further calculations can be made between the end points of the line.

By Station and Offset

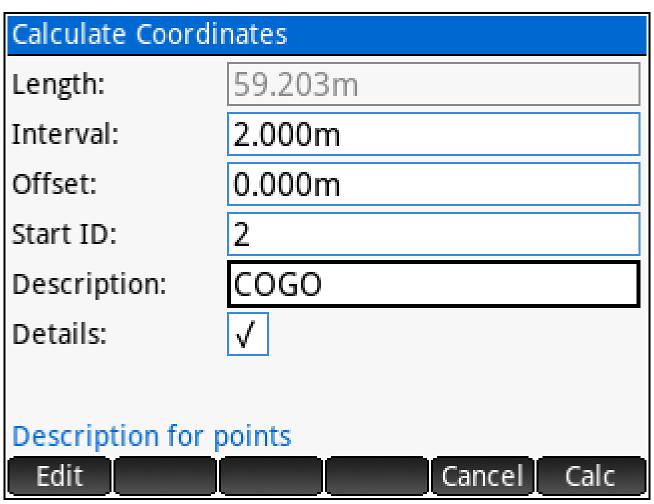
Enter any Station and Offset to solve the coordinates. The station at the BC, PI, or EC of the curve is required, then 3D coordinates are calculated at the specified station and offset. The solved positions can be stored in the project database with the Store option.

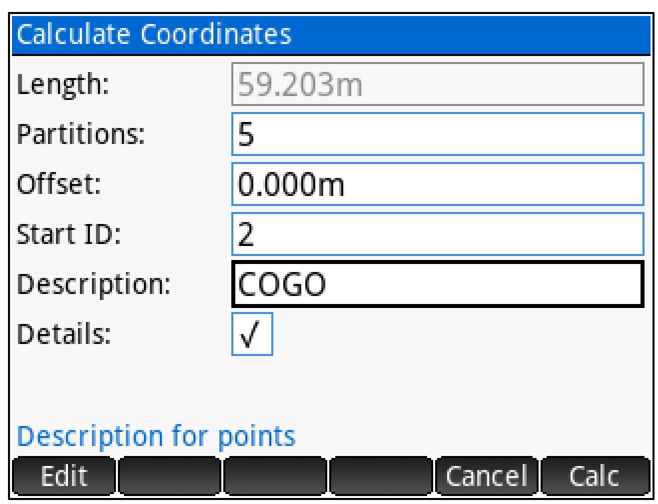




By Distance Interval or Equal Partitions

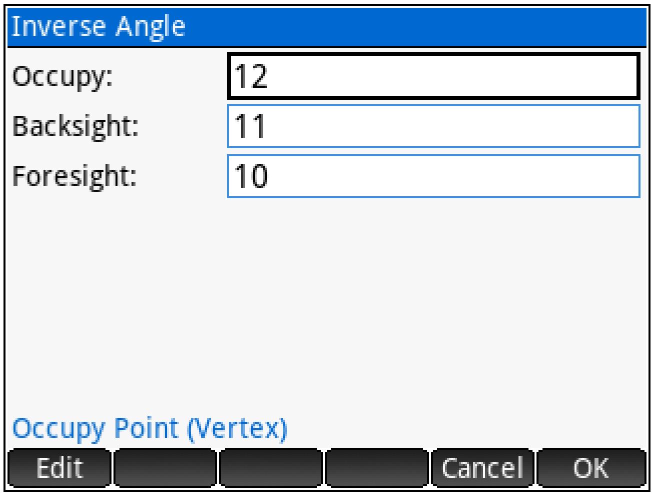
Calculate multiple points at a specific interval or by dividing the line into equal partitions.

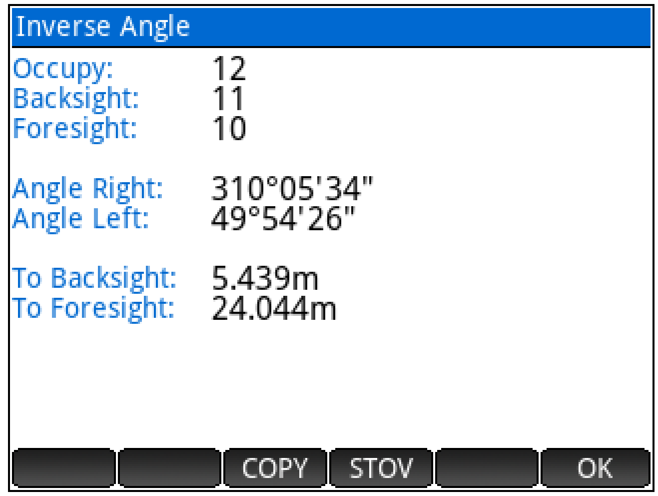




Inverse Angle

Enter the ***Occupy Point***, the ***Backsight Point*** and the ***Foresight Point*** to calculate the included angle. The results screen displays the angles turned right and left as well as the distances to the backsight and foresight points from the occupy point.

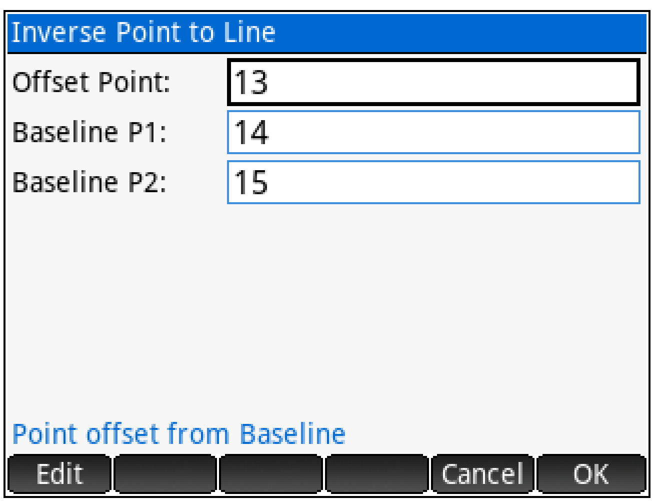


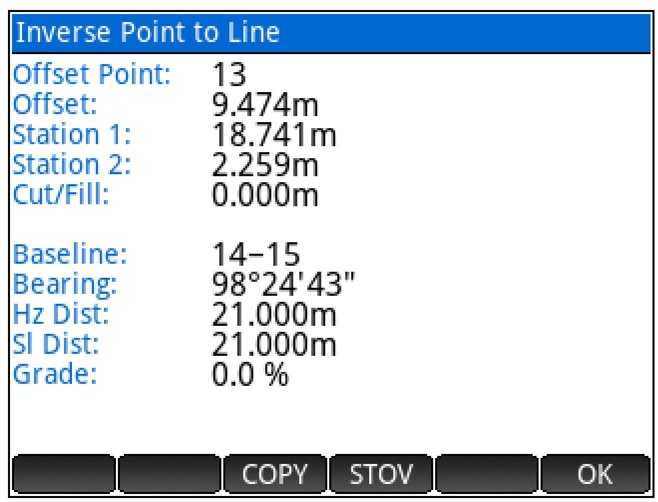


Inverse Point to Line

Enter two points, ***Baseline P1*** and ***Baseline P2***, to define a baseline and an ***Offset Point*** to calculate the perpendicular offset of the point to the line.

The results screen displays the offset from the baseline, Station 1 from ***Baseline P1*** to a point along the baseline that is perpendicular to the offset point, Station 2 to the same point from ***Baseline P2***, the cut/fill to the baseline and the length, direction and the grade of the baseline.

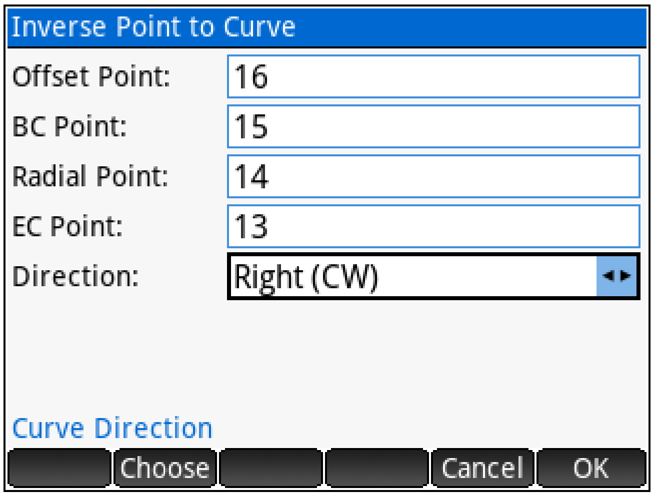


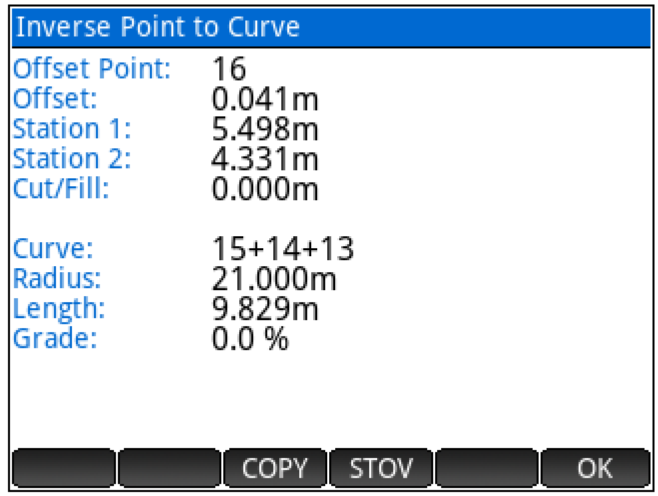


Inverse Point to Curve

Enter a ***Beginning of Curve Point***, a ***Radius Point*** and an ***End of Curve Point***, choose a ***Curve Direction***, and enter an ***Offset Point*** to calculate the perpendicular offset of the point to the curve.

The results screen displays the offset from the curve, Station 1 from the ***Beginning of Curve*** to a point along the curve that is perpendicular to the offset point, Station 2 to the same point from the ***End of Curve***, the cut/fill to the curve, and the radius, length and grade of the curve.

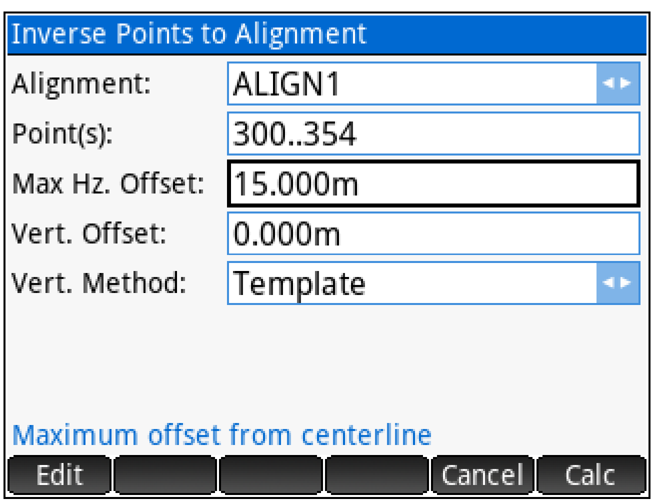


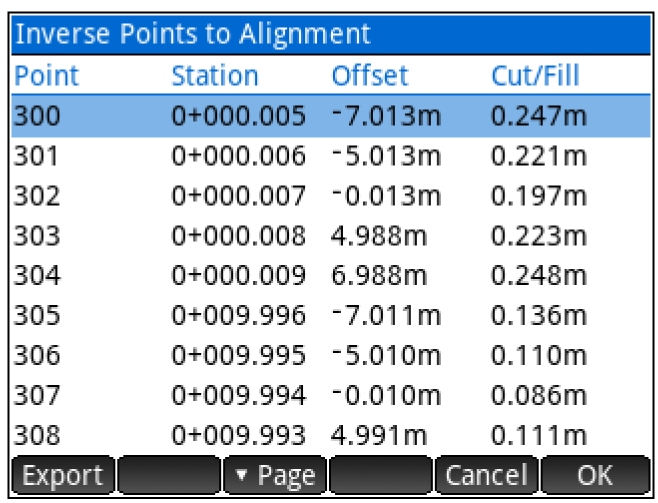


Inverse Points to Alignment

Select a pre-defined alignment and enter a single point or a range of points to inverse to the alignment. A maximum horizontal offset may be specified to ensure the point offset information is applied to the correct segment. A vertical offset constant may be entered to report cuts/fills to an offset from the vertical design. The vertical method may be set to template or centerline.

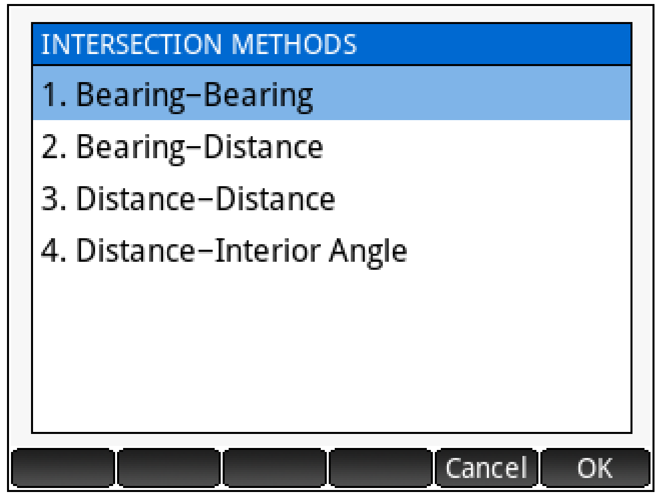
Export Results may be exported in ***CSV*** or ***HTML*** format.



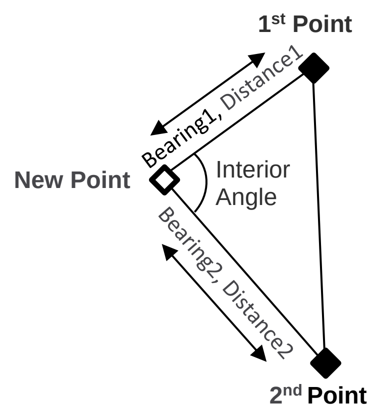


4.3 Intersections

The **Intersections** program can solve four types of intersections.

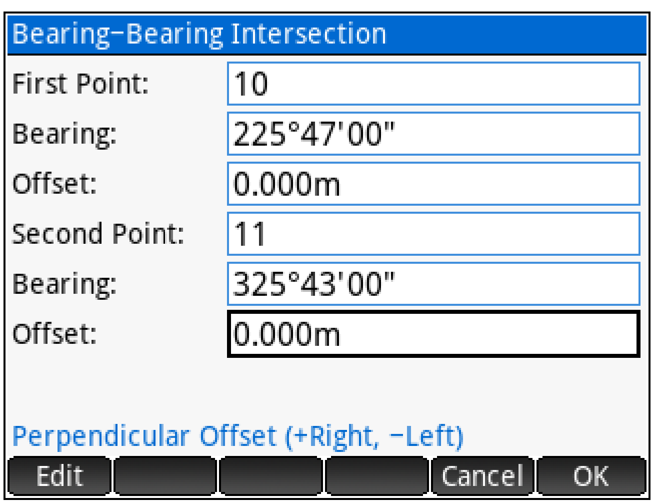


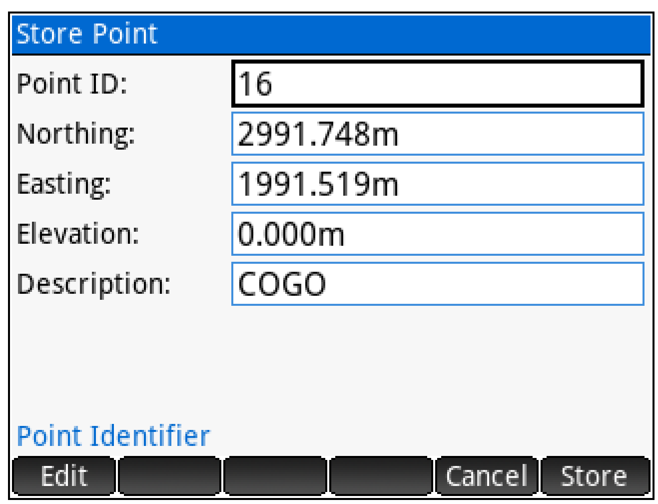
In the diagram shown, the ‘1st Point’ and “2nd Point’ points are always known points and the ‘New Point’ point can be calculated from the known information.



Bearing-Bearing

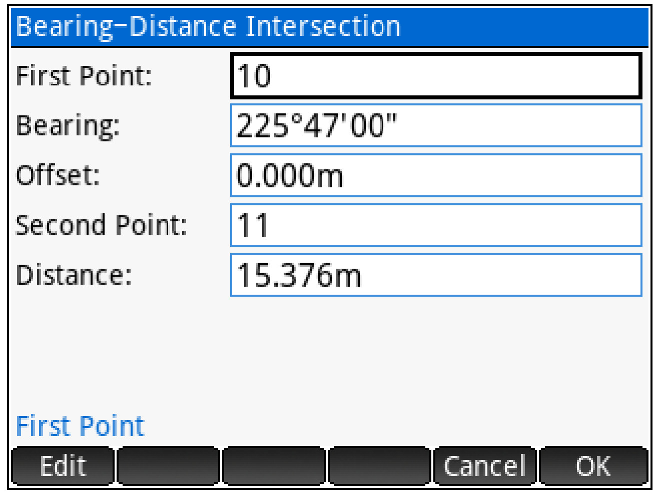
A bearing-bearing intersection can be solved when BEARING1 and BEARING2 are known. Offsets may be entered for both direction inputs.

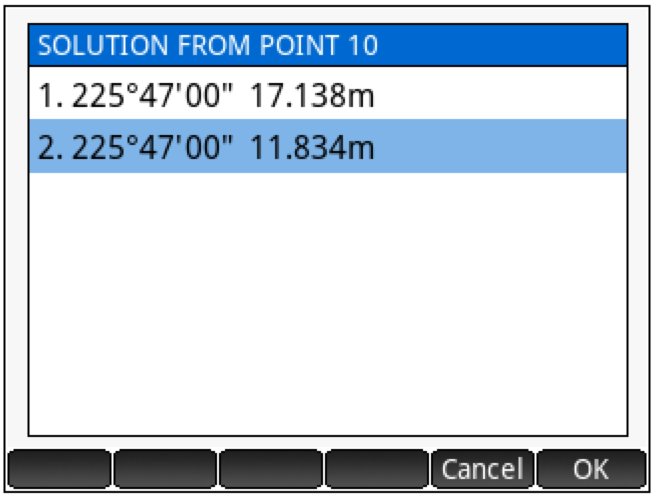


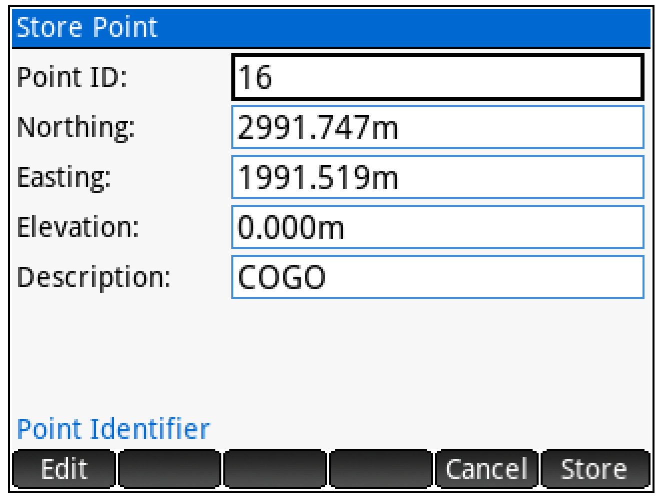


Bearing-Distance

A bearing-distance intersection can be solved when Bearing1 and Distance2 are known. This type of intersection usually has two possible solutions. The user is prompted to choose which of the two solutions is desired by selecting one of the two possible Distance1 solutions. A “No Solution” error indicates that the intersection is not possible with the data provided.

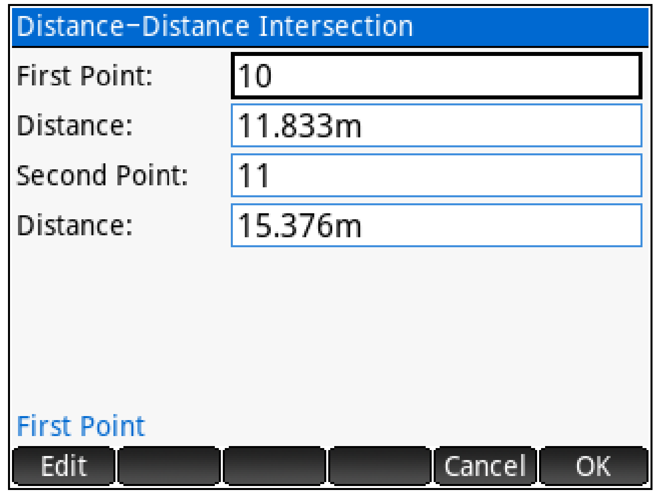


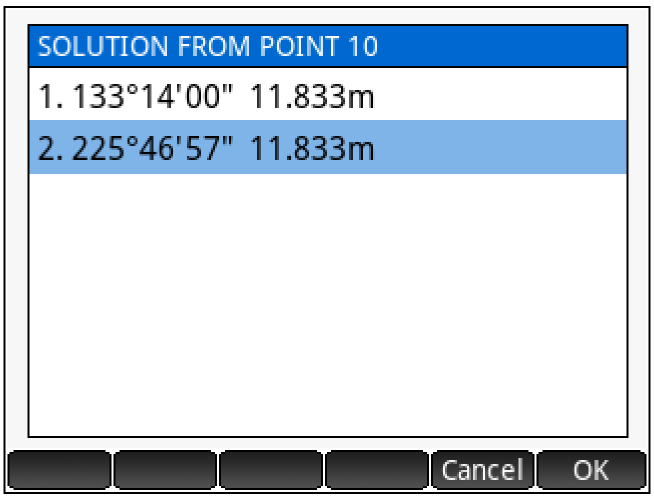


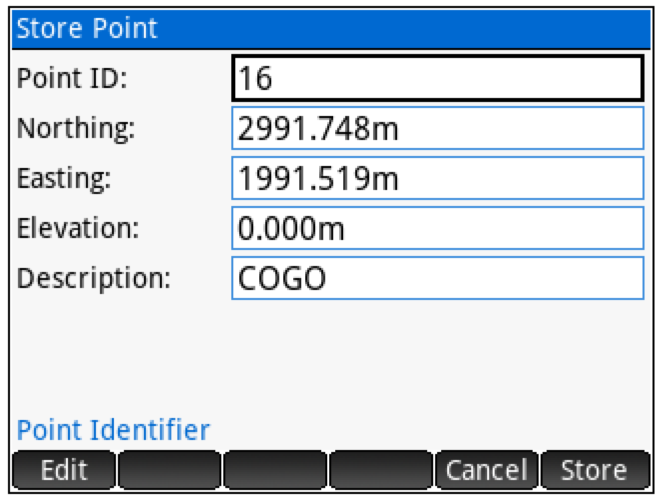


Distance-Distance

A distance-distance intersection can be solved when Distance1 and Distance2 are known. This type of intersection usually has two possible solutions. The user is prompted to choose which of the two solutions is desired by selecting one of the two possible solutions from the first point.

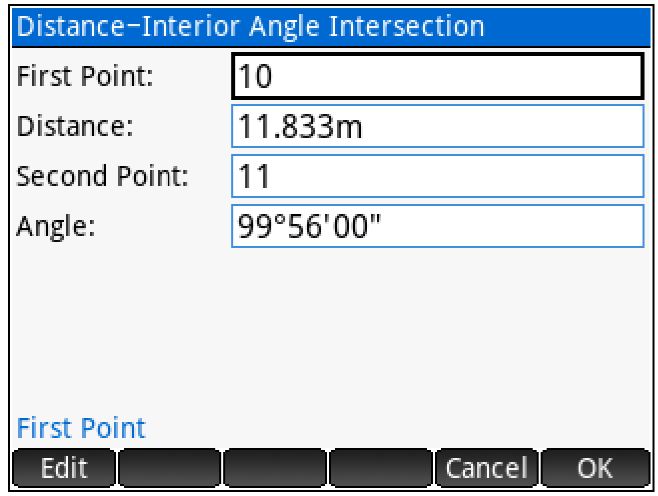


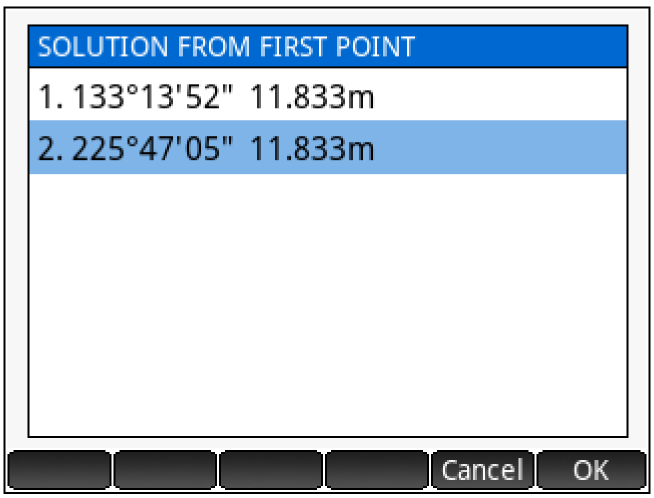


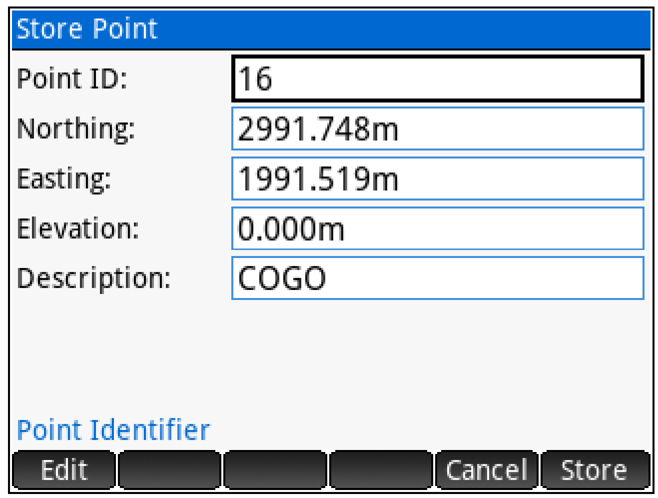


Distance-Interior Angle

A distance-interior angle intersection can be solved when Distance1 and the Interior Angle at the new point are known. This type of intersection can have up to 4 possible solutions. The user is prompted to choose the preferred solution.

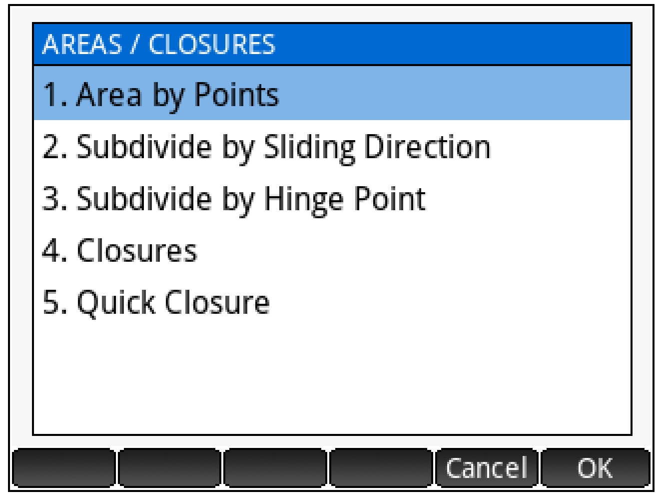






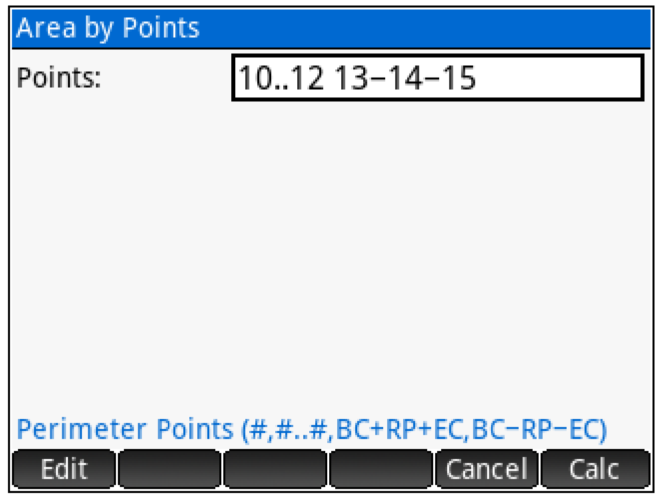
4.4 Areas / Closures

Calculate an **Area by Points**, subdivide a desired area from an existing parcel using the **Sliding Bearing** or **Hinge Point** methods, check your Plan using the **Lot Closures** routine, or use the **Quick Closure** routine to quickly check the closure of a figure or to calculate missing dimensions.



Area by Points

The **Area by Points** program calculates the area of a polygon when the points along the perimeter of the polygon are entered in sequence. The polygon can consist of straight segments and curves.



To enter straight segments:

1. Enter individual points separated by spaces. For example, ***1 2 3 4 5 6***.
2. Enter a range of points in sequence and in numerical ascending order. For example, ***1..6***.
3. Enter any combination of the above. For example, ***1 3 9..15 18 20..29 33***.

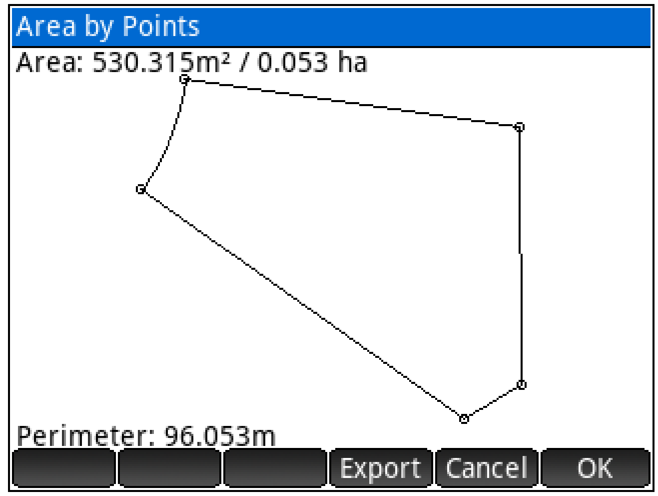
To enter curves:

1. Curve 'Right' – Enter points separated by the '+' character so that the curve is defined by BC+CC+EC. For example, ***1+2+3***.
2. Curve 'Left' – Enter points separated by the '-' character so that the curve is defined by BC-CC-EC. For example, ***1-2-3***.
3. Compound curves and reverse curves – Enter each curve component separately so that each curve component is its own block of points, BC+CC+EC or BC-CC-EC, and each block is separated by a space. For example, ***1+2+3 3-4-5*** or ***1+2+3 3+4+5***, etc.

NOTE: An error occurs when the points provided as curve points do not actually define a curve, i.e. the radius differs by more than the radius tolerance setting.

Any mix of straight segments and curves is accepted. For example, an area with straight segments and a curve could be ***10 11 12 13-14-15*** which could also be entered as ***10..12 13-14-15***.

The area (square units and hectares/acres) and perimeter are displayed following a valid input. The program automatically determines the direction (clockwise or counter clockwise) the points were entered. The primary distance unit affects the results displayed.



Export Export a DXF File of the area calculated

Cancel Exit the Area by Ponts program.

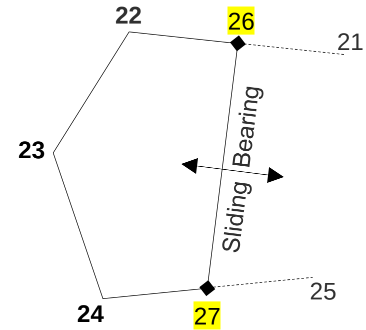
OK Return to the Input Form.

Sample Coordinates

```
Point,Northing,Easting,Elevation,Description
10,3000.0000,2000.0000,0.0000,AREA
11,2979.0430,2000.1800,0.0000,AREA
12,2976.3950,1995.4290,0.0000,AREA
13,2994.9938,1969.0919,0.0000,AREA
14,3007.1076,1951.9380,0.0000,AREA_CC
15,3004.0355,1972.7121,0.0000,AREA
```

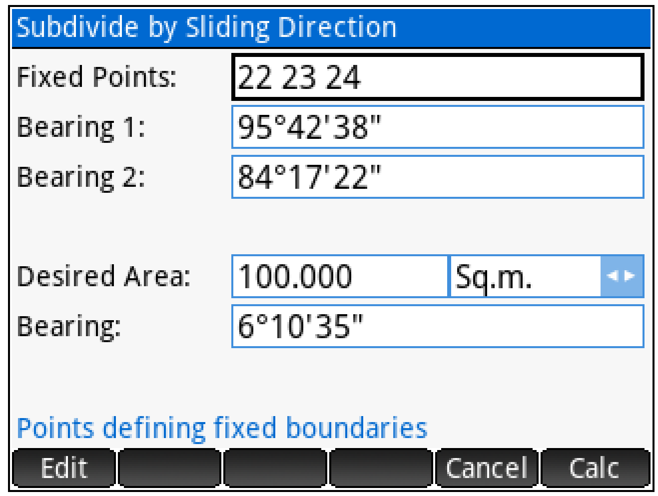
Subdivide by Sliding Direction

Calculate a specified area by sliding a line of fixed bearing. For the diagram on the right, assume the known coordinates as listed and the fixed bearing line to be 6°10’35” with a desired area of 100m². The program will calculate the coordinates for highlighted points 26 and 27 shown.



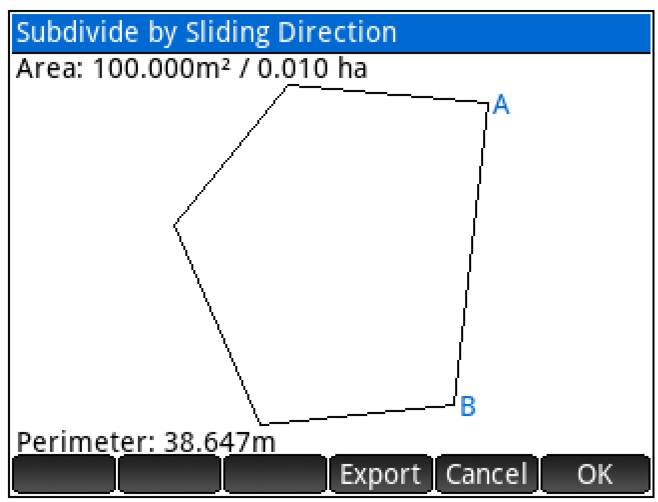
First, enter the points that define the fixed boundaries, in this example those points are 22, 23 and 24.

Next, enter the directions from the first and from the last point that you entered for the fixed points. Use any of the standard directions input options.



Next, enter the desired area and the direction of the sliding bearing.

The solution is displayed with the locations of the solution points marked as “A” and “B” on the plot.



Export Export a DXF File of the area subdivided.

Cancel Exit the Area Subdivision program.

OK Return to the Input Form.

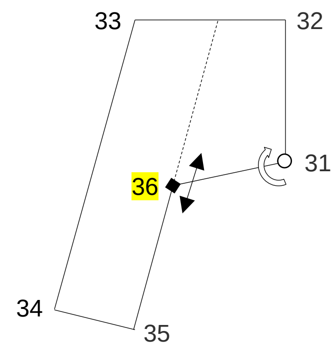
A prompt provides the option to store the solution points.

Sample Coordinates

```
Point,Northing,Easting,Elevation,Description
21,2100.000,1100.000,0.000,SLIDE
22,2101.000,1090.000,0.000,SLIDE
23,2096.000,1086.000,0.000,SLIDE
24,2089.000,1089.000,0.000,SLIDE
25,2090.000,1099.000,0.000,SLIDE
```

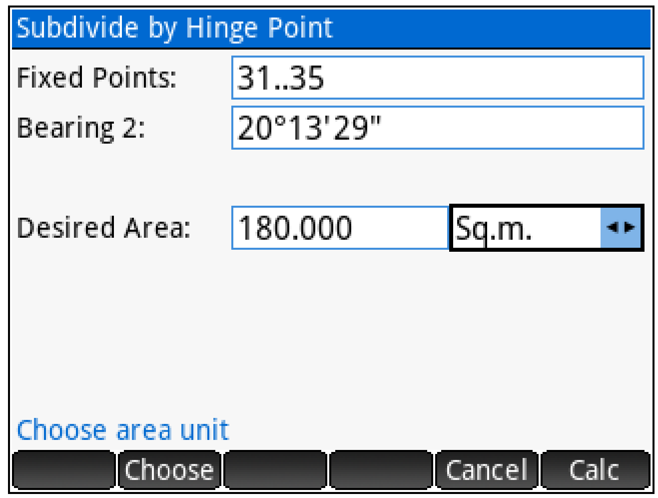
Subdivide by Hinge Point

Calculate a specified area by swinging a line from a hinge point into another line of fixed bearing. For the diagram on the right, assume the known coordinates as listed and the direction from Point 35 to be parallel to the line 34-33 with a desired area of 180m². The program will calculate the coordinates for highlighted point 36 shown.



First, enter the points that define the fixed boundaries, ***starting with the hinge point***. In this example those points are ***31***, 32, 33, 34 and 35.

Next, enter the direction from the last fixed point followed by the desired area. Use any of the standard directions input options.



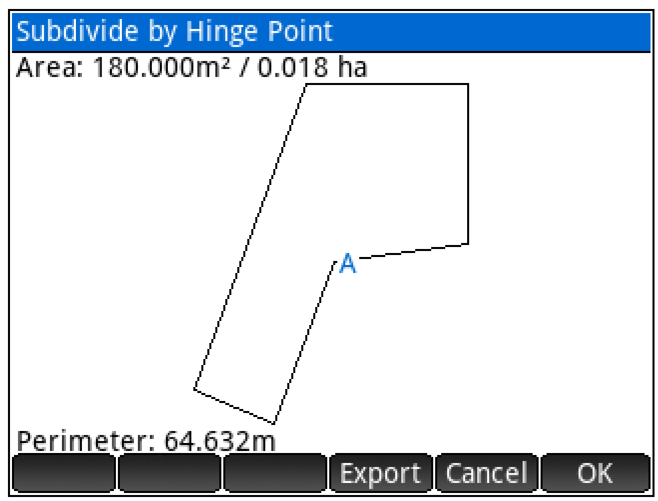
The solution is displayed with the location of the solution point marked as "A" on the plot.

Export Export a DXF File of the area subdivided.

Cancel Exit the Area Subdivision program.

OK Return to the Input Form.

A prompt provides the option to store the solution point.



Sample Coordinates

```
Point,Northing,Easting,Elevation,Description
31,120.000,220.000,0.000,HINGE
32,130.000,220.000,0.000,HINGE
33,130.000,210.000,0.000,HINGE
34,111.000,203.000,0.000,HINGE
35,109.000,208.000,0.000,HINGE
```

Closures

Closures are associated with the active project at the time of creation, and multiple closures can be stored within each project.

Closure Manager

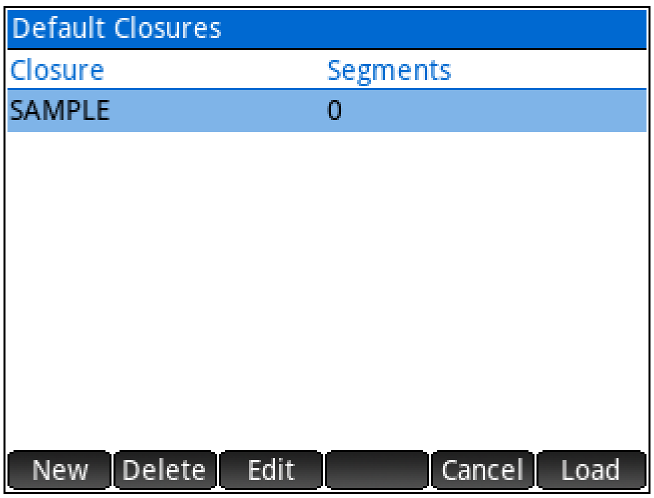
The Closure Manager keeps track of the closures computed in the current project.

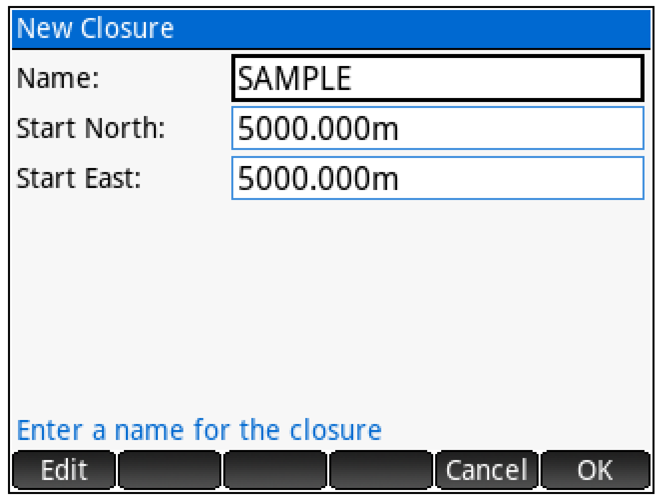
New Create a new Closure. The name and starting point coordinates are entered.

Delete Delete the selected closure. A confirmation prompt is displayed.

Edit Edit the name and starting point coordinates of the selected closure.

Load Load the selected closure for editing and calculating.





Closure Editor

When a closure is loaded, the segments that have been defined are displayed.

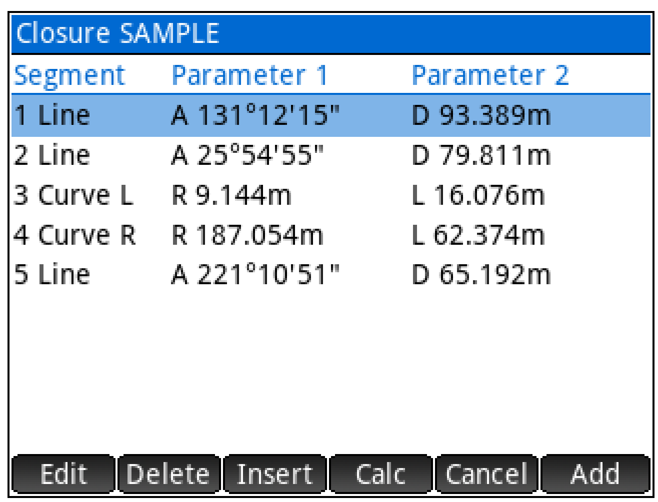
Edit Edit the selected segment.

Delete Delete the selected segment. A confirmation prompt is displayed.

Insert Insert a segment above the selected segment.

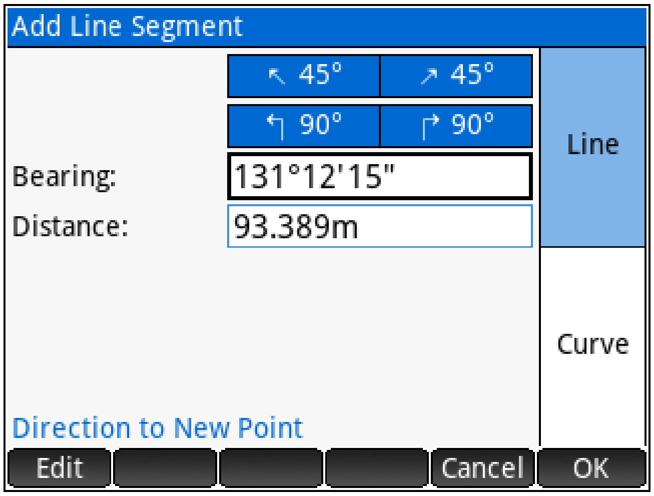
Calc Calculate the Closure.

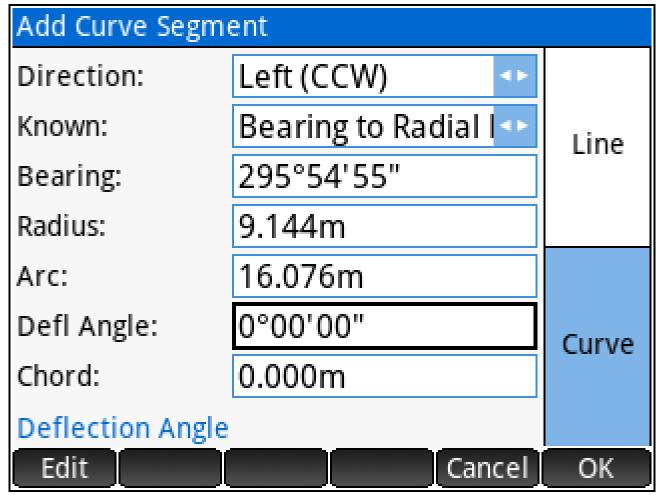
Add Add a segment to the Closure. Line and Curve segments can be added.



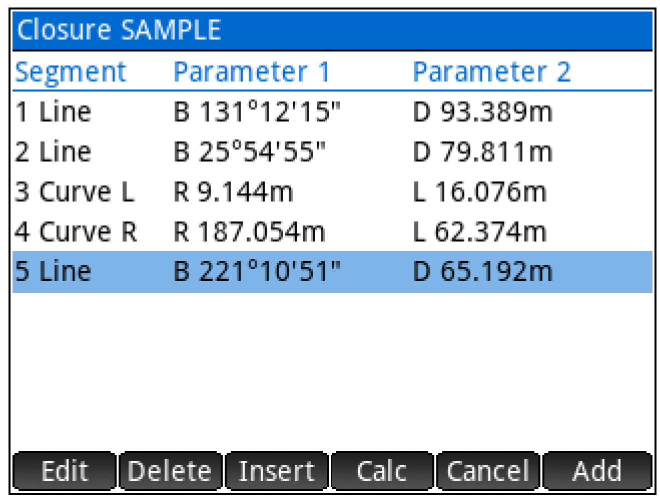
Add Segment

When adding a segment, the input form features two pages. One page takes input to add a Line and the other takes input to add a Curve. The input form continues in a loop until cancelled.





The Closure Editor displays the segments with their key parameters once they are defined.



Delete Segment

Select a segment to delete and choose the menu option. A confirmation is required.

Edit Segment

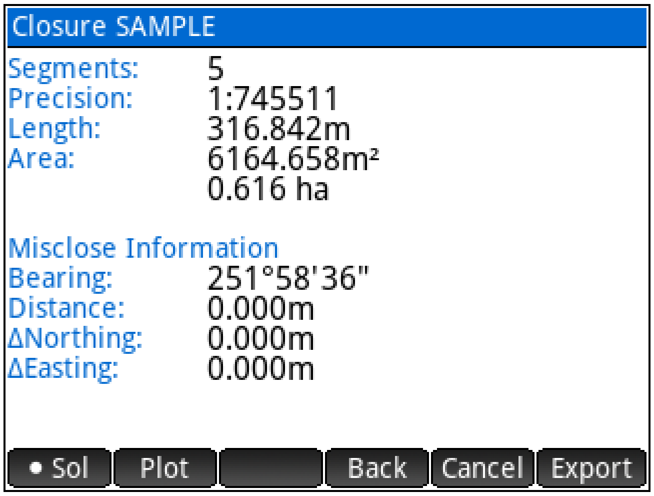
Select the segment to edit and choose the menu option. The current information is loaded for editing.

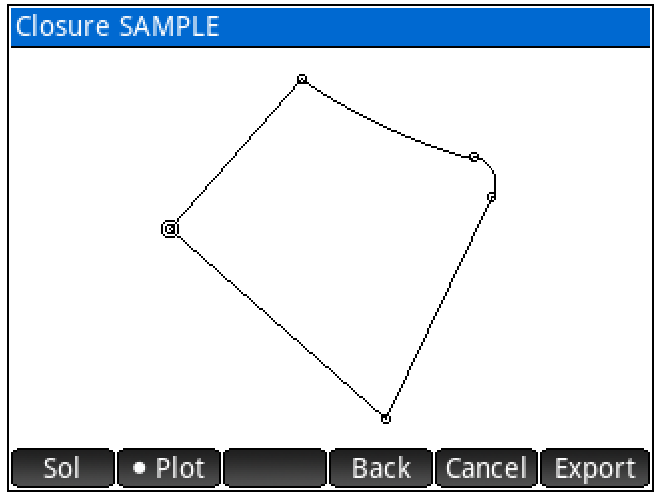
Insert Segment

Select a segment and choose the menu option to insert a new segment before the selected segment.

Closure Solution

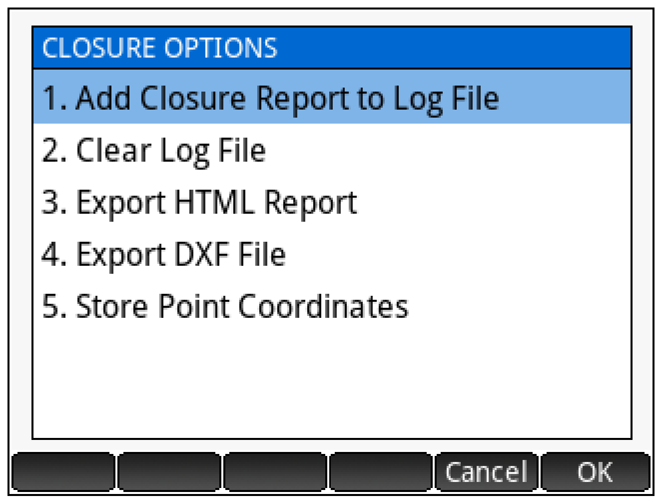
When all the segments are defined, the **Calc**ulate option will display the results of the closure. The **Sol**ution page shows the numeric results, while the **Plot** page will draw the segments.





