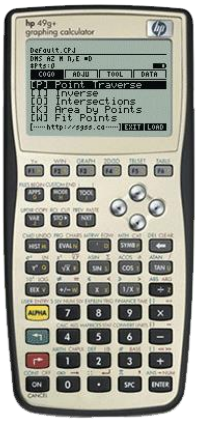
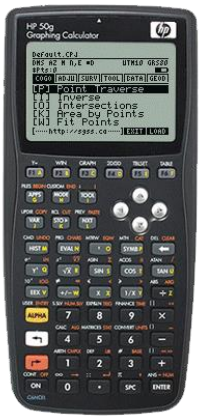




COGO+ VERSION 4.10

Reference Manual

January 19, 2017

Simple Geospatial Solutions

https://sgss.ca/

Table of Contents

1 Installation 1

1.1 Install COGO+ Pro or COGO+ Std with SD Card 1

Update with SD Card 3

1.2 Install COGO+ Pro or COGO+ Std with USB Cable 3

Update with USB Cable 4

1.3 Install COGO+ Lt on HP 48gii, 49g+ or 50g with USB Cable 5

Update with USB Cable 6

1.4 Install COGO+ Lt on HP 49g+ or 50g with SD Card 6

Update with SD Card 8

1.5 Install COGO+ Lt on m48+ for iPhone 8

Update on m48+ 10

1.6 Install COGO+ Lt on Emu48 for Windows 10

Update on Emu48 11

1.7 Running COGO+ 12

1.8 COGO+ Library Menu 12

First Page Menu 12

Second Page Menu 12

Third Page Menu 13

1.9 Activation Code 14

2 User Interface 15

2.1 Screen 15

2.2 Keyboard 17

2.3 Input Screens 18

Point Numbers 18

Directions 18
Angles 19
Distances 19
2.4 Input Forms 20
2.5 Choose Boxes 20
2.6 Output Screens 21
3 User Settings 22
3.1 Units 22
Angle Unit 22
Direction Reference 22
Primary Distance Unit 23
Foot Definition 23
3.2 Display 24
Angle Decimals 24
Distance Decimals 24
Coordinate Decimals 24
Coordinate Display 24
Stationing Display 24
Grade Display 24
3.3 General 25
ASCII File Extension 25
Scale Factor 25
Radius Tolerance 25
3.4 Toggles 25
Description Prompts 25
Codelist Translation 25

Adjusted Points 26
Point Traverse Mode 26
COGO Print 26
Font Size 26
3.5 Geodetic 27
Coordinate Groups 27
Coordinate Systems 27
Reference Ellipsoid 28
Mean Earth Radius 28
Custom Projections 29
3.6 Codelist 32
Add a Code 32
Delete a Code 32
Edit a Code 32
3.7 Cross Section Templates 33
Create a new Template 33
Delete a Template 33
Exit the Template Manager 33
Edit a Template 33
4 BACKUP.HP and RESTORE.HP 35
4.1 Backup 35
4.2 Restore 35
5 COGO Menu 36
5.1 Point Traverse 36
Standard Mode 36
Sideshot Mode 41

Curve Traverse 43
5.2 Inverse 44
Inverse Points 44
Inverse Curve 47
Inverse Angle 50
Inverse Point to Line 50
Inverse Point to Curve 51
Inverse Point to Alignment 52
5.3 Intersections 53
Bearing-Bearing 53
Bearing-Distance 54
Distance-Bearing 54
Distance-Distance 54
5.4 Area by Points 55
Area Subdivisions 56
5.5 Fit Points 60
Best Fit Line 60
Best Fit Curve 61
Double Proportion 63
Irregular Boundary Adjustment 64
Grant Boundary Adjustment 65
6 Adjustments Menu 66
6.1 Compass Rule 66
Closed Figure 66
Close to Fixed Point 68
6.2 Rotate/Mirror Points 69

Rotate Points 69
Mirror Points 70
6.3 Shift/Average Points 71
Shift Points by Northing/Easting/Elevation 71
Shift Points by Distance/Direction/Elevation 72
Shift Points by From/To Points 72
Average Points 73
3D to Plan 74
6.4 Scale Points 75
6.5 Helmerts 76
Add Control Pairs 77
Delete or Edit Control Pairs 77
Calculate Solution 77
Apply Transformation 78
7 Surveying Menu 79
7.1 Traverse Plus 79
Setup 79
Enter and Record 83
Stake Points 84
Stake Alignment 86
Reference Line 88
Reference Arc 90
7.2 Levelling 92
Manager 92
Working with a Levelling Job 93
7.3 Alignments 98