Export Options

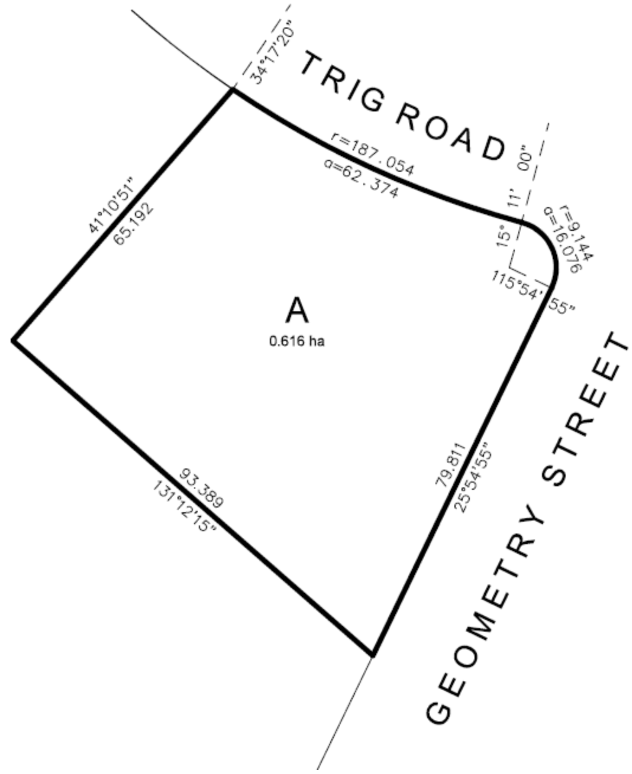
Export the closure results.



- **Add Closure Report to Log File** – Adds the current closure results to a **ClosureLOG.txt** file. With this option it is possible to have numerous closures reported in a single TEXT file for printing, etc.
- **Clear Log File** – Clears the ClosureLOG.txt file if it exists.
- **Export HTML Report** – Creates an HTML report of the closure. The user can enter a file name for the report, which can then be viewed in a web browser on a PC or Mac.
- **Export DXF File** – Creates a DXF file of the closure lines and curves. The user can enter a file name for the DXF file, which can then be viewed in a CAD program on a PC or Mac.
- **Store Point Coordinates** – Store the points that define the closure. Coordinates are calculated from the starting point coordinates for the closure. The user can enter a Starting Point ID and a descriptor for the points.

Sample Closure Report

Enter the lot dimensions to calculate the lot closure as shown below. The most westerly corner was used as the starting point, then counter clockwise around the perimeter. Arbitrary coordinates 5000,5000 were assigned to the starting point.

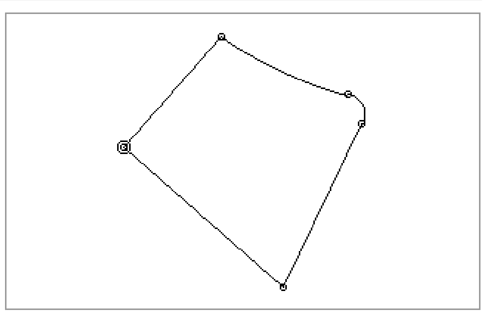


SIMPLE Geospatial Solutions

Closure Report:	SAMPLE
Project:	Default
Date and Time:	December 21, 2019 - 5:58PM
Start Northing:	5000.000m
Start Easting:	5000.000m

	Segment	Bearing	Length	End Northing	End Easting
1	Line	131°12'15"	93.389m	4938.481m	5070.263m
2	Line	25°54'55"	79.811m	5010.266m	5105.144m
3	Curve Left	335°32'59"	14.084m	5023.087m	5099.314m
	- Radial Direction:	295°54'55"			
	- Radius Length:	9.144m			
	- Arc Length:	16.076m			
4	Curve Right	294°44'10"	62.085m	5049.066m	5042.925m
	- Radial Direction:	15°11'00"			
	- Radius Length:	187.054m			
	- Arc Length:	62.374m			
5	Line	221°10'51"	65.192m	5000.000m	5000.000m

Precision:	1:745511
Length:	316.842m
Area:	6164.658m² / 0.616 ha
Misclose Bearing:	251°58'36"
Misclose Distance:	0.000m
- Northing:	0.000m
- Easting:	0.000m



Quick Closure

A **Quick Closure** is created by entering the known dimensions of the sides of a figure. There are no points or coordinates required and the results are not stored; it is optimized for quick entry and ease of use.

A closure may have one or two missing dimensions, which will be calculated whenever possible.

Curved segments may also be entered by specifying a chord distance and curve radius.

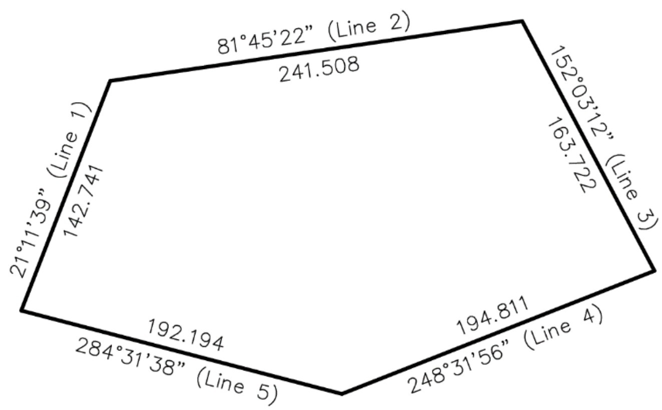
Examples will be used to illustrate the methods and results obtained.

Example 1 – Closure with all dimensions known

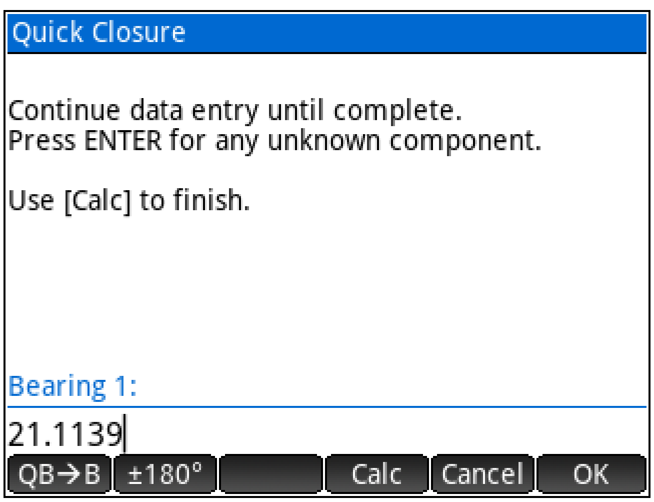
The **Quick Closure** routine immediately opens to an input screen, prompting for the direction of the first line.

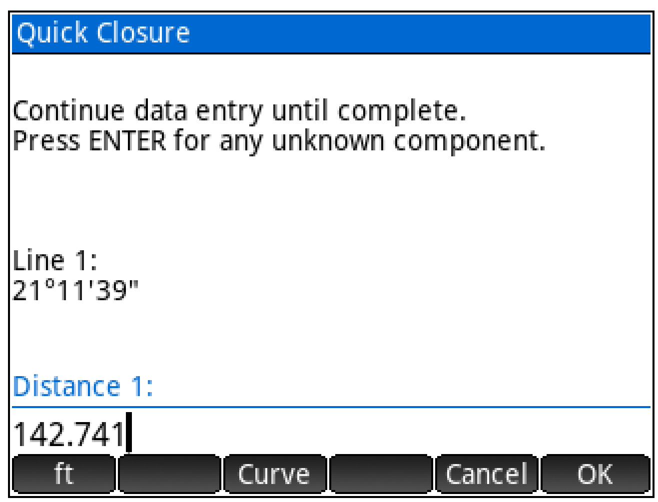
The entered values of the previous input are displayed for verification.

The menus provide the standard tools for working with direction and distance inputs.



Enter each direction and distance as prompted, then Calc after entering the fifth and final distance.





The results are displayed when finished. The first page of the results shows the solution with figure details and misclose information. A second page plots the figure geometry on the screen.

The menu:

• Sol Sets the solution page current.

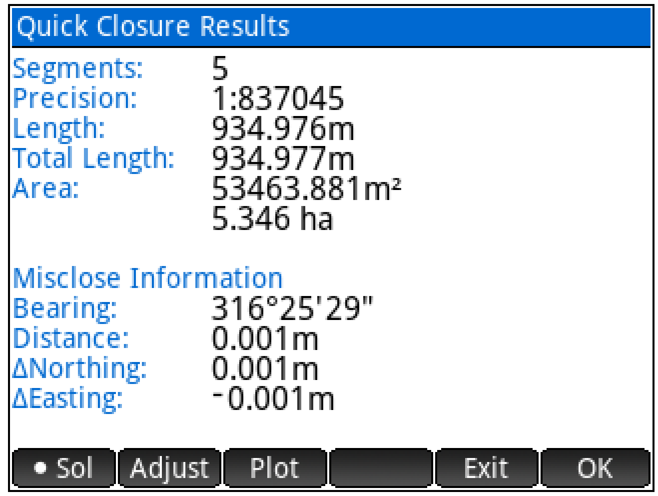
Adjust Sets the adjusted solution page current.

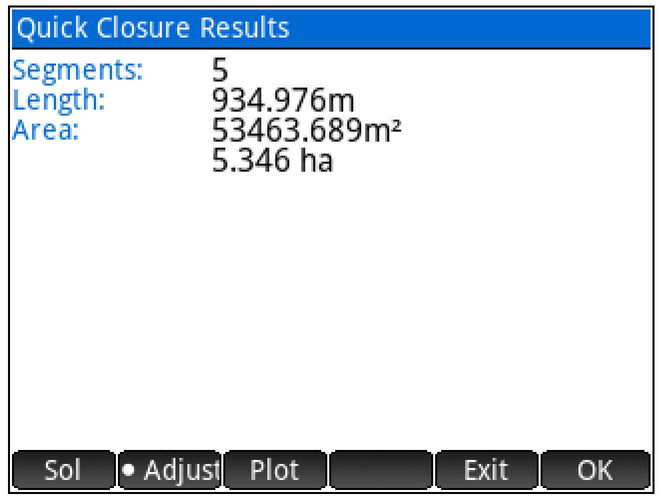
Plot Sets the plot page current.

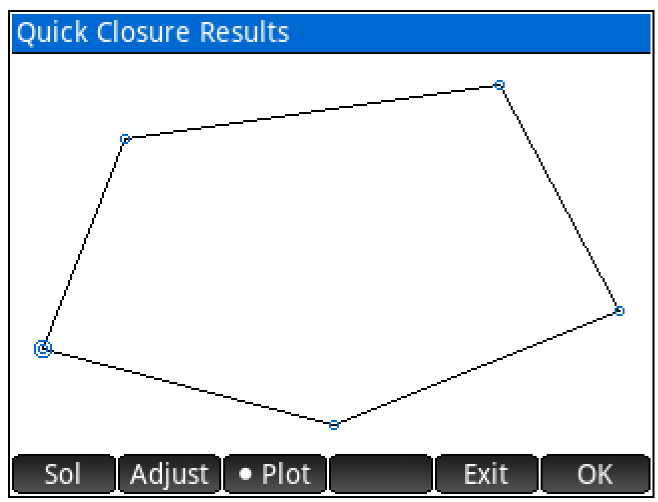
Exit Exit the **Quick Closure** routine and return to the main menu.

OK Start a new closure.

NOTE: The adjusted solution is shown only when an adjustment is possible. The adjusted length and area are displayed.

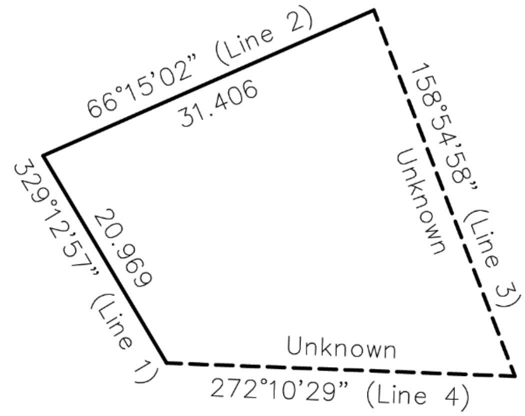


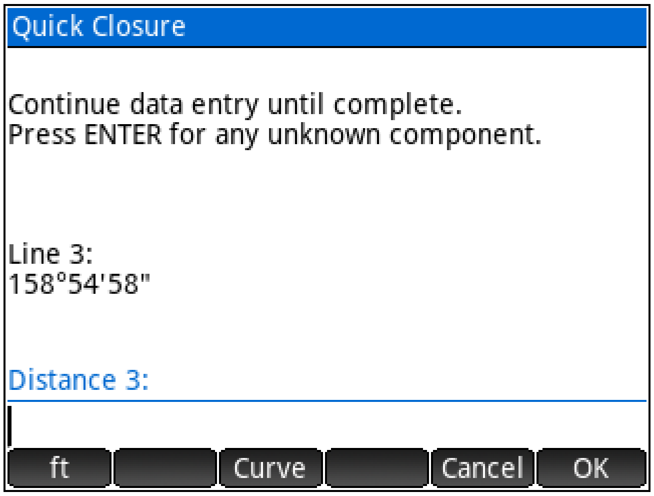




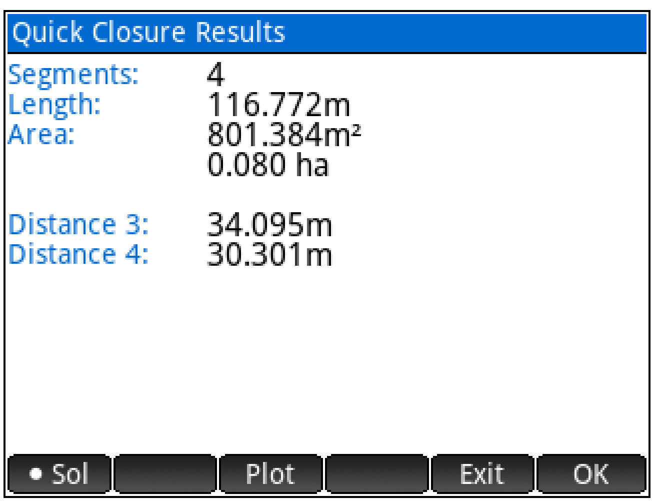
Example 2 – Closure with missing dimensions

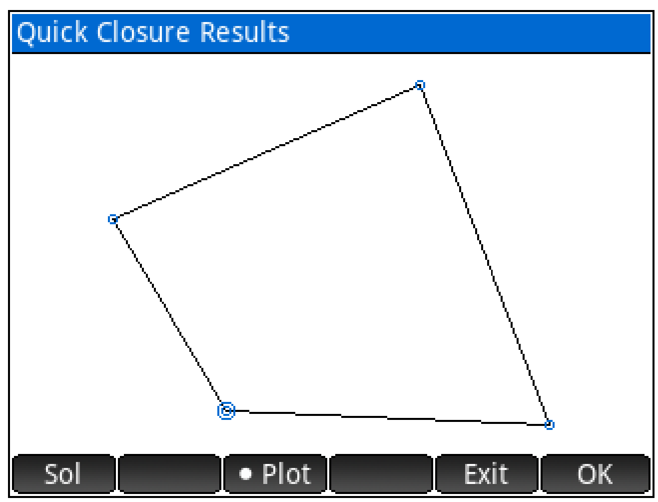
Enter the dimensions of the first two lines, and the direction of the third line. When prompted to enter the Distance 3 and 4 inputs; simply leave them blank and press [Enter ≈].





The result in this case does not show a misclose. The calculated values of the missing dimensions are shown.

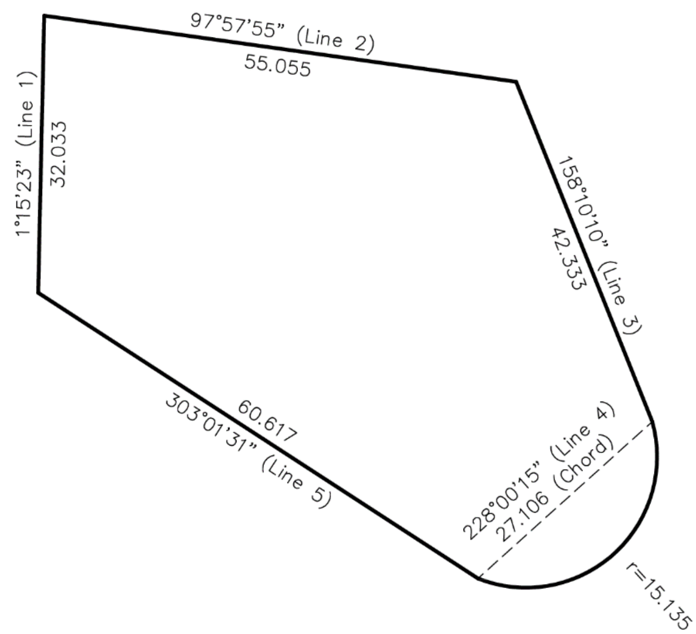


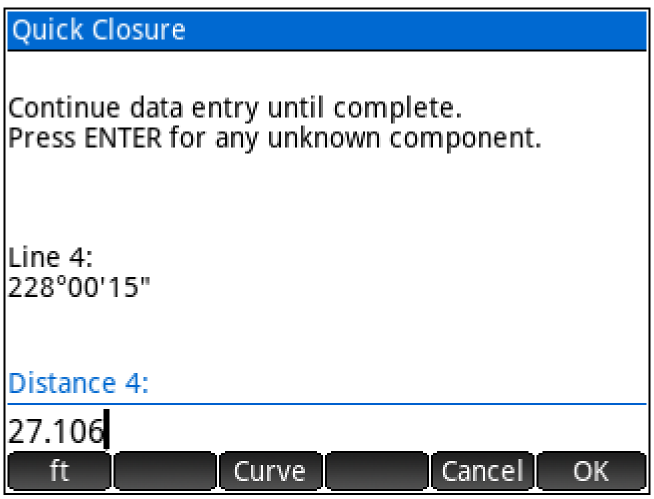


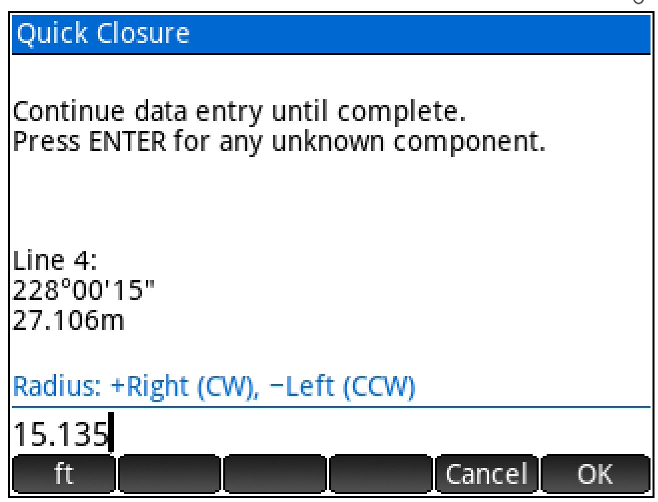
Example 3 – Closure with curve

Enter the dimensions for the first three lines, and the direction of the fourth line (chord). When prompted to enter Distance 4, use the Curve key on the menu to specify that a chord distance is being entered.

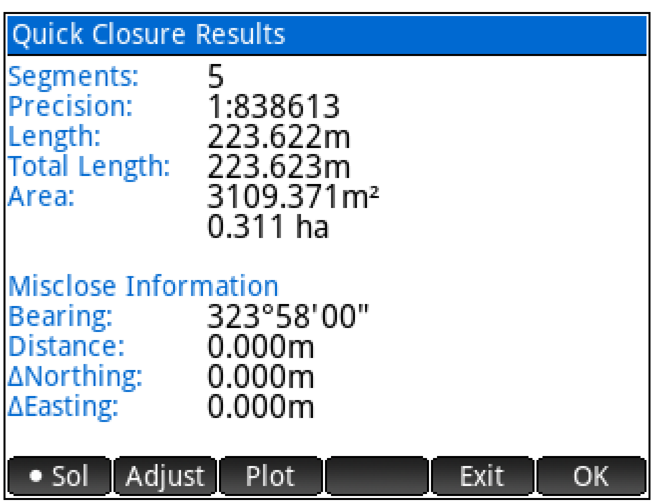
After the chord distance is entered; a prompt will ask for the radius of the curve. Enter a ***positive*** radius value if the curve follows a clockwise direction and enter a ***negative*** radius value if the curve follows a counter clockwise direction. In this case it is a clockwise direction, therefore a positive radius.

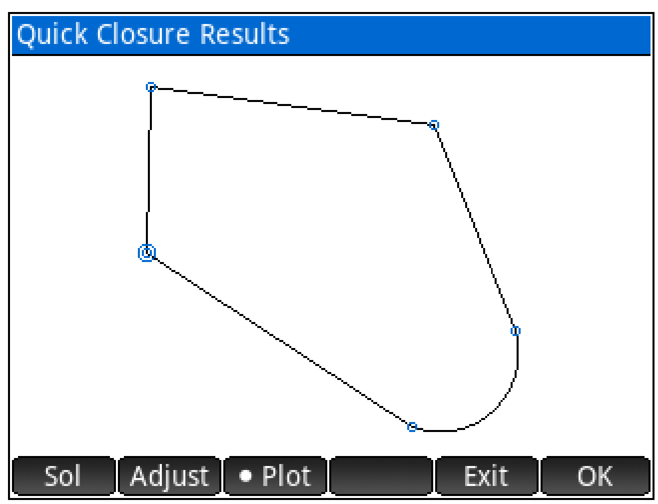




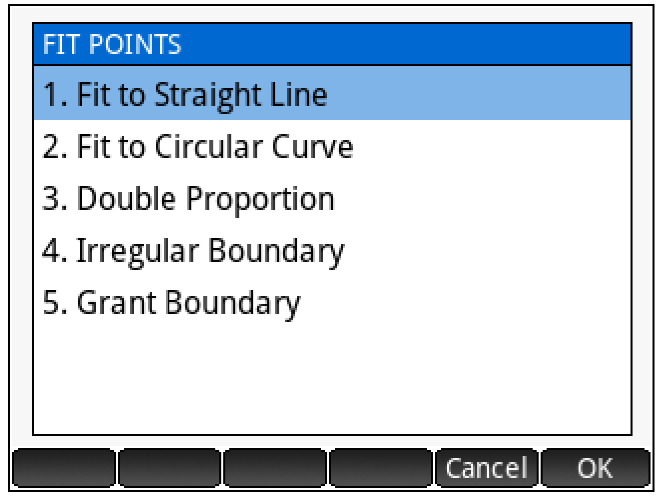


Enter the dimensions for the final line and then Calc to finish.





4.5 Fit Points



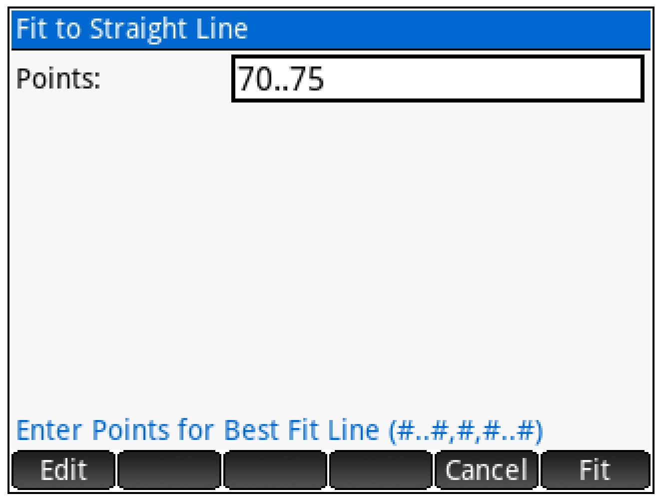
The **Fit Points** program consists of:

1. Best fit points to **Straight Line**, linear regression.
2. Best fit points to **Circular Curve**, like linear regression but fits points to a circular curve.
3. Solve the position of a lost corner using the **Double Proportionate Method**.
4. Solve the position of a lost corner using the **Irregular Boundary Adjustment Method**.
5. Solve the positions of lost angle points using the **Grant Boundary Adjustment Method**.

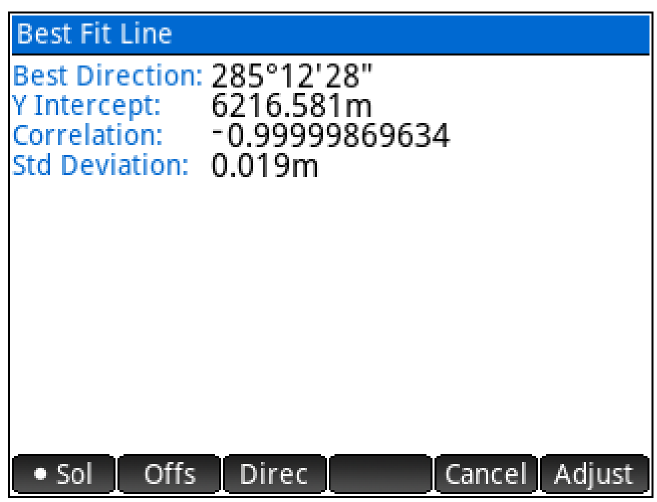
Fit to Straight Line

Enter a series of points to compute the least squares straight line that best fits the points. Enter point numbers using any of the point numbers input options.

An un-weighted linear regression method that minimizes X and Y residuals simultaneously is used to calculate the line.



The direction and Y-Intercept of the line, the correlation coefficient (a value between -1 and 1), and the point offsets standard deviation are computed and displayed.

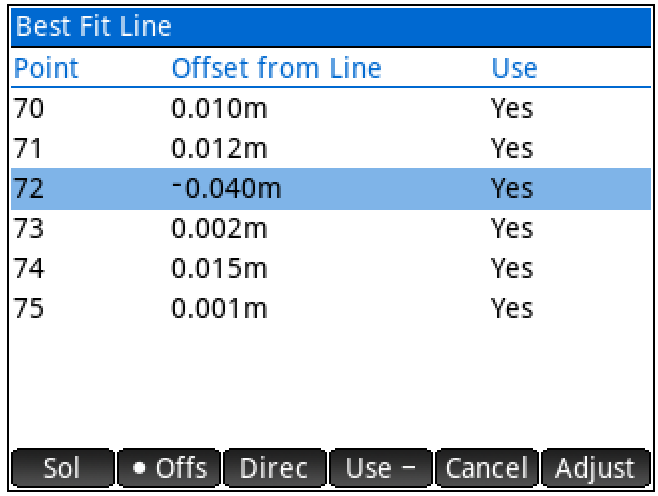


The Menu

• Sol Displays the solution details.

Offs Displays the perpendicular offsets to the line for each point used in the computation.

Direc Option to enter a direction constraint for the line or use the best fit direction. The solution details page indicates whether a **Best Direction** or **Fixed Direction** is in effect.



Use − **Use +** While viewing the perpendicular offsets, toggle whether the selected point will be used for the calculation.

Proceeding with the adjustment provides the option to overwrite the existing points or to create new points.

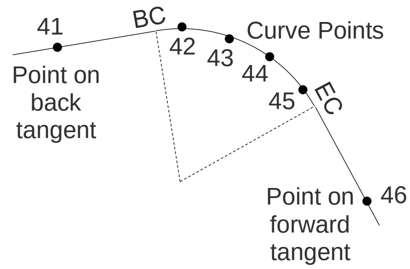
Points are shifted perpendicular to the best-fit line to minimize the shift.

Sample Coordinates

```
Point,Northing,Easting,Elevation,Description
70,5142.364,3951.682,0.000,FIT_LINE
71,5126.301,4010.781,0.000,FIT_LINE
72,5122.959,4022.875,0.000,FIT_LINE
73,5119.064,4037.366,0.000,FIT_LINE
74,5109.751,4071.672,0.000,FIT_LINE
75,5105.428,4087.524,0.000,FIT_LINE
```

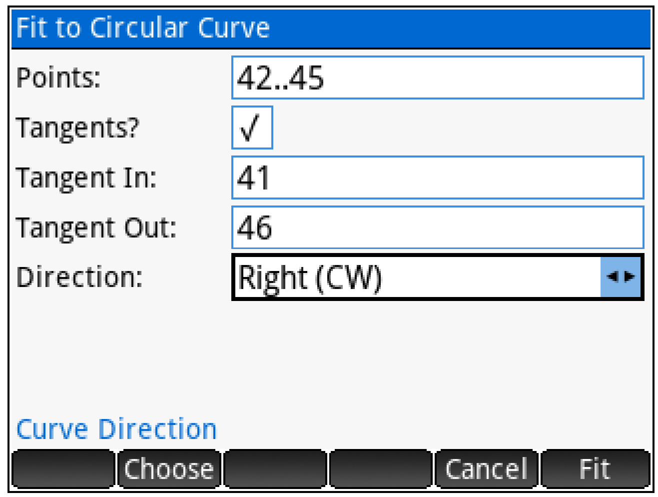
Fit to Circular Curve

The main purpose of this program is to calculate the radius and the coordinates of the radius point of the least squares circle that best fits a series of points. When providing points along one or both tangents, the program will also solve the BC and/or EC point coordinates.

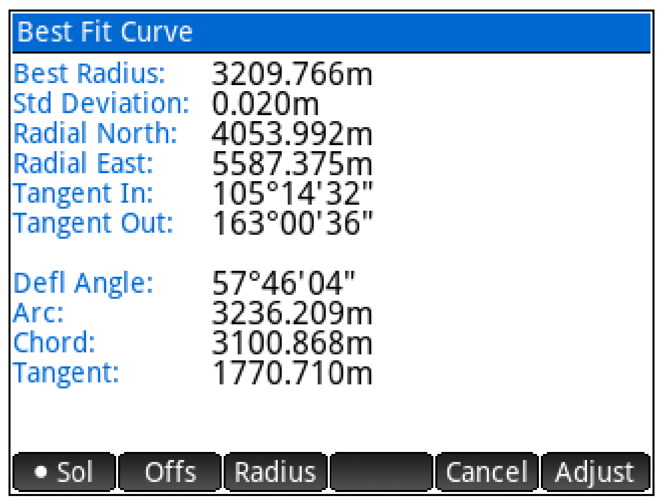


In the input form, enter a series of points along the curve to compute the circle that best fits the points. Enter point numbers using any of the point numbers input options.

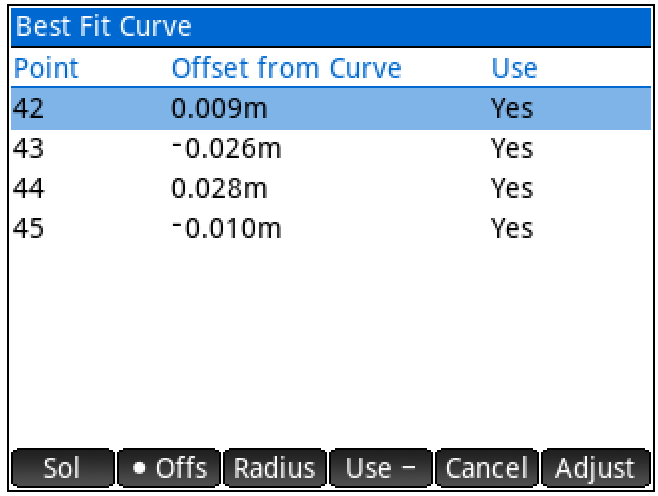
Optional: Also enter points on the Tangent In/Out to compute the BC/EC points. If specifying tangent points, it is important to select the correct curve direction Right/Left.



The curve solution displays the computed radius, the radius standard deviation, the coordinates of the radius point, and if applicable, the bearings of the back and forward tangents.



The Menu



• Sol Displays the solution details.

Offs Displays the radial offsets to the curve for each point used in the computation.

Radius Option to enter a radius constraint for the curve or use the best fit radius. The solution details indicate whether a **Best Radius** or **Fixed Radius** is in effect.

Use − **Use +** While viewing the radial offsets, toggle whether the selected point will be used for the calculation.

Proceeding with the adjustment provides the option to overwrite the existing points or to create new points.

Prompts will be displayed to choose whether to store the Origin Point, and if possible; the BC and EC points.

> Points are shifted radially to the best-fit curve to minimize the shift.

Sample Coordinates

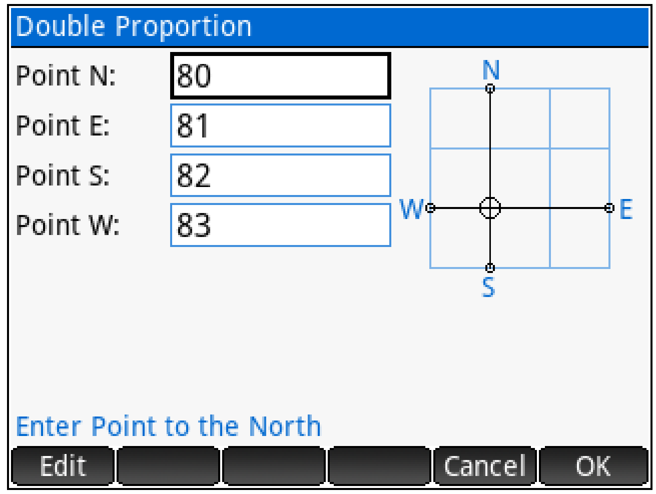
```
Point,Northing,Easting,Elevation,Description
41,7444.140,5354.860,0.000,FIT_CURVE
42,6947.930,6975.820,0.000,FIT_CURVE
43,6572.600,7577.110,0.000,FIT_CURVE
44,6071.290,8084.030,0.000,FIT_CURVE
45,5542.000,8431.380,0.000,FIT_CURVE
46,4268.900,8877.960,0.000,FIT_CURVE
```

Double Proportion

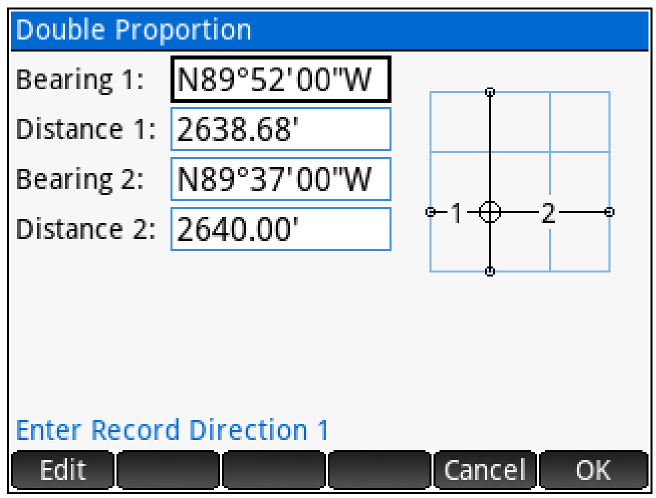
"The term 'double proportionate measurement' is applied to a new measurement made between four known corners, two each on intersecting meridional and latitudinal lines, for the purpose of relating the cardinal equivalent intersection to both." (Page 166, BLM Manual of Surveying Instructions 2009).

The **Double Proportion** program solves this type of problem by accepting point numbers for the four known corners, and the record measurements to the lost corner.

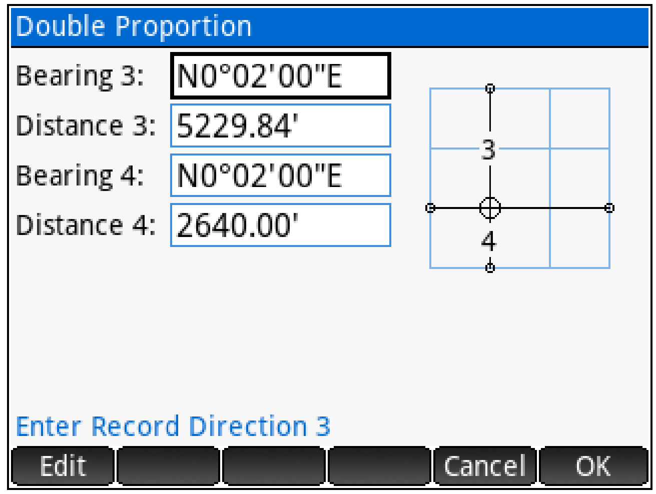
The first input form requires existing point numbers of the corners to the north, east, south and west of the lost corner.



The second input form requires the **record** bearings and distances to the known corners west and east of the lost corner.

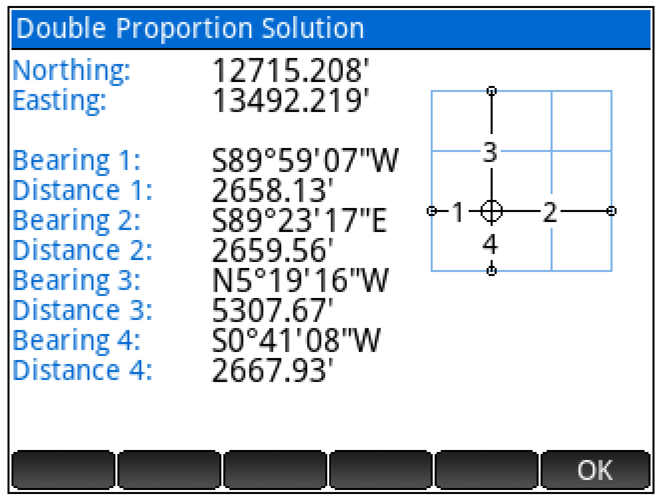


The third input form requires the **record** bearings and distances to the known corners north and south of the lost corner.



The solution displays the coordinates of the calculated corner point, and the dimensions to the four known corners.

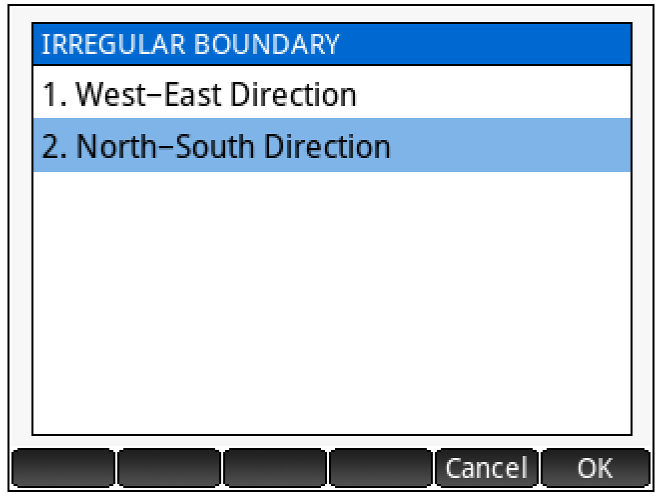
The option to store the calculated corner point is provided upon completion.



Sample Coordinates

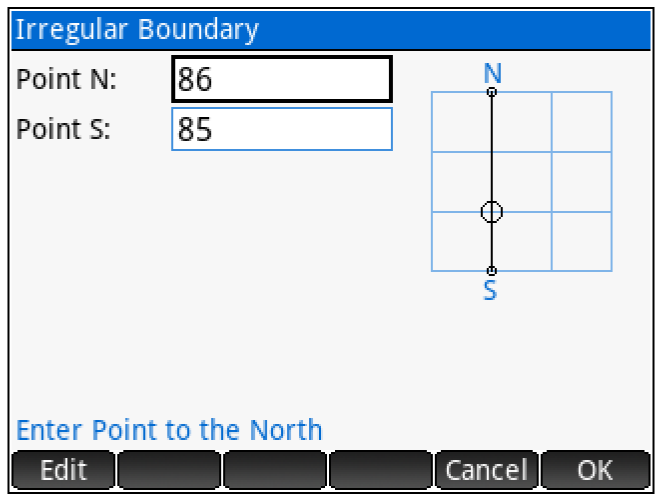
```
Point,Northing,Easting,Elevation,Description
80,18000.000,13000.000,0.000,DP_NORTH
81,12686.799,16151.626,0.000,DP_EAST
82,10047.468,13460.294,0.000,DP_SOUTH
83,12714.524,10834.089,0.000,DP_WEST
```

Irregular Boundary Adjustment

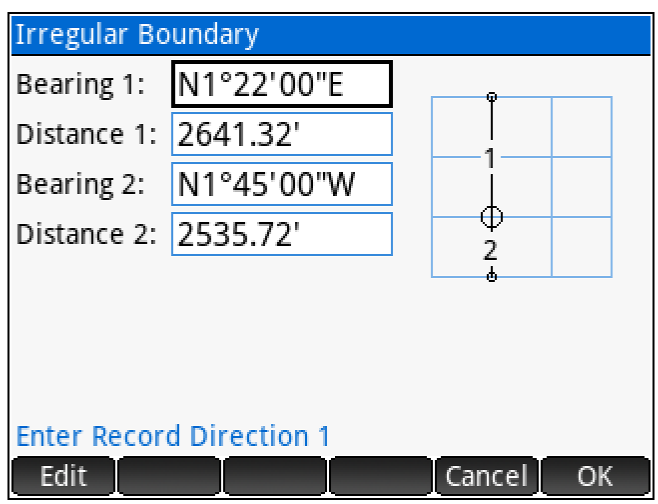


Irregular boundaries are the result of boundaries surveyed from opposite directions, or piecemeal surveys where resulting boundaries are not straight lines. “In order to restore one or more lost corners or angle points on such irregular exterior, a retracement between the nearest known corners is made on the record courses and distances to ascertain the direction and length of the closing distance. A position is calculated for each lost corner or angle point at the record position.” (Page 174, BLM Manual of Surveying Instructions 2009) A combination of single proportion and compass rule is then used to re-establish the lost corner. The direction (East-West or North-South) determines how the adjustment is performed.

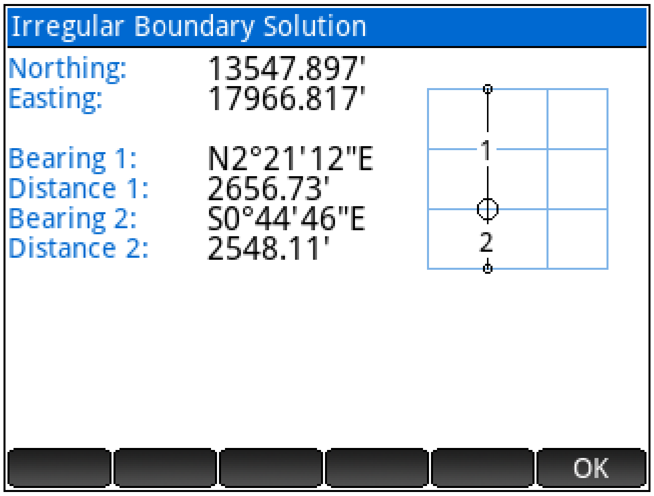
The **Irregular Boundary** program prompts for the direction of the line, and then the first input form requires the point numbers for the surveyed points (W + E, or N + S).



The second input form requires the **record** dimensions to the corners on either side of the lost corner.



The solution displays the coordinates of the calculated corner point, and the dimensions to the two known corners.



The option to store the calculated corner point is provided upon completion.

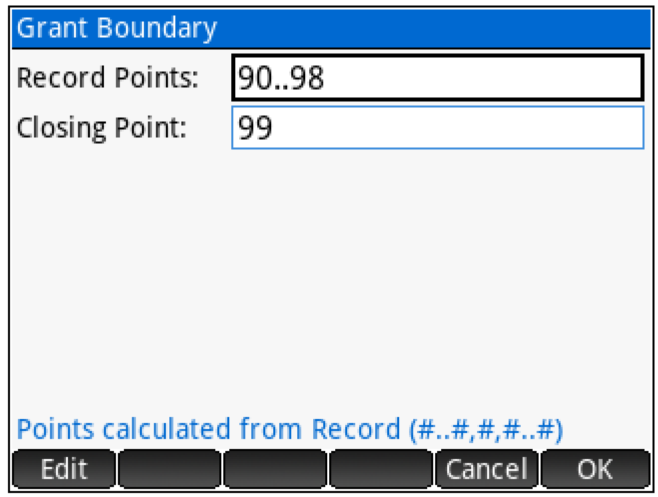
Sample Coordinates

```
Point,Northing,Easting,Elevation,Description
85,11000.000,18000.000,0.000,IB_SOUTH
86,16202.385,18075.912,0.000,IB_NORTH
```

Grant Boundary Adjustment

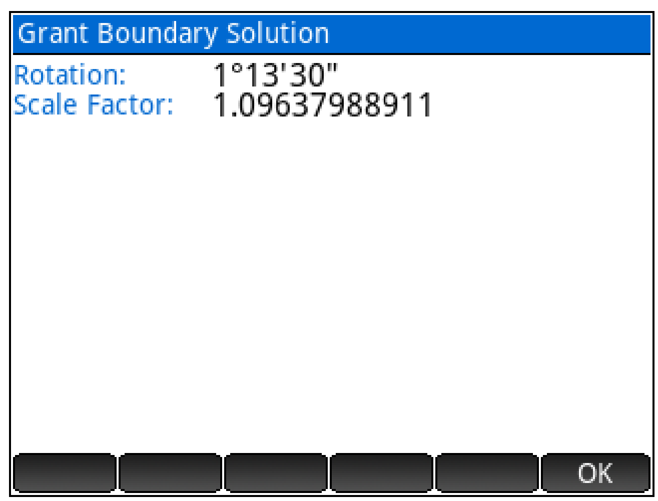
"In many of the States there are irregular grant and reservation boundaries that were established prior to the public rectangular surveys. In these cases, the township and section lines are regarded as the closing lines. The grant boundary field notes may call for natural objects, but these are often supplemented by metes-and-bounds descriptions. The natural calls are ordinarily given precedence then the existent angle points of the metes-and-bounds survey. The lost angle points are then restored by uniformly orienting the record courses to the left or right and adjusting the lengths of the lines on a constant ration." (Page 176, BLM Manual of Surveying Instructions 2009)

The **Grant Boundary** program requires a series of points that define the grant boundary, starting with a known (found) point followed by calculated points using **record** dimensions. The first field asks for these points. The second field asks for a ***Closing Point***, which is a found original point representing the last calculated point that was entered. The spatial difference between the closing point and the last calculated point determines the adjustment parameters.



The calculated rotation and scale are displayed on the results screen.

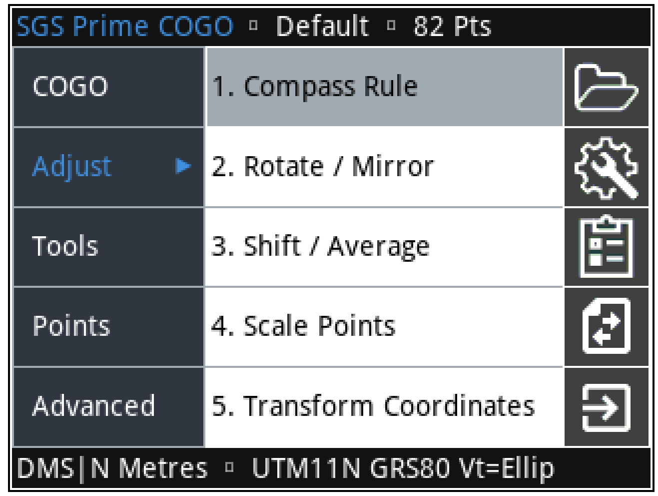
A choice is presented to adjust the record points. Proceeding with the adjustment provides the option to overwrite the existing points or to create new points.



Sample Coordinates

```
Point,Northing,Easting,Elevation,Descript
90,15000.0000,11000.0000,0.0000,GRANT
91,15008.3755,10990.0184,0.0000,GRANT
92,15027.8573,10960.0192,0.0000,GRANT
93,15136.4522,10883.9802,0.0000,GRANT
94,15136.4522,10776.6602,0.0000,GRANT
95,15126.4853,10744.0597,0.0000,GRANT
96,15123.7945,10667.0067,0.0000,GRANT
97,15123.7945,10638.7067,0.0000,GRANT
98,15084.8497,10558.8578,0.0000,GRANT
99,15103.3462,10518.4399,0.0000,GRANT
```

5 Adjust Menu



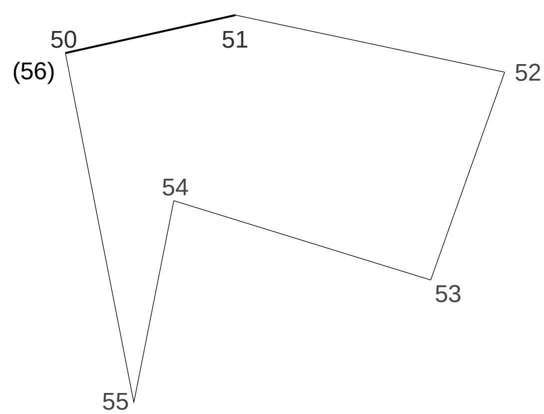
- Compass Rule – Perform a compass rule adjustment on a **Closed Figure** or **Close to Known Point** traverse.
- Rotate / Mirror – **Rotate around Base Point**, **Rotate around Origin (0,0)** and **Mirror along Baseline**.
- Shift / Average – **Shift by ΔX/ΔY/Δ**, **Shift by Distance/Direction/ΔZ**, **Shift by From/To Points** and **Average Points**.
- Scale Points – **Scale from Base Point**, and **Scale from Origin (0,0,0)**.
- Transform Coordinates – **Helmert Transformation** and **3D to Plan Cross Section**.

5.1 Compass Rule

A “compass rule” or “bowditch rule” adjustment distributes the linear misclose of a traverse proportionally throughout each leg of a traverse. A ‘closed figure’ traverse ends back on the starting point while a ‘close to fixed point’ traverse ends on a known control point that is held fixed.

Closed Figure

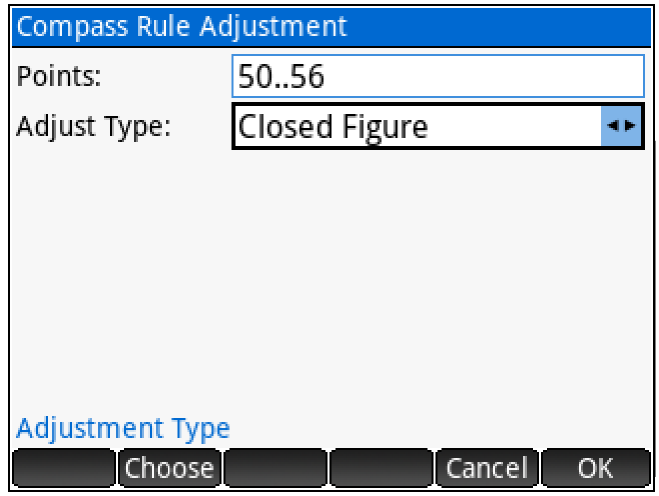
A known starting point, followed by a series of intermediate points, and ending back on the starting point defines a closed figure. Prior to adjustment, the loop ending point coordinates as measured will differ from the starting point coordinates. The difference between these coordinates will be distributed proportionally through each leg of the figure.

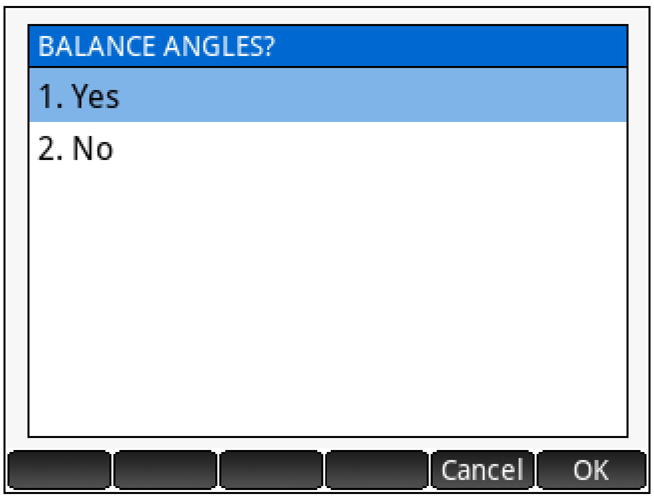


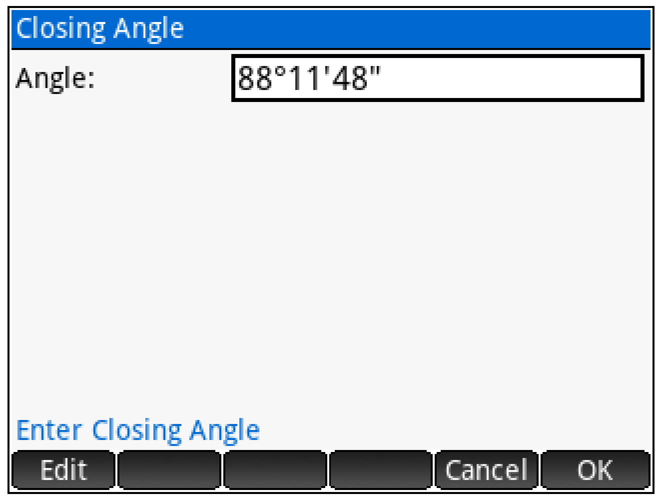
First, enter the point numbers using any of the point numbers input options, and select the Adjustment Type.

Next, an option to **Balance Angles** is presented. If the closing angle is known, choose “Yes”, otherwise choose “No”.

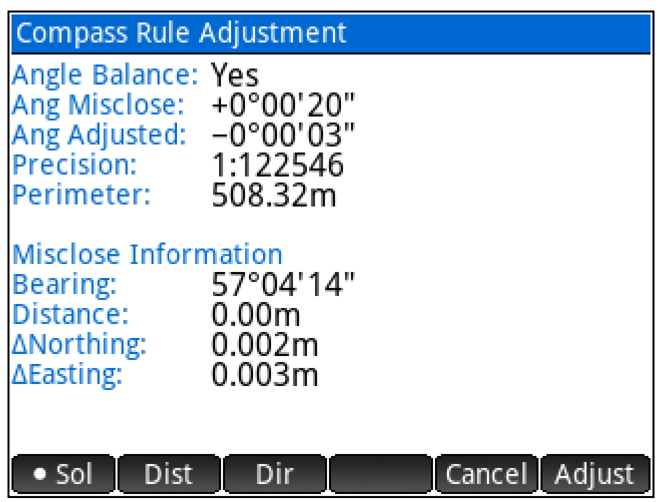
If the user selected “Yes” to balance angles, an input form will allow for the closing angle to be entered.







The COMPASS RULE RESULTS screen displays information about the adjustment including the angle balance information, precision, the perimeter of the figure, and the misclose information.



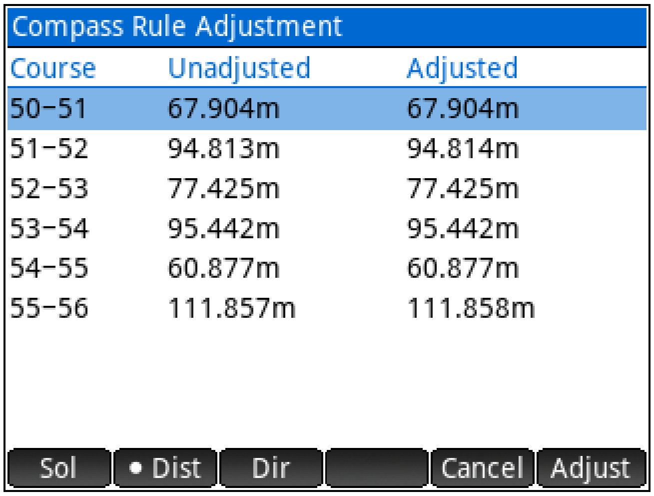
• Sol Display the Adjustment Solution.

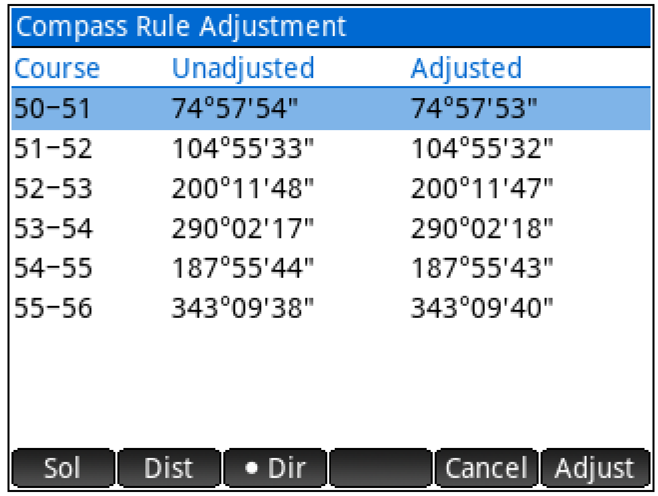
• Dist Display the unadjusted and adjusted distances for each course of the traverse.

• Dir Display the unadjusted and adjusted directions for each course of the traverse.

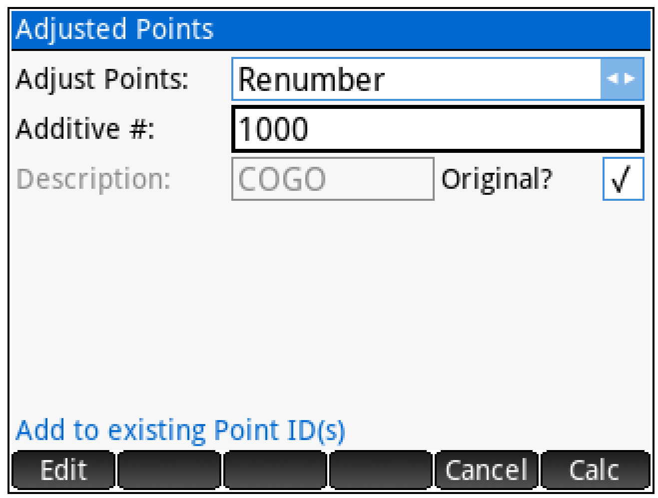
Adjust Proceed with adjusting the points.

Examples of the distance and direction result pages:





Proceeding with the adjustment will present the option to Renumber or Overwrite the existing point numbers. When renumbering, a description for the new points can also be set.

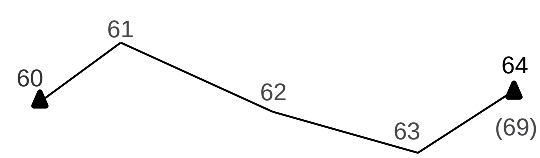


Sample Coordinates

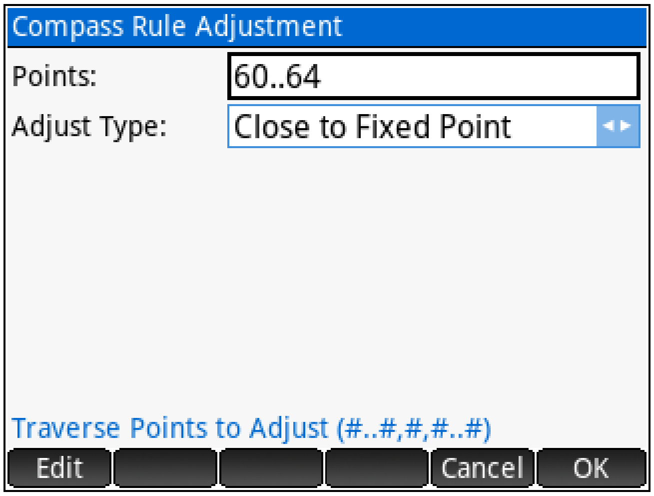
```
Point,Northing,Easting,Elevation,Descript
50,6102.894,4125.949,0.000,CRA_CLOSED
51,6120.510,4191.528,0.000,CRA_CLOSED
52,6096.092,4283.143,0.000,CRA_CLOSED
53,6023.426,4256.416,0.000,CRA_CLOSED
54,6056.123,4166.749,0.000,CRA_CLOSED
55,5995.827,4158.356,0.000,CRA_CLOSED
56,6102.885,4125.942,0.000,CRA_CLOSED
```

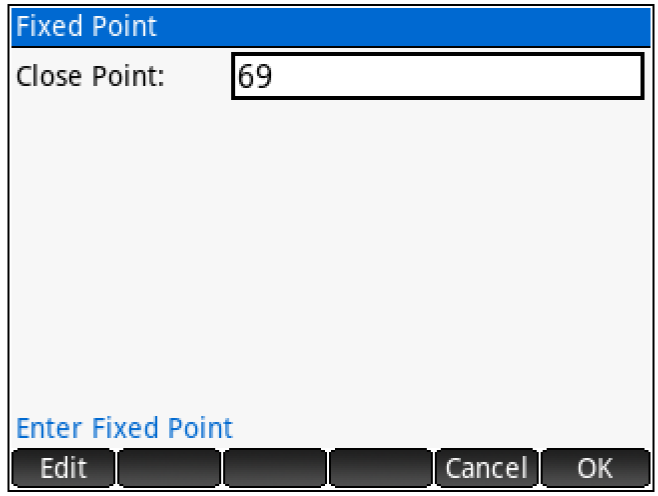
Close to Fixed Point

A close to fixed point traverse begins on a known control point followed by a series of intermediate points and ends on a second known control point which will be held fixed. The difference between the measured ending point coordinates and the fixed values will be distributed proportionally through each leg of the traverse.

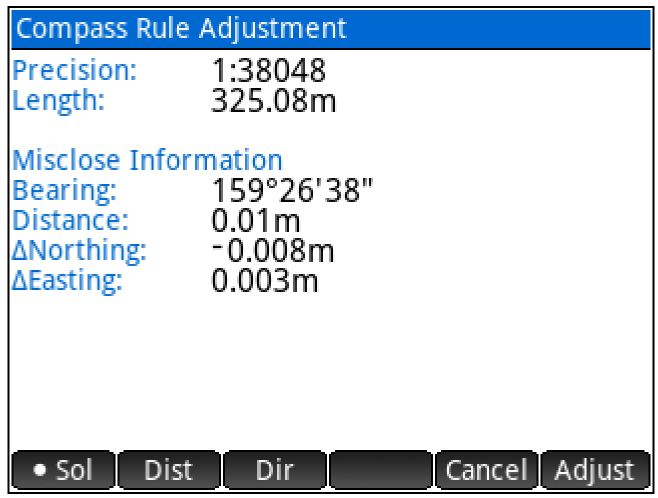


First, enter the point numbers using any of the point numbers input options, and select the Adjustment Type. When a ‘Close to Fixed Point’ type is selected, the following input form will ask for the Fixed Point.





The COMPASS RULE RESULTS screen displays information about the adjustment including the precision, the length of the figure, and the misclose information.

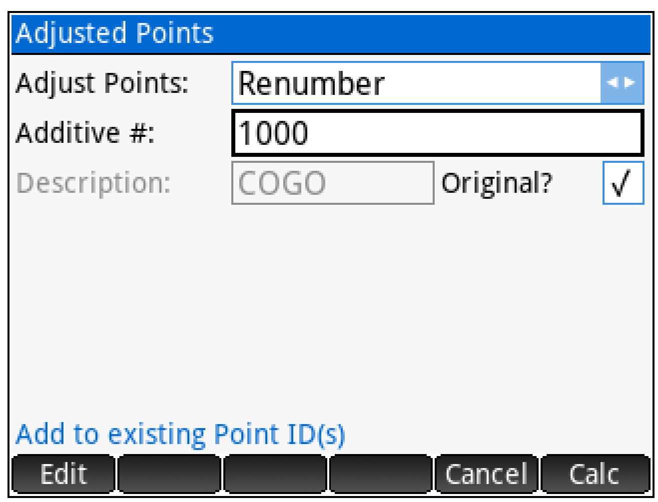


• Sol Display the Adjustment Solution.

• Dist Display the unadjusted and adjusted distances for each course of the traverse.

• Dir Display the unadjusted and adjusted directions for each course of the traverse.

Adjust Proceed with adjusting the points.

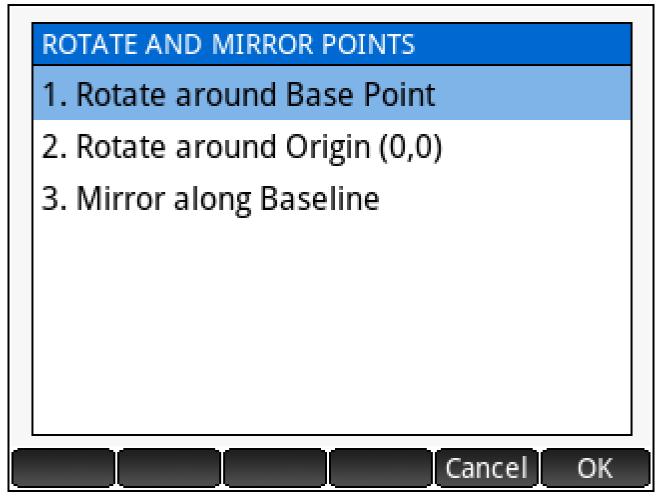


Sample Coordinates

```
Point,Northing,Easting,Elevation,Descript
60,7033.458,5311.207,0.000,CRA_KNOWN
61,7070.237,5360.793,0.000,CRA_KNOWN
62,7037.104,5460.587,0.000,CRA_KNOWN
63,7010.119,5550.529,0.000,CRA_KNOWN
64,7028.068,5612.263,0.000,CRA_KNOWN
69,7028.060,5612.266,0.000,CRA_KNOWN
```

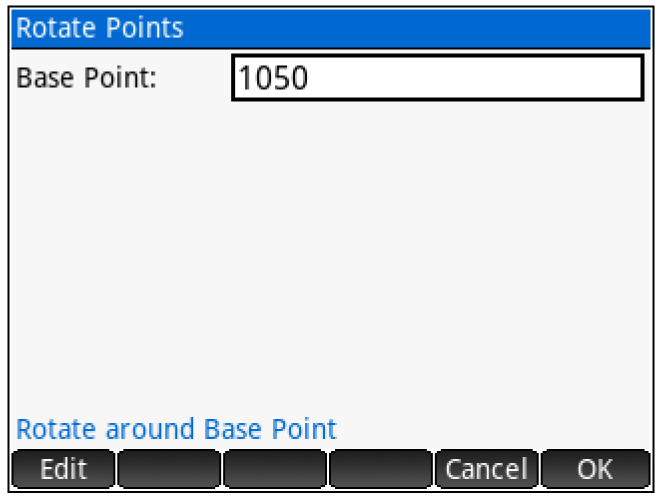
5.2 Rotate/Mirror Points

Rotate Points around a base point or the coordinate system origin, and **Mirror Points** mirrors points along a baseline.



Rotate around Base Point

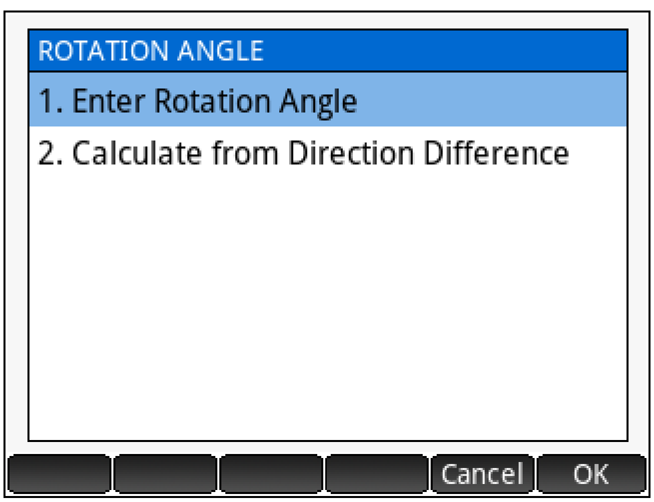
First, enter the point number to use as a base point.

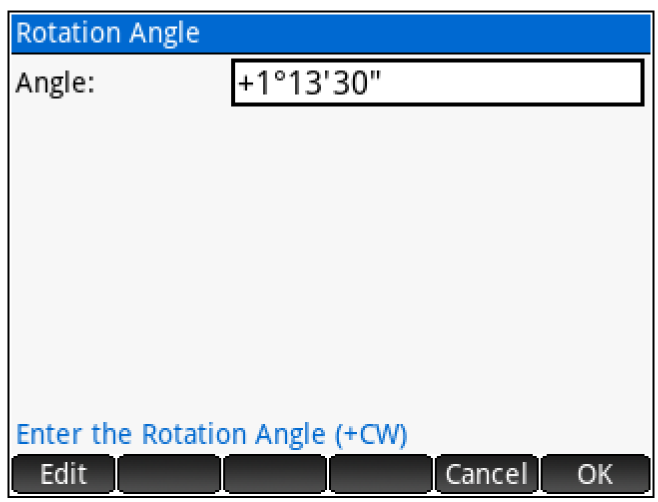


Next, select if you're entering a known rotation angle, or if you are calculating the rotation angle from two reference directions.

- Enter a positive angle for clockwise rotation and a negative angle for a counter clockwise rotation.
- Use any of the standard directions input options to enter reference directions.

Next, enter the points to rotate, and select how to store the newly calculated points.





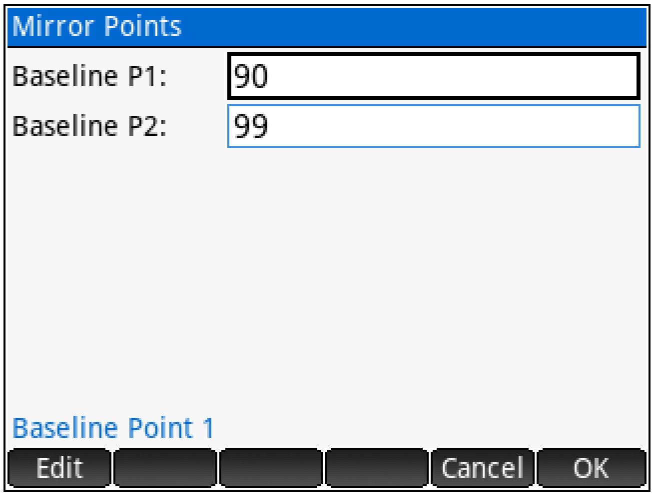
Rotate around Origin (0,0)

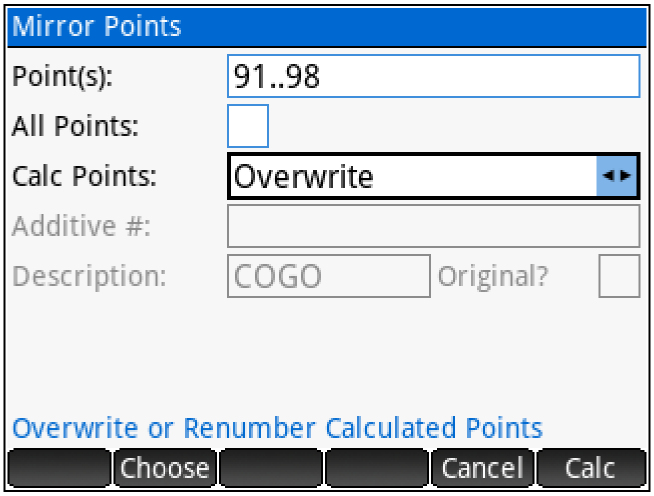
Like **Rotate Around Base Point**, except no base point is required, the points will be rotated around 0,0.

Mirror along Baseline

First, enter two points to define a baseline.

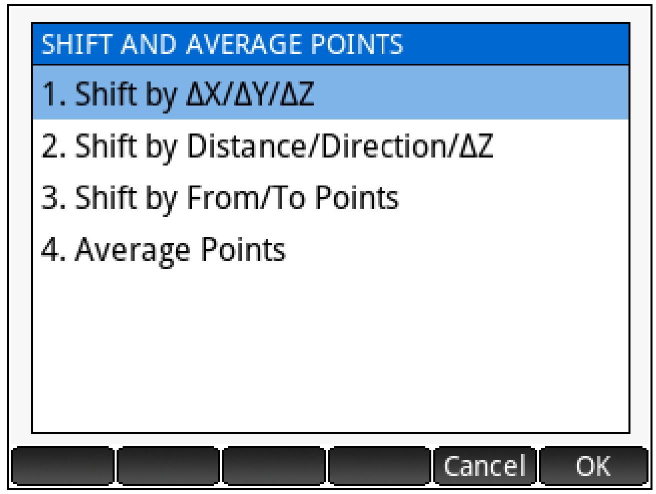
Next, enter the points to mirror and specify how to store the new coordinates.





5.3 Shift/Average Points

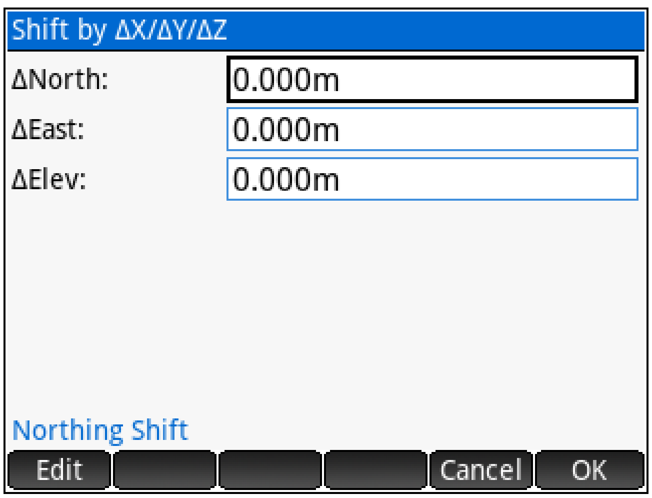
Point coordinates can be shifted by using one of three possible methods, and a range of point coordinates can be averaged to create a new point at the calculated average position. The 3D to Plan option transforms 3D measurements to 2D plan cross sections.

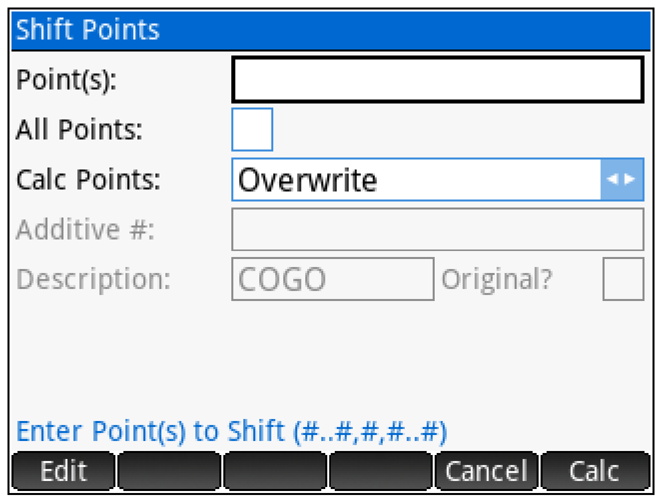


Shift by ΔX/ΔY/ΔZ

Enter the changes in ***Northing***, ***Easting*** and ***Elevation*** to define the shift parameters.

Next, enter the points to shift, and select how to store the newly calculated points.

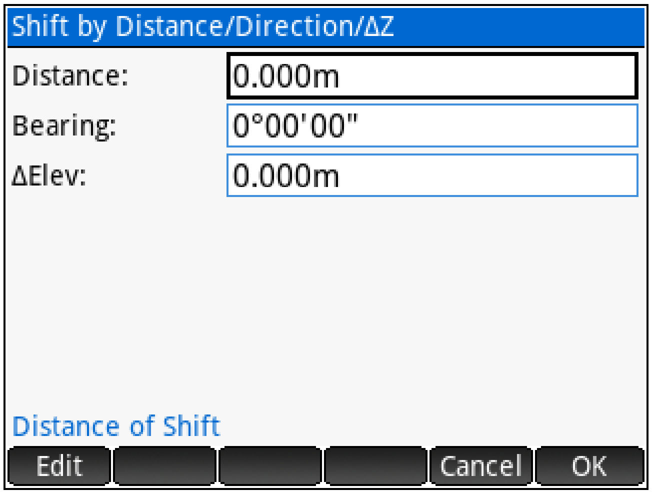


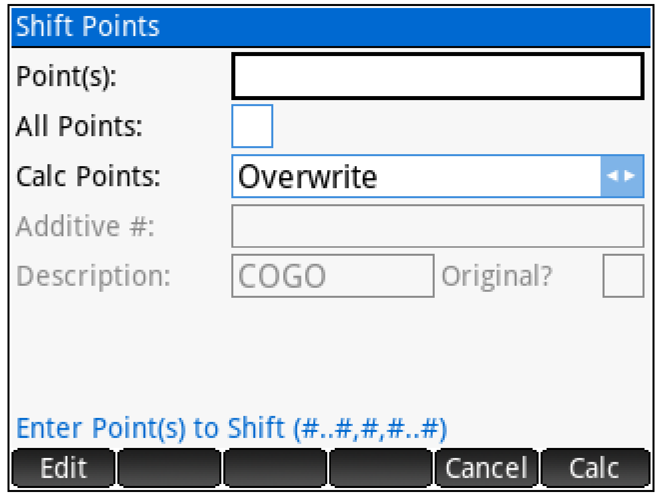


Shift by Distance/Direction/ΔZ

Enter the horizontal ***Distance***, the ***Bearing*** and the change in ***Elevation*** to define the shift parameters. Use any of the standard distances and directions input options.

Next, enter the points to shift, and select how to store the newly calculated points.

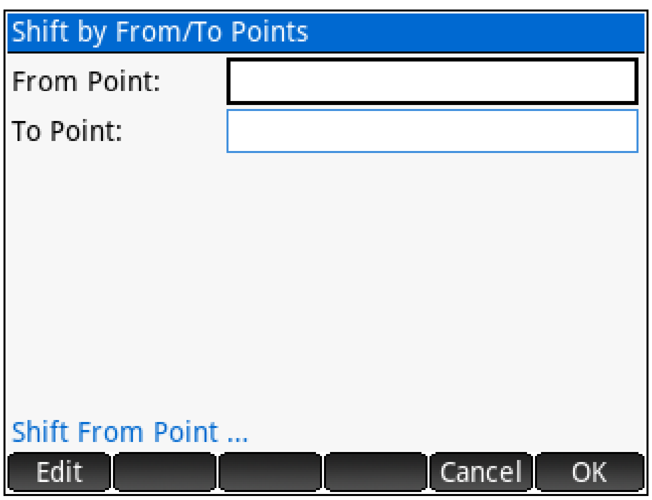


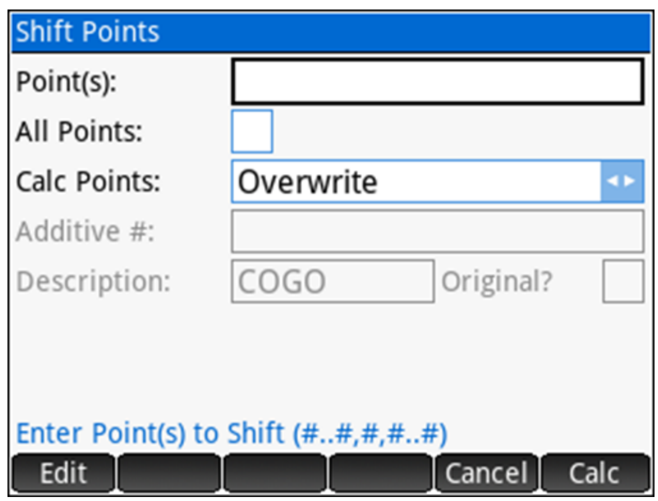


Shift by From/To Points

Enter the ***From Point*** and ***To Point*** to allow the program to calculate the 3D shift parameters between the two points.

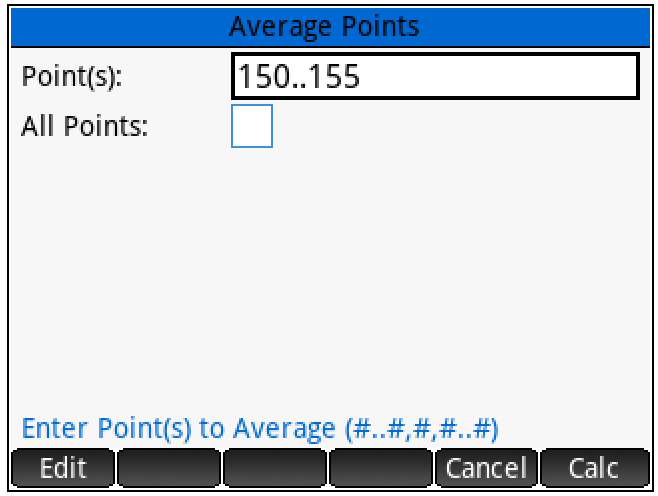
Next, enter the points to shift, and select how to store the newly calculated points.





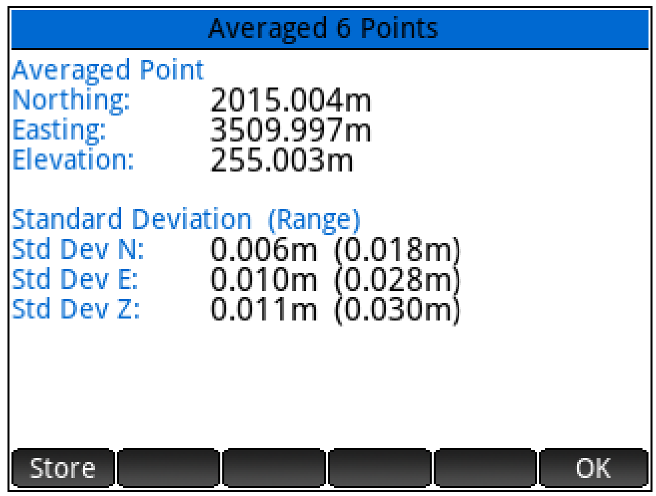
Average Points

Enter a series of points to compute their arithmetic mean coordinate values. Point numbers can be entered using any of the point numbers input options. At minimum two points are required to calculate average values.

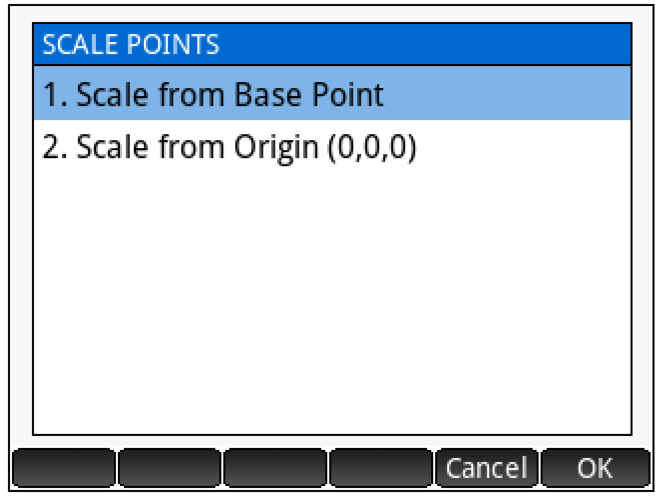


The solution displays the calculated coordinates, their standard deviation and the range in coordinate values.

The user is given the option to store the averaged point in the project database.



5.4 Scale Points



Scale Points from a Base Point or from the coordinate system origin (0,0).

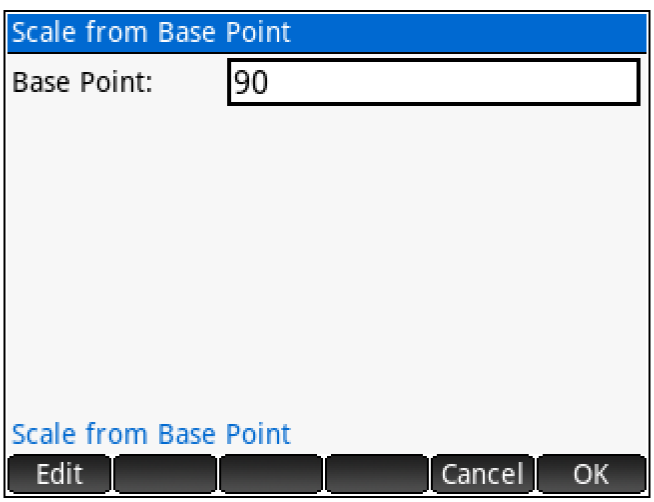
Scale from Base Point

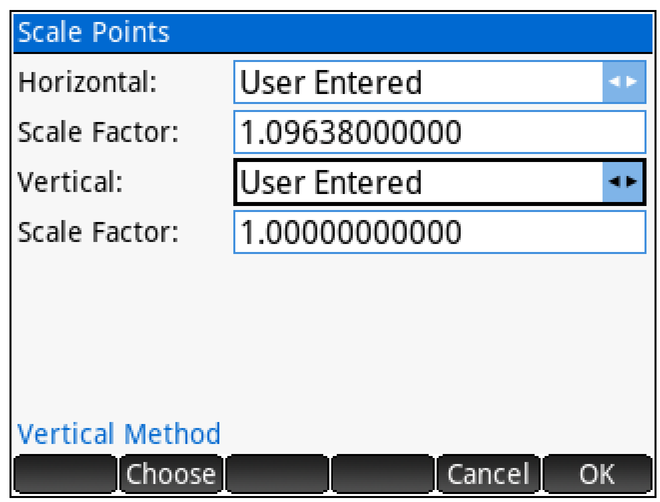
Point coordinates can be scaled from a base point with separate scale factors for the horizontal and vertical components.

First, enter the point number to use as the ***Base Point***.

Next, specify the horizontal and vertical scale factors. Options exist on how to define the scale factors:

- **User Entered** – Enter a scale factor value. It is possible to enter a math operation such as 1/0.99962051 to calculate the scale factors.
- **Feet to Meters** – The scale factor is automatically determined.
- **Meters to Feet** – The scale factor is automatically determined.
- **Input Scale Factor** – From User Settings.
- **Output Scale Factor** – From User Settings.



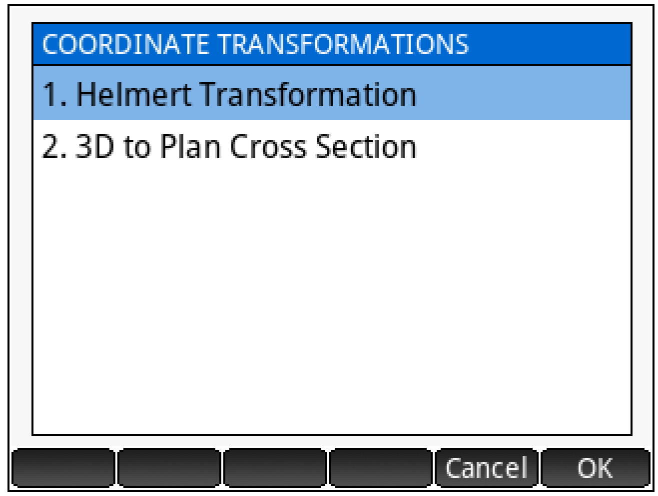


Last, enter the points to scale, and select how to store the newly calculated points.

Scale from Origin (0,0,0)

Like **Scale from Base Point**, except no base point is required, the points will be scaled from 0,0,0.

5.5 Transform Coordinates

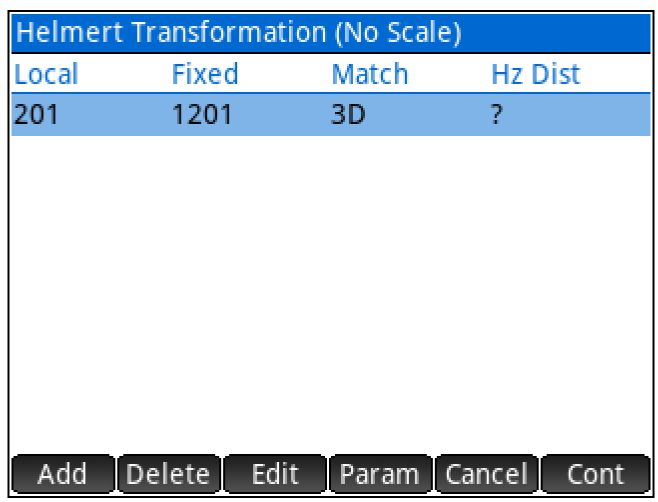


Transform point coordinates in one coordinate system to another by matching up control points using the **Helmert Transformation** tool or create 2D cross section points from points on a 3D feature such as a building face using the **3D to Plan Cross Section** utility.

Helmert Transformation

The **Helmert Transformation** program is a least squares coordinate transformation program that allows the user to transform points from one coordinate system to another. A two-dimensional conformal coordinate transformation (aka four-parameter similarity transformation) is used to calculate the least squares transformation. Scale, rotation and translation are computed when a minimum of two common control points are present in two separate coordinate systems. The procedure in general is:

1. Match up control points from both coordinate systems, i.e. these points represent the same objects in two different coordinate systems.
2. Calculate the transformation and review the residuals for each control pair that was defined.
3. If necessary, modify the control points used to address any “poorly fitting” control pairs.
4. Apply the transformation to a specified range of points.



The main **Helmert Transformation** screen accepts all input through the menu:

Add Add control pairs to be used for the calculation.

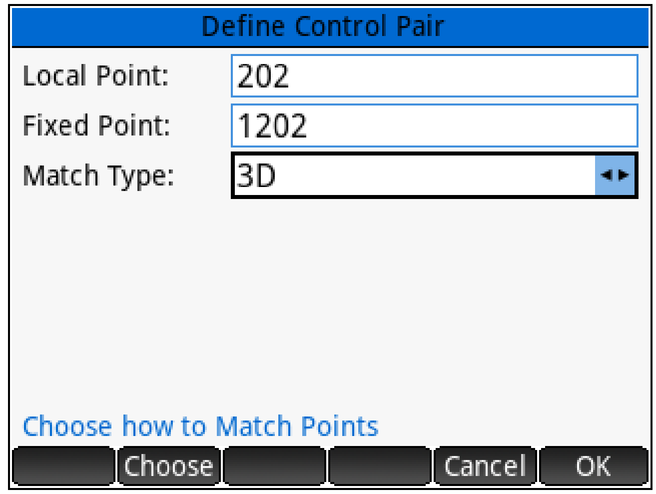
Delete Delete the selected control pair from the calculation.

Edit Edit the selected control pair.

Param Set the Scale **Param**eter, which can be fixed at 1 or calculated best fit. The title in the header indicates (No Scale) when the scale parameter is fixed, or (Scaled) when the calculated scale factor will be applied.

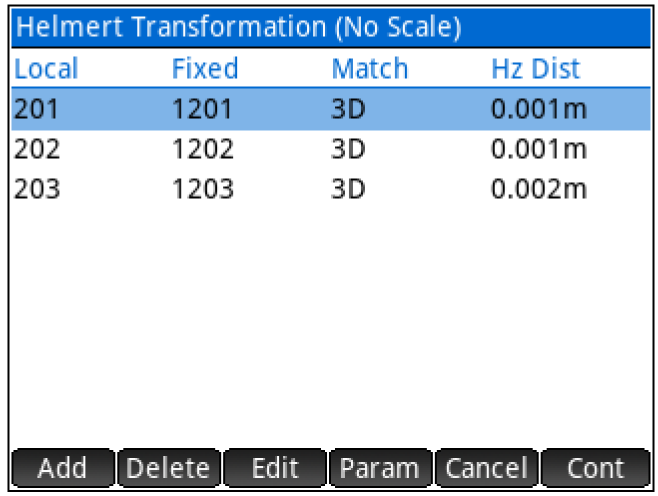
Once at least two pairs are added, their horizontal distance residuals are displayed.

Add Control Pairs



The ***Local Point*** is in the coordinate system that you wish to transform, while the ***Fixed Point*** is in the coordinate system that is not changing. Points can be matched in 1D, 2D, 3D or None. You may continue entering all your control pairs without leaving the DEFINE CONTROL PAIRS input form.

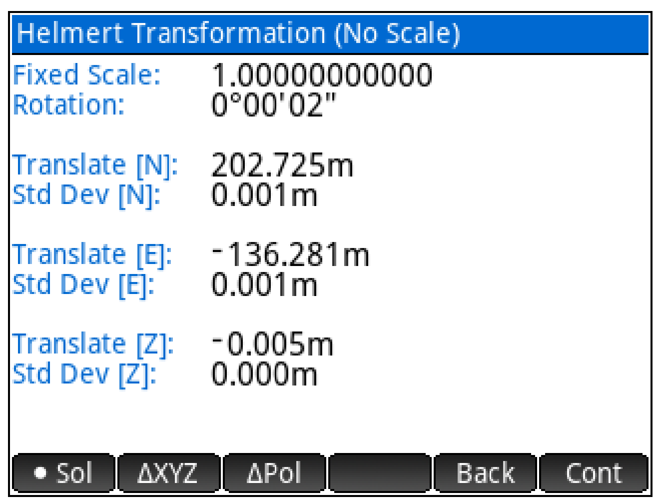
Delete or Edit Control Pairs



Control pairs can be deleted or edited when necessary. From the main **Helmert Transformation** screen, select a control pair and use menu options to delete or edit the selected control points. The screen updates immediately to reflect the changes made.

Calculate Solution

Use Cont to display the calculated transformation parameters based on the defined control pairs.



The solution presented displays the best-fit transformation parameters (scale, rotation, and translation in northing and easting) as well as the standard deviation in the northing and easting and the calculated average elevation shift between any/all control pairs that were matched 3D. The menu:

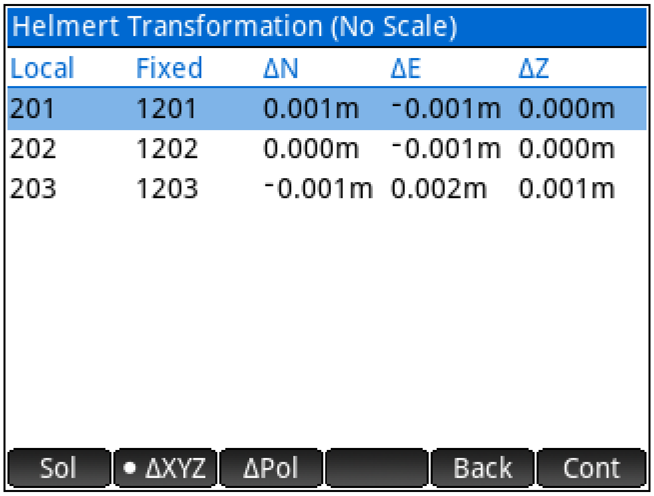
• Sol Display the transformation solution.

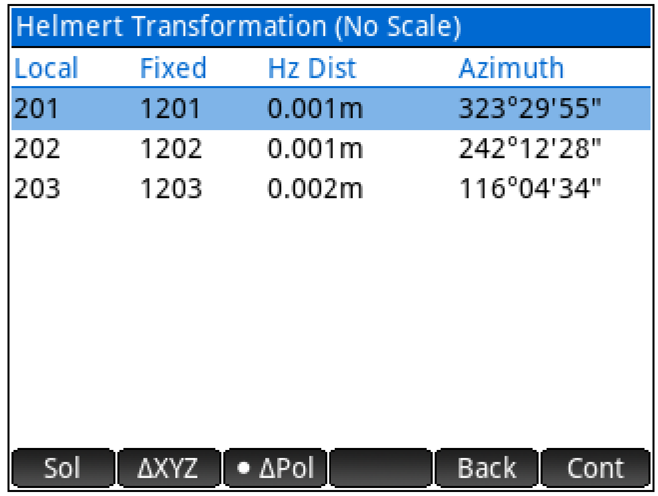
• ΔXYZ Display the coordinate residuals for each control pair.

• ΔPol Display the polar distance and direction residuals for each control pair.

Back Return to the previous input screen to Add/Delete/Edit control pairs.

Examples of the residual screens:

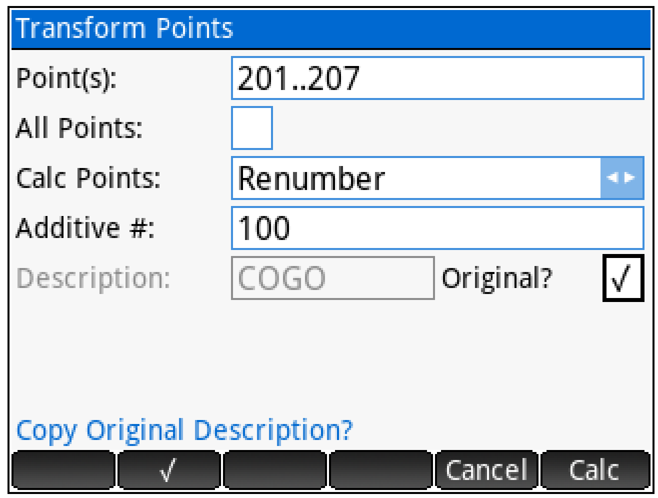




Apply Transformation

Use Cont when ready to apply the transformation.

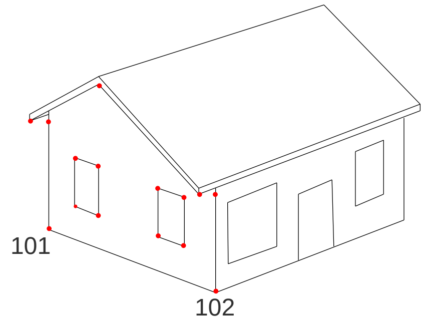
Enter the points to transform and select how to store the newly calculated points.



Sample Coordinates

```
Point,Northing,Easting,Elevation,Description
201,5366358.241,470146.326,22.112,HT_LOCAL
202,5366207.625,470340.584,17.416,HT_LOCAL
203,5366043.182,470551.834,14.643,HT_LOCAL
204,5366215.676,470348.232,0.000,HT_LOCAL
205,5366290.117,470401.822,0.000,HT_LOCAL
206,5366123.497,470616.424,0.000,HT_LOCAL
207,5366048.800,470552.152,0.000,HT_LOCAL
1201,5366557.381,470050.977,22.107,HT_FIXED
1202,5366406.762,470245.234,17.411,HT_FIXED
1203,5366242.317,470456.485,14.639,HT_FIXED
```

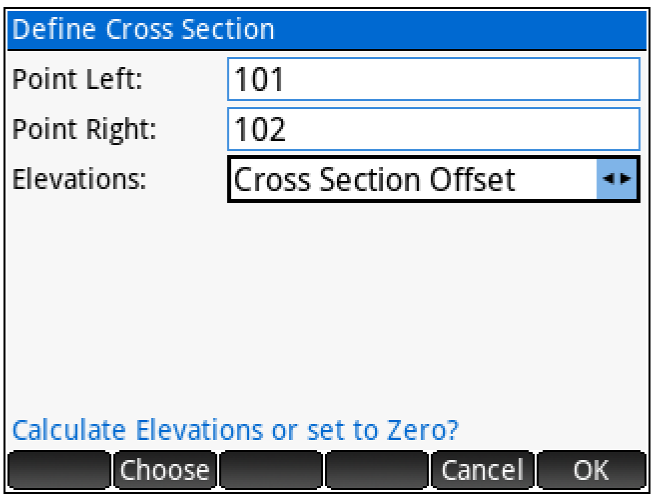
3D to Plan Cross Section

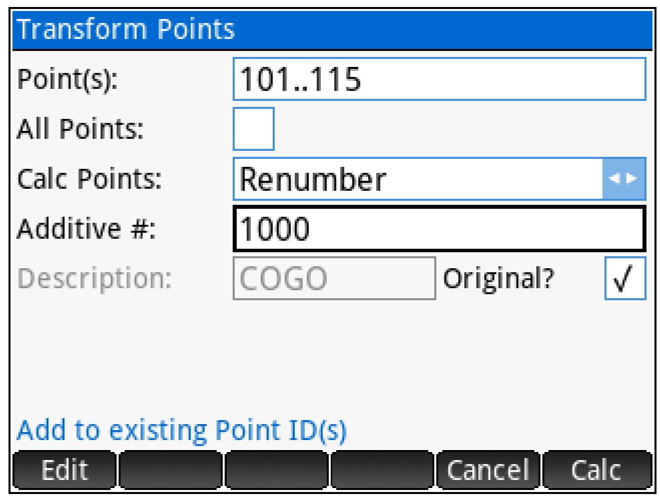


In the diagram on the right, consider the red dots shown as being reflector-less measurements made with a total station. The goal is to calculate the ratio of glass surface area to total surface area of the wall. The 3D to Plan program transforms the 3D measured coordinates into 2D plan points to create a section view.