Alignment Manager 98
Working with an Alignment 99
7.4 Inaccessible Point 109
7.5 Plot Points 110
8 Tools Menu 111
8.1 Triangle Solver 111
Spherical Triangle Solver 112
8.2 Horizontal Curve Solver 113
Solve COORDinates 114
MORE Solvers 115
8.3 Vertical Curve Solver 120
Grades + Length 121
Elevations + Length 122
Fixed Point + VPI 123
Fixed Point + BVC 124
Slope Intersection 125
Solution Screen and Calculations 126
8.4 Bearing<>Azimuth 128
8.5 Configure Settings 129
Save to Flash 129
Restore from Flash 129
9 Data Menu 130
9.1 Job Manager 130
Create a New Job 130
Delete a Job 131
Job Information 131

Job Options 132
9.2 Store New Point 133
9.3 Review Points 134
View Point Coordinates 134
Renumber Points 135
9.4 Delete Points 136
9.5 Import/Export 137
Import ASCII points 137
Export ASCII points 138
Export DXF File 139
Export KML File 140
Export Lat/Long ASCII File 141
Import Codelist 142
Export Codelist 142
10 Geodetic Menu 143
10.1 Conversions 143
Grid to Geodetic 143
Geodetic to Grid 144
10.2 Ellipsoid Calculations 145
Direct Calculation 145
Inverse Calculation 146
Appendix A 148

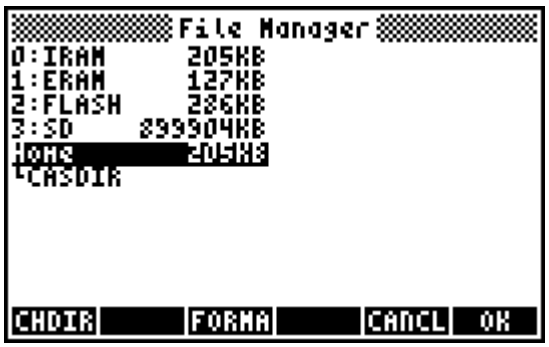
1 Installation

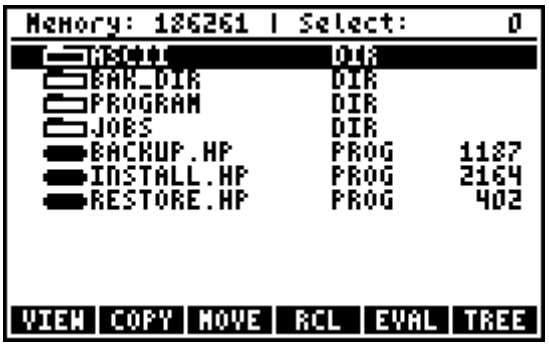
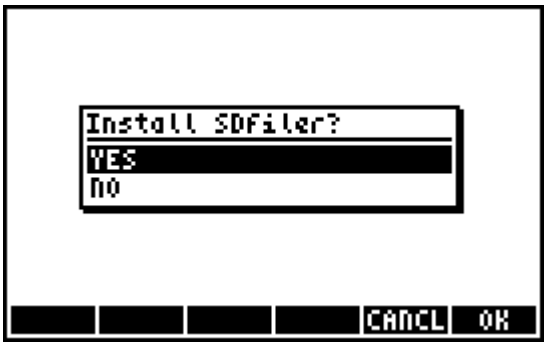
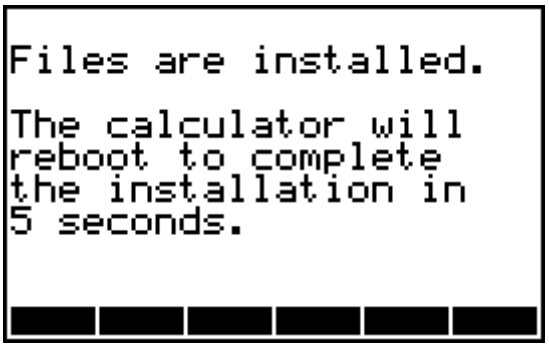
You can install and preview ***COGO+ Pro***, ***COGO+ Std*** or ***COGO+ Lt*** prior to purchasing an Activation Code. The software functions in a DEMO mode until activation.