First, define the section cut line by entering a point towards the left of the section cut line, and a point to the right of the section cut line. Consider the points measured at the base of the walls as the section cut line, Point 101 on the left and Point 102 on the right. Elevations of the calculated points can be calculated from their offsets relative to the baseline, or the elevations can be set to zero, if not important.

Next, enter the points to transform, and select how to store the newly calculated points.

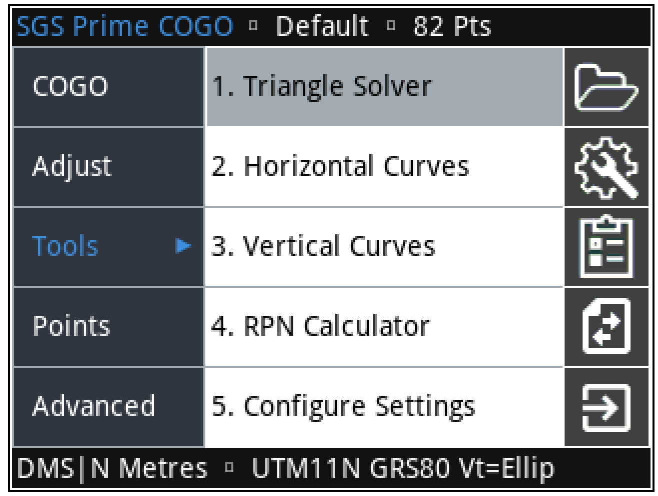




Sample Coordinates

```
101,5000.000,5000.000,68.743,3D2PLAN
102,4982.603,5019.322,68.743,3D2PLAN
103,5000.000,5000.000,77.743,3D2PLAN
104,4982.603,5019.322,76.743,3D2PLAN
105,4997.323,5002.973,71.743,3D2PLAN
106,4994.647,5005.945,71.743,3D2PLAN
107,4997.323,5002.973,75.743,3D2PLAN
108,4994.647,5005.945,75.743,3D2PLAN
109,4987.956,5013.377,71.743,3D2PLAN
110,4985.279,5016.349,71.743,3D2PLAN
111,4987.956,5013.377,75.743,3D2PLAN
112,4985.279,5016.349,75.743,3D2PLAN
113,4999.852,4997.175,78.243,3D2PLAN
114,4979.778,5019.470,78.243,3D2PLAN
115,4989.815,5008.323,84.493,3D2PLAN
```

6 Tools Menu

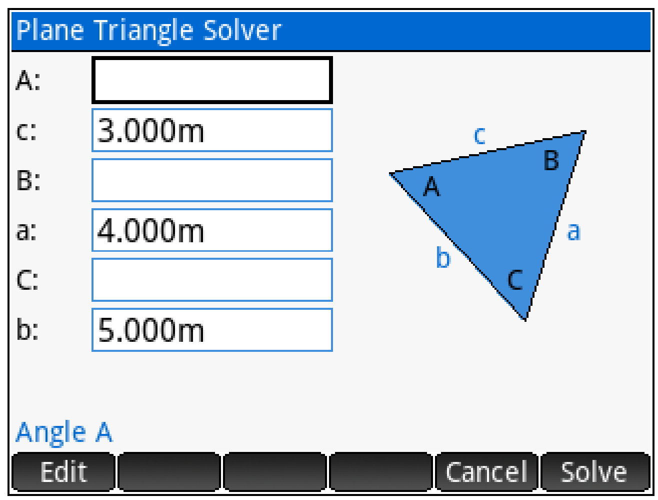


- Triangle Solver – Solve a plane triangle from three known values.
- Horizontal Curves –Features a **Circular Curve Solver**, **Curve Through Fixed Point** Solver, and a **Spiral Curve Solver**.
- Vertical Curves – Various methods including **Grades and Length known**, **Elevations and Length known**, **Fixed Point, VPI and Grades known**, **Fixed Point, BVC and Grades known** and **Intersect Slopes from two known points**.
- RPN Calculator – Calculator app designed for survey calculations.
- Configure Settings – Configure User Settings.

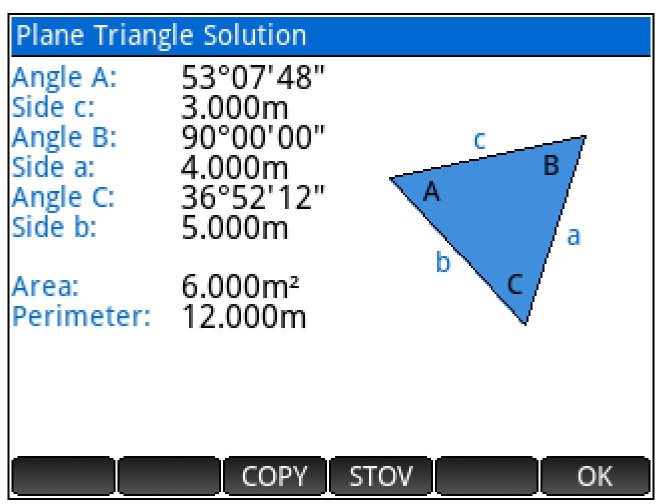
6.1 Triangle Solver

The triangle solver accepts three known values (at least one of which must be a side) and solves for the remaining values.

For side value inputs, any of the standard distances input options are accepted to allow the user to inverse points in the current job database to calculate distances for triangle sides, as well as any of the other operations.



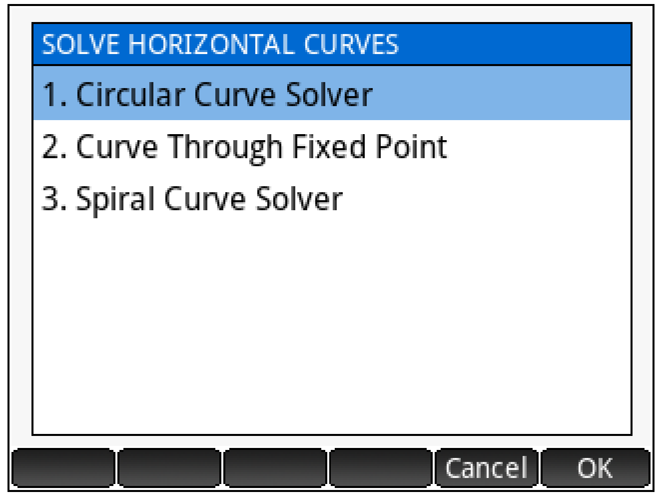
The output screen displays the solved values, including the triangle area and perimeter.



6.2 Horizontal Curves

Three options to solve horizontal curves:

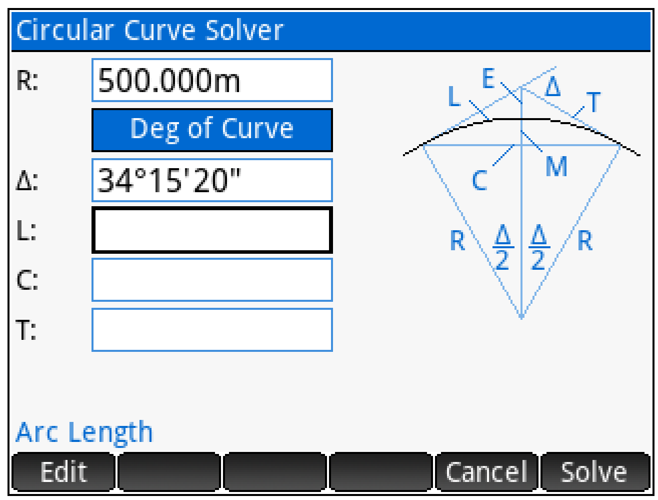
1. Circular Curve Solver – Solve a simple circular curve by entering two known elements.
2. Curve Through Fixed Point – Calculate the curve that passes through a fixed point. Calculations are possible when a point on the back tangent, at the PI, on the forward tangent, and the fixed point are provided.
3. Spiral Curve Solver – Solves all the Spiral-Curve-Spiral parameters when entering a Spiral Length, a total SCS deflection angle, and the curve radius.



Circular Curve Solver

The circular curve solver requires two known curve elements and solves for the rest. Acceptable input combinations include:

- The radius and any of the other accepted inputs.
- The deflection angle and any of the other accepted inputs.
- The arc length and the chord length. NOTE: THIS TYPE OF SOLUTION INVOKES THE ITERATIVE NEWTON'S METHOD TO SOLVE FOR THE REMAINING VALUES. THE RESULT ACCURACY DEPENDS ON THE INPUT PRECISION.

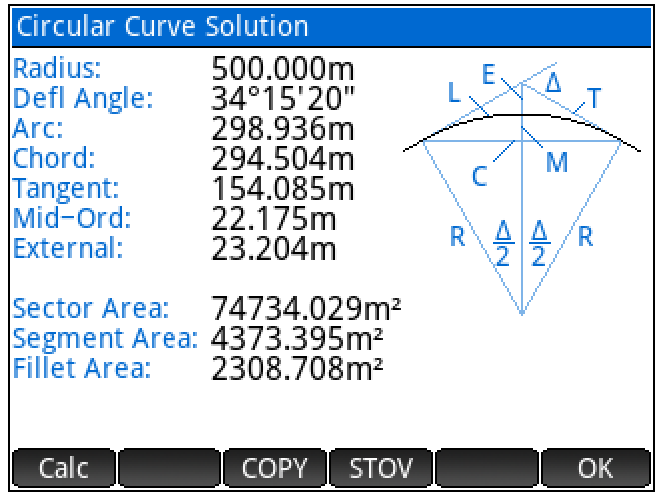


Degree of Curve

A **Deg of Curve** button provides easy access to determine the radius of the curve by degree of curve, both chord and arc definitions are available.

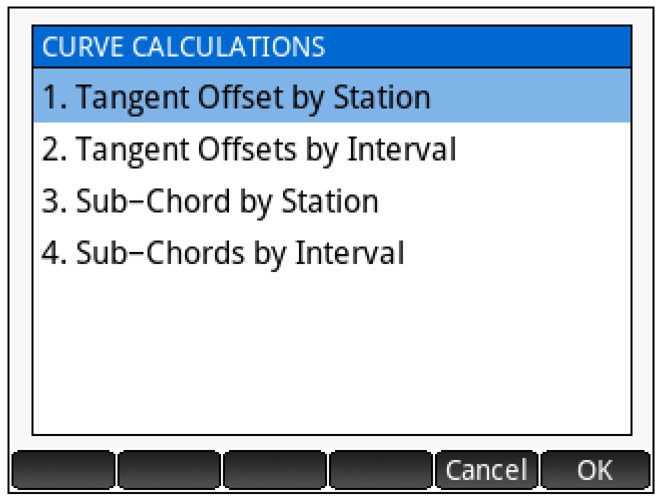
The solution displays all the elements of the circular curve, including the sector, segment and fillet areas.

The Calc button on the menu features Tangent Offset calculations.



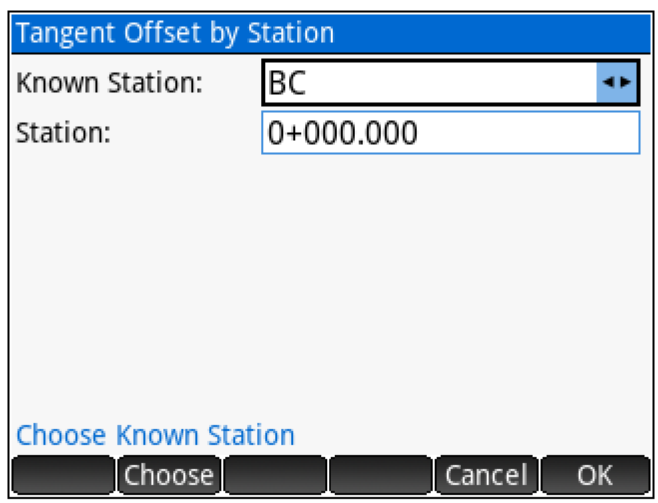
Curve Calculations

Further calculations are possible with the solved curve parameters.



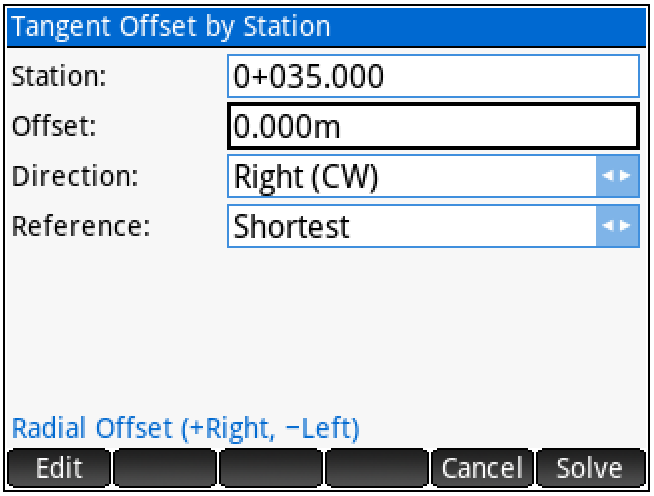
- **Tangent Offset by Station** – Enter any station on the curve to calculate the tangent distance and offset to layout the curve using the Tangent Offset method.
- **Tangent Offsets by Interval** – Calculates the tangent distances and offsets for all stations on the curve at a specified interval.
- **Sub-Chord by Station** – Enter any station on the curve to calculate the turned angle and chord distance from either end of curve to layout the curve using the Sub-Chord method.
- **Sub-Chords by Interval** – Calculates the turned angles and chord distances for all stations on the curve at the specified interval.

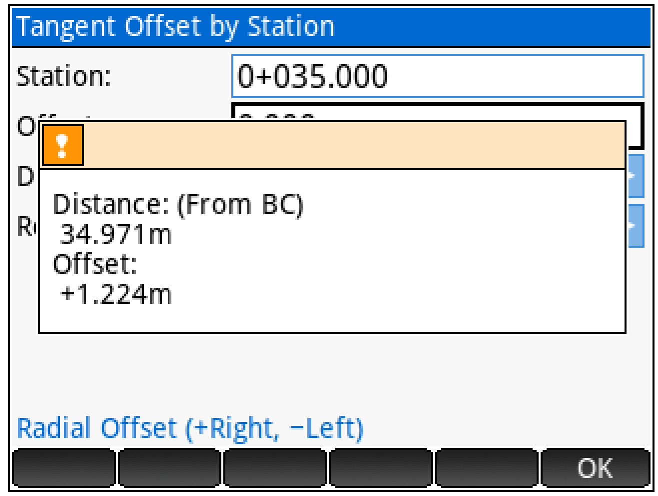
For all methods, enter the known station at either the BC, PI or EC to continue with the calculations.



Tangent Offset by Station

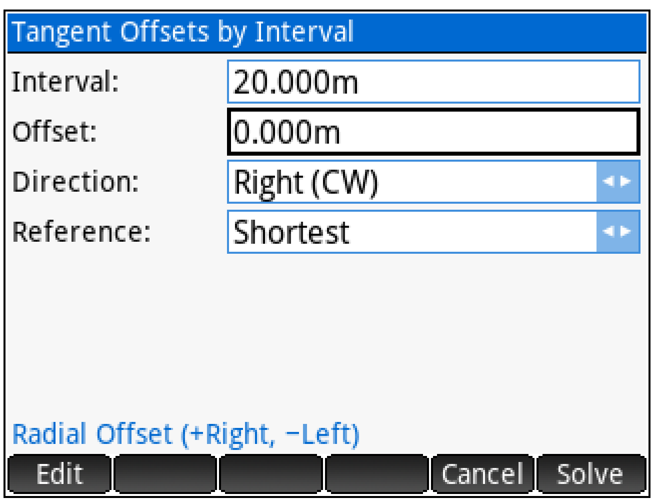
Enter any station on the curve, enter an offset from centerline (optional), choose the curve direction, and choose the Calculation Reference (Shortest tangent distance, From BC, or From EC) to calculate and display the tangent distance and tangent offset.

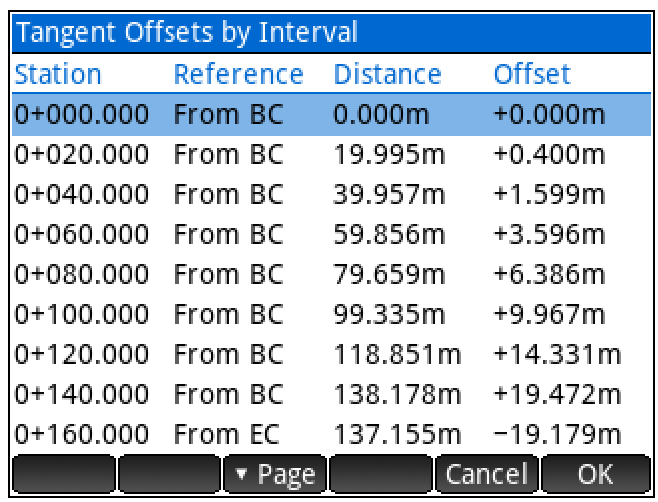




Tangent Offset by Intervals

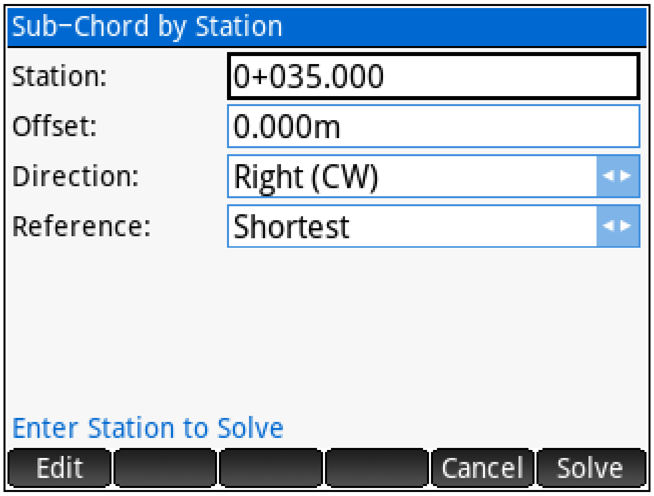
Enter the station interval, enter an offset from centerline (optional), choose the curve direction, and choose the Calculation Reference (Shortest tangent distance, From BC, or From EC) to calculate and display the tangent distances and tangent offsets for all stations at the given interval.

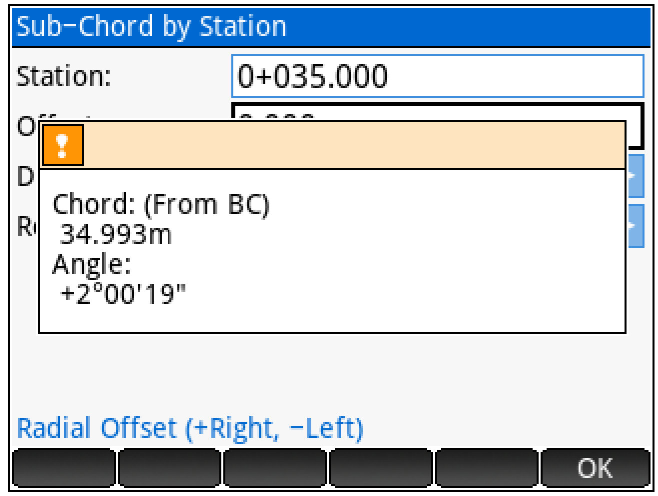




Sub-Chord by Station

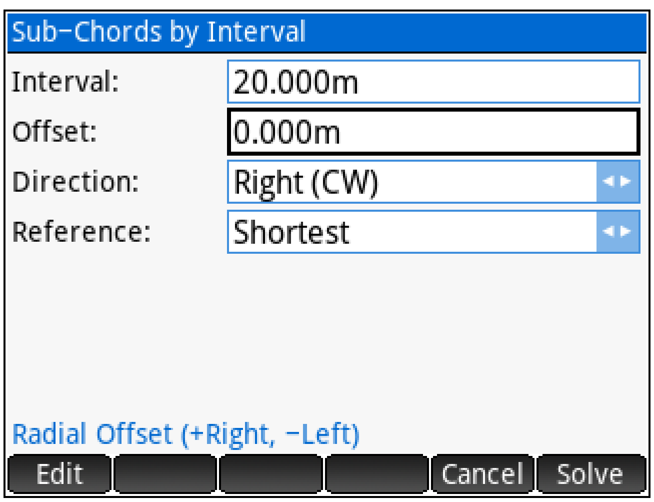
Enter any station on the curve, enter an offset from centerline (optional), choose the curve direction, and choose the Calculation Reference (Shortest chord distance, From BC, or From EC) to calculate and display the chord distance and turned angle.

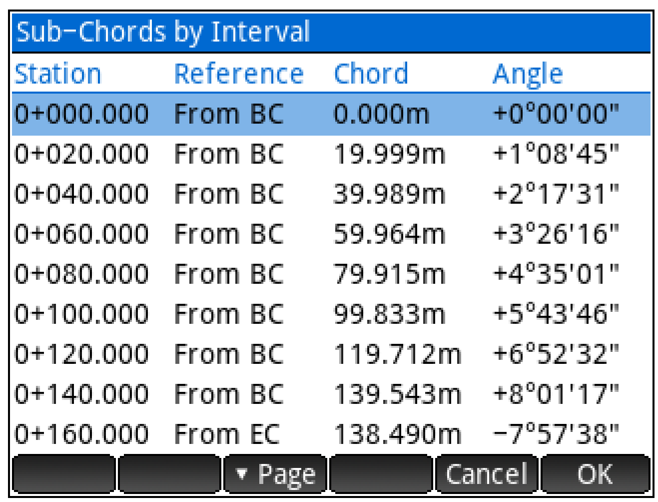




Sub-Chords by Intervals

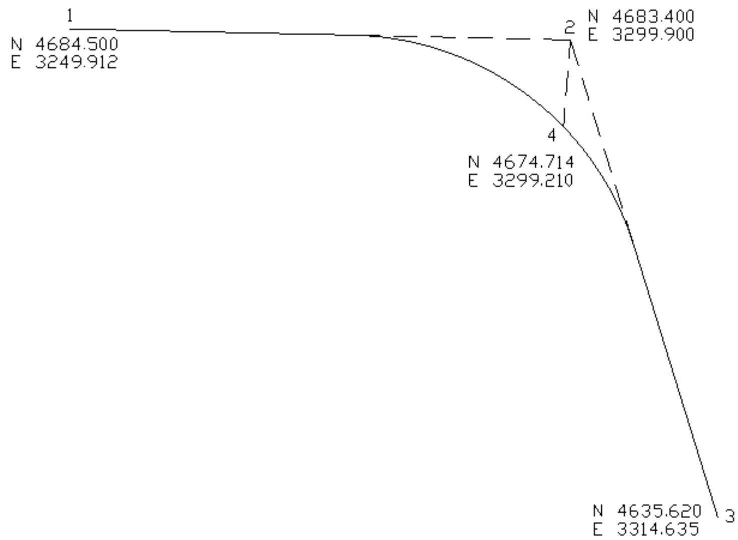
Enter the station interval, enter an offset from centerline (optional), choose the curve direction, and choose the Calculation Reference (Shortest chord distance, From BC, or From EC) to calculate and display the chord distances and turned angles for all stations at the given interval.





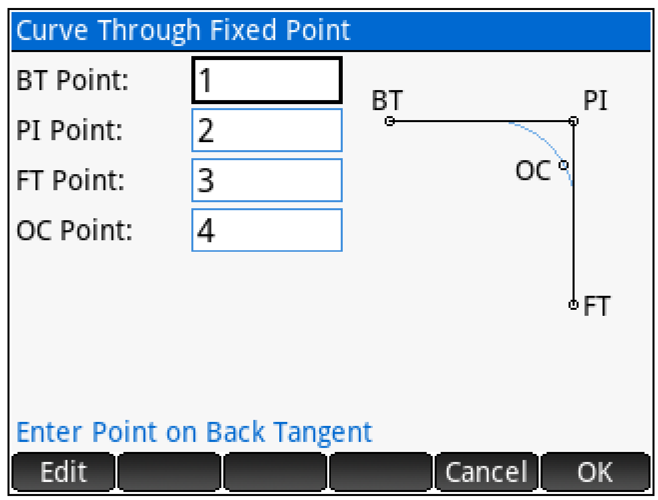
Curve Through Fixed Point

The Curve through Fixed Point solver solves a curve that is required to fit fixed tangents and a fixed point. In the diagram to the right, let's assume that the back tangent from Point 1 to Point 2 is a street curb line, and the forward tangent from Point 2 to Point 3 is also a street curb line. A curve is required so that the curb will pass through Point 4, which represents the back of a catch basin, for example.



In the input form; enter the points on the BT (Back Tangent), at the PI (Point of Intersection), on the FT (Forward Tangent), and OC (On the Curve).

The diagram is for general reference only.

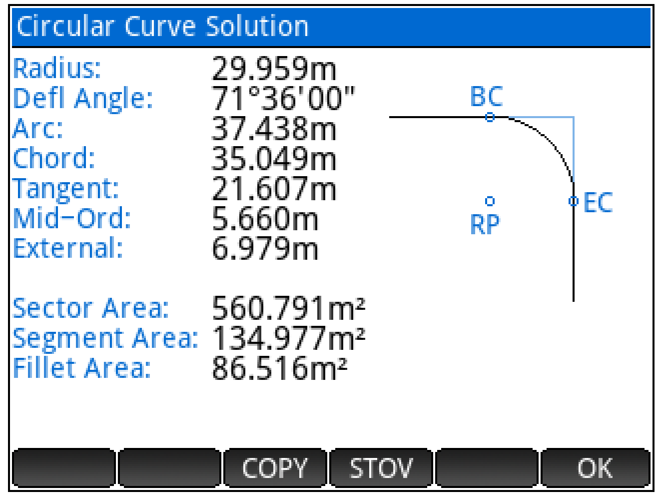


Sample Coordinates

```
Point,Northing,Easting
1,4684.500,3249,912
2,4683.400,3299.900
3,4635.620,3314.635
4,4674.714,3299.210
```

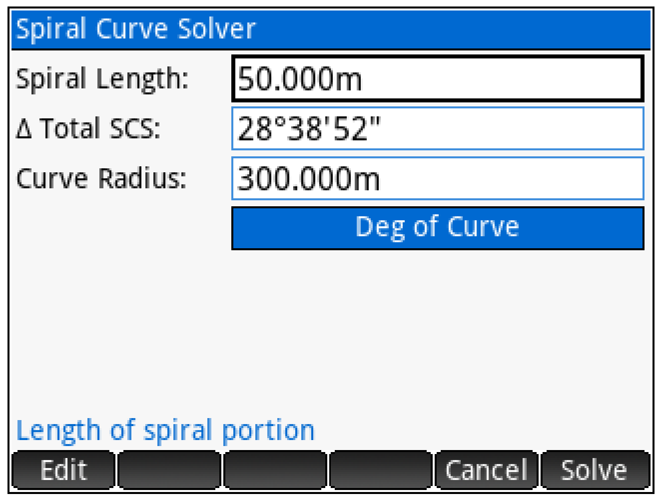
The solution displays the curve parameters, and the updated diagram shows the direction of the solved curve by placing the BC & EC labels at the appropriate locations.

After reviewing the solution, the options to store the calculated Radius Point, the calculated BC Point, and the calculated EC Point will be presented.



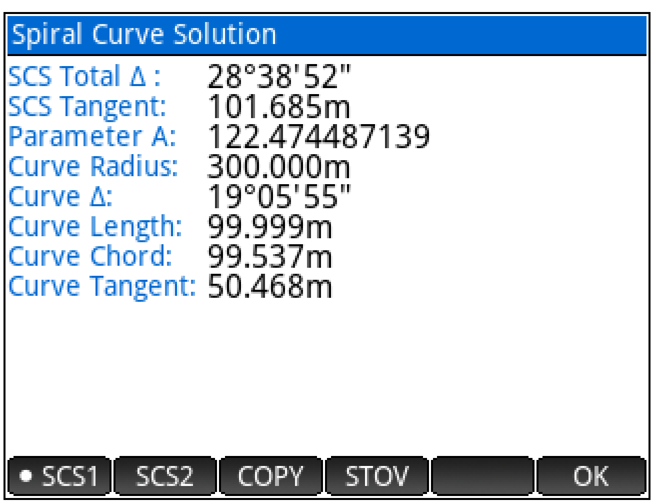
Spiral Curve Solver

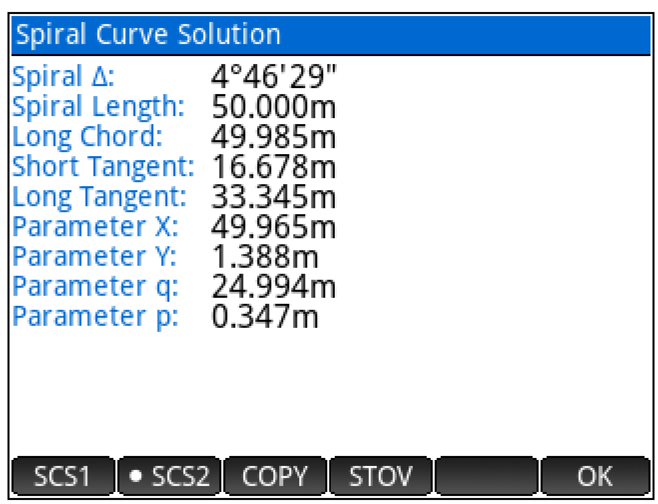
Solve all parameters of an equal spiral transition curve. Input the ***Spiral Length***, ***Total Deflection Angle***, and ***Curve Radius*** to solve the rest. The Curve Radius can also be solved by using the **Deg of Curve** button.



The solution is displayed on two pages, toggle the page by using the menu.

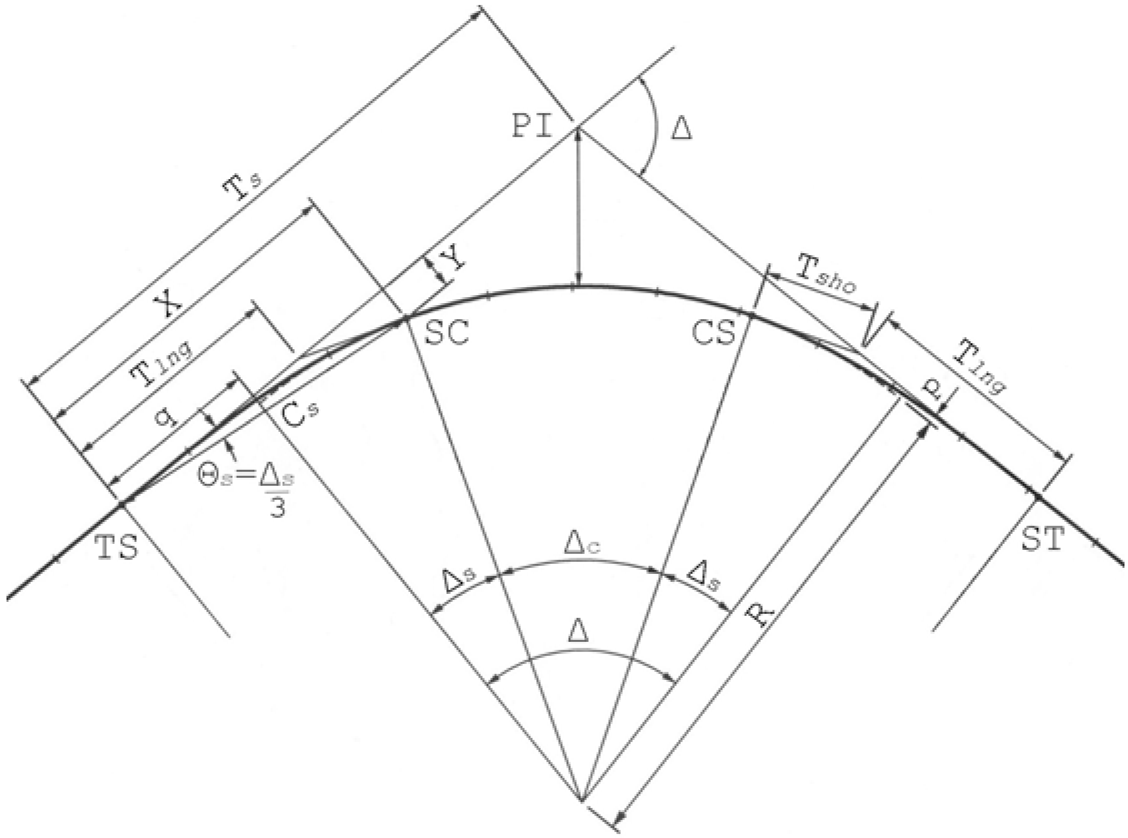
See the next page for a diagram of the spiral geometry.





Reference Diagram

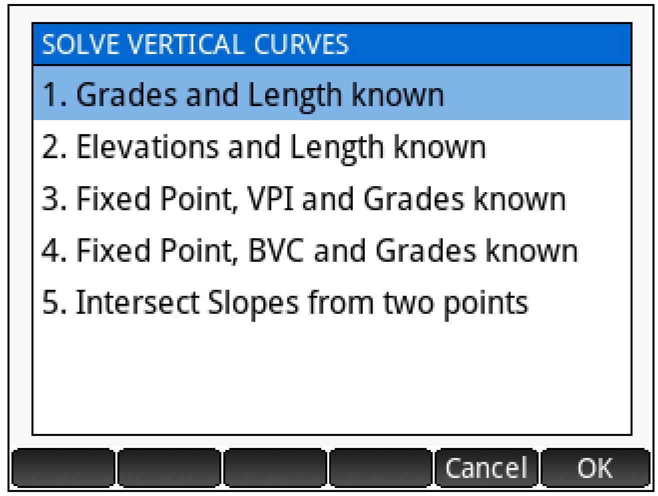
The diagram below illustrates the spiral geometry and associated symbols.



Below is a table legend of the spiral parameter symbols.

Ts	Tangent of Spiral-Curve-Spiral	Cs	Long Chord (Spiral)
X	Distance along Tangent from TS to Point at Right Angle to SC	Cc	Curve Chord (not labelled)
Y	Right Angle distance from Tangent to SC	Δs	Spiral Delta
Tlng	Long Tangent (Spiral)	Δc	Curve Delta
Tsho	Short Tangent (Spiral)	Δ	Total Delta
Ls	Length of Spiral (not labelled)	A	Spiral Parameter
q	Distance along Tangent to a Point at Right Angle to Ghost BC	R	Curve Radius
p	Distance from Tangent that the Curve (Ghost BC) has been Offset	Lc	Length of Curve (not labelled)
Tc	Tangent of Curve (not labelled)		

6.3 Vertical Curves

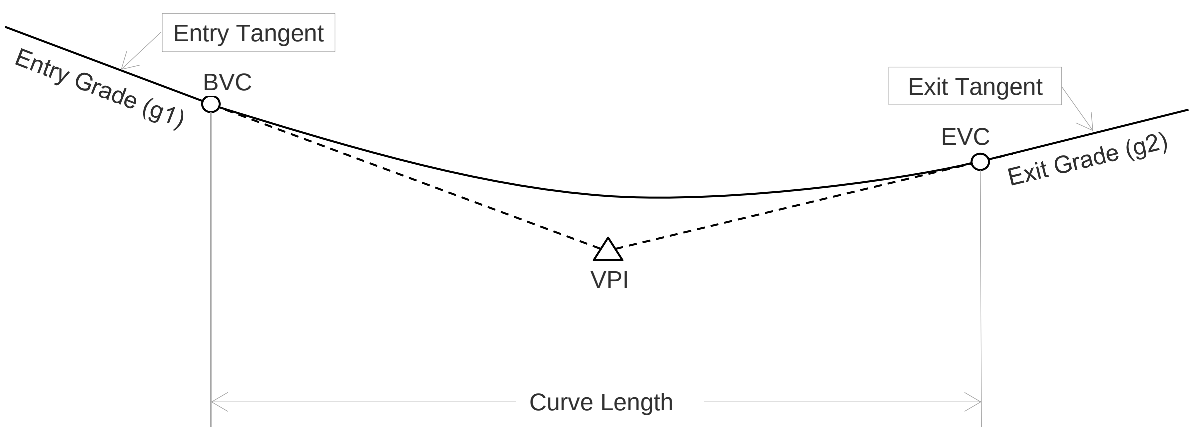


The Vertical Curve Solver solves vertical curves using various combinations of known parameters, including:

1. Grades and Length known – Requires a known station at the BVC, VPI or EVC, the vertical curve length, entry and exit grades, and a known elevation at the BVC VPI, EVC or the High/Low point on the curve.
2. Elevations and Length known – Requires a known station at the BVC, VPI or EVC, the vertical curve length, and elevations at the BVC, VPI and EVC.
3. Fixed Point, VPI and Grades known – Requires the station and elevation at the VPI, a fixed-point station and elevation, entry and exit grades.
4. Fixed Point, BVC and Grades known – Requires the station and elevation at the BVC, a fixed-point station and elevation, entry and exit grades.
5. Intersect Slopes from two known points – Requires the vertical curve length, the entry grade, a station with a known elevation on the entry tangent, the exit grade, and a station with a known elevation on the exit tangent.

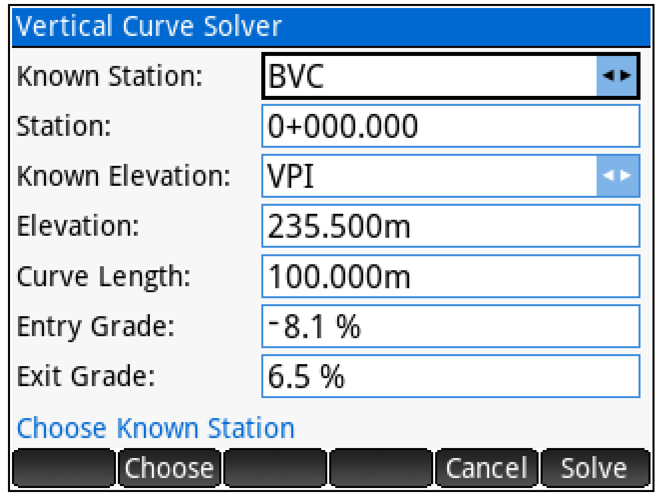
NOTE: BVC = Beginning of Vertical Curve, VPI = Vertical Point of Intersection, and EVC = End of Vertical Curve.

The diagram below illustrates the vertical curve geometry.



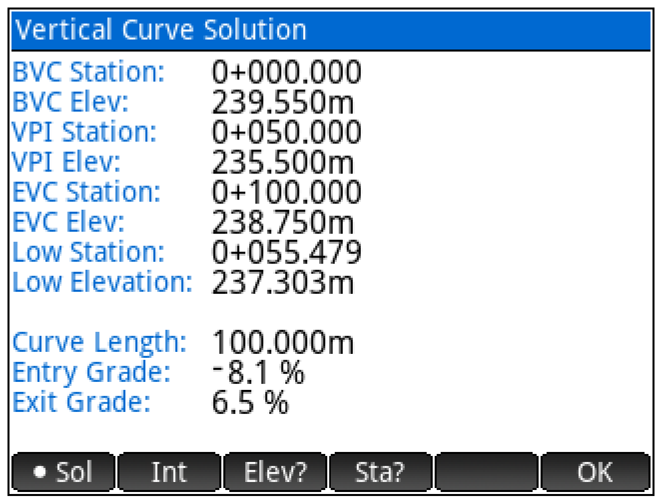
Grades and Length known

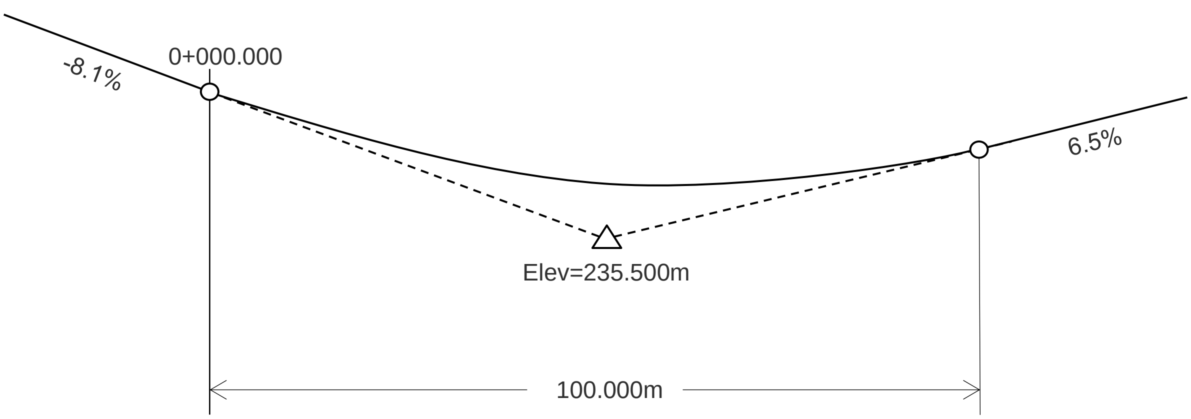
Enter all the required information to solve the curve.



- ▶ Choose the point on the vertical curve with a known station (BVC, VPI or EVC)
- ▶ Enter the known station for the point
- ▶ Choose the point on the vertical curve with a known elevation (BVC, VPI, EVC or the High/Low Point)
- ▶ Enter the known elevation for the point
- ▶ Enter the vertical curve length
- ▶ Enter the entry grade
- ▶ Enter the exit grade

The solution displays the stations and elevations for each the BVC, VPI, EVC and High/Low Point. See the Solution Screen and Calculations section for more information.

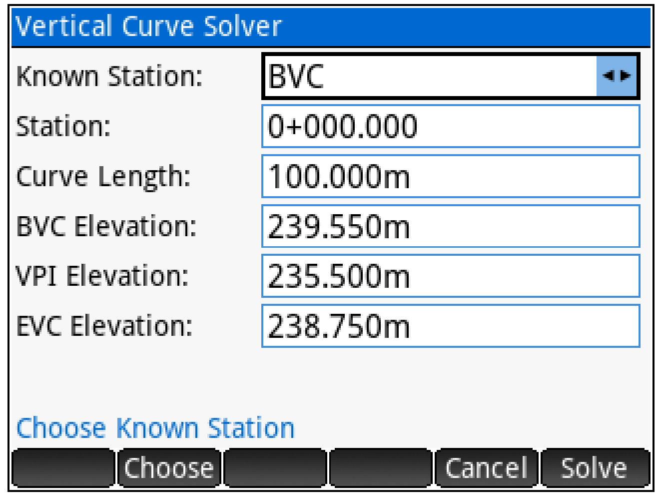




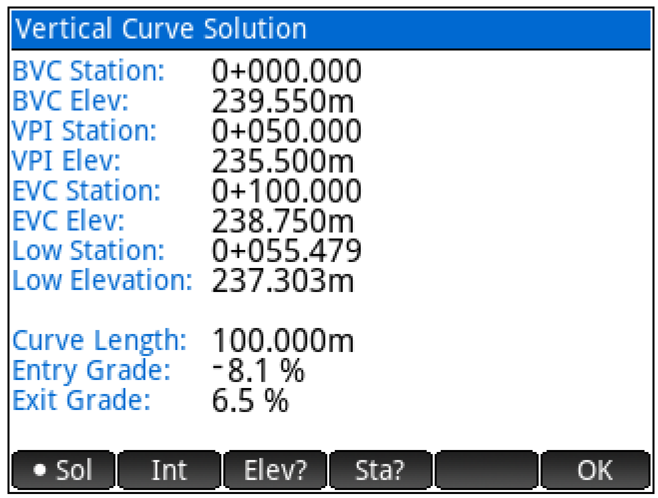
Elevations and Length known

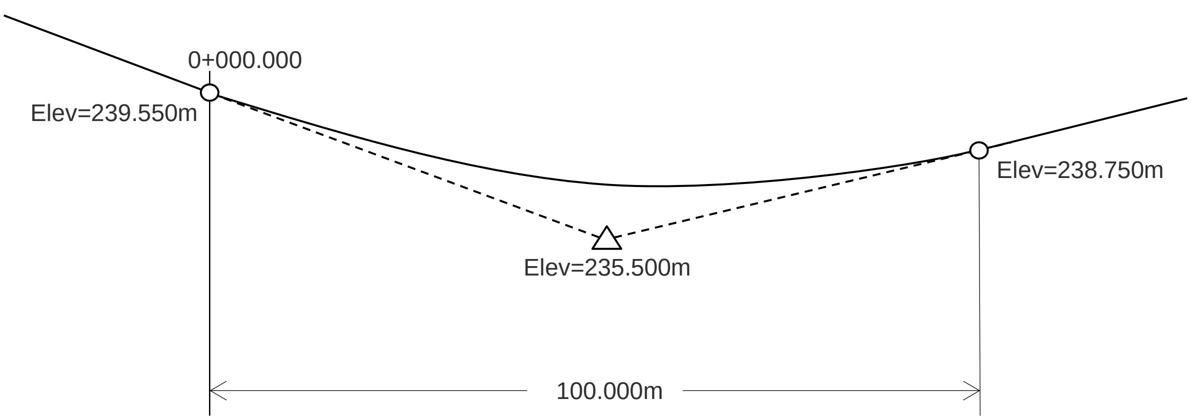
Enter all the required information to solve the curve.

- Choose the point on the vertical curve with a known station (BVC, VPI or EVC)
- Enter the known station for the point
- Enter the vertical curve length
- Enter the BVC elevation
- Enter the VPI elevation
- Enter the EVC elevation



The solution displays the stations and elevations for each the BVC, VPI, EVC and High/Low Point. See the Solution Screen and Calculations section for more information.

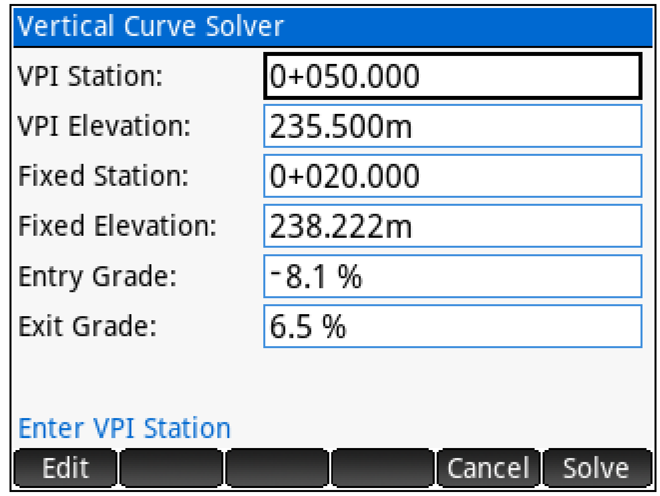




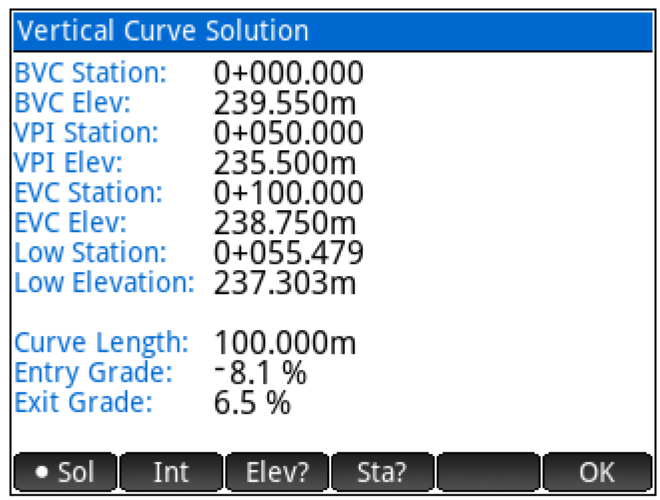
Fixed Point, VPI and Grades known

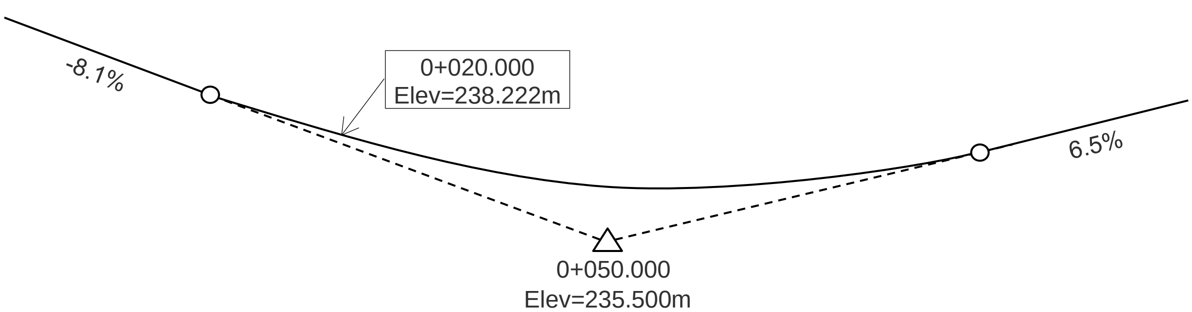
Enter all the required information to solve the curve.

- Enter the VPI station
- Enter the VPI elevation
- Enter the fixed station
- Enter the elevation at the fixed station
- Enter the entry grade
- Enter the exit grade



The solution displays the stations and elevations for each the BVC, VPI, EVC and High/Low Point. See the Solution Screen and Calculations section for more information.

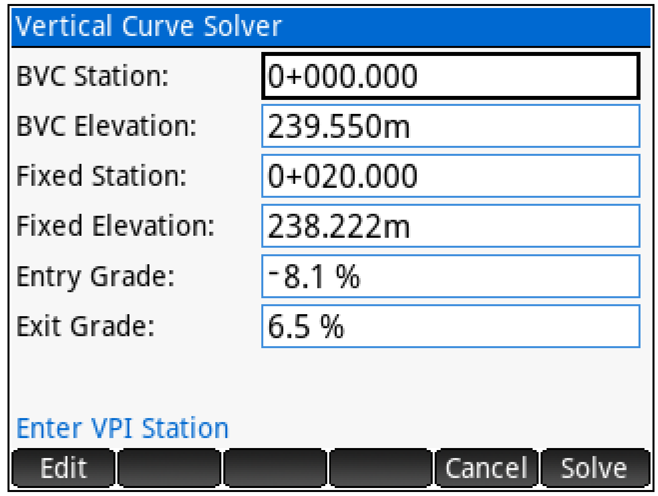




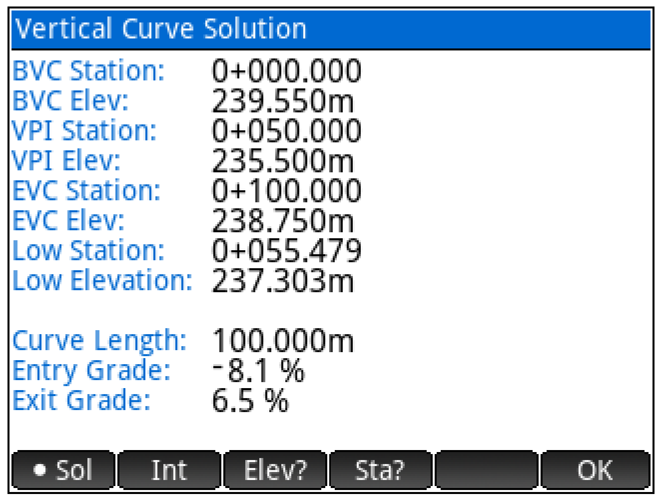
Fixed Point, BVC and Grades known

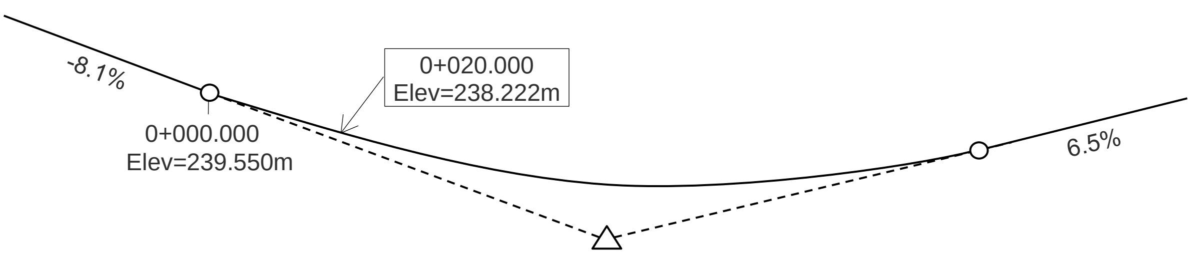
Enter all the required information to solve the curve.

- Enter the BVC station
- Enter the BVC elevation
- Enter the fixed station
- Enter the elevation at the fixed station
- Enter the entry grade
- Enter the exit grade



The solution displays the stations and elevations for each the BVC, VPI, EVC and High/Low Point. See the Solution Screen and Calculations section for more information.

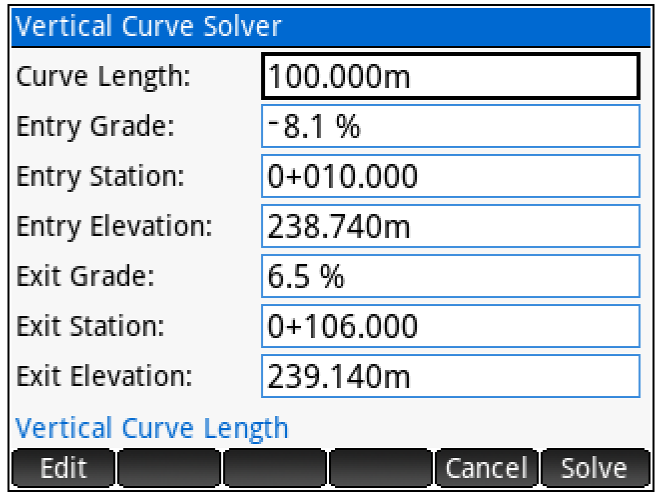




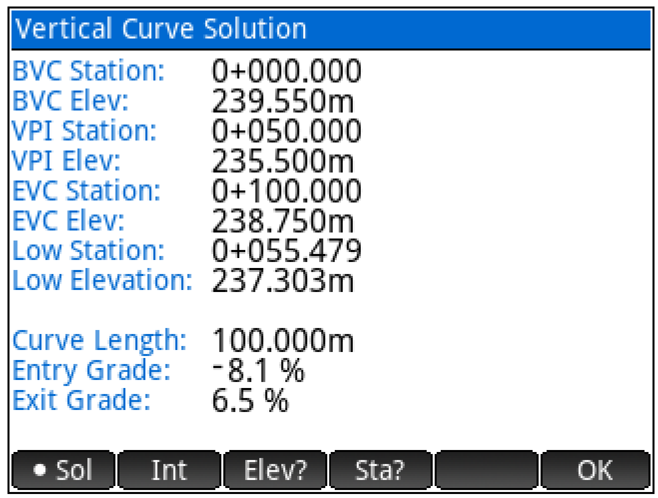
Intersect Slopes from two known points

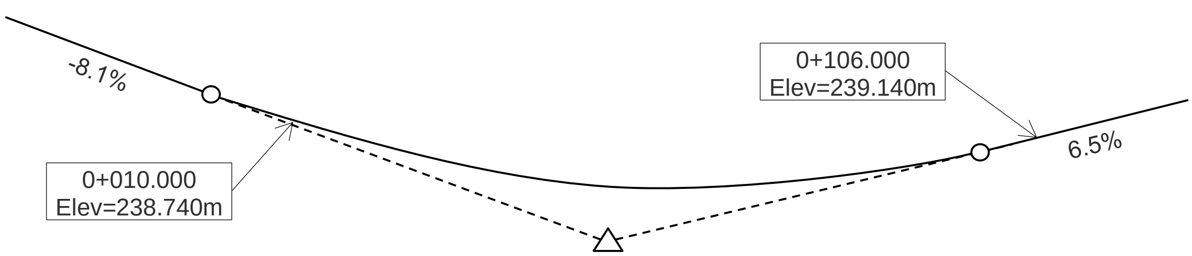
Enter all the required information to solve the curve.

- Enter the curve length
- Enter the entry grade
- Enter a known station on the entry tangent
- Enter the elevation at the known station
- Enter the exit grade
- Enter a known station on the exit tangent
- Enter the elevation at the known station

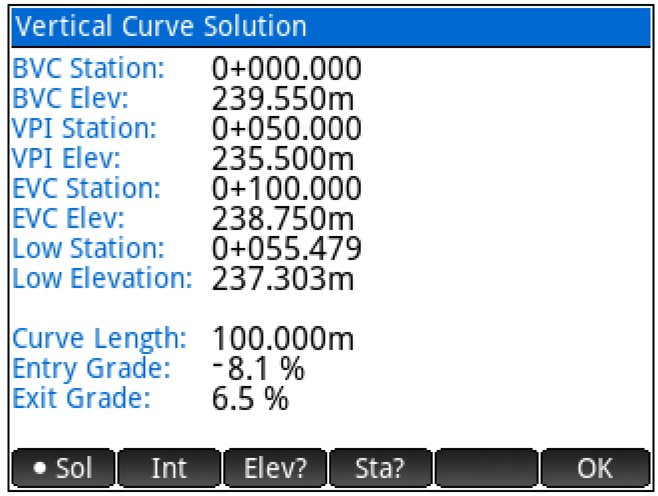


The solution displays the stations and elevations for each the BVC, VPI, EVC and High/Low Point. See the Solution Screen and Calculations section for more information.





Solution Screen and Calculations



For each of the combinations of known parameters to solve a vertical curve; the solution screen displays the unknown solved parameters, and the menu on the solution screen is the same for all combinations, offering the same functionalities:

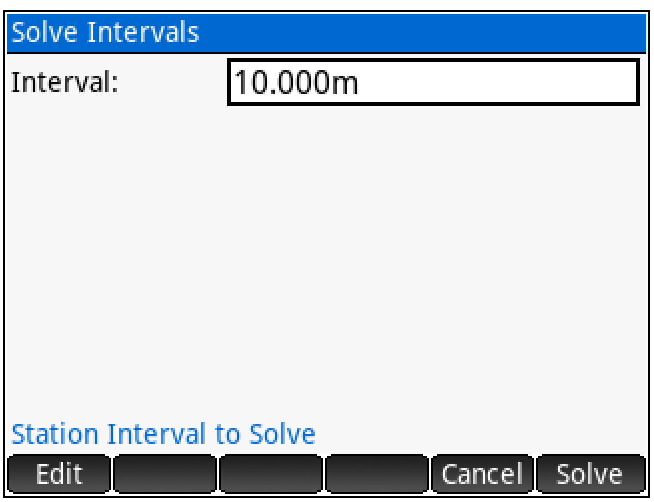
Int Calculate elevations at all stations at a given interval.

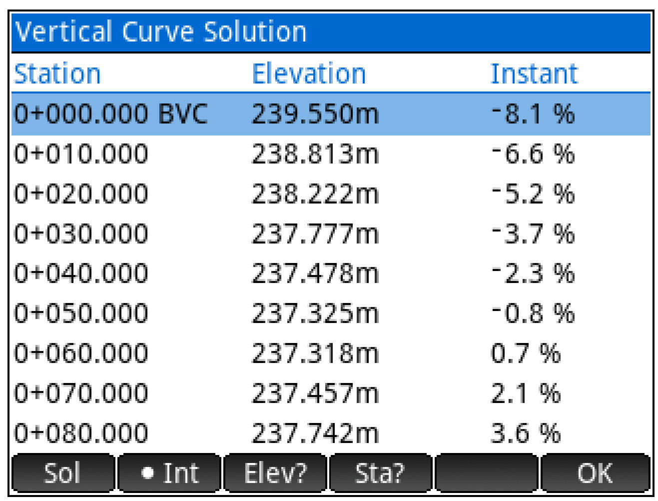
Elev? Calculate elevations on the vertical curve by entering a station.

Sta? Calculate stations on the vertical curve by entering an elevation.

Calculate Intervals

Enter a station interval to solve the elevations and instantaneous grade for each station at the given interval. The BVC and EVC elevations are always solved, regardless of their station. Scroll down to see all the results if they do not fit on one screen.

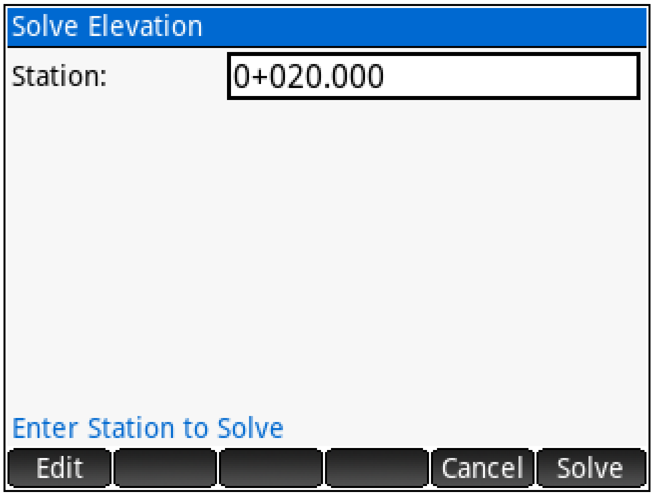


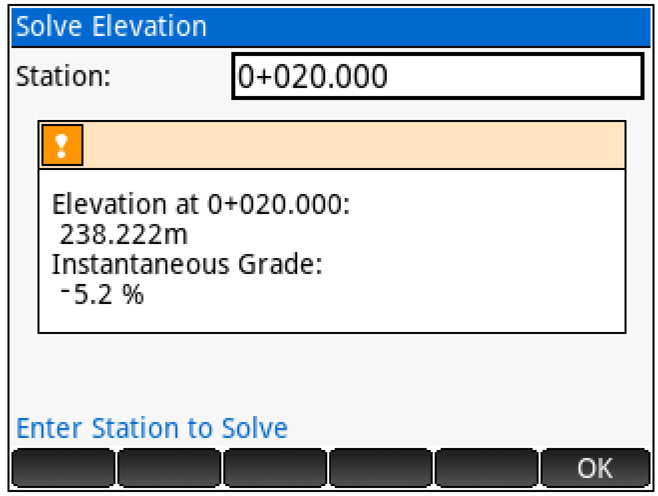


Calculate Elevations

Enter any station to solve its elevation on the vertical curve.

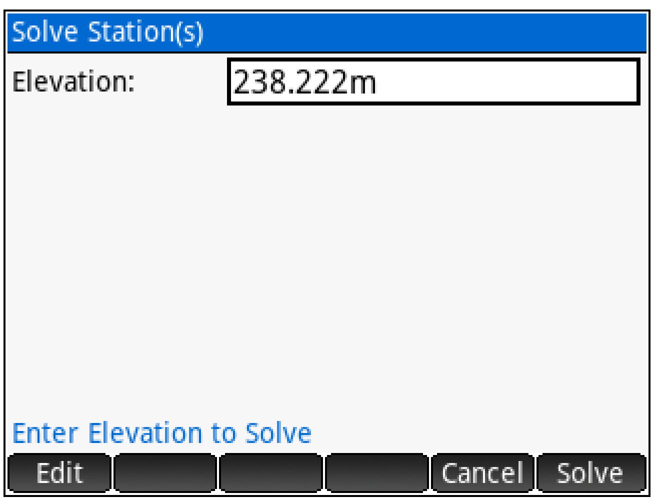
When entering a station lower than the BVC station or greater than the EVC station, a notation will indicate such a case.

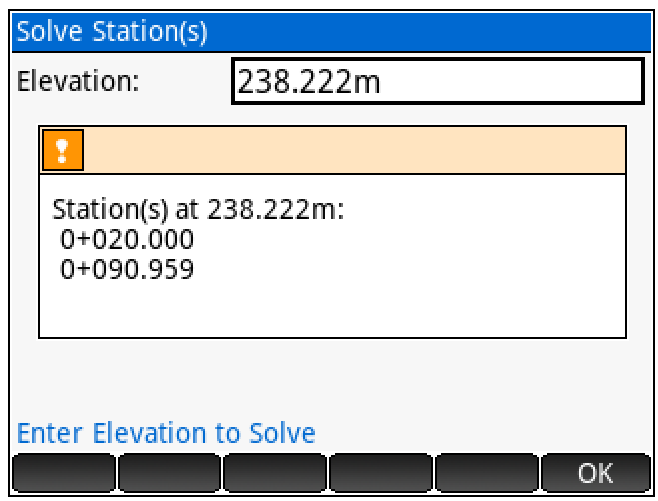




Calculate Stations

Enter an elevation to solve the station(s) on the vertical curve. Both solutions are displayed when two solutions exist. Only stations between the BVC and EVC are solved.

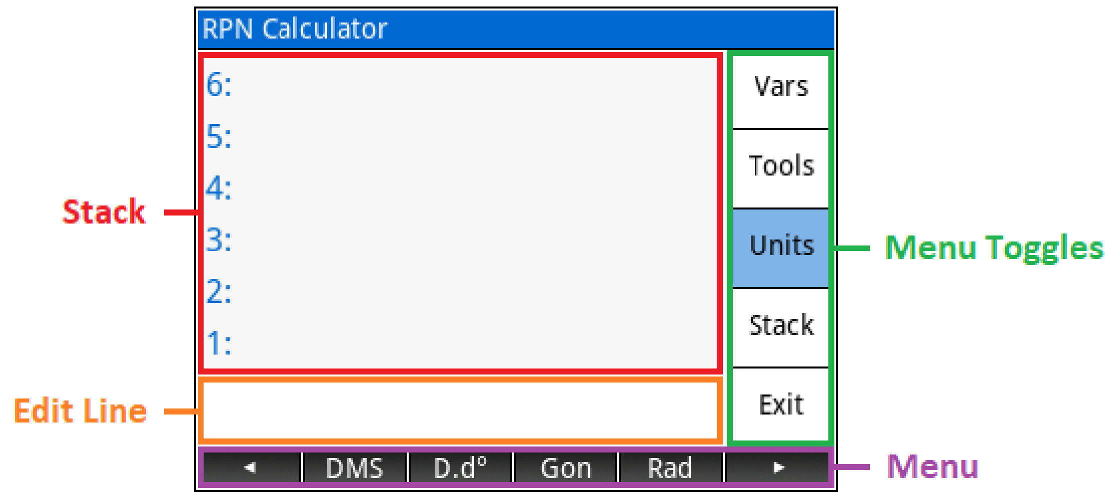




6.4 RPN Calculator

The RPN Calculator is designed for survey calculations with units for distance, angle, area and volume.

Main Interface



Use the **touch screen** to:

- ▶ Select an object on the stack
- ▶ Open the Edit Line
- ▶ Toggle the current menu
- ▶ Execute a menu option

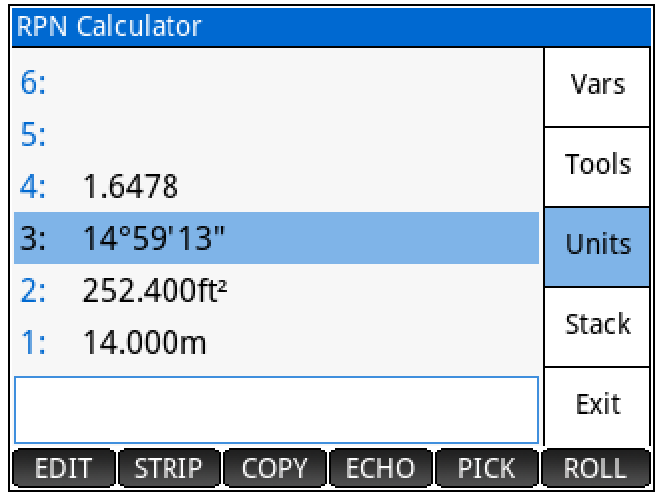
The **Keyboard** keys have common functions assigned:

- ▶ [Enter ≈] to DUP Level 1 of the stack
- ▶ [◀] or [▶] to SWAP Level 1 and 2 of the stack. Moves the cursor when the Edit Line is open.
- ▶ [⌫ Del] to DROP Level 1 of the stack. [Shift] + [⌫ Del] clears the stack.
- ▶ [Esc Clear] to exit the application, cancel the Edit Line, or unselect a stack object.
- ▶ [▲] or [▼] to scroll through the stack. [Shift] + [▲] or [▼] jumps to the top or bottom level of the stack. When no object is selected on the stack, [▼] opens the Edit Line.
- ▶ [Shift] and [+ Ans ;] to UNDO the previous action. Only one level of UNDO is possible.
- ▶ [Vars Chars A] / [Mem B] / [Shift] + [Units C] to toggle the ***Vars*** / ***Tools*** / ***Units*** menus.
- ▶ [Shift] + [EEX Sto▸ P] to store a variable, more details in the ***Vars*** menu section.

Stack Area

The Stack Area displays six levels of the stack. Stack objects can be selected by using the touch screen or the ▲ and ▼ keys. The stack will scroll up and down as required.

When a stack object is selected, the menu will always change to the following options:



EDIT Edit the selected value. When editing is complete, the value remains selected.

STRIP Strip any associated unit from the object.

COPY Copy the object to the Clipboard.

ECHO Echoes the selected object to the Edit Line. When editing is complete, the previous stack selection is no longer selected.

PICK Pick the selected object and copy it to Level 1 of the stack. The object remains selected on the stack.

ROLL Roll the selected object down to Level 1 of the stack. The stack level of the selection is not changed.

Edit Line

The Edit Line displays the value being entered or edited and is also used to display any status or error messages. When the Edit Line is open; the menu updates with the primary angle and distance units to assign to the entered value, and **Cancel** and **OK**. Copy and Paste are available with **Shift** and **View/Copy**, and **Shift** and **Menu/Paste**.

NOTE: It is possible to enter feet, inches, fractions in the specified comma-delimited format. The current distance unit will automatically be applied to the value entered. The unit conversion happens automatically if required.

Menu Toggles

Four different menus are available within the app for specific tasks; the menu toggles change the current menu or group of menus.

Menus

Vars Menu

The ***Vars*** Menu displays all the variables stored on the HP Prime as **HVars**. The first and last menu keys are used to change the page of the menu while the middle four keys show the names of the variables.

◄ | V3 | V2 | V1 | AA | ►

- Tap any of the keys to pop the variable's content onto Level 1 of the stack.
- Press Shift and then tap any of the keys to store the value on Level 1 of the stack into the variable.
- Enable ALPHA mode and then 0 ("") followed by the menu key to quote a variable name. Use the PURGE option from the Tools menu to purge the quoted variable.
- Press Shift + EEX (Sto►) to store a variable. If Level 1 is a string then it will be used as the variable name to store object on Level 2, otherwise prompts for a variable name to store Level 1.
- Type the variable name (without quotes) followed by Enter to recall the variable contents.
- When storing or recalling a variable, any associated units are kept intact (with the exception of the Links distance unit).

Tools Menu

EDIT Edit Level 1 of the stack.

STRIP Strip any associated unit from the object on Level 1 of the stack.

STO Stores the object on Level 2 of the stack into the variable name on Level 1 of the stack. When Level 1 is not a string, then a touchscreen keypad opens to enter a variable name.

PURGE Purges the variable name on Level 1 of the stack from memory. When Level 1 is not a string, then a list of variables is shown, and the variable can be chosen to be purged.

P<>R Toggles between rectangular and polar display modes of vectors.

> Requires a vector on Level 1 of the stack.

>V> Compiles a vector from stack objects or explodes a vector if Level 1 contains a vector.

> To build a vector; Level 1 of the stack needs to be a 2 or 3 to specify the dimension (2D or 3D) and levels above must contain either the rectangular or polar components of the vector.
>
> Exploding a vector results in vector components on the stack and a 2 or 3 on Level 1 of the stack indicating if it was a 2D or 3D vector.

Units Menu

Four pages of the ***Units*** menu exist. The first and last menu keys on each page are used to change the page of the menu. The four menus are

▶ Angle Units	◂	DMS	D.d°	Gon	Rad	▸
▶ Distance Units	◂	m	ft	lks	ch	▸
▶ Area Units	◂	m²	ft²	ha	Ac	▸
▶ Volume Units	◂	m³	ft³	yd³		▸

Units can be assigned to any value as it is typed, is on Level 1 of the stack or is selected on the stack. Unit conversions are single tap if the existing value is unit-less or is of the same type of unit.

Stack Menu

DUP DUPlicate Level 1 of the stack. {… 3 2 1} to {… 3 2 1 1}

SWAP SWAP Level 1 and Level 2 of the stack. {… 3 2 1} to {… 3 1 2}

DROP DROP Level 1 of the stack. {… 3 2 1} to {… 3 2}

OVER Copy OVER Level 2 and place it on Level 1 of the stack. {… 3 2 1} to {… 3 2 1 2}

ROT ROTate the bottom three levels of the stack. {… 3 2 1} to {… 2 1 3}

UNROT UNROTate the bottom three levels of the stack. {… 3 2 1} to {… 1 3 2}

Vector objects

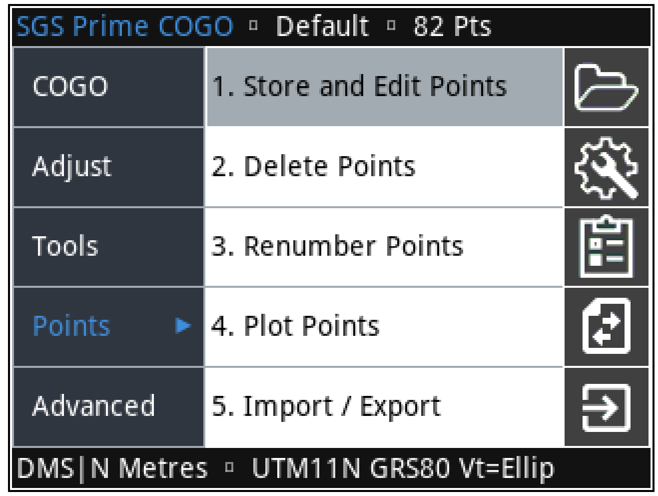
2D and 3D vectors are supported.

- Use Shift + 5 to open the vector entry form where a rectangular or polar vector can be entered.
- Use Shift + × to convert the vector on Level 1 of the stack between polar and rectangular display modes.
- Vectors can be added or subtracted, and multiplied or divided by a scalar.

6.5 Configure Settings

See the User Settings chapter.

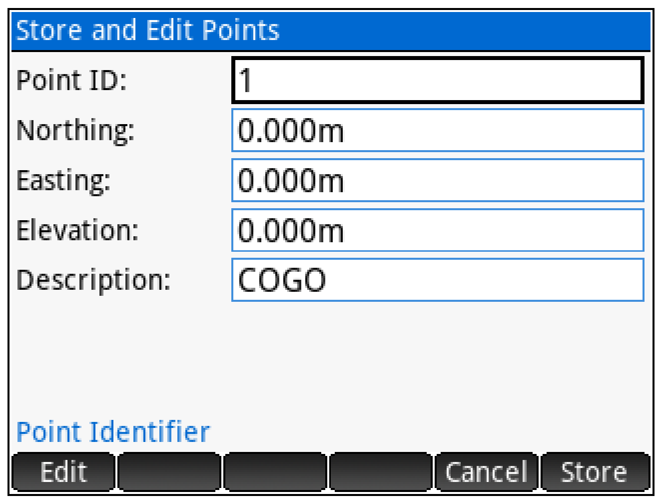
7 Points Menu



- Store and Edit Points – Store new points in the current project database or edit the coordinates and description of an existing point.
- Delete Points – Delete points from the current project database.
- Renumber Points – Renumber a range of points using a New Starting Number scheme or an Additive Number scheme.
- Plot Points – Graphically display the points in the current project. Zoom and pan functionality is available with all points in the current project, or a specified range of points.
- Import / Export – **Import ASCII Points**, **Export ASCII Points** and **Export DXF Points**.

7.1 Store and Edit Points

It is possible to store and edit points in the same input form.



Point ID

Enter a Point ID to edit its coordinates or to store a new point. The coordinate and description fields automatically populate with existing coordinates and description if the point exists.

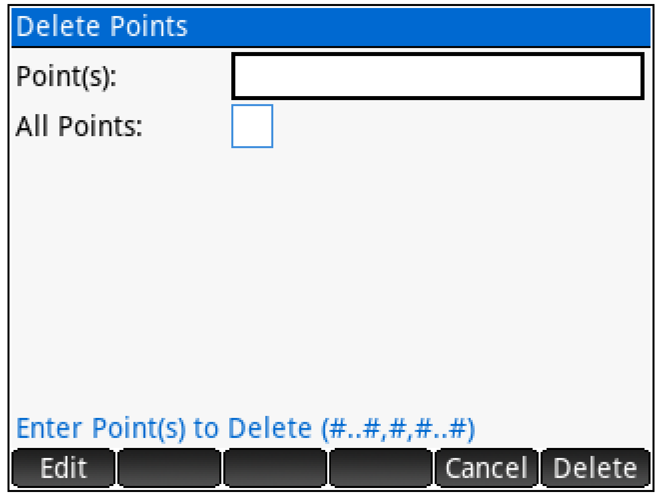
Options while editing this field:

Low Search for the lowest unused point number in the job.

Next Search for the lowest unused point number starting from the current value.

7.2 Delete Points

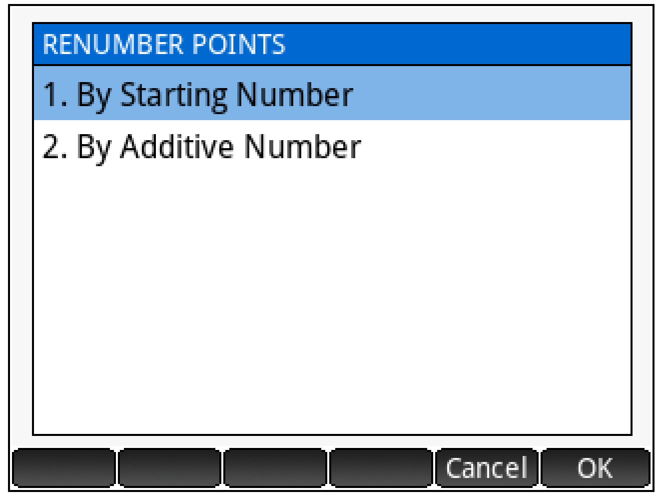
Delete individual points, a range of points or all the points from the current job. To delete individual points or ranges of points, enter points using any of the point numbers input options.



Check the **All Points** checkbox to delete all points.

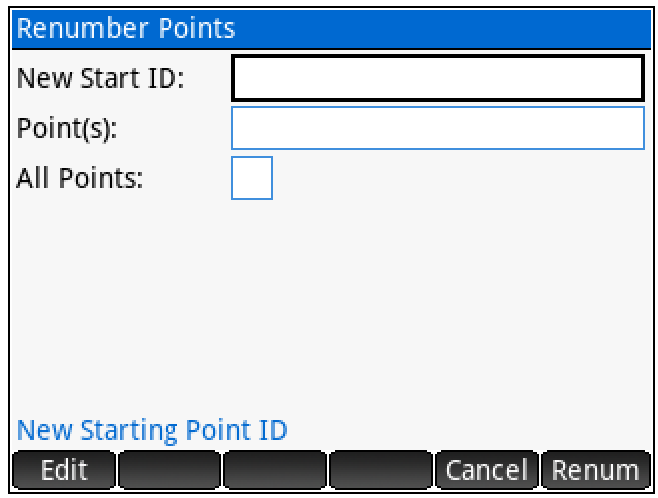
7.3 Renumber Points

Two methods are available for point renumbering. Neither method overwrites conflicting point numbers.



By Starting Number

Enter the New Starting Point ID to use for renumbering. The points' new numbers will begin at this starting number, or in the case where the provided starting number exists, the next available number.

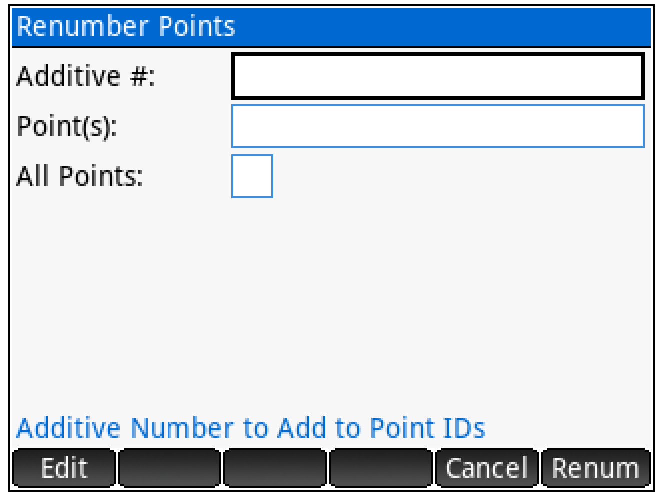


Enter the points to be renumbered using any of the point numbers input options or check the **All Points** checkbox to renumber all the points in the current project.

Some examples to illustrate this method of renumbering points:

1. When a new starting point number is given as 101, and existing points 1 to 4 are to be renumbered, Point 1 becomes 101, 2 becomes 102, etc.
2. Same as above but in fact there already exists a Point 101, then Point 1 becomes 102, 2 becomes 103, etc.
3. Same as above but there is no Point 3, then 1 becomes 101, 2 becomes 102, and 4 becomes 103.

By Additive Number



Enter an additive number to add to existing point numbers as a renumbering method. In the case where this added number creates a point number that already exists, the next available number will be used.

Enter the points to be renumbered using any of the point numbers input options or check the **All Points** checkbox to renumber all the points in the current project.

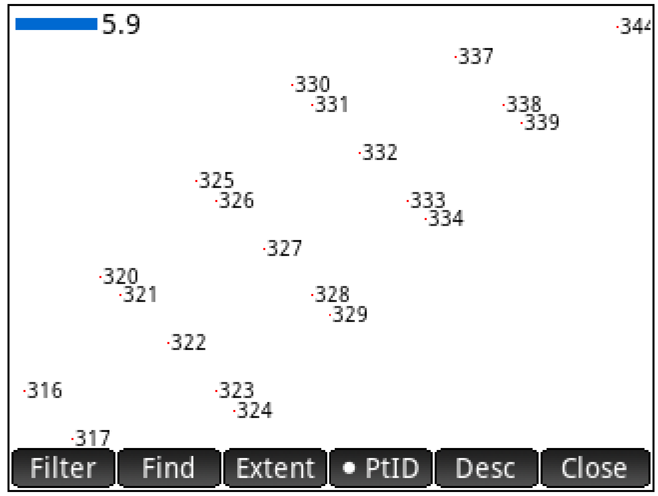
Some examples to illustrate this method of renumbering points:

1. When an additive number is given as 100, and existing points 1 to 4 are to be renumbered, Point 1 becomes 101, 2 becomes 102, etc.
2. Same as above but in fact there already exists a Point 101, then Point 1 is NOT renumbered, 2 becomes 102, etc.
3. Same as above but there is no Point 3, then 1 becomes 101, 2 becomes 102, and 4 becomes 104.

Always ensure that the range of numbers you wish to use are not already in use.

7.4 Plot Points

Plot Points by default will display all points in the current project. The initial map view is zoomed to fit all the points on the screen. Point range filters can be applied to limit the points that are displayed.



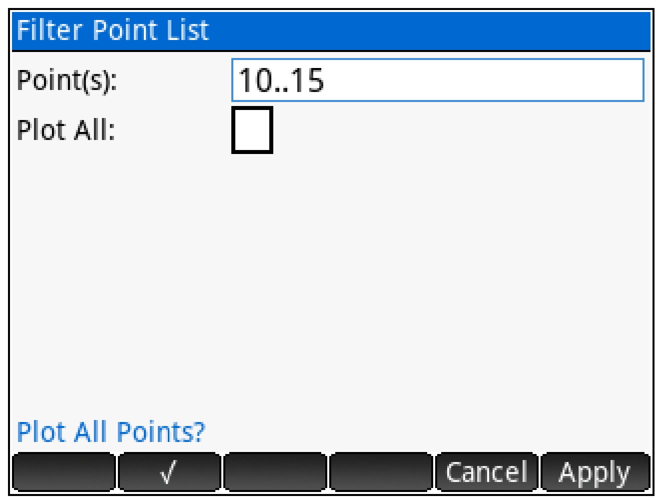
Keyboard and touch navigation are possible.

Using Touch

- ▶ Drag to Pan
- ▶ Pinch to Zoom
- ▶ Tap to Center on the tap location

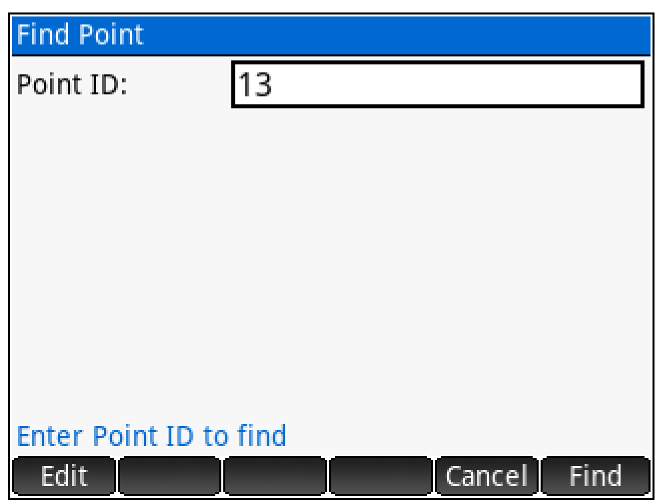
Using the Keyboard

- ▶ Cursor keys to pan ▲/▼ and ◀/▶
- ▶ + and − to Zoom



Using the Menu

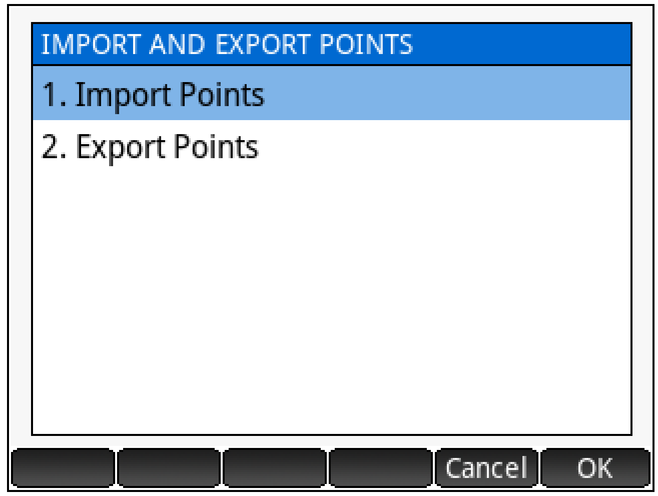
Filter	Set a point range filter
Find	Find a specific point and center on it
Extent	Zoom Extents
• PtID	Toggle to display the Point ID
• Desc	Toggle to display the Point Description
Close	Close the Plot Points screen



Access Plot Points from any input form or the main menu by using the Plot Setup key on the keyboard.

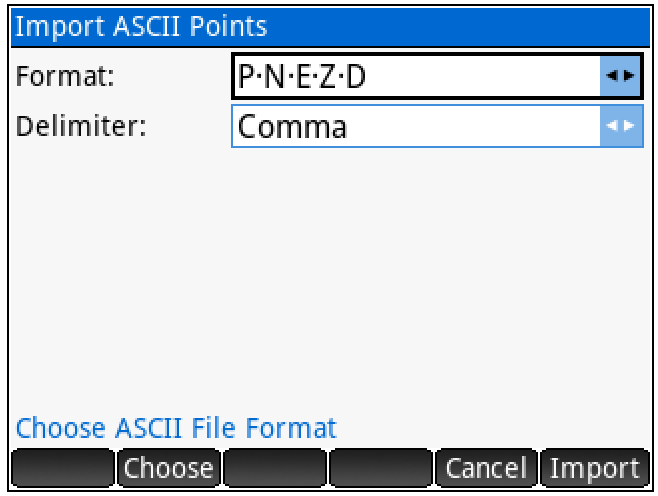
7.5 Import/Export

Import and Export files containing Point data from/to the App Files on the Prime calculator.



Import Points

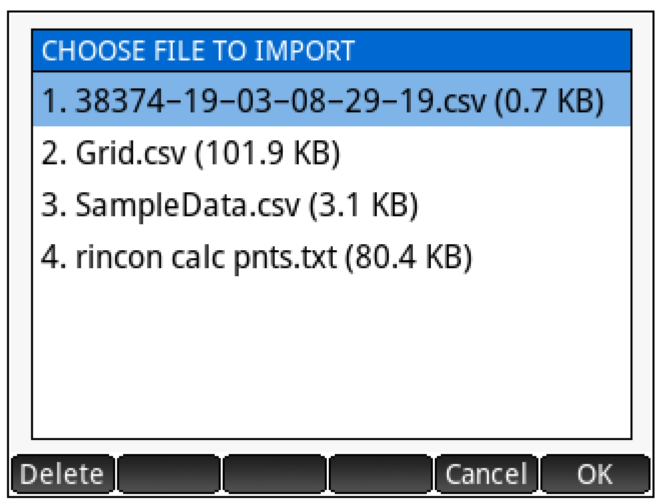
Import a delimited ASCII points file into the current project database. The file must be present within the App Files section of the **SGS Prime COGO** app and must have one of the following extensions:



- ✓ .asc **ASC**ii text file
- ✓ .csv **C**omma **S**eparated **V**alues
- ✓ .txt **T**e**XT** file
- ✓ .pts STAR*NET point coordinates
- ✓ .gnd STAR*NET ground coordinates

First, select the format and delimiter of the ASCII file you wish to import. NOTE: THIS STEP IS CRITICAL TO ENSURE THAT THE DATA IS STORED CORRECTLY.

Select an ASCII file from the list to import.



The selected file is parsed line by line and the coordinates are stored if valid data is found. Point number conflicts result in a screen showing the coordinate differences and ***YES***/***NO***/***YES TO ALL***/***NO TO ALL*** options to overwrite the existing point(s). The import progress is displayed while the file is processed, and the total number of points added or modified in the project database is reported when import is completed.

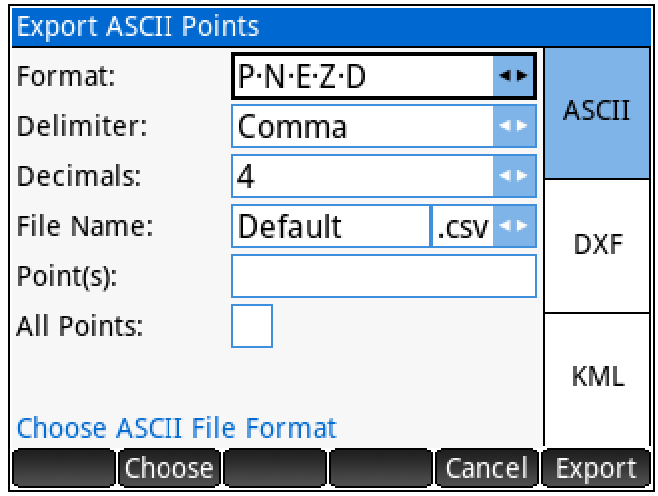
During Import, lines starting with the # character are ignored.

Export Points

Points can be exported in ASCII, DXF or KML format. Each of the three options are available as a page within the main input form.

Export ASCII Points

Write a delimited ASCII points file of points in the current project for archiving or importing into CAD software on your PC, or any number of other possible uses.



Select the ASCII file format, the delimiter and the number of decimals to export.

Enter a file name to save the exported points and choose the file extension. By default; the file name will be populated with the current project name, and the file extension will be set to the previously used extension.

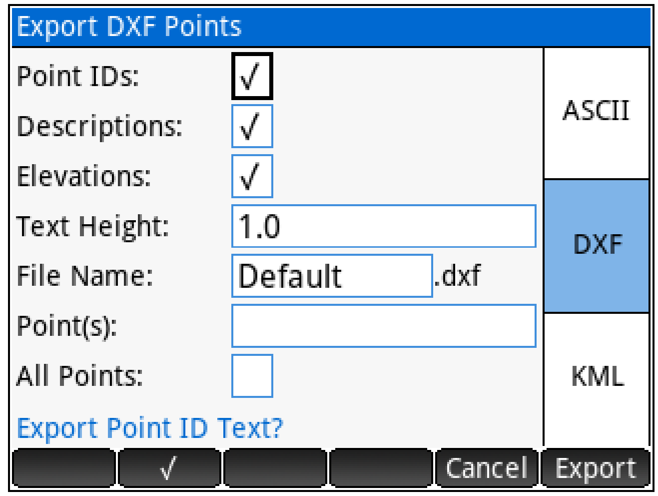
Enter the points you wish to export using any of the point numbers input options, or optionally select **All Points** to export all points.

The export progress is displayed while the program is working, and the total number of points exported is displayed when complete.

When a file name conflict is encountered, the option to overwrite the existing file is given.

NOTE: The available number of decimals for selection ranges from 0 to 8, however the calculator is capable of a maximum of 12 digits for real numbers. The actual number of decimals may not be possible when point coordinates are stored in higher numerical ranges.

Export DXF Points



Write a DXF file (ASCII format) of points in the current project to open with CAD software on your PC.

Select the items to export. Point nodes are always exported, but the text attributes of the points are optional.

Specify the text height for the text attributes. By default, for metric projects the text height will be suggested as 1.0, and for imperial projects the text height will be suggested as 3.0.

Enter a file name to save the exported points. By default; the file name will be populated with the current project name.

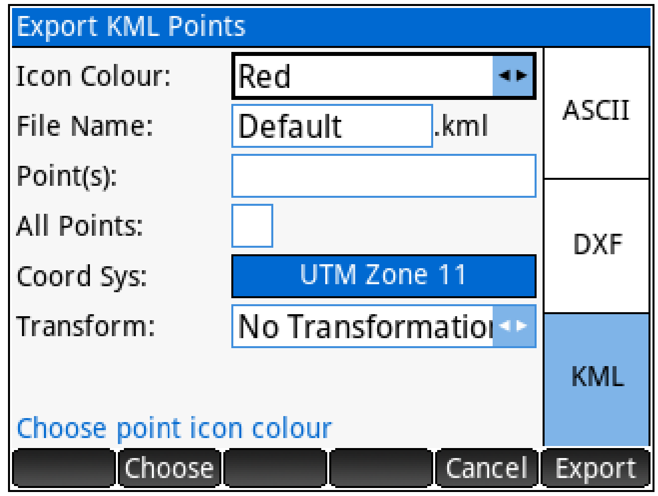
Enter the points you wish to export using any of the point numbers input options, or optionally select **All Points** to export all points.

The export progress is displayed while the program is working, and the total number of points exported is displayed when complete.

When a file name conflict is encountered, the option to overwrite the existing file is given.

The point node and text entities will be created using the DXF File Layers settings.

Export KML Points

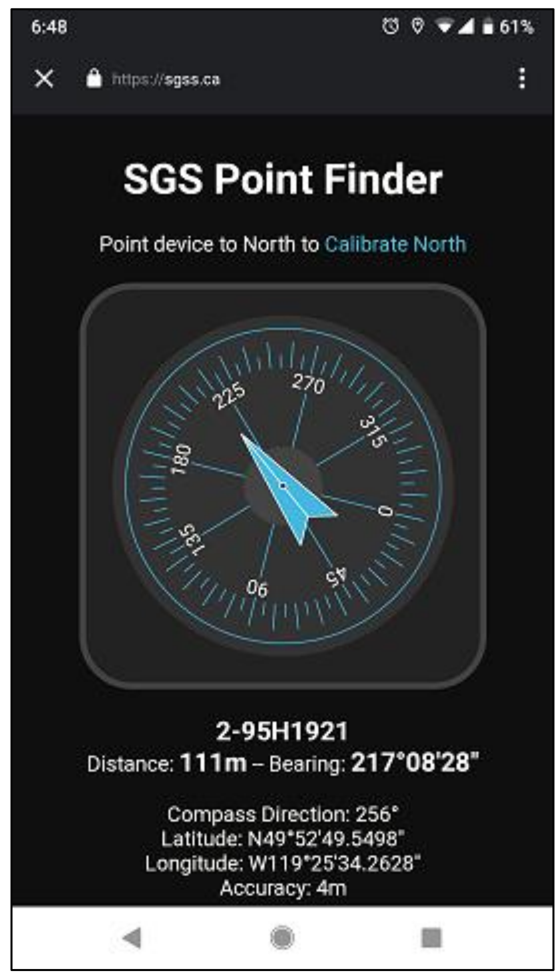


Write a KML file of points in the database so that they can be viewed in Google Earth (or other GIS related software).

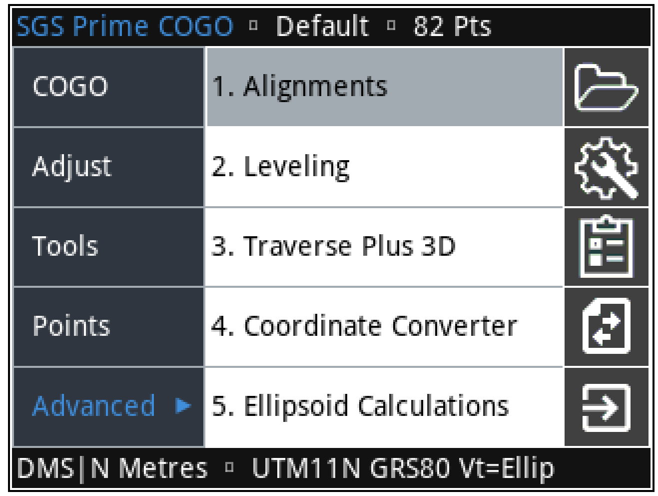
Select the icon colour for the icons that the points will be displayed with in Google Earth.

Ensure the correct coordinate system is set, and if necessary, set a transformation to transform the exported points. Available options for transformations include ***Ground to Grid*** and ***3 or 7 Parameter*** transformations.

HINT: Open the KML in Google Earth on your mobile device to take advantage of the "Find" feature which will use the mobile device geo-location to guide you to the point.