1.1 Install COGO+ Pro or COGO+ Std with SD Card

Installation requirements:

1. Internet connection to download files
2. Software to unzip *.zip files, such as 7-Zip
3. SD card NOTE: THE 49G+ AND 50G CALCULATORS DO NOT RECOGNIZE SDHC CARDS, A SD CARD IS 2 GB OR SMALLER CAPACITY.
4. SD card reader to transfer the files to the SD card
5. HP 49g+ or 50g calculator. NOTE: FOR COGO+ TO FUNCTION AS INTENDED YOU SHOULD HAVE ROM VERSION 2.00 OR LATER INSTALLED, OLDER 49G+ CALCULATORS MAY REQUIRE A ROM UPDATE.
6. Minimum 125KB of free space in the HOME directory of your calculator

Step	Description
Step 1	Download and save the COGOpro.zip or COGOstd.zip file on your computer.
Step 2	Extract the contents of the zip file. This can usually be achieved by 'right-clicking' on the file and selecting "Extract here" or "Extract files" or similar. THE RESULT SHOULD BE A DIRECTORY NAMED COGOPLUS WITH FILES AND SUB-DIRECTORIESS WITHIN IT.
Step 3	Copy the entire COGOPLUS directory to your SD card. IT IS IMPORTANT TO PLACE THIS DIRECTORY INTO THE ROOT DIRECTORY OF THE SD CARD AND NOT INTO SOME DIRECTORY THAT EXISTS ON YOUR SD CARD.
Step 4	Insert your SD card into your calculator's card slot and open the File Manager. TO OPEN THE FILE MANAGER USE ↰, THEN APPS KEY. 
Step 5	Press the 3 key to browse the SD card, or select **3:SD** and press the ▶ key.
Step 6	Locate the COGOPLUS directory on the SD card, then select it and press the ▶ key to browse the directory.

Step 7	Select the INSTALL.HP program and press F5 **EVAL** to run the installation program. NOTE: USE THE BACKUP.HP FILE IN THE DIRECTORY TO CREATE BACKUPS AT ANY TIME. THE RESTORE.HP FILE RESTORES A SAVED BACKUP. SEE Chapter 4 FOR MORE INFORMATION ON BACKING UP AND RESTORING THE CALCULATOR.	
Step 8	A backup prompt provides the option to back up your calculator before installing the software. If you choose to back up your calculator, you will need to enter a name to store the backup file. ALL BACKUPS ARE STORED IN THE COGOPLUS\BAK_DIR DIRECTORY ON THE SD CARD.	
Step 9	The program displays the name of the file that is currently being installed. For example "Installing L930.HP" is shown while installing Library 930. FIVE SEPARATE LIBRARIES WILL BE INSTALLED (930, 931, 932, 933 AND 934) WITH COGO+ PRO, WHILE FOUR LIBRARIES (930, 931, 932 AND 933) ARE INSTALLED WITH COGO+ STD.	
Step 10	The option to install ***SDfiler*** is presented if the software is not already installed. SDFILER IS A THIRD PARTY APPLICATION THAT WILL BE OF BENEFIT TO ANYONE EXPORTING ASCII FILES TO THE SD CARD AND IMPORTING THESE FILES INTO CAD OR VIEWING THEM ON THE COMPUTER. TWO ADDITIONAL LIBRARIES WILL BE INSTALLED (935 AND 936) FOR THE SDFILER APPLICATION.	
Step 11	A screen displays the message that all files have been installed and a six second countdown begins until the calculator automatically reboots to complete the installation.	

Update with SD Card

To update ***COGO+ Pro*** or ***COGO+ Std*** with your SD card simply follow the same instructions as for a fresh installation. Overwrite all existing files when copying a new COGOPLUS directory to the SD card by choosing "Yes to all" to replace the old files with the latest files. Any additional files you have stored within the COGOPLUS directory will be left intact.

1.2 Install COGO+ Pro or COGO+ Std with USB Cable

Installation requirements:

1. Internet connection to download files
2. Software to unzip *.zip files, such as 7-Zip
3. HP Calculator Connectivity Kit (Conn4x) available from HP Website
4. HP 49g+ or 50g calculator. NOTE: FOR COGO+ TO FUNCTION AS INTENDED YOU SHOULD HAVE ROM VERSION 2.00 OR LATER INSTALLED, OLDER 49G+ CALCULATORS MAY REQUIRE A ROM UPDATE.
5. Minimum 125KB of free space in the HOME directory of your calculator

NOTE: These instructions are for the Windows Operating System and are provided to allow installation with the minimum available memory on the calculator.