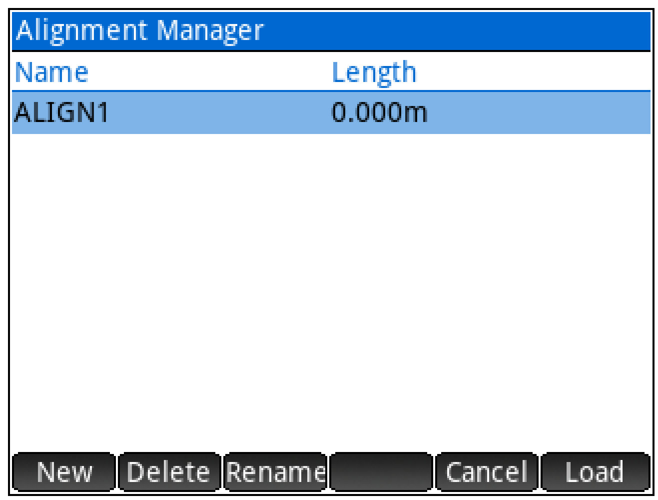


8 Advanced Menu



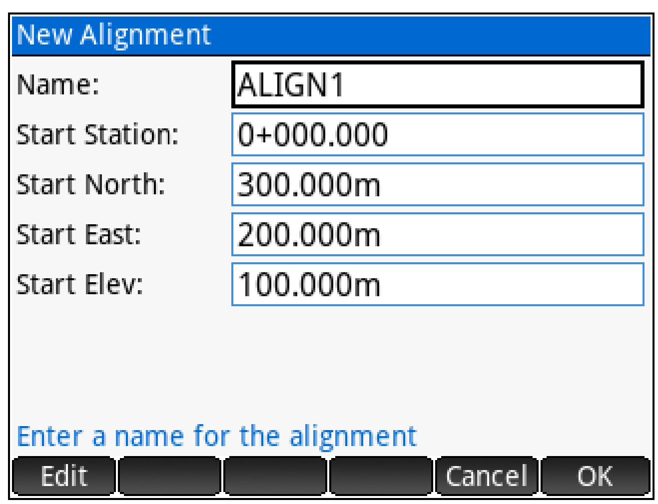
- Alignments – Create complex 3D alignments and perform various calculations.
- Leveling – Enter and edit level observations, export and perform calculations.
- Traverse Plus 3D – Calculate coordinates from field notes, simulate data collection and field calculation procedures.
- Coordinate Converter – Convert coordinates between grid, geodetic and cartesian. Convert from one grid projection to another grid projection using 3 or 7 parameter transformations. Convert between grid and ground based on provided parameters.
- Ellipsoid Calculations – Calculate DIRECT and INVERSE Computations on the ellipsoid.

8.1 Alignments



SGS Prime COGO includes an Alignments program to manage multiple complex 3D alignments. Each alignment consists of horizontal, vertical and cross section components. The horizontal centerline of the alignment is the only mandatory definition for any alignment. Various calculations are possible with alignments.

Alignment Manager



The Alignment Manager lists all the alignments created, and allows the user to create new alignments, delete existing alignments, or to load an alignment for editing, review and calculations. Available Options:

New – Create a new Alignment.

Delete – Delete the selected alignment

Rename – Rename the selected alignment.

Load – Load the selected alignment.

Defining an Alignment

The interface features 5 tabs on the right edge of the screen; each tab allowing the user to edit different components of the alignment. Within each tab, the defined segments are displayed, and the menu provides access to all the functionality. The menu is common across the tabs.

Edit — Edit the selected segment.

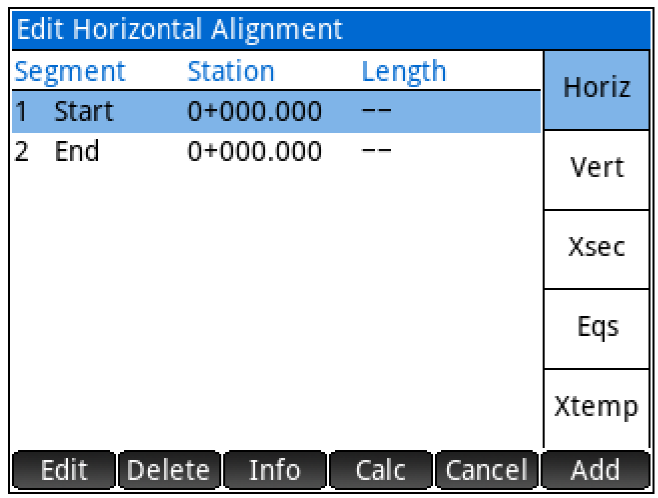
Delete — Delete the selected segment.

Info — Display more information about the selected segment.

Calc — Perform Calculations with alignment data.

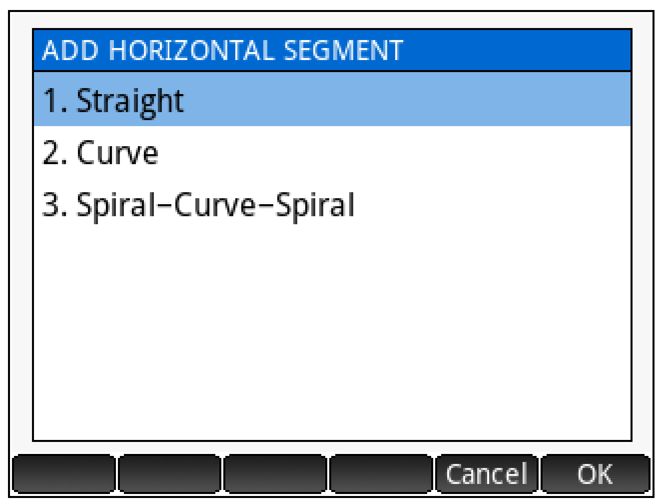
Add — Add a new element to the current active component.

Horizontal Alignment



A new alignment is created by default to have a starting station of 0 (displayed as 0 or 0+00 or 0+000 depending on the user setting) and starting coordinates of 0,0. These parameters can be edited at any time; the entire horizontal alignment is updated to reflect any starting point station and coordinates changes.

Add Horizontal Segment



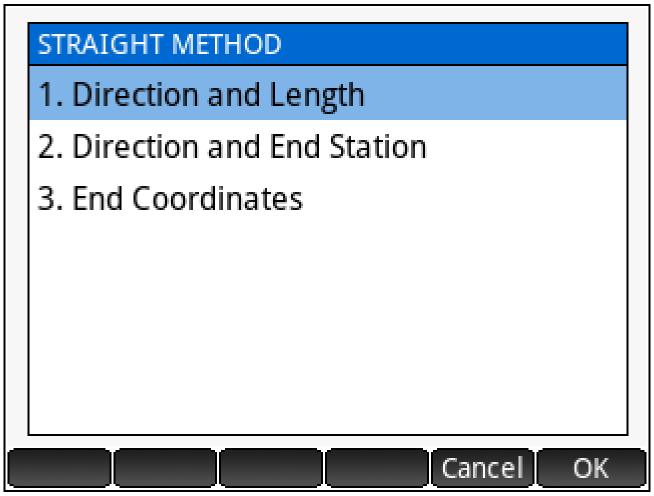
With the Horizontal Alignment tab active, use the Add button or Enter to add a new horizontal segment. All segments are added to the end of the list of already defined segments. The end coordinates of the existing alignment are used as the starting coordinates for the new segment. The available options for horizontal segments are:

- Straight
- Curve, and
- Spiral-Curve-Spiral.

Horizontal Straight

Horizontal Straight segments may be defined using one of three methods:

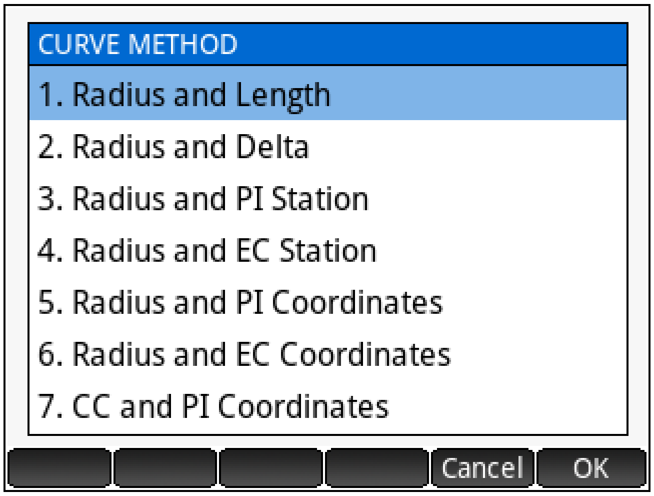
1. Direction and Length
2. Direction and End Station, or
3. End Coordinates



Horizontal Curve

Horizontal Curve segments may be defined using one of eight methods:

1. Radius and Length
2. Radius and Delta
3. Radius and PI Station
4. Radius and EC Station
5. Radius and PI Coordinates
6. Radius and EC Coordinates
7. CC and PI Coordinates
8. CC and EC Coordinates

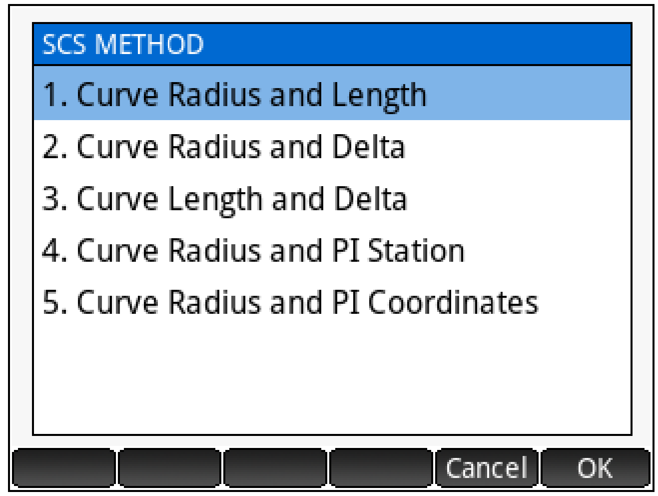


NOTES: Methods 1-4 also require the “Tangent In” direction, which is automatically calculated from the previous element. Methods 1-6 also require the curve direction, left or right. For all radius fields, a “Degree of Curve” option is available to calculate the radius from the Degree of Curve, arc or chord definition.

Horizontal Spiral-Curve-Spiral

Horizontal Spiral-Curve-Spiral segments may be defined using one of five methods:

1. Curve Radius and Length
2. Curve Radius and Delta
3. Curve Length and Delta
4. Curve Radius and PI Station
5. Curve Radius and PI Coordinates

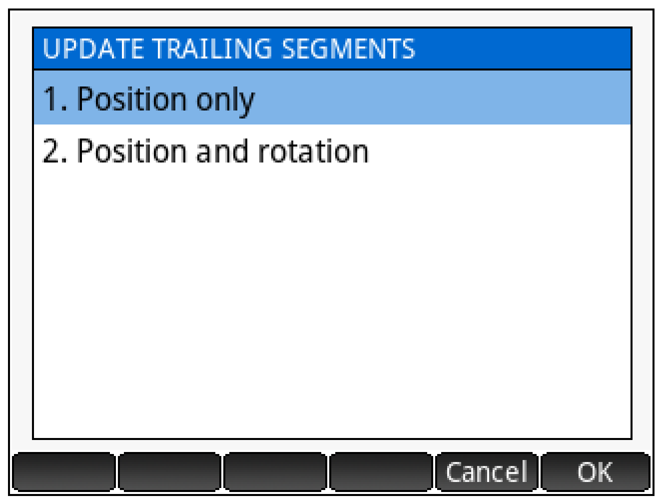


NOTES: The curve radius refers to the radius of the circular curve portion. PI station and coordinates refer to the PI of the transition curve, not the circular portion. All methods require the “Tangent In” direction, which is automatically calculated from the previous element. All methods require the curve direction, left or right. For all radius fields, a “Degree of Curve” option is available to calculate the radius from the Degree of Curve, arc or chord definition.

<u>Edit Horizontal Segment</u>

Touch **Edit** to edit the selected horizontal segment. For each segment type, straight, curve or SCS, the same options are available as when adding a new segment. The current values are automatically inserted into the input form regardless of which method is chosen.

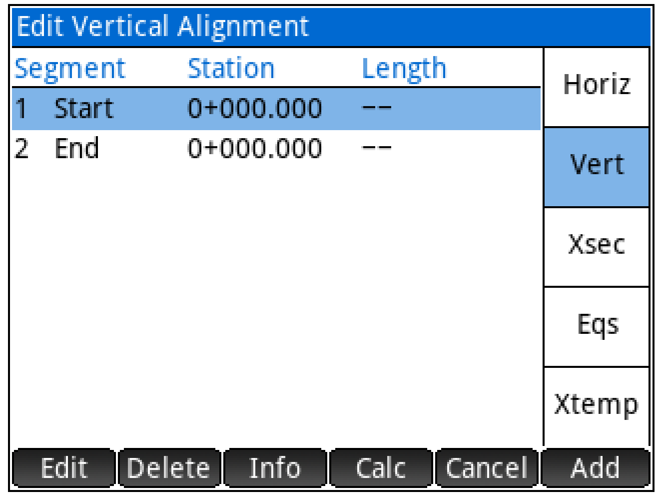
When edits are made to a segment, the segment itself is updated, and any segments following the edited segments are also updated. A prompt allows the user to choose whether to update the position only, or the position and rotation of any trailing segments.



<u>Delete Horizontal Segment</u>

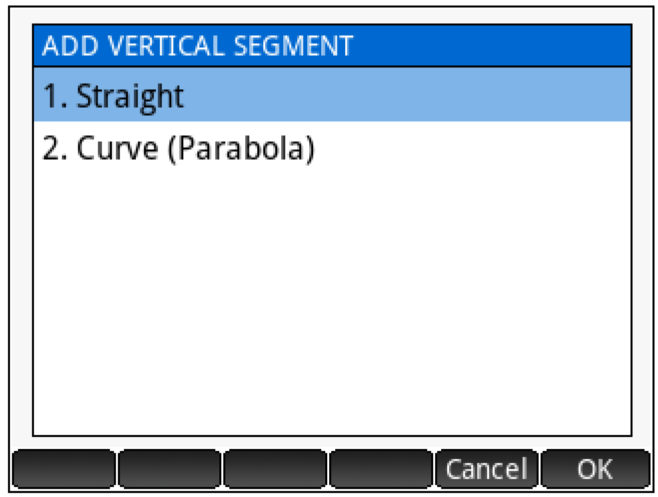
Touch **Delete** to delete the selected horizontal segment. When a segment is deleted, all segments following the deleted segment are shifted to join the segment preceding the deleted segment. Where applicable; the option to update position or position and rotation is presented.

Vertical Alignment



Generally, the vertical alignment is defined after the horizontal alignment and the extents of the vertical alignment match the horizontal alignment, however a vertical alignment may start and end within or outside the parameters of the horizontal alignment. By default, the vertical alignment is defined to start at Station 0 and Elevation 0. These parameters may be edited at any time.

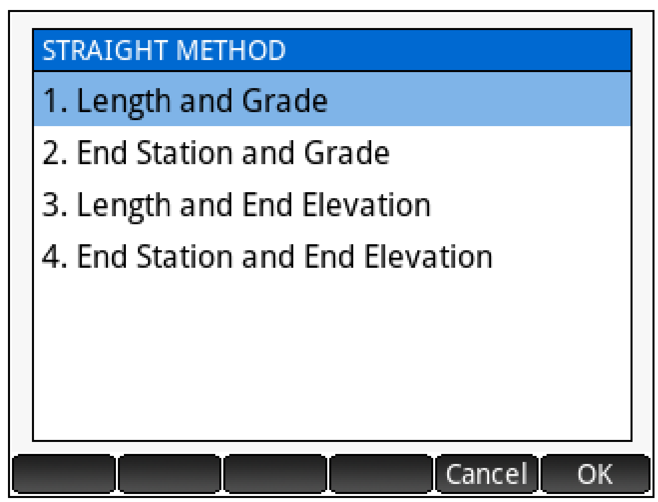
Add Vertical Segment



With the Vertical Alignment tab active, use the Add button or Enter to add a new vertical segment. All segments are added to the end of the list of already defined segments. The end elevation of the existing vertical alignment is used as the starting elevation for the new segment. The available options for vertical segments are:

- Straight, or
- Curve (Parabola)

Vertical Straight

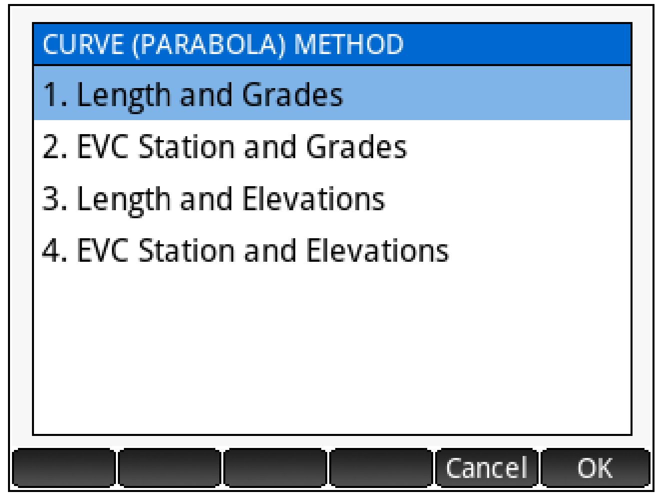


Vertical Straight segments may be defined using one of four methods:

1. Length and Grade
2. End Station and Grade
3. Length and End Elevation
4. End Station and End Elevation

NOTES: For each method, the length or end station field is automatically set to match the end of the horizontal alignment. Grade values are automatically determined from the preceding segment.

Vertical Curve (Parabola)



Vertical Curve segments may be defined using one of four methods:

1. Length and Grades
2. EVC Station and Grades
3. Length and Elevations
4. EVC Station and Elevations

NOTES: For each method, the length or end station field is automatically set to match the end of the horizontal alignment. Entry grade values are automatically determined from the preceding segment.

Edit Vertical Segment

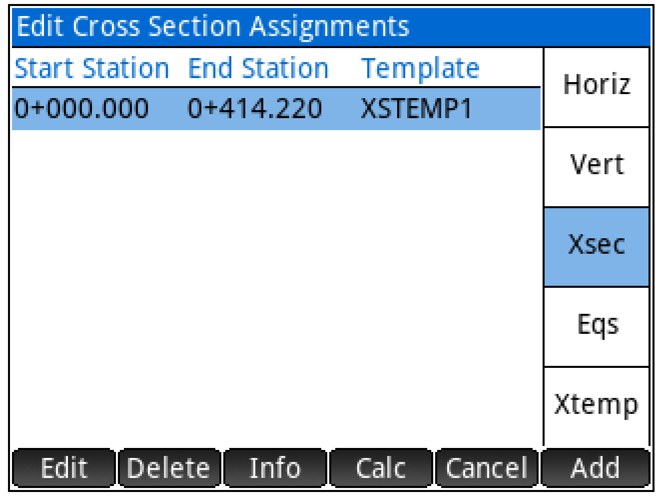
Touch **Edit** to edit the selected vertical segment. For each segment type, the same options are available as when adding a new segment. The current values are automatically inserted into the input form regardless of which method is chosen.

When edits are made to a segment, the segment itself is updated, and any segments following the edited segments are also updated by moving its start/end stations to keep a continuous vertical alignment without overlaps or gaps.

Delete Vertical Segment

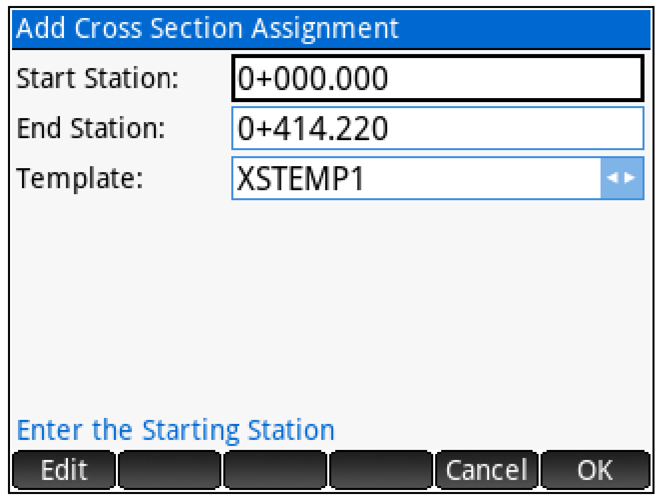
Touch **Delete** to delete the selected vertical segment. When a segment is deleted, all segments following the deleted segment are shifted to join the segment preceding the deleted segment.

Cross Section Assignments



Cross section assignments require a cross section template, which can be created from the bottom-most tab labeled “Xtemp”. Cross section assignments are dependent on the vertical alignment. When a vertical alignment is not defined for a station, the cross-section assignment will be ignored for the station when performing any calculations.

Add Cross Section Assignment



With the Cross-Section Assignment tab active, use the Add button or Enter to add a new assignment.

To add a new assignment; specify the start and end station for the assignment and choose a pre-defined template to assign to the range of stations.

Assignments are chained together, therefore a second or subsequent assignment will only allow the end station to be edited.

Edit Cross Section Assignment

Touch Edit to edit the selected assignment. The current values are automatically inserted into the input form.

When edits are made to an assignment, the assignment itself is updated, and any assignments following the edited assignment are also updated by moving its start/end stations to keep a continuous chain without overlaps or gaps.

Delete Cross Section Assignment

Touch Delete to delete the selected assignment. When an assignment is deleted, all assignments following the deleted assignment are shifted to join the assignment preceding the deleted assignment.

Station Equations

Station equations are used to change the stationing at key points, often where the alignment meets another alignment. A station equation consists of a Station Back and Station Ahead. The Station Back is the chainage of the alignment up to that point, and the Station Ahead is the chainage that is adopted moving ahead.

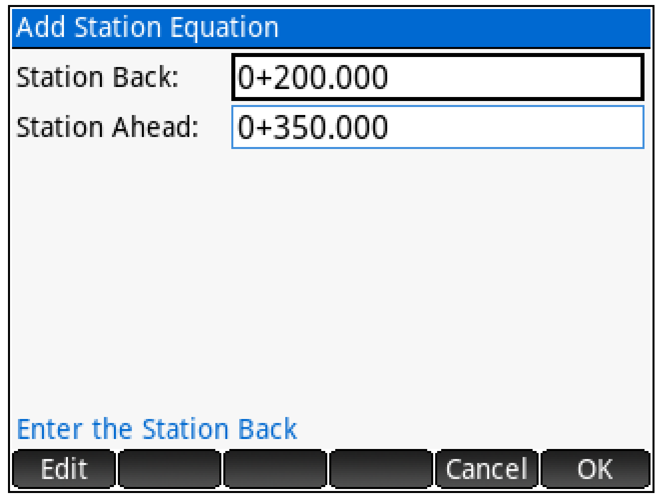
NOTE: Station Equations should be defined first if other components of the alignment will be defined with the modified stationing.

Add Station Equation

With the Station Equation tab active, use the **Add** button or **Enter** to add a new equation.

To add a new equation, specify the station back and station ahead.

Equations should be entered in sequence if multiple equations exist. It is up to the user to ensure the order and definition is correct. Once created, station equations will impact stationing input and output.



Edit Station Equation

Touch **Edit** to edit the selected equation. The current values are automatically inserted into the input form.

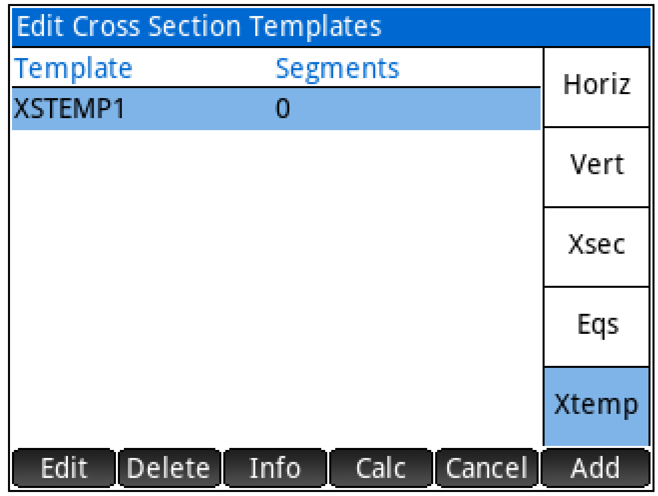
Only the selected equation is impacted, there is no relationship between separate equations.

Delete Cross Section Assignment

Touch **Delete** to delete the selected equation. No changes will occur to any remaining equations.

Cross Section Templates

Cross section templates are used to define cross sections of alignments and can be re-used unlimited times once created. The cross-section template manager lists all the templates created. New templates can be created, and existing templates can be deleted or edited. The menu provides access to the operations described below.



Add Cross Section Template

With the Cross-Section Template tab active, use the Add button or Enter to add a new template.

A name is required to create a new template.

Edit Cross Section Template

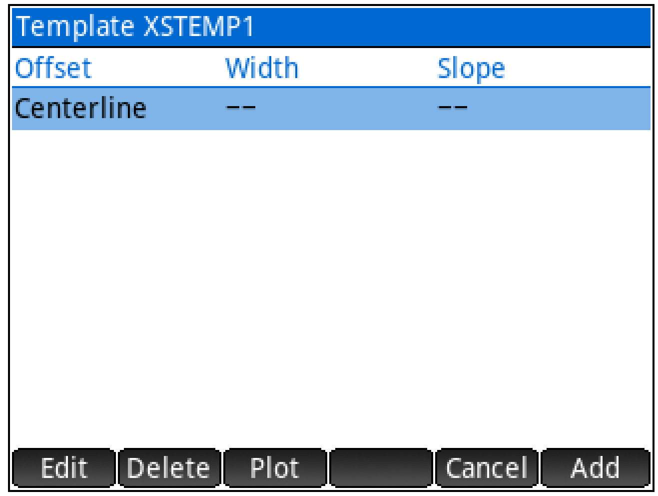
Touch Edit to edit the selected cross section template. The Template Editor opens to edit the template.

Delete Cross Section Template

Touch Delete to delete the selected template. It is not possible to delete a template currently assigned to an alignment.

Template Editor

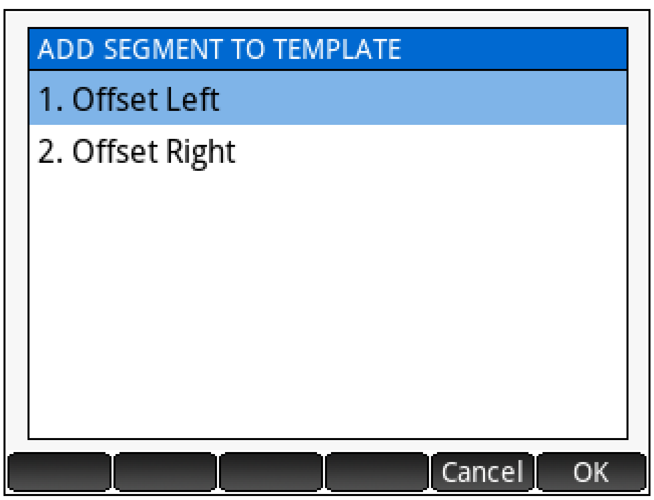
The Template Editor opens to define and edit the template. Templates are created by adding offsets to the left and right of centerline.

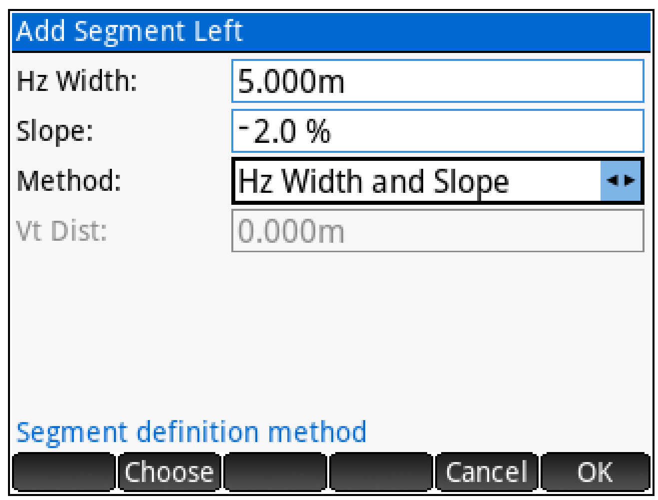


Add Offset Segment

Use the Add button or Enter to add a new offset to the template. Offsets are created from centerline out; each new offset being added to the left-most or right-most extreme of the template.

When adding a new offset segment, first choose whether to add an offset left or right, then enter the parameters to define the offset. The offset definition method can be set to horizontal width and slope, or horizontal width and vertical distance.





Edit Offset Segment

Touch Edit to edit the selected offset segment. The current values are automatically inserted into the input form for editing.

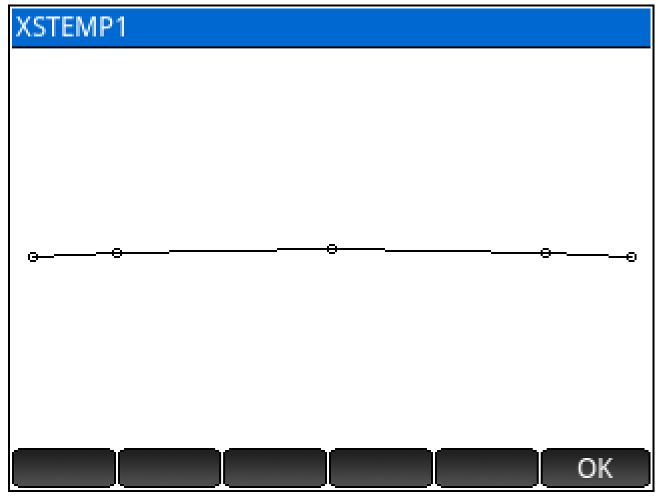
When edits are made to a segment, the segment itself is updated, and any segments outward of the edited segment are also updated by moving its offsets to keep a continuous cross section without overlaps or gaps.

Delete Offset Segment

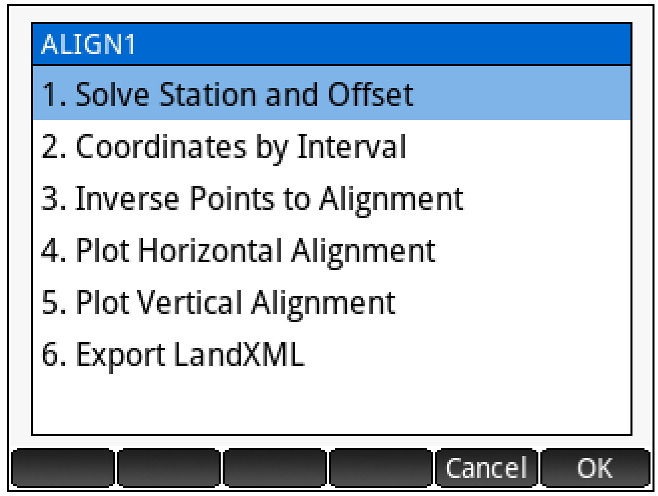
Touch **Delete** to delete the selected offset segment. Only the left-most or right-most segments may be deleted.

Plot Template

Touch **Plot** to plot the template cross section.



Alignment Calculations

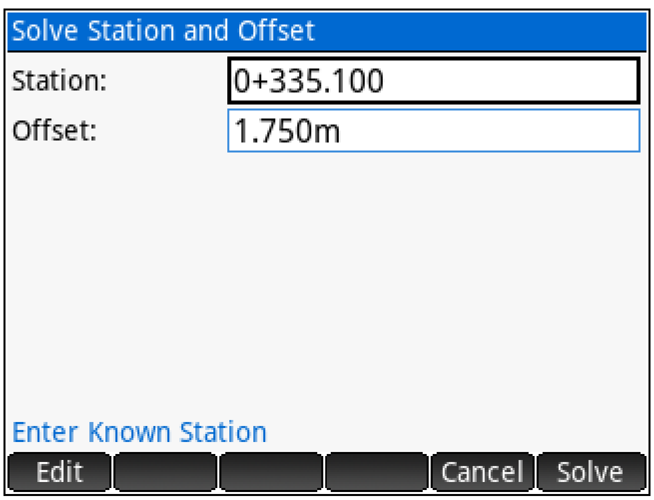


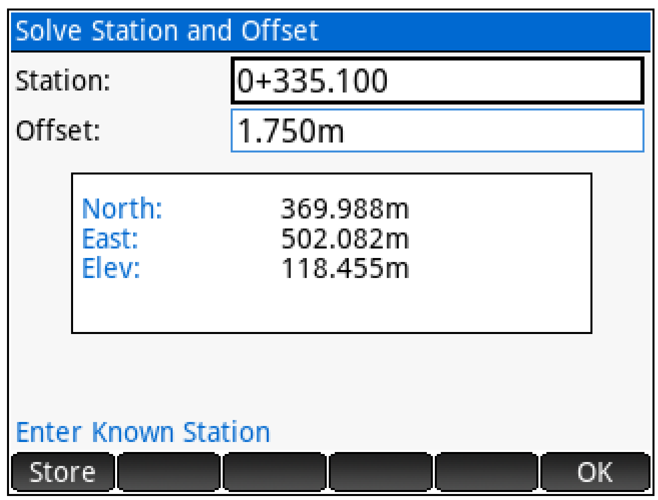
When an alignment has been defined, the alignment definition can be used for:

- Solve Station and Offset – By entering any station and offset along the alignment, the 3D coordinates of the point are solved.
- Coordinates by Interval – Specify a station interval to calculate 3D points at each interval along the alignment.
- Inverse Points to Alignment – Calculate the station, offset and cut/fill of any point in the current project relative to the alignment.
- Plot Horizontal Alignment – Draws the horizontal alignment on the screen.
- Plot Vertical Alignment – Draws the vertical alignment on the screen.
- Export LandXML – Writes a LandXML file of the alignment.

Solve Station and Offset

Simply enter the station and offset to solve the coordinates.

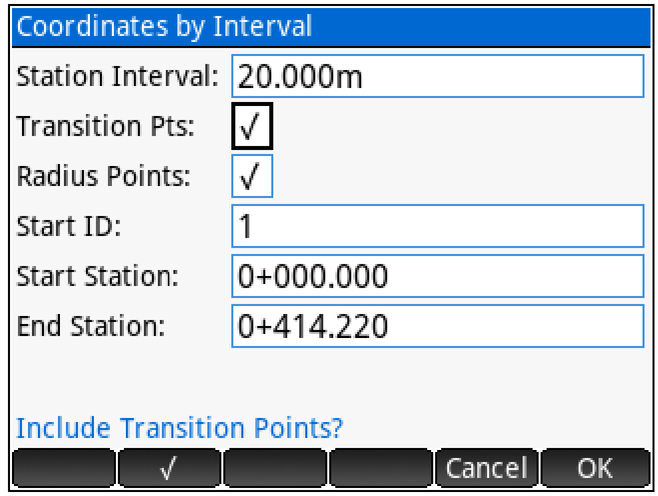




Use the Store option to store the coordinates as a point in the current project.

Coordinates by Interval

To calculate and store points automatically, specify the parameters:

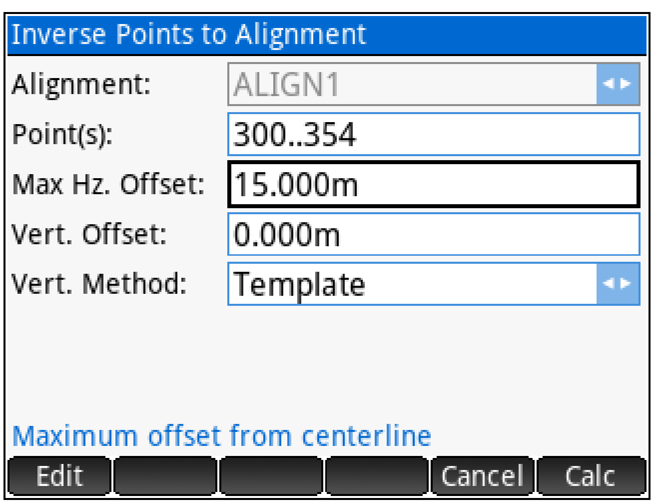


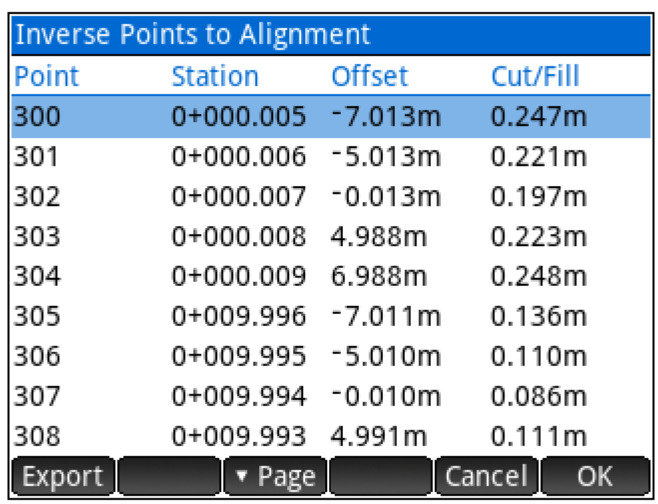
- Station Interval – Points will be created at each interval, including at each break point of any cross-section assignment at the station.
- Transition Points – Toggle specifies whether to store points at the station of the horizontal transition points where segments start/end.
- Radius Points – Toggle specifies whether to store radius points of any curves within the station range.
- Start ID – The Point ID to use for the first point calculated, then incremented for each subsequent calculation. Existing points will never be overwritten, the next available ID will be used when a conflict is encountered.
- Start Station – The Starting Station to begin calculations.
- End Station – The Ending Station to end calculations.

Inverse Points to Alignment

Enter a single point or a range of points to inverse to the alignment. A maximum horizontal offset may be specified to ensure the point offset information is applied to the correct segment. A vertical offset constant may be entered to report cuts/fills to an offset from the vertical design. The vertical method may be set to template or centerline.

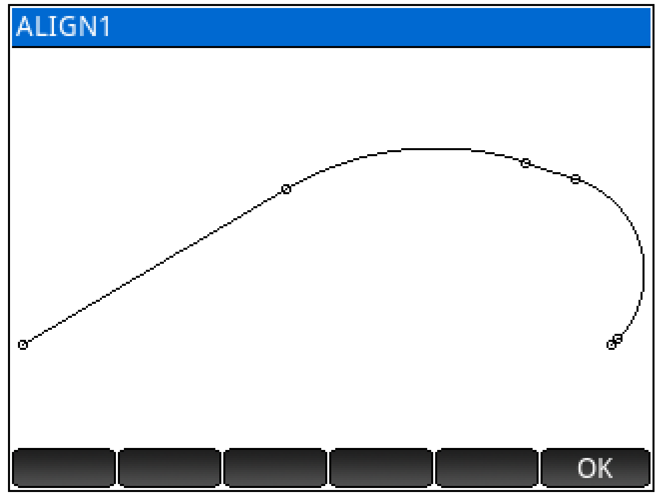
Export Results may be exported in ***CSV*** or ***HTML*** format.





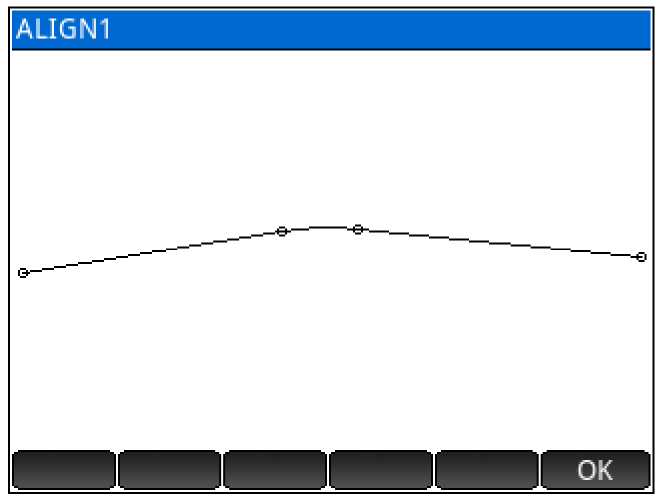
Plot Horizontal Alignment

Draws the horizontal alignment on the screen.



Plot Vertical Alignment

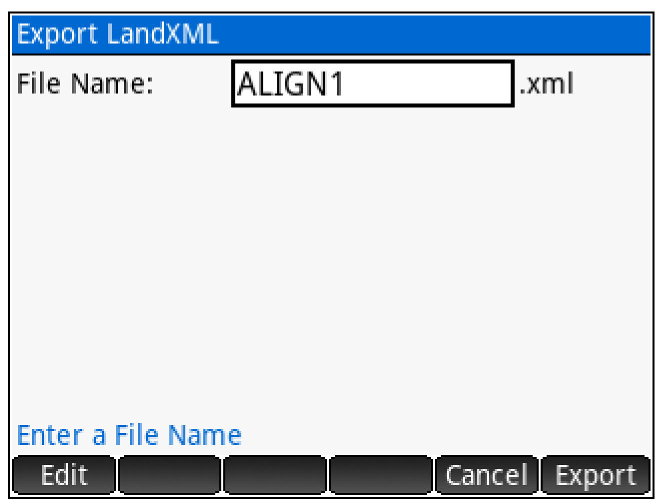
Draws the vertical alignment on the screen.



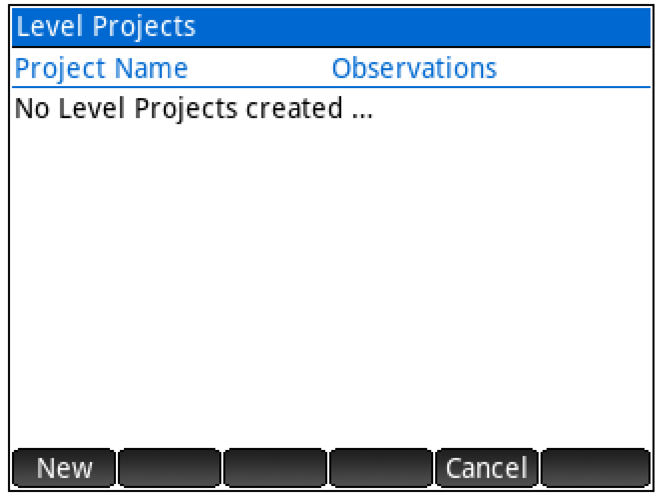
Export LandXML

Specify a name for the XML file to export the alignment definition in LandXML format.

Many software packages can read the LandXML files, see http://landxml.org/ for more information on the LandXML schema.



8.2 Leveling



SGS Prime COGO includes a Leveling program to manage multiple leveling projects. Each project consists of backsight, foresight and intermediate foresight observations. Edit and review observations and perform calculations such as cuts/fills using observed data.

Leveling Project Manager

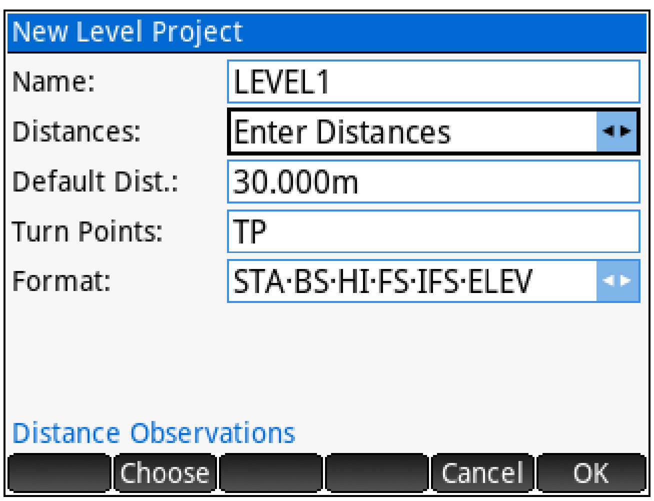
The Project Manager lists all the Leveling projects created, and allows the user to create new projects, delete existing projects, or to load a project for edits and calculations. Available Options:

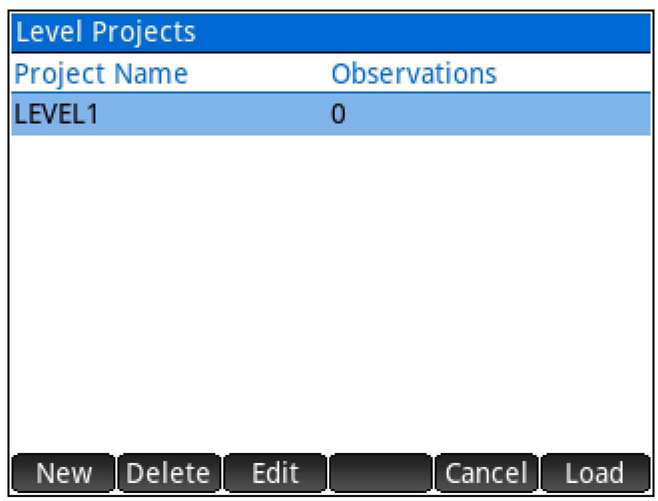
New Create a new Project. Enter a name for the project to create a new project and specify the project-specific settings. The project is added to the Project Manager List.

Delete Delete the selected project. A confirmation prompt is displayed.

Edit Edit the project name and settings.

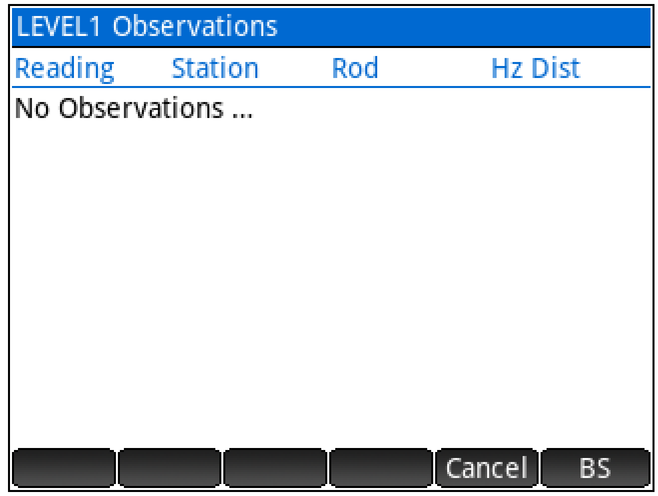
Load Load the selected project.





Projects can be created with option to use default distances or to require entered distances to observed stations. Turn Point prefixes can be customized for the job.

Working with a Leveling Project



New projects contain no observations or data, therefore some of the options are not available until enough data has been entered.

The interface displays the observation data entered and the menu provides access to all the functionality.

Edit Edit the selected observation.

Delete Delete the selected observation.

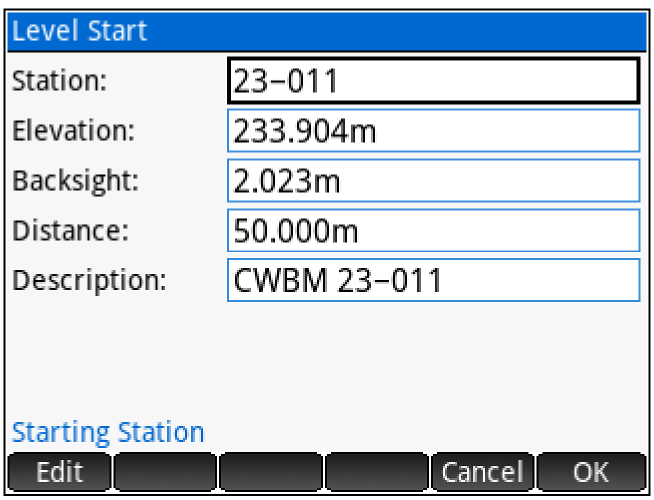
Data Review or process the Observation Data.

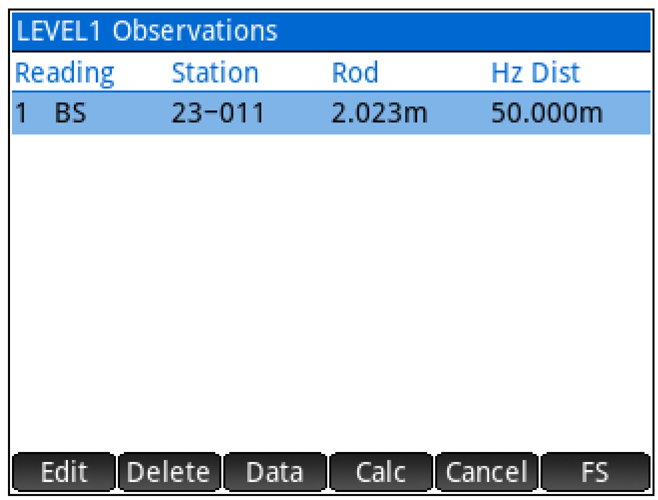
Calc Perform Calculations from project data.

BS or **FS** Enter a backsight or foresight observation.

Entering the Initial Backsight

The first observation of any Leveling project is the initial backsight observation. The elevation of the initial backsight is required; however, it can be edited later if needed.





Entering Foresights

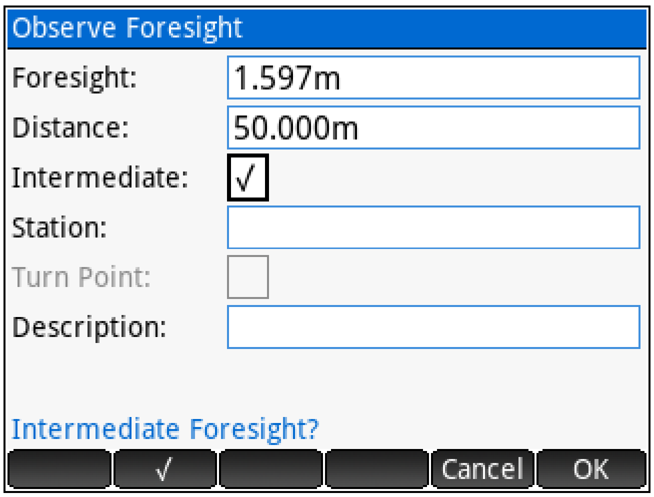
When entering foresights, toggles are available to specify the station as an Intermediate Foresight (IFS) or a Turn Point. Leaving both toggles unchecked specifies a Network Foresight Station.

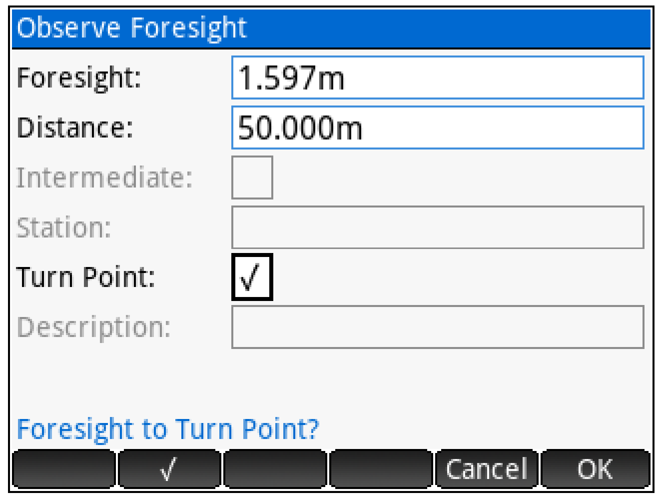
Intermediate Foresights

A Station name is still required; however, the BS / FS action of the menu will remain as FS. All intermediate foresights are entered before the observation to the Network Foresight Station.

Turn Points

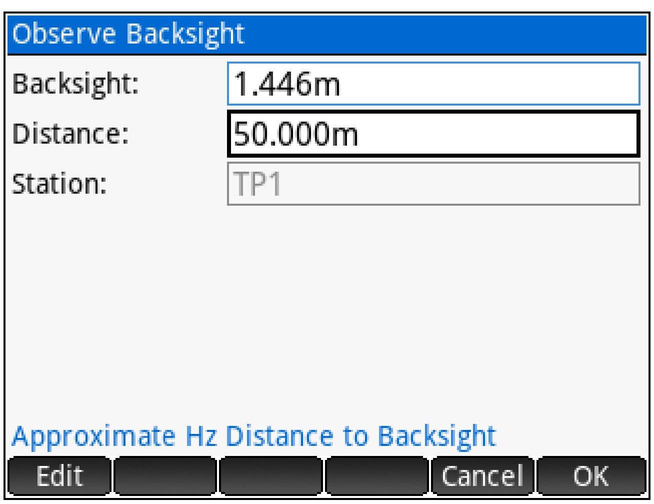
Turn Points are automatically given a “TPx” name, where x starts at 1 and increments at each Turn Point. Turn Points are generally temporary locations for the sake of carrying on a Level Run. Turn Point stations are not selectable for Cut/Fill calculations, etc.

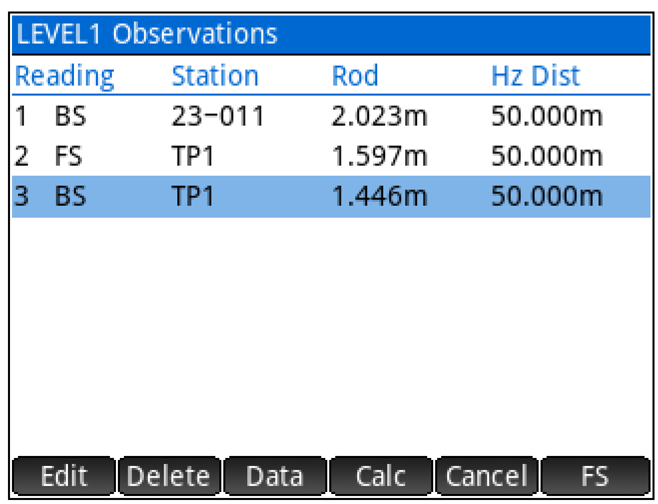




Entering Backsights

The Station name is not editable when entering a Backsight observation.





Deleting Observations

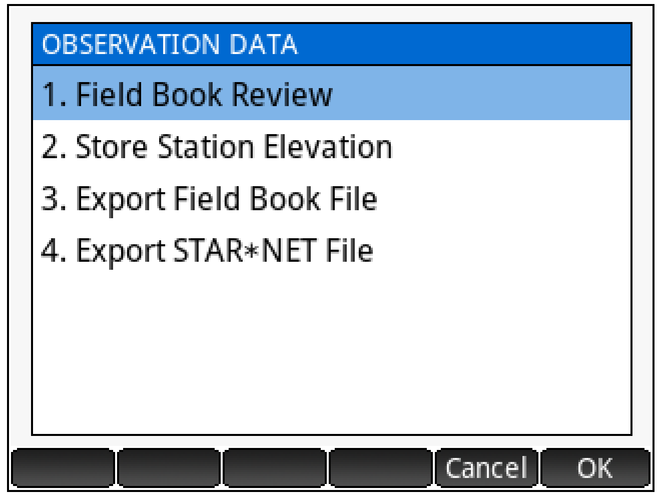
The selected observation may be deleted, if it is either:

1. An Intermediate Foresight observation, or
2. The very last observation entered

A confirmation prompt is displayed prior to deletion. An error message is displayed when the observation cannot be deleted.

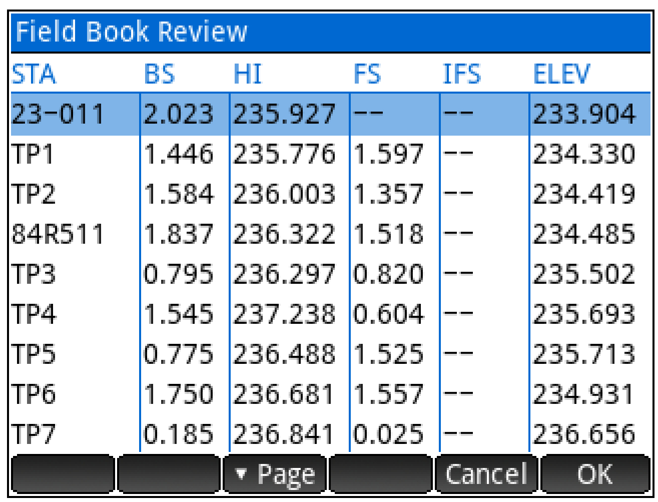
Observation Data

Review the observation data in a typical field book format, store a Level Station elevation to a point in the current project point database, export a text file of the current field book observations, or export a STAR*NET format data file for a Least Squares adjustment using STAR*NET.



Field Book Review

Displays the observation data like how it would be entered in a field book.



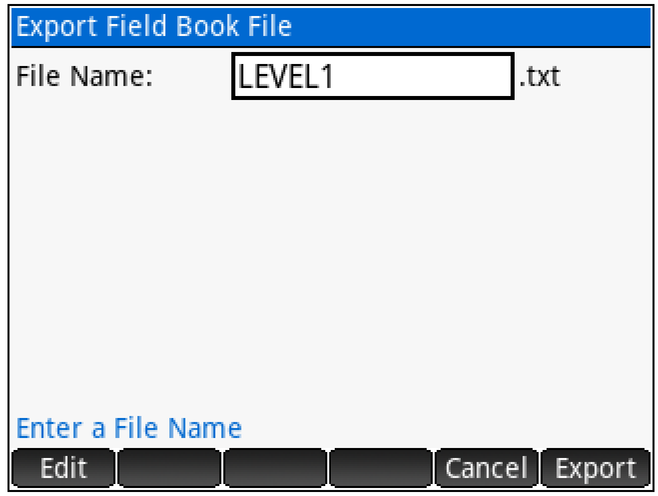
Field Book Review

STA	BS	HI	FS	IFS	ELEV
23-011	2.023	235.927	--	--	233.904
TP1	1.446	235.776	1.597	--	234.330
TP2	1.584	236.003	1.357	--	234.419
84R511	1.837	236.322	1.518	--	234.485
TP3	0.795	236.297	0.820	--	235.502
TP4	1.545	237.238	0.604	--	235.693
TP5	0.775	236.488	1.525	--	235.713
TP6	1.750	236.681	1.557	--	234.931
TP7	0.185	236.841	0.025	--	236.656

▾ Page Cancel OK

Export Field Book File

Export the observation data to a text file, formatted like a Field Book. The fieldbook format of the current project Four format options are available for order and content of the exported file.

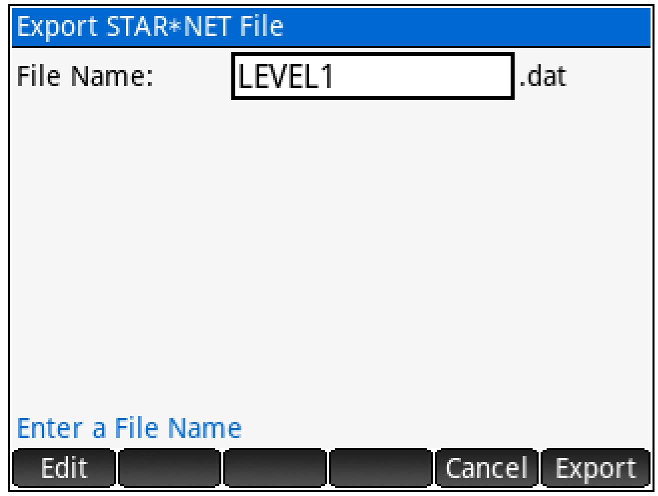


Sample Output

STA	BS	HI	FS	IFS	ELEV
23-011	2.023	235.927	--	--	233.904
TP1	1.446	235.776	1.597	--	234.330
TP2	1.584	236.003	1.357	--	234.419
84R511	1.837	236.322	1.518	--	234.485
TP3	0.795	236.297	0.820	--	235.502
TP4	1.545	237.238	0.604	--	235.693
TP5	0.775	236.488	1.525	--	235.713
TP6	1.750	236.681	1.557	--	234.931
TP7	0.185	236.841	0.025	--	236.656
TP8	1.720	237.157	1.404	--	235.437
TP9	1.950	237.354	1.753	--	235.404
TP10	0.691	236.318	1.727	--	235.627
TP11	2.078	237.038	1.358	--	234.960
23-013	--	--	1.253	--	235.785

Export STAR*NET File

Export the observation data in a STAR*NET input data format. Any dashes found in station names are replaced with underscore characters to conform with the default STAR*NET station separator.



Sample Output

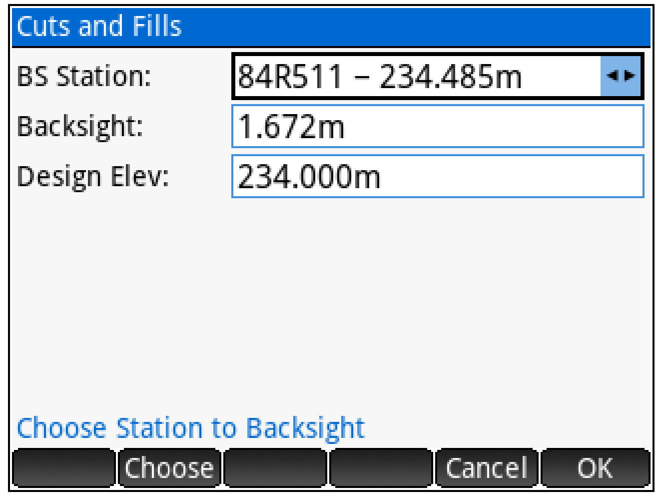
```
# SGS Prime COGO 1.2.x - LEVEL1
# Created July 16, 2018

# Fixed Elevations
E 23_011      233.904 ! 'CWBM 23-011

# Leveling Observation Data
L 23_011-84R511    0.581   300 'GPS MON 84R511
L 84R511-23_013    1.300  1000 'CWBM 23-013
```

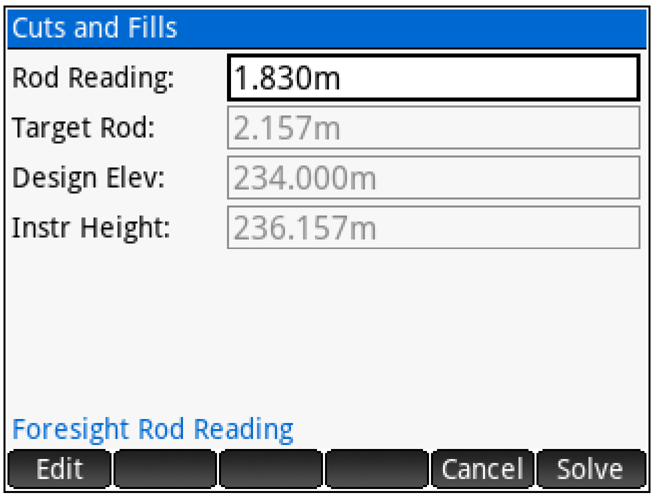
Calculations

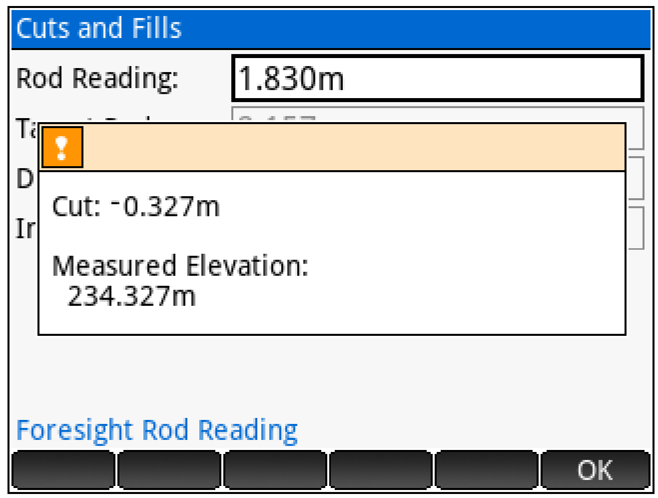
Calculate cuts and fills by observing (backsight) a station in the current Leveling project and specifying the design elevation.



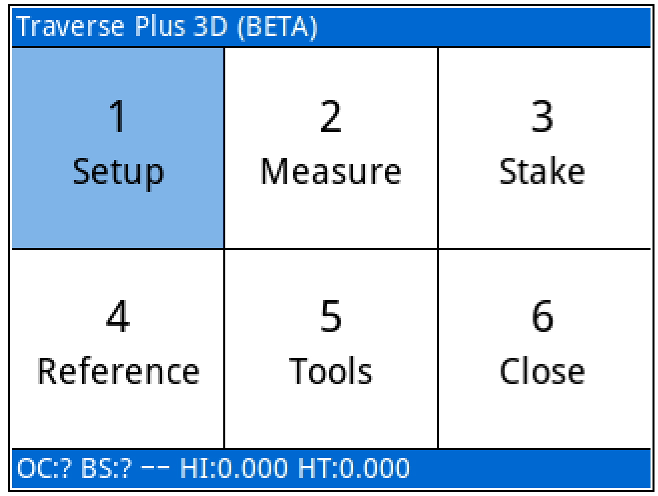
In the next input form, enter the rod reading observed to calculate the cut or fill.

The solution displays the cut or fill, and the observed elevation.





8.3 Traverse Plus 3D (BETA)



Traverse Plus 3D in SGS Prime COGO Version 1.5 is released as a BETA. While most of the planned features are included and tested; there are further enhancements planned and more testing required before removing the BETA status. The user is advised to verify results before relying on them.

The primary purpose of this application is to recreate coordinates from field notes or to simulate data collection and field calculation procedures.

Traverse data and settings are specific to the project that is in use. Each project can have its own running traverse, with data and settings saved and restored when closing and opening a project.

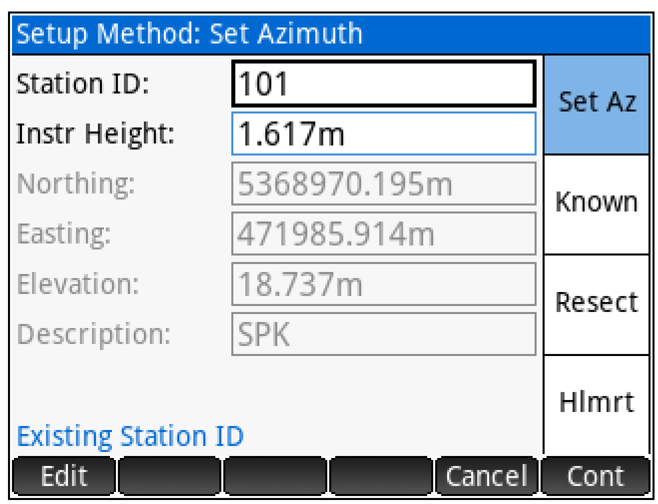
A grid of buttons provides access to all functionality of the program, which can also be accessed by using the corresponding numeric key (1-6) on the keyboard.

NOTE: See the Tools section on available settings to configure, prior to getting started.

Setup

A valid setup is required before measuring or staking is possible. There are four setup methods:

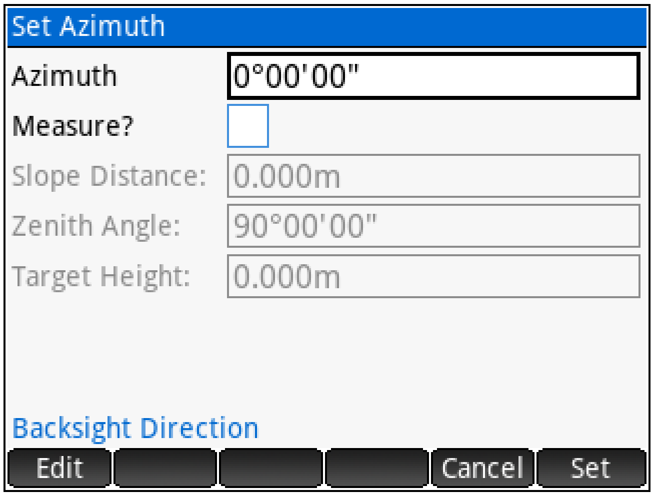
Set Azimuth

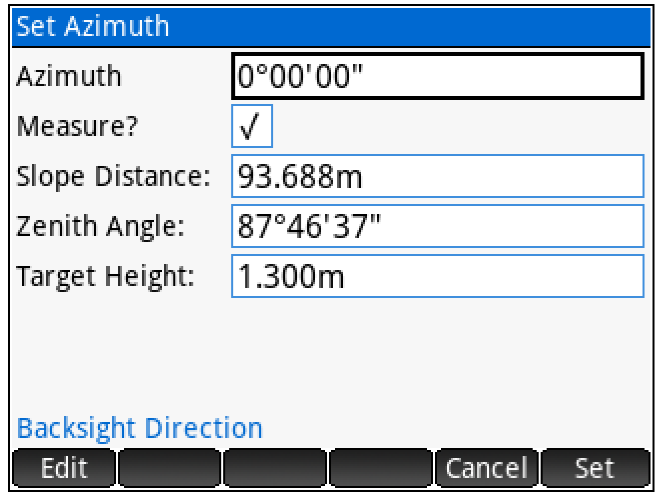


Set Azimuth is useful for the initial setup of a Traverse when control points do not exist. Generally, the Station will be assigned arbitrary coordinates, and an approximate direction to a second point is entered to get started.

Enter an existing Point ID (which can be created if not yet existing) to set the Station and enter the Instrument Height. The coordinates of the station are displayed (greyed out). Continue to the next screen to enter a direction.

The Backsight Direction is the only required information to complete the setup. Additional measured information may be entered to calculate the coordinates of the Backsight point, and then optionally store the Backsight Point.



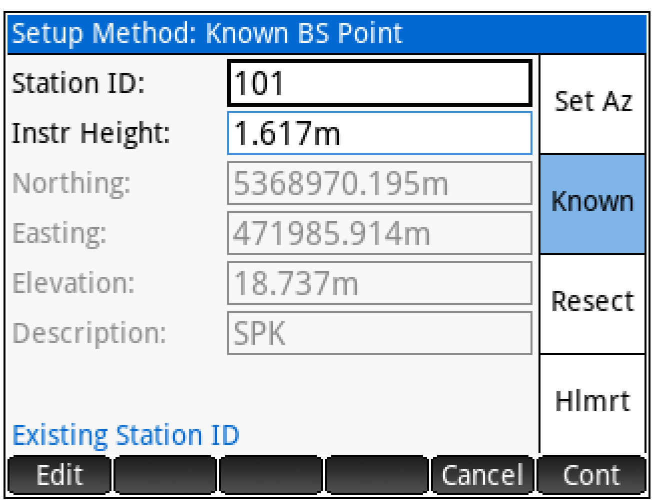


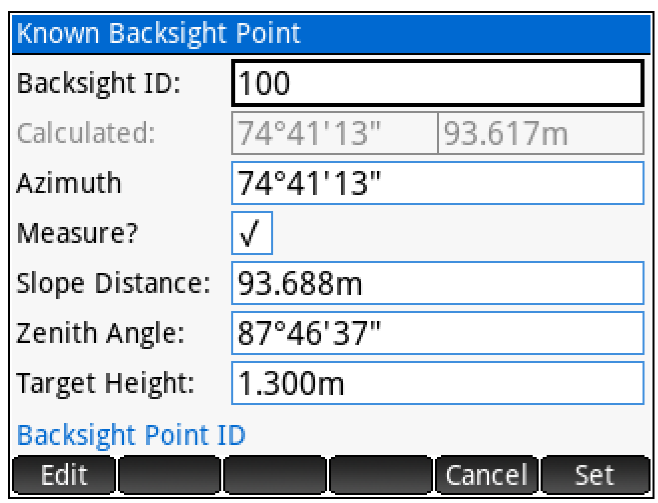
Known Backsight Point

Known Backsight Point is a very common type of setup. In this situation the user sets the station over a known point and sets the orientation to another known point.

Enter an existing Point ID (which can be created if not yet existing) to set the Station and enter the Instrument Height. The coordinates of the station are displayed (greyed out). Continue to the next screen to enter the Backsight Point ID.

Enter an existing Point ID for the Backsight to display the calculated direction and distance. Optionally enter the observed direction (to set 0° for example) and the measurements to the Backsight. When measurements are provided, the deltas will be displayed.



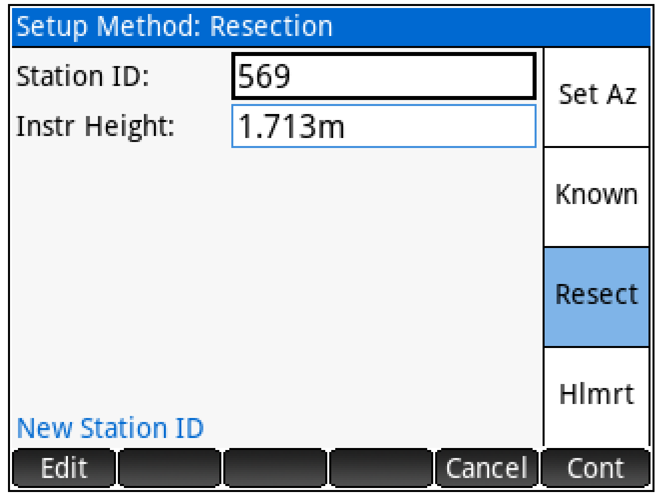


Resection

Resection involves observing three or more known control points (angles only) to determine the coordinates of the Station. Least squares methods are applied when more than three control points are used. Zenith angles to one or more control points may be observed to determine the elevation of the station.

The example coordinates and directions below will be used to compute the coordinates of Point 569 (2D).

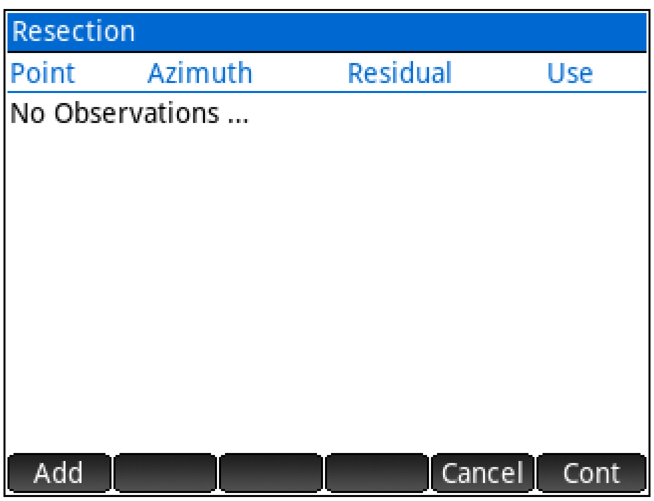
Pt#	Northing	Easting	Direction
570	3127.451	9030.360	180°00’02”
571	3213.971	8947.972	13°18’00”
572	3198.659	8967.350	84°29’40”
573	3189.142	8982.625	144°50’07”

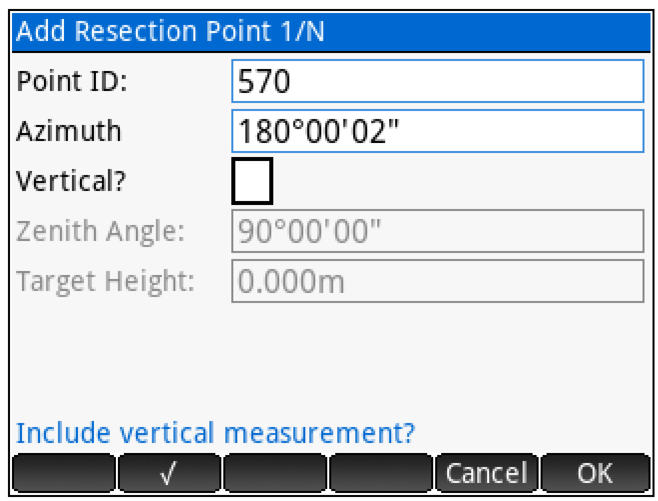


Enter a new Point ID to be used to store the Station coordinates and enter the Instrument Height. Continue to the next screen to add the resection points.

Use the Add button on the Resection input screen to add observations to the resection points.

For each resection point; enter the Point ID and the direction to the point. Vertical angles are not observed for this example.

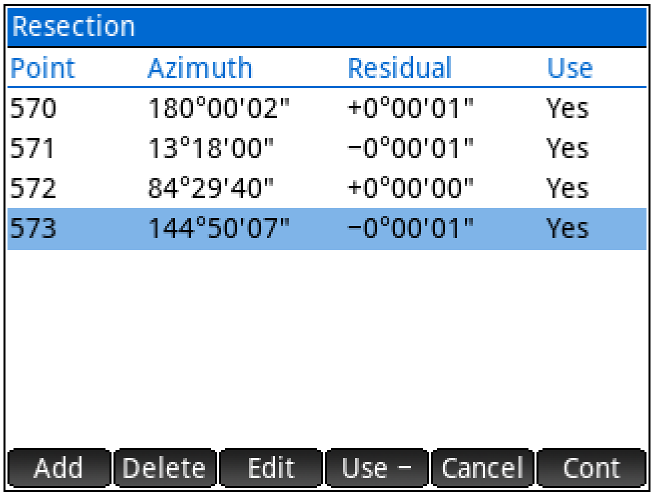


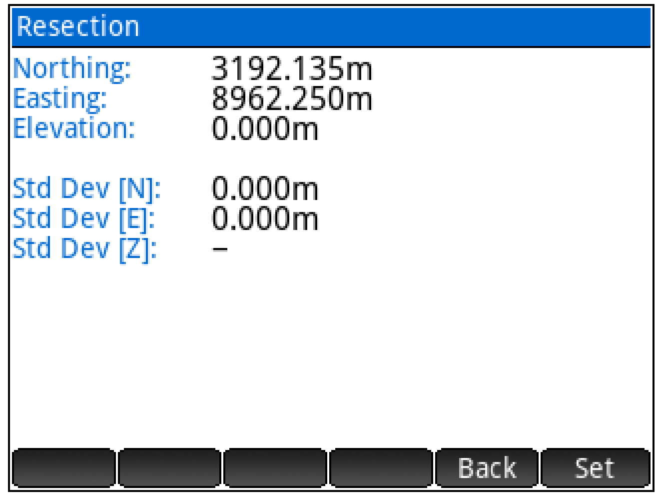


When all the observations are entered, the Resection input screen will display the directions and the computed residuals of each direction. The Use − button will toggle the inclusion of the selected point in the calculation.

Continue to the next screen when the residuals are satisfactory. The coordinates and standard deviations of the resection station are displayed.

The Set option on the menu will store the point in the project database and complete the setup.





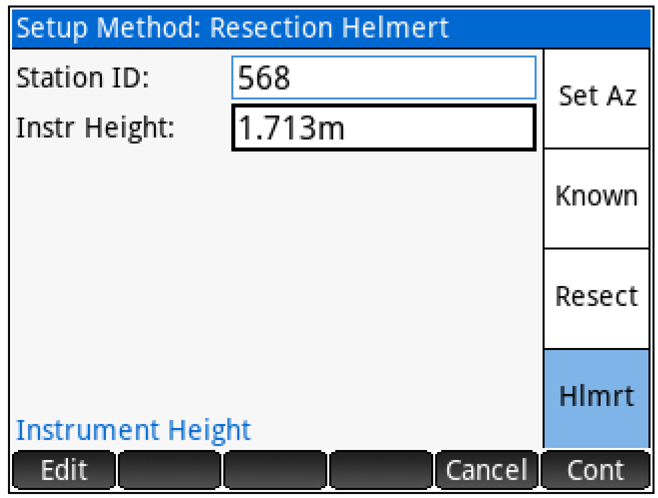
NOTE: When completing a **Resection** setup; the first point observed will be set as the Backsight Point. The observed direction will be set as the Backsight Direction.

Resection Helmert

Resection Helmert involves observing two or more control points (angles and distances) to compute the least squares best-fit coordinates of the Station.

The example coordinates, slope distances, directions and zenith angles below will be used to compute the coordinates of Point 568 (3D).

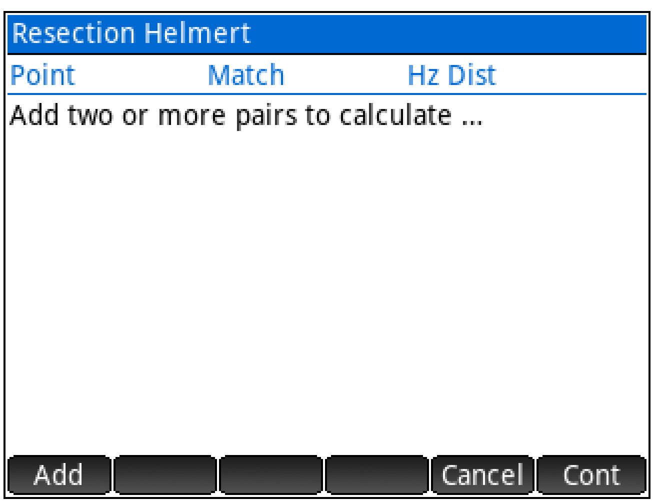
Pt#	Northing	Easting	Elevation	Distance	Direction	Zenith
570	3127.451	9030.360	396.190	94.016	180°00′02″	92°34′20″
571	3213.971	8947.972	399.345	26.112	13°18′00″	92°21′00″
572	3198.659	8967.350	398.600	8.474	84°29′40″	102°14′55″
573	3189.142	8982.625	398.610	20.672	144°50′07″	95°00′55″

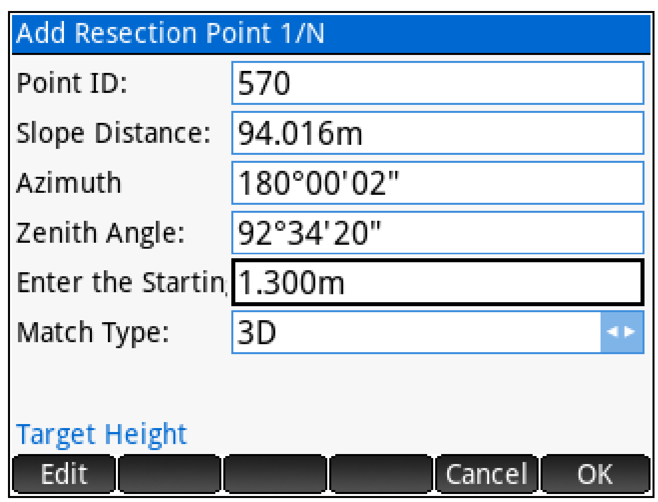


Enter a new Point ID to be used to store the Station coordinates and enter the Instrument Height. Continue to the next screen to add the resection points.

Use the Add button on the Resection input screen to add observations to the resection points.

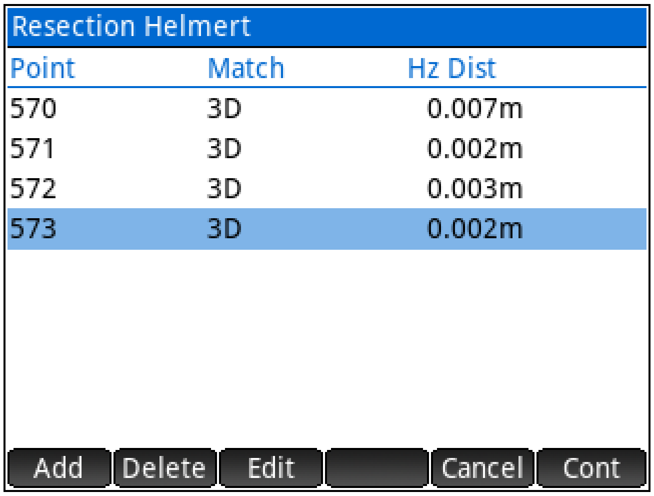
For each resection point; enter the Point ID, the distance, direction and zenith angle observation to the point. The same target height was used for all observations (1.300m).

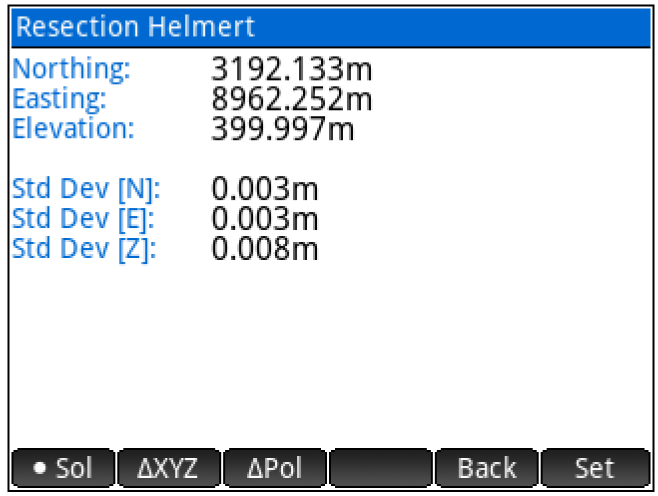




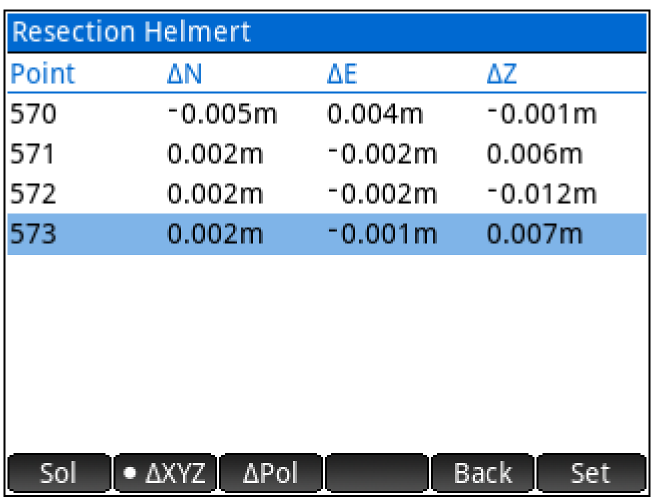
When all the observations are entered, the Resection input screen will display the directions and the computed residuals of each direction. The Use – button will toggle the inclusion of the selected point in the calculation.

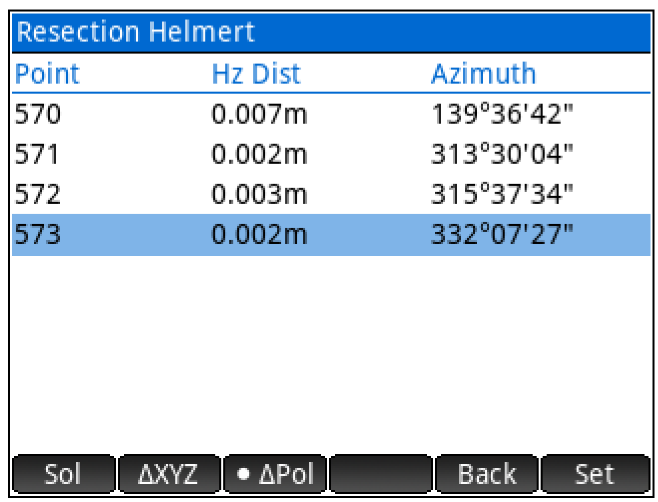
Continue to the next screen when the residuals are satisfactory. The coordinates and standard deviations of the resection station are displayed.





Residuals in coordinates (transformed measurements fit to control coordinates) and polar residuals are viewable through the • ΔXYZ and • ΔPol menu options.



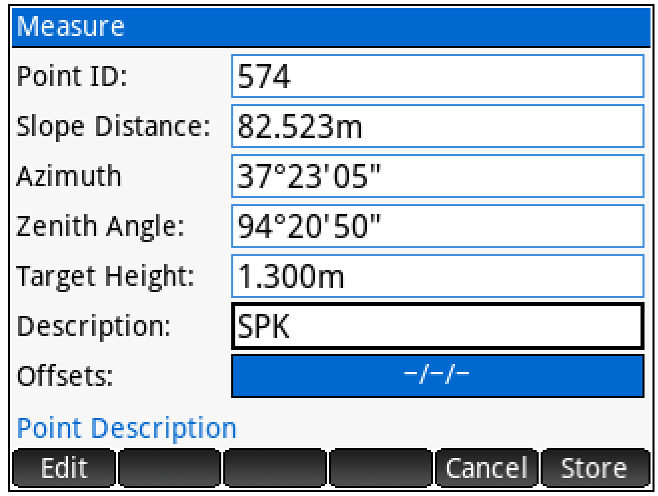


The Set option on the menu will store the point in the project database and complete the setup.

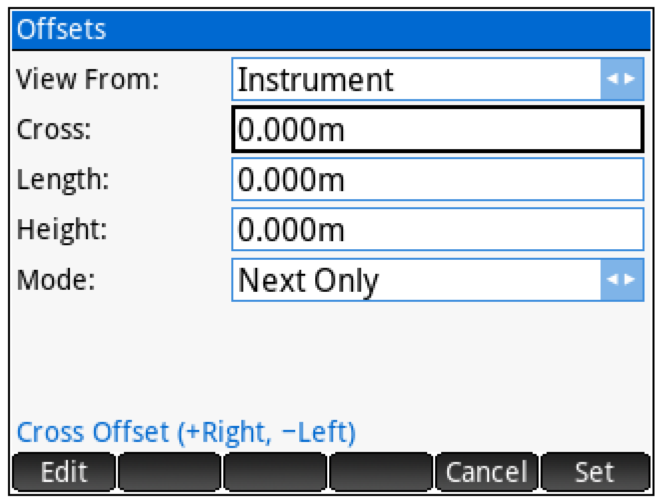
NOTE: When completing a **Resection Helmert** setup; the first point observed will be set as the Backsight Point. The observed direction will be set as the Backsight Direction.

Measure

The **Measure** option In Traverse Plus 3D is used to calculate coordinates relative to the current Setup; by entering the measured angles and distances. Current settings will affect how information is entered; including:



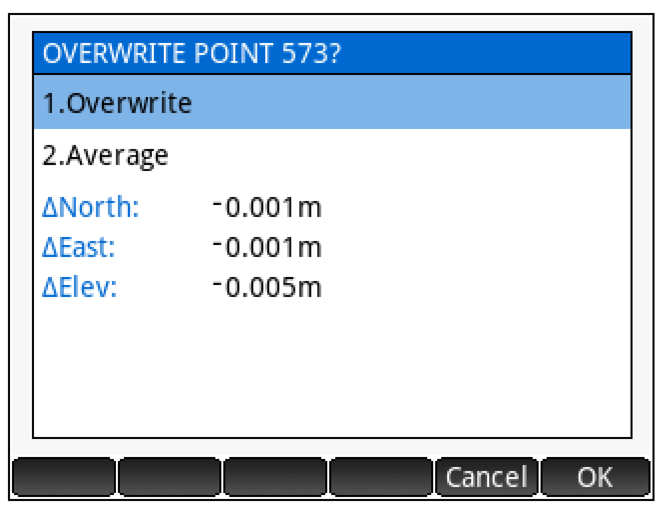
1. ***Zenith Angle*** and ***Target Height*** fields are only available in **3D mode**.
2. ***Azimuth*** or ***Angle Right*** field depends on setting.
3. ***Slope Distance*** or ***Horizontal Distance*** field depends on setting. ***Slope Distance*** is only available in **3D mode**.
4. When storing the results, the coordinates of the solved position can either be displayed or automatically stored without displaying the coordinates.



Offsets may be applied to the measured values. Offsets are calculated perpendicular and parallel to the line of sight.

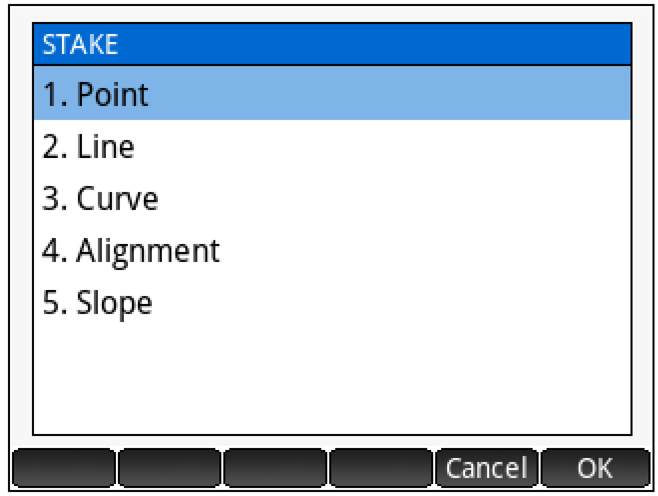
1. Offset values (positive or negative) can be input from the perspective of viewing either the ***Instrument*** or the ***Target***.
2. Offset mode can be set to apply the current offsets to ***Next Only*** or ***Permanent***.

When a point already exists with the same Point ID as the specified Point ID; the option to overwrite or to average the existing and new coordinates is presented.



Stake

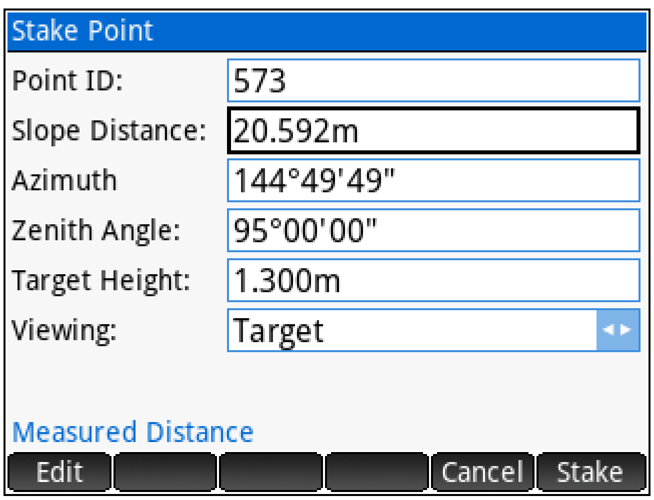
Staking calculations generally work by specifying the precise location to be guided towards. The precise location can be a point, a specific distance and offset relative to a line, curve or alignment, or it can be a slope away from a reference line.

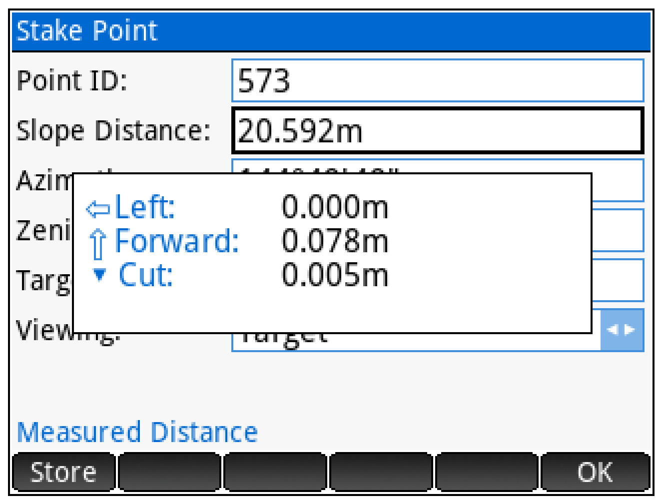


Point

To stake a point; simply enter the Point ID to be staked. The horizontal distance and horizontal angle to the point are calculated and populated.

NOTE: The calcualted distance is always horizotnal, even if the current setting is set to use slope distances.



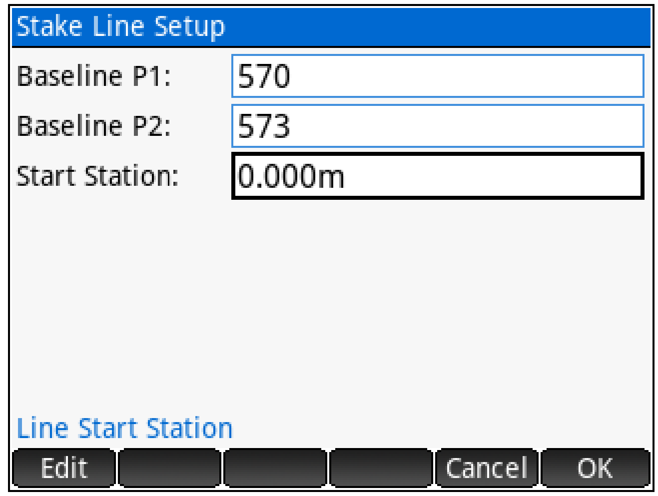


When the measured values are entered, use the Stake button on the menu to calcualte and display the staking directions. The staking directions are displayed as per the selected option: ***Viewing Target***, ***Viewing Instrument***, or ***Cardinal***.

The Store button on the results menu can be used to store the coordinates of the measured position.

Line

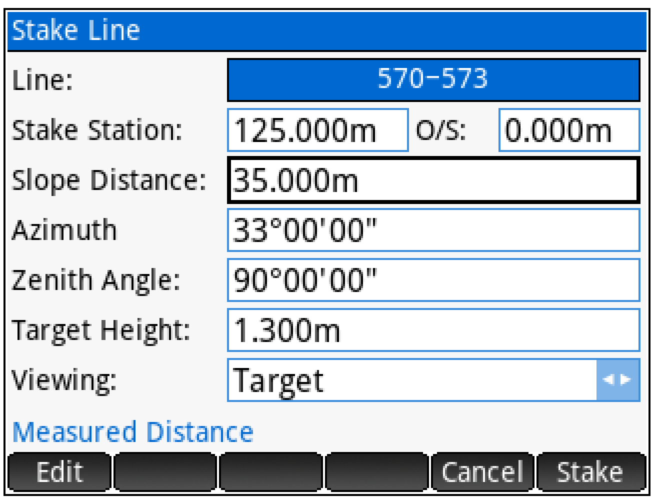
To stake a line, first define the line. Two points are used to define the line, the order of which are important when specifying offsets.

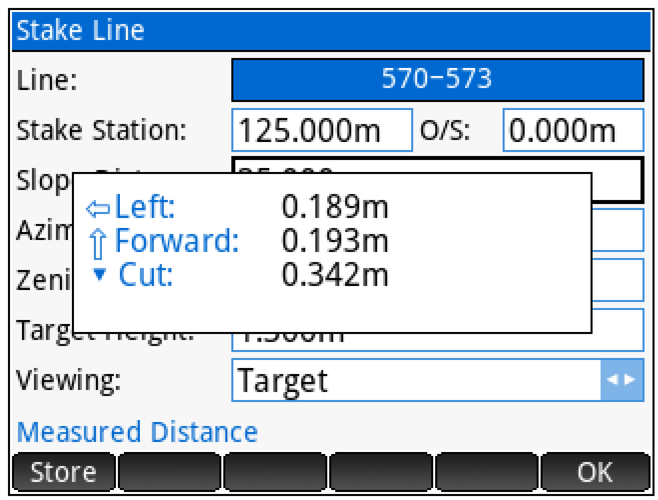


The Start Station specifies the station at the first point of the baseline.

On the main input screen; enter the station to stake and the offset from the line.