Step	Description
Step 1	Download and save the COGOpro.zip or COGOstd.zip file on your computer.
Step 2	Extract the contents of the zip file. This can usually be achieved by 'right-clicking' on the file and selecting "Extract here" or "Extract files" or similar. THE RESULT SHOULD BE A DIRECTORY NAMED COGOPLUS WITH FILES AND SUB-DIRECTORIES WITHIN IT.
Step 3	Locate and open the COGOPLUS directory and then open the PROGRAM sub-directory. If you downloaded the COGOpro.zip file you should see L930.HP, L931.HP, L932.HP, L933.HP, L934.HP, L935.HP and L936.HP in this sub-directory. You will be missing the L934.HP file if you downloaded the COGOstd.zip file.
Step 4	Connect your calculator to the USB cable and start the Connectivity Software, then from the File Menu select "Connect" to start the connection.
Step 5	Drag and drop the first file L930.HP from the PROGRAM sub-directory on your computer into your HOME directory on the calculator.

Step 6	Disconnect (File Menu/Disconnect) from the connectivity kit following the transfer. Next, on your calculator you should see the softkey for F1 A labelled **L930** , if not press the VAR key. Press F1 A to recall the library file to the stack, then enter 2 STO to store library 930 in Port 2.	
Step 7	Purge the L930 variable by quoting it and entering the command PURGE. To quote the L930 variable, press the ' key followed by F1 A.	
Step 8	Repeat steps 4-7 for L931.HP, L932.HP, L933.HP and L934.HP if installing ***COGO+ Pro***, or just for L931.HP, L932.HP and L933.HP if installing ***COGO+ Std***.	
Step 9	Reboot (warmstart) the calculator to complete the installation. HOLD DOWN THE ON KEY AND PRESS THE F3 C KEY, THEN RELEASE BOTH TO REBOOT.	

Update with USB Cable

To update ***COGO+ Pro*** or ***COGO+ Std*** using the Connectivity Kit software, first delete the existing libraries from Port 2 then follow the same instructions as for a fresh installation. To delete a library from a Port, enter the Port and Library ID in the format :Port:LibID, for example :2:930, followed by the PURGE command. Repeat this step for libraries 931, 932, 933 and 934.

LIBRARIES MAY ALSO BE DELETED BY USING THE FILE MANAGER.

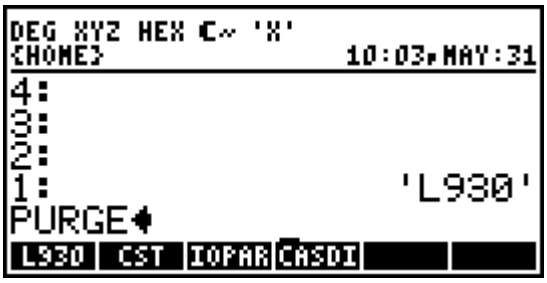
1.3 Install COGO+ Lt on HP 48gii, 49g+ or 50g with USB Cable

Installation requirements:

1. Internet connection to download files
2. Software to unzip *.zip files, such as 7-Zip
3. HP Calculator Connectivity Kit (Conn4x) available from HP Website
4. HP 48gii calculator
5. Minimum 100KB of free space in the HOME directory of your calculator. NOTE: THERE ARE TWO VERSIONS OF THE 48GII PRODUCED. THE EARLIER VERSION DOES NOT HAVE ENOUGH MEMORY TO RUN COGO+ LT. THE LATER VERSION HAS FOUR BATTERIES, BOTH USB AND SERIAL CONNECTORS, AND MORE MEMORY.

NOTE: These instructions are for the Windows Operating System and are provided to allow installation with the minimum available memory on the calculator.

Step	Description
Step 1	Download and save the COGOlt48.zip file on your computer if installing on the 48gii, or download and save the COGOlt50.zip file on your computer if installing on the 49g+ or 50g.
Step 2	Extract the contents of the zip file. This can usually be achieved by 'right-clicking' on the file and selecting "Extract here" or "Extract files" or similar. THE RESULT SHOULD BE A DIRECTORY NAMED COGOPLUS WITH THREE FILES IN IT.
Step 3	Locate and open the COGOPLUS directory, you should see L930.HP, L931.HP and L932.HP in this directory.
Step 4	Connect your calculator to the USB cable and start the Connectivity Software, then from the File Menu select "Connect" to start the connection.
Step 5	Drag and drop the first file L930.HP from the COGOPLUS directory on your computer into your HOME directory on the calculator.
Step 6	Disconnect (File Menu/Disconnect) from the connectivity kit following the transfer. Next, on your calculator you should see the softkey for [F1 A] labelled **L930**, if not press the [VAR] key. Press [F1 A] to recall the library file to the stack, then enter 0 STO to store library 930 in Port 0. On the 50g it is recommended to store the libraries into Port 2 by entering 2 STO instead of 0 STO. 

Step 7	Purge the L930 variable by quoting it and entering the command PURGE. To quote the L930 variable, press the ['] key followed by [F1 A].	
Step 8	Repeat steps 4-7 for L931.HP and L932.HP.	
Step 9	Reboot (warmstart) the calculator to complete the installation. HOLD DOWN THE [ON] KEY AND PRESS THE [F3 C] KEY, THEN RELEASE BOTH TO REBOOT.	