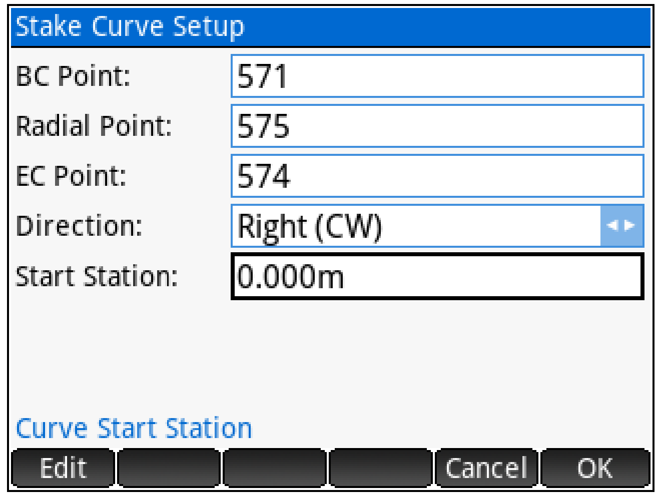
When the measured values are entered, use the Stake button on the menu to calcualte and display the staking directions. The staking directions are displayed as per the selected option: ***Viewing Target***, ***Viewing Instrument***, or ***Cardinal***.





The Store button on the results menu can be used to store the coordinates of the measured position.

Curve

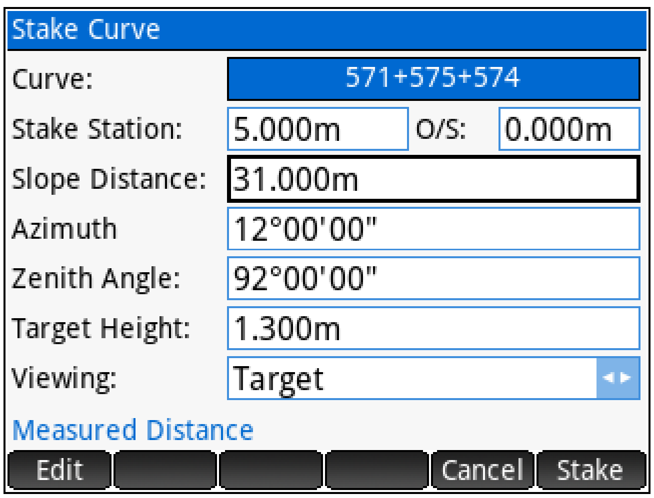


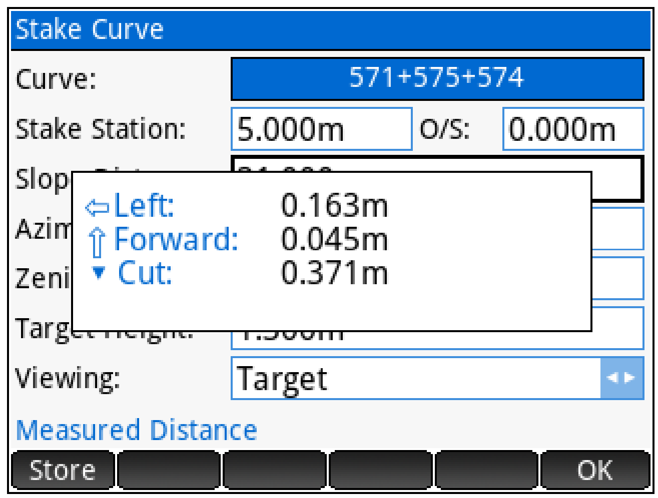
To stake a curve, first define the curve. The beginning of curve, radial point, and end of curve points are required to define the curve. The direction of curve is important for both stationing and offsets.

The Start Station specifies the station at the beginning of curve point.

On the main input screen; enter the station to stake and the offset from the curve.

When the measured values are entered, use the Stake button on the menu to calcualte and display the staking directions. The staking directions are displayed as per the selected option: ***Viewing Target***, ***Viewing Instrument***, or ***Cardinal***.





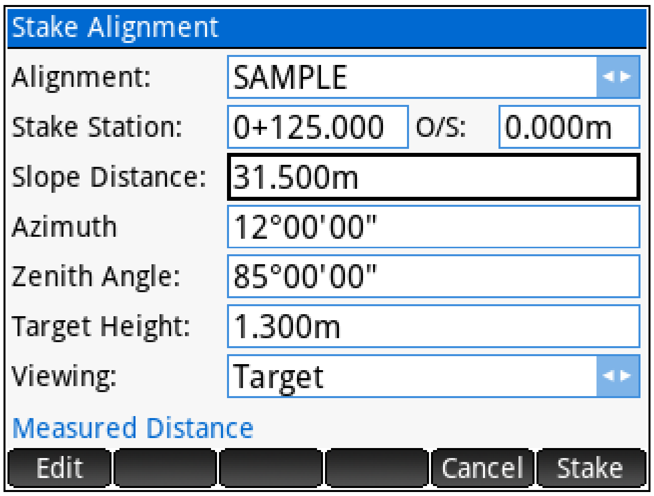
The Store button on the results menu can be used to store the coordinates of the measured position.

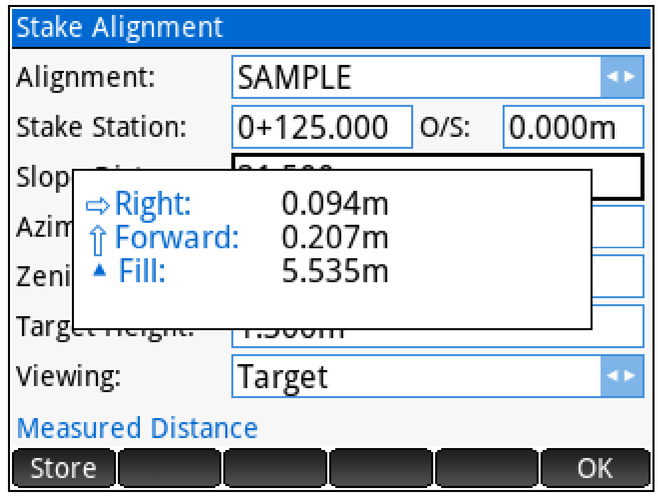
Alignment

To stake any station and offfset along an alignment; the alignment must already be created.

On the main input screen; select the alignment to use, then enter the station and offset to stake.

When the measured values are entered, use the Stake button on the menu to calcualte and display the staking directions. The staking directions are displayed as per the selected option: ***Viewing Target***, ***Viewing Instrument***, or ***Cardinal***.

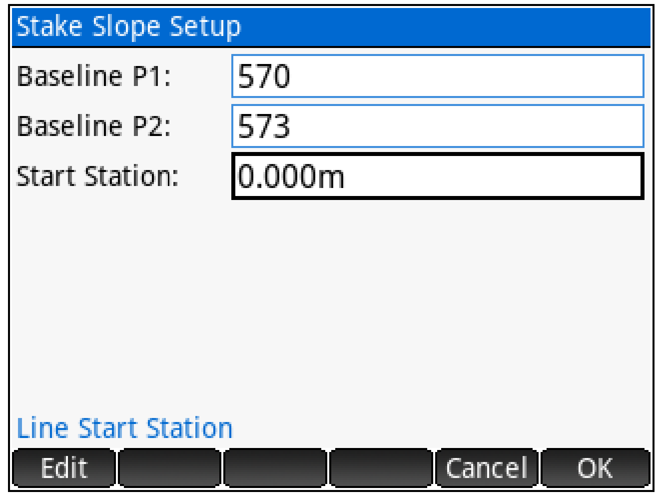




The Store button on the results menu can be used to store the coordinates of the measured position.

Slope

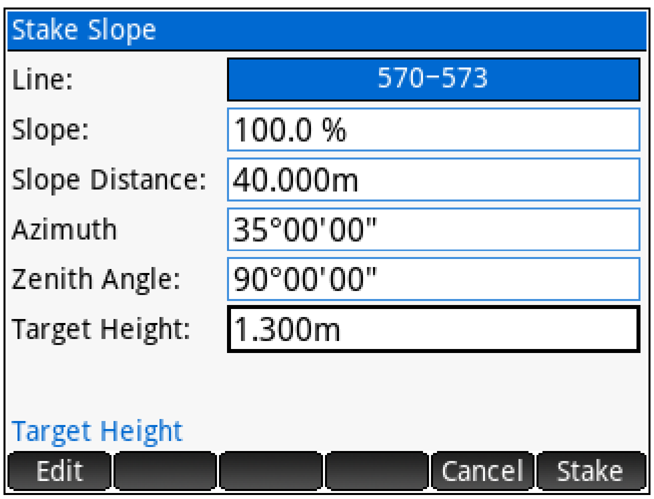
To stake a slope, first define the line from which the slope calculations will be determined. Two points are used to define the line, the order of which are important when specifying offsets and slope.

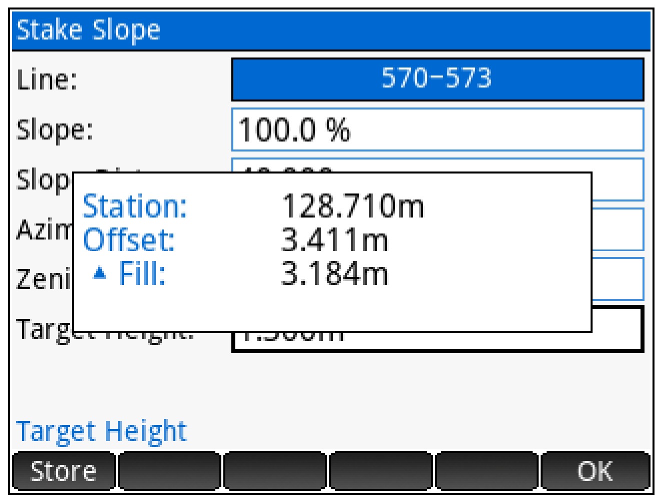


The Start Station specifies the station at the first point of the baseline.

On the main input screen; enter the slope to stake.

When the measured values are entered, use the Stake button on the menu to calcualte and display the cut/fill amounts. The station and offset relative to the line are also displayed.

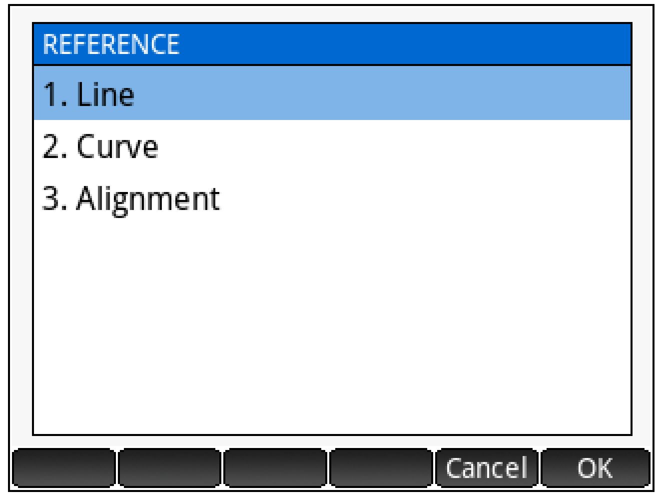




The Store button on the results menu can be used to store the coordinates of the measured position.

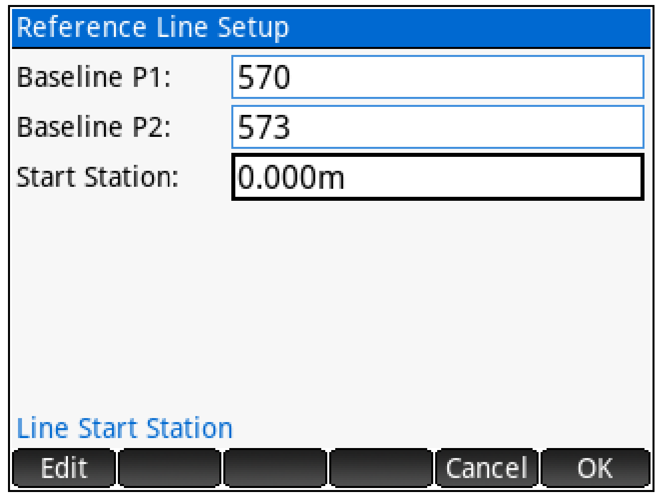
Reference

Reference calculations generally work by specifying a reference geometry, and then obtaining information to report the measured position relative to the geometry. The reference geometry can be a line, curve or alignment.



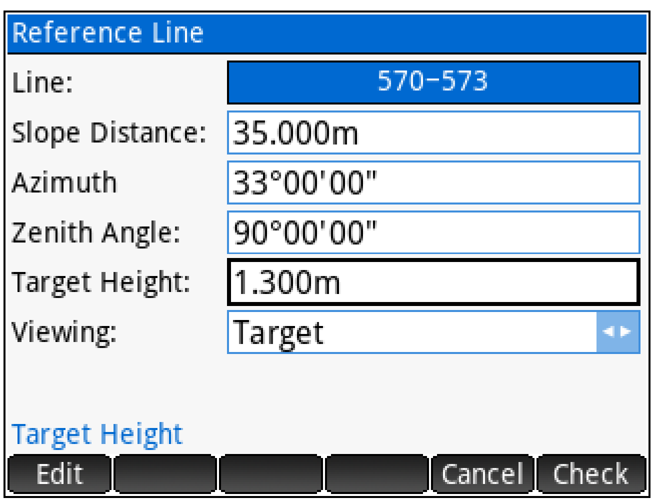
Line

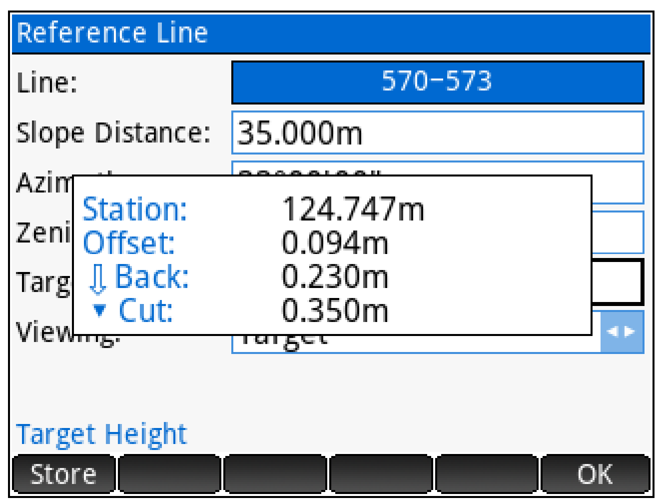
To measure relative to a reference line, first define the line. Two points are used to define the line, the order of which are important to determine offsets.



The Start Station specifies the station at the first point of the baseline.

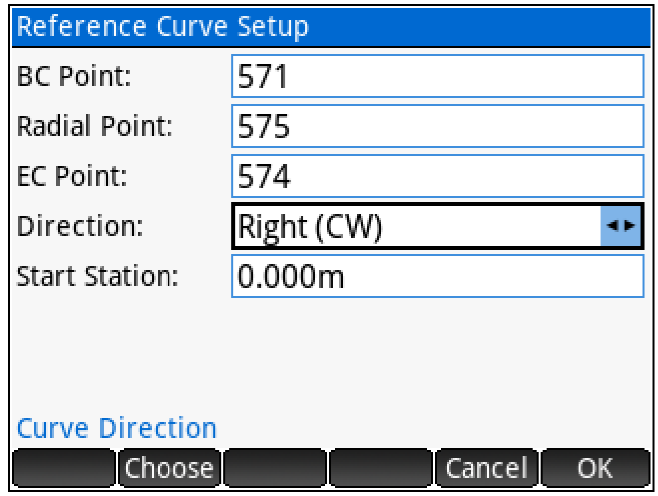
When the measured values are entered, use the Check button on the menu to calcualte and display the position relative to the line. The forward/back distances are on the current line of sight to intersect the reference geometry, and are displayed as per the selected option: ***Viewing Target***, or ***Viewing Instrument***.





The Store button on the results menu can be used to store the coordinates of the measured position.

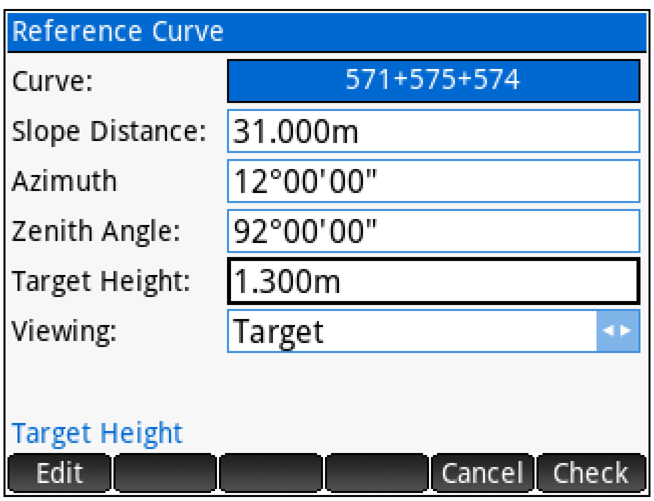
Curve

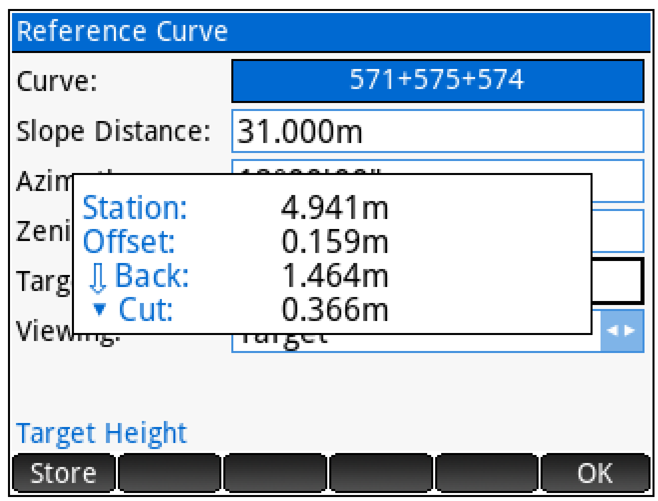


To measure relative to a reference curve, first define the curve. The beginning of curve, radial point, and end of curve points are required to define the curve. The direction of curve is important for both stationing and offsets.

The Start Station specifies the station at the beginning of curve point.

When the measured values are entered, use the Check button on the menu to calcualte and display the position relatve to the curve. The forward/back distances are on the current line of sight to intersect the reference geometry, and are displayed as per the selected option: ***Viewing Target***, or ***Viewing Instrument***.





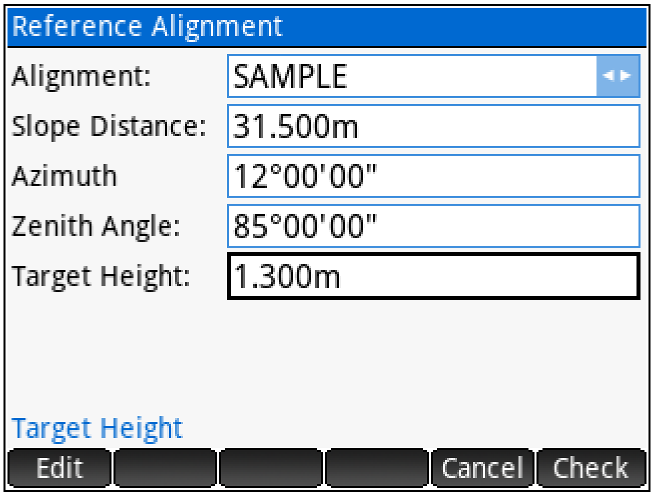
The Store button on the results menu can be used to store the coordinates of the measured position.

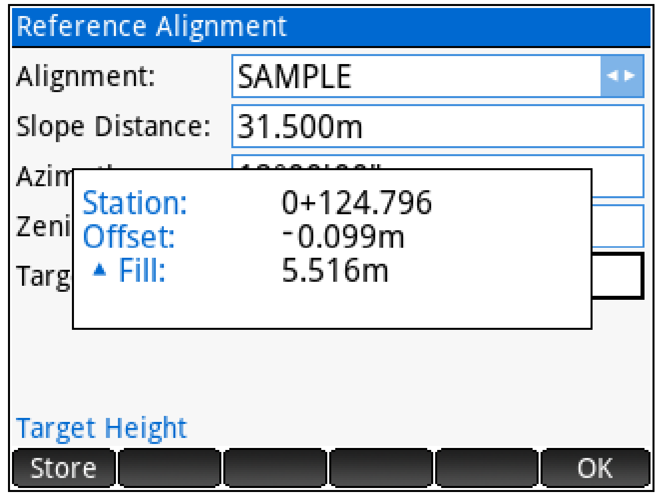
Alignment

To measure relative to an alignment; the alignment must already be created.

On the main input screen; select the alignment to use, then enter the station and offset to stake.

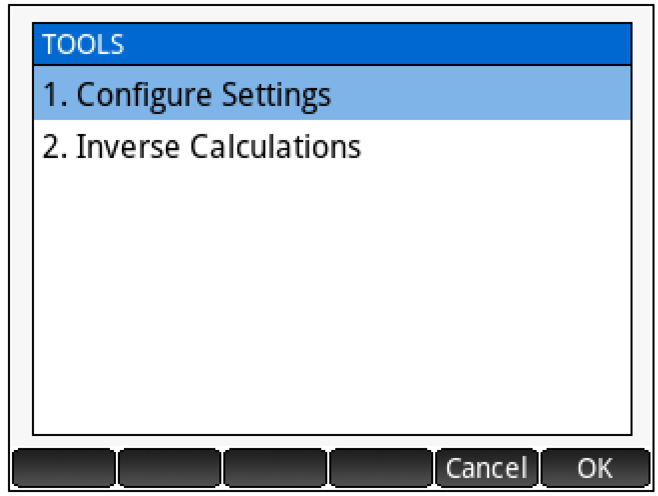
When the measured values are entered, use the Check button on the menu to calcualte and display the position relative to the alignment.





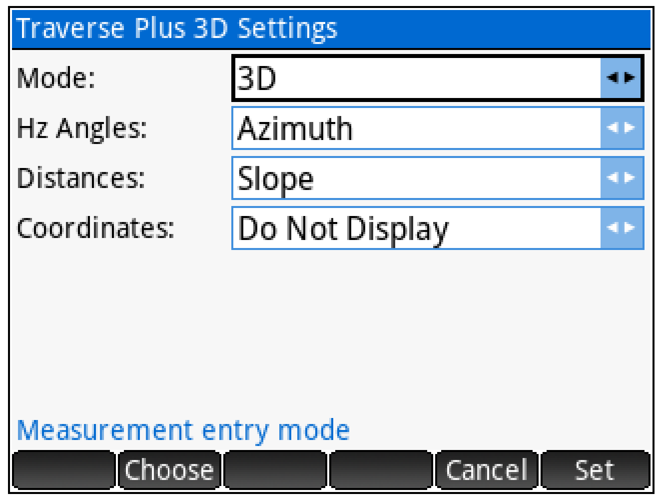
The Store button on the results menu can be used to store the coordinates of the measured position.

Tools



Traverse Plus 3D tools are necessary or handy utilities that are related to the measurment data. Additional tools will be added in a future release.

Configure Settings



Settings make it possible to add flexibility to how **Traverse Plus 3D** operates.

- Mode – ***2D*** mode disables zenith angle and target height fields for measurements, and requires horizontal distance measurements. ***3D*** mode enables all fields and allows a choice of entering horizontal or slope distances.
- Horizontal Angles – Set true ***Azimuth*** or ***Angle Right*** input for horizontal angles.
- Distances – Set ***Slope*** or ***Horizontal*** input for distances. 2D mode only supports horizontal.
- Coordinates – Within the ***Measure*** application this setting determines if the coordinates of the measured point are displayed prior to storing the point.

Inverse Calculations

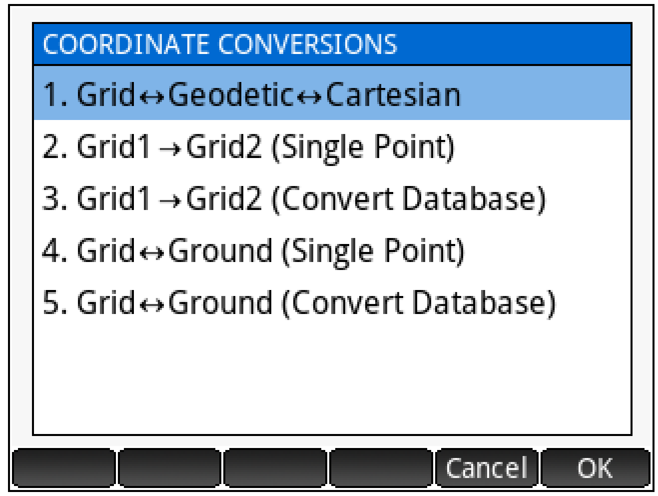
Opens the Inverse Calculations options to eliminate the need to exit **Traverse Plus 3D** to calculate inverses.

Close

Closes **Traverse Plus 3D** and returns to the main menu.

8.4 Coordinate Converter

The Coordinate Converter includes the following coordinate conversion capabilities:

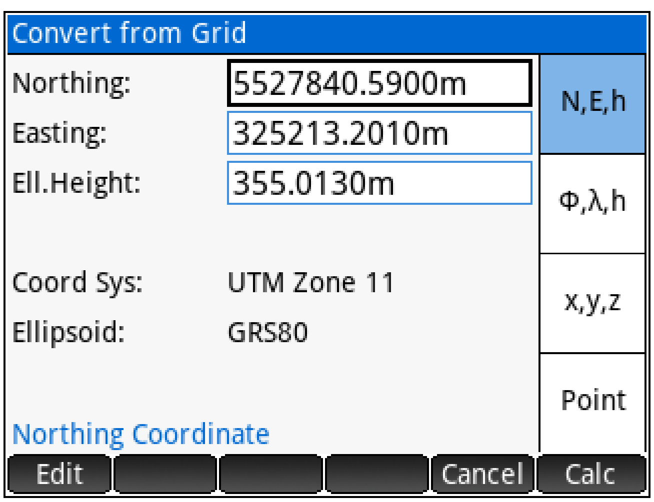


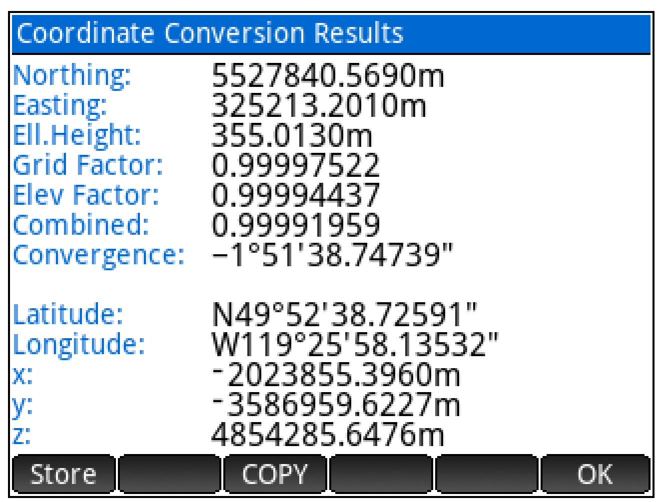
1. Grid↔Geodetic↔Cartesian – Convert between grid coordinates, geodetic coordinates, and cartesian coordinates.
2. Grid1→Grid2 (Single Point) – Convert a coordinate position from one grid projection to another. Input can be grid, geodetic, or cartesian coordinates.
3. Grid1→Grid2 (Convert Database) – Convert points in the project database from one grid projection to another.
4. Grid↔Ground (Single Point) – Convert coordinates of a single point between grid and ground based on supplied parameters.
5. Grid↔Ground (Convert Database) – Convert points in the database between grid and ground based on supplied parameters.

Grid↔Geodetic↔Cartesian

Convert between grid coordinates, geodetic coordinates, and cartesian coordinates using the current Coordinate System settings. Input can be grid coordinates (N,E,h), geodetic coordinates (Φ,λ,h), cartesian coordinates (x,y,z), or grid coordinates from a point in the database.

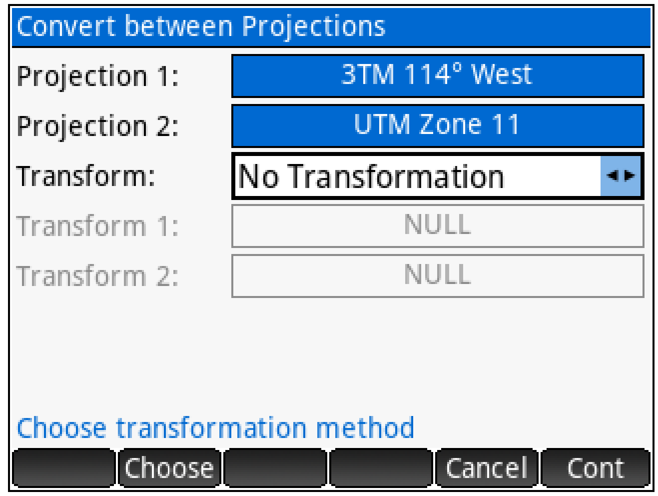
Results include all three coordinate representations, the point grid/elevation/combined factors, and the grid convergence angle at the point.





Grid1→Grid2 (Single Point)

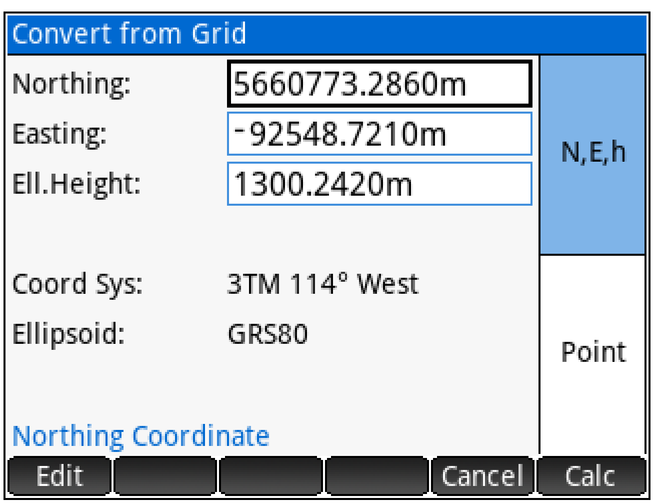
Convert a coordinate position from one grid projection to another. Both grid projections, the transformation method and the transformations parameters are selected prior to calculation. Available transformation methods include:

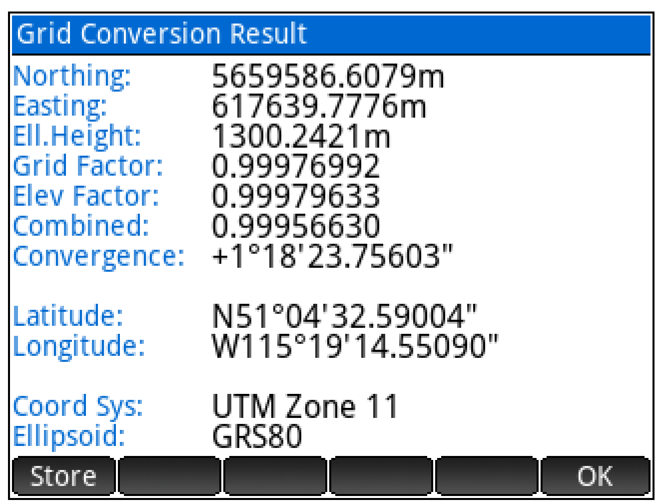


- **No Transformation** – Generally if both grid projections are based on the same ellipsoid, then no transformation is required.
- **Dual Step (via WGS84)** – When an intermediate reference frame is required to convert to and from. Frequently the transformation parameters are known to convert to WGS84, in this case the user MUST define the transformation parameters for both ***Transform 1*** and ***Transform 2*** to be TOWGS84. The first step transforms to WGS84 with the supplied parameters directly, the second step transforms from WGS84 by changing the signs of the transformation parameters. This is done to eliminate the need to have two sets of transformation parameters for typical use. See the Transformation Parameters section for more information.
- **Single Step (Direct)** – When the transformation parameters to convert directly from one reference frame to another are known.

Input can be grid coordinates (N,E,h), or grid coordinates from a point in the database. The vertical system from the Coordinate System settings is used for height entry. See elevations note next page.

The results include the position of the point in the second projection, the point grid/elevation/combined factors, the grid convergence angle at the point, and the geodetic coordinates of the point.



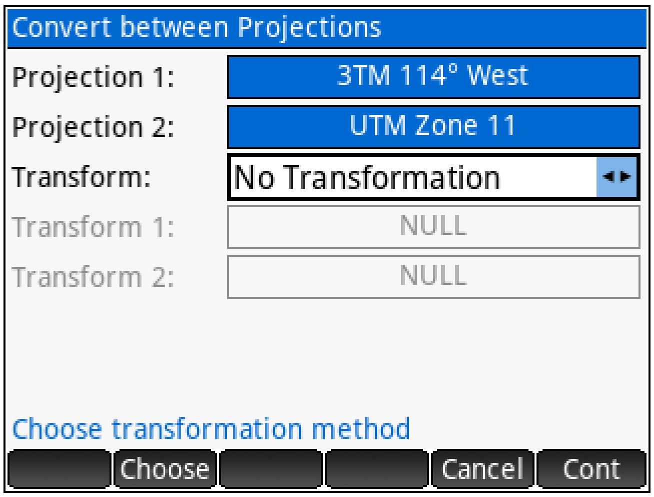


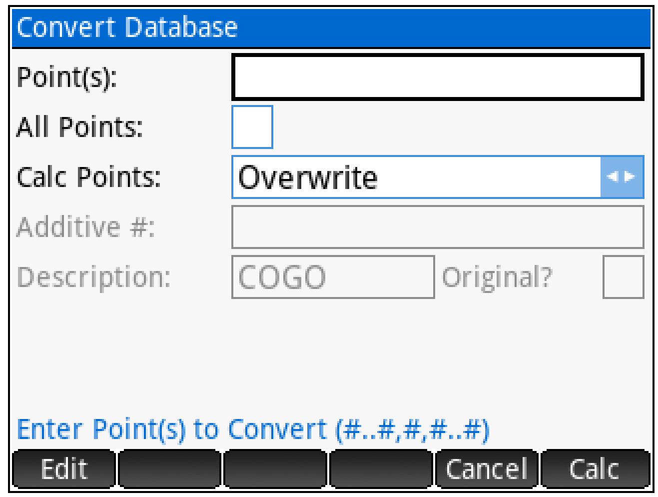
NOTE: When using transformations to transform points between projections based on different ellipsoids, the Vertical System should be set to ***Ellipsoidal*** to obtain meaningful height results.

Grid1→Grid2 (Convert Database)

Convert points in the project database from one grid projection to another. Both grid projections, the transformation method and the transformations parameters are selected prior to calculation. See previous section for more information on available transformation methods.

Next, enter the point range to convert the coordinates in the database and specify how to store the new coordinates.

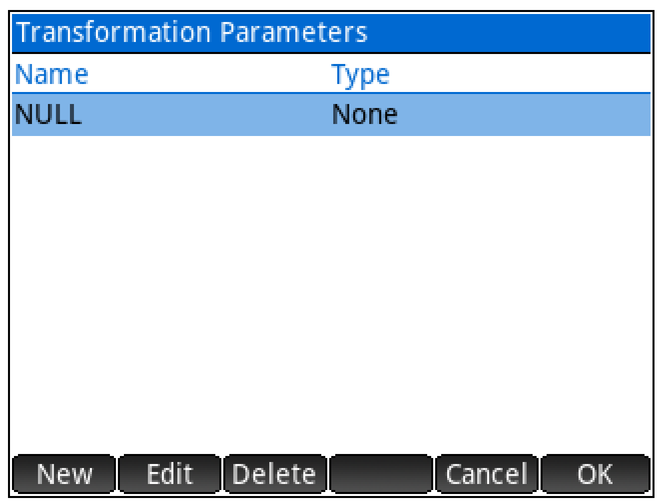




Transformation Parameters

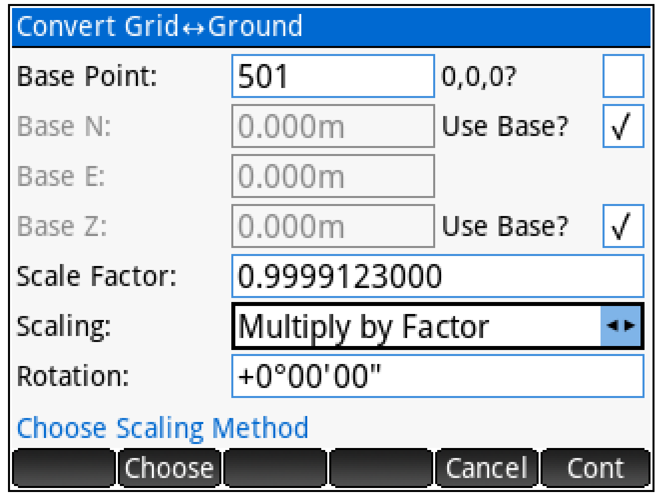
A default **NULL** transformation is included, it does nothing but can be useful in some cases. All other transformations can be defined as 3 or 7 parameter transformations. The menu can be used to create new transformations and edit or delete existing ones. Other types of transformations:

- **Bursa/Wolf** – Use the 7 Parameter in lieu of.
- **4 Parameter** – Use the 7 Parameter and set the 3 rotations to zero.
- **6 Parameter** – Use the 7 Parameter and set the scale parameter to zero.
- **Molodensky** – Use the 3 Parameter in lieu of.



Grid↔Ground (Single Point)

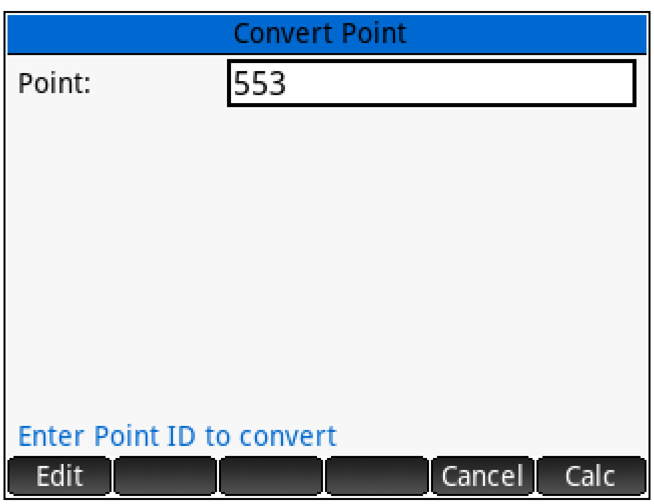
Land surveyors will often work with “ground-level” coordinates to eliminate the need to correct for a scale factor for distance/area/volume calculations; but for various reasons they also require the “geo-referenced” grid positions of their coordinates for other purposes. The grid/ground conversion tool is created to make the conversion from one to the other a simple task for any/all points in a project.

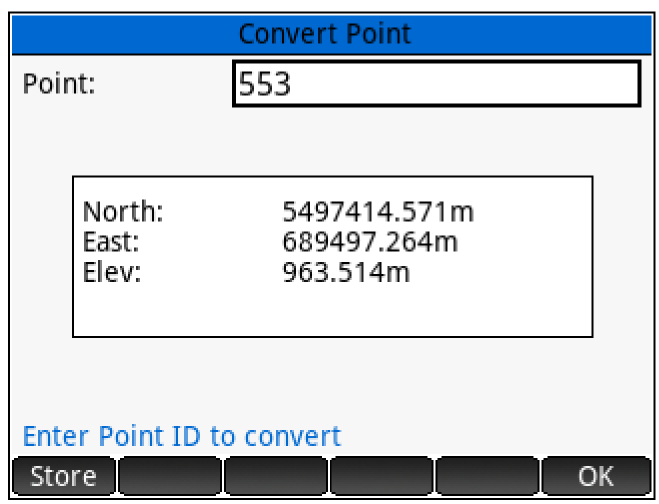


The parameters are defined and stored separately for each project and include:

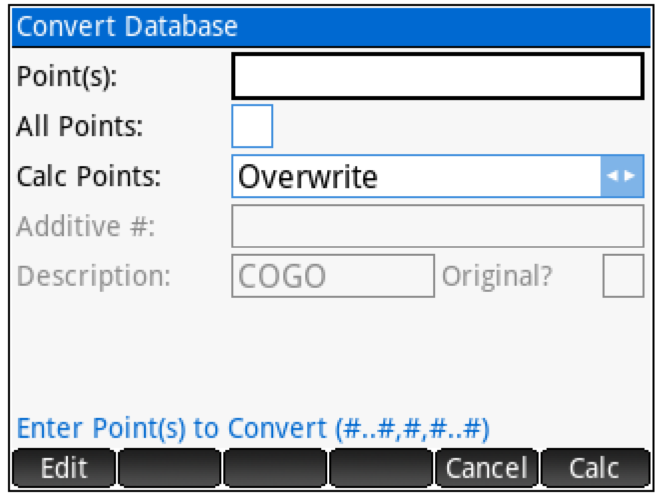
1. A base point from which any scaling and rotation is done. This can be set to the coordinate system origin 0,0,0.
2. The base point horizontal coordinates in the converted system (ground or grid). This can often be a common point with the same coordinates in both grid and ground, in which case the ***Use Base*** option applies. The shift is calculated between the base point and the given coordinates.
3. The base point elevation in the converted system (ground or grid). The shift is calculated between the base point and the given elevation.
4. The scale factor to scale the horizontal coordinates from the base point.
5. The scaling method, either multiply or divide by the given scale factor.
6. The rotation angle to rotate from the base point.

When the parameters are defined; enter any point number in the database to convert.





Grid↔Ground (Convert Database)



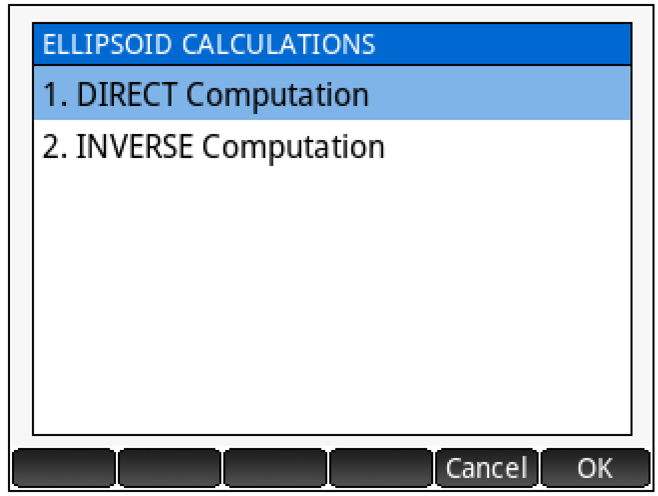
Convert multiple points in the database between grid and ground based on supplied parameters. See the previous section for information about the conversion parameters.

When the parameters are defined; enter the point range to convert the coordinates in the database and specify how to store the new coordinates.

8.5 Ellipsoid Calculations

DIRECT and INVERSE Computations on the ellipsoid are implemented using Vincenty's equations.

Position input for both types of calculations can be grid coordinates (N,E,h), geodetic coordinates (Φ,λ,h), cartesian coordinates (x,y,z), or grid coordinates from a point in the database.

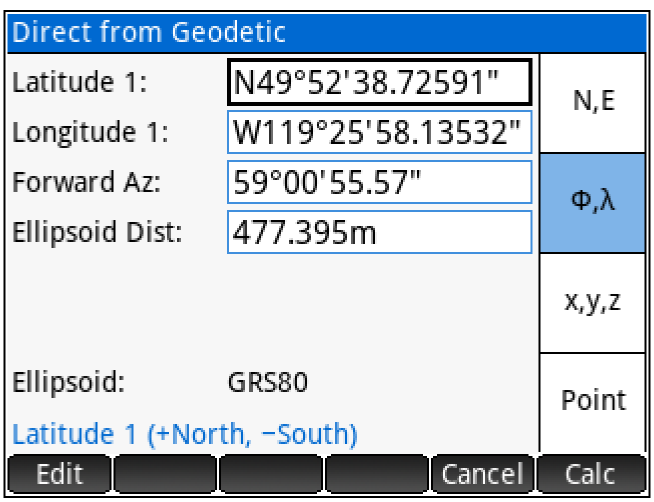


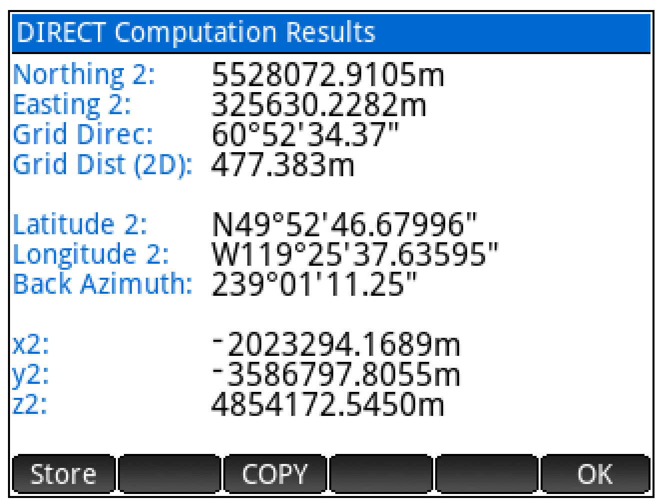
DIRECT Computation

Enter the position of the first point in any of the available formats and provide the forward azimuth and ellipsoidal distance to the second point.

The solution shows:

- ► The grid coordinates of the second point, the grid direction and grid distance to the second point
- ► The geodetic coordinates of the second point and the back azimuth.
- ► The cartesian coordinates of the second point.



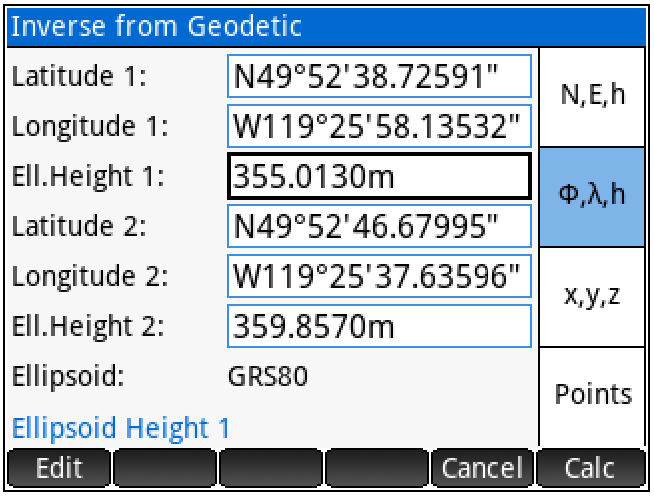


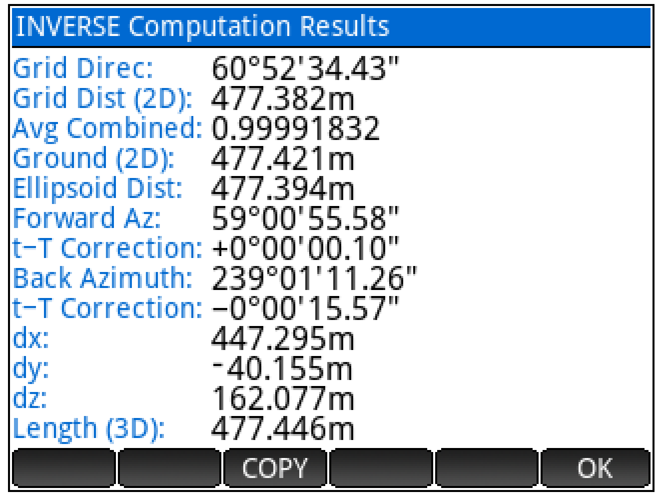
INVERSE Computation

Enter the positions of two points in any of the available formats

The solution shows:

- The grid direction, grid distance, the average combined factor and the ground distance between the two points.
- The ellipsoid distance, the forward and back azimuths between the two points.
- The cartesian deltas, and the 3D point to point vector length.





Appendix A

The table below includes the parameters used for the ellipsoid definitions in **SGS Prime COGO**.

$$b = a \times (1 - f)$$

$$f = (a - b) \div a$$

$$e' = \sqrt{\frac{a^2 - b^2}{a^2}}$$

$$e'' = \sqrt{\frac{a^2 - b^2}{b^2}}$$

Reference Ellipsoid	Defining and Calculated Parameters	
Clarke 1866 (NAD27)	**a = 6378206.4** f = 0.00339007530392879	**b = 6356583.8** 1/f = 294.978698213898
GRS80 (NAD83)	**a = 6378137** f = 0.00335281068118232	b = 6356752.31414036 **1/f = 298.257222101**
WGS84	**a = 6378137** f = 0.00335281066474748	b = 6356752.31424518 **1/f = 298.257223563**
International 1924 (Hayford)	**a = 6378388** f = 0.00336700336700337	b = 6356911.94612795 **1/f = 297**
Clarke 1880 (ARC)	**a = 6378249.145** f = 0.00340754619444173	b = 6356514.96639875 **1/f = 293.4663077**
Clarke 1880 (IGN)	**a = 6378249.2** f = 0.00340754952001565	**b = 6356515** 1/f = 293.466021293627
Clarke 1880 (RGS)	**a = 6378249.145** f = 0.00340756137869933	b = 6356514.86954978 **1/f = 293.465**
Airy 1830	**a = 6377563.396** f = 0.00334085064149708	b = 6356256.90923729 **1/f = 299.3249646**
Airy 1830 (Modified)	**a = 6377340.189** f = 0.00334085071675583	b = 6356034.44745858 **1/f = 299.3249575**
Australian National Spheroid	**a = 6378160** f = 0.00335289186923722	b = 6356774.71919531 **1/f = 298.25**
Krassovsky 1940	**a = 6378245** f = 0.00335232986925913	b = 6356863.01877305 **1/f = 298.3**
Bessel 1841	**a = 6377397.155** f = 0.00334277308160762	b = 6356078.96345955 **1/f = 299.1528218**
Parametry Zemli 1990 (PZ-90)	**a = 6378136** f = 0.00335281317789691	b = 6356751.30156878 **1/f = 298.257**