Update with USB Cable

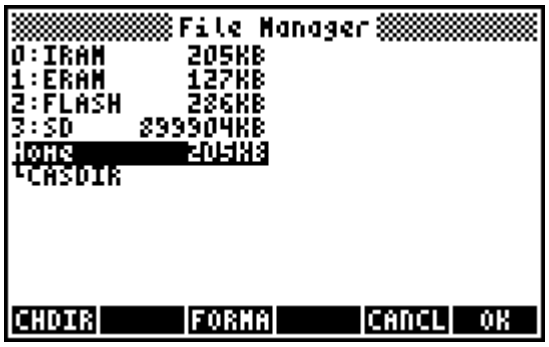
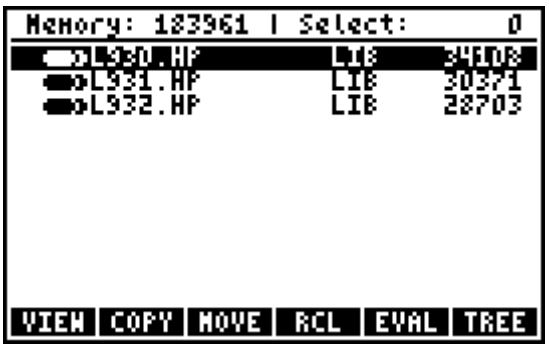
To update ***COGO+ Lt*** using the Connectivity Kit software, first delete the existing libraries from Port 0 then follow the same instructions as for a fresh installation. To delete a library from a Port, enter the Port and Library ID in the format :Port:LibID, for example :0:930, followed by the PURGE command. Repeat this step for libraries 931 and 932. LIBRARIES MAY ALSO BE DELETED BY USING THE FILE MANAGER.

1.4 Install COGO+ Lt on HP 49g+ or 50g with SD Card

Installation requirements:

1. Internet connection to download files
2. Software to unzip *.zip files, such as 7-Zip
3. SD card NOTE: THE 49G+ AND 50G CALCULATORS DO NOT RECOGNIZE SDHC CARDS, A SD CARD IS 2 GB OR SMALLER CAPACITY.
4. SD card reader to transfer the files to the SD card
5. HP 49g+ or 50g calculator. NOTE: FOR COGO+ TO FUNCTION AS INTENDED YOU SHOULD HAVE ROM VERSION 2.00 OR LATER INSTALLED, OLDER 49G+ CALCULATORS MAY REQUIRE A ROM UPDATE.
6. Minimum 125KB of free space in the HOME directory of your calculator

Step	Description
Step 1	Download and save the COGOlt50.zip file on your computer.

Step 2	Extract the contents of the zip file. This can usually be achieved by 'right-clicking' on the file and selecting "Extract here" or "Extract files" or similar. THE RESULT SHOULD BE A DIRECTORY NAMED COGOPLUS WITH THREE FILES IN IT.
Step 3	Copy the entire COGOPLUS directory to your SD card.
Step 4	Insert your SD card into your calculator's card slot and open the File Manager. TO OPEN THE FILE MANAGER USE ↰, THEN APPS KEY. 
Step 5	Press the 3 key to browse the SD card, or select **3:SD** and press the ▶ key.
Step 6	Locate the COGOPLUS directory on the SD card, then select it and press the ▶ key to browse the directory.
Step 7	Select the L930.HP library file and press F2 **COPY** to copy the file. 
Step 8	Note the message at the top of the screen "PICK DESTINATION". Select 2:FLASH and press F6 **OK**. The calculator returns to the SD directory when the file copy is completed. 
Step 9	Repeat Steps 7 and 8 for L931.HP and L932.HP.
Step 10	Reboot (warmstart) the calculator to complete the installation. HOLD DOWN THE ON KEY AND PRESS THE F3 C KEY, THEN RELEASE BOTH TO REBOOT.

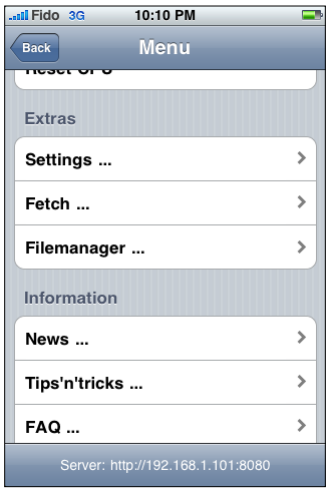
Update with SD Card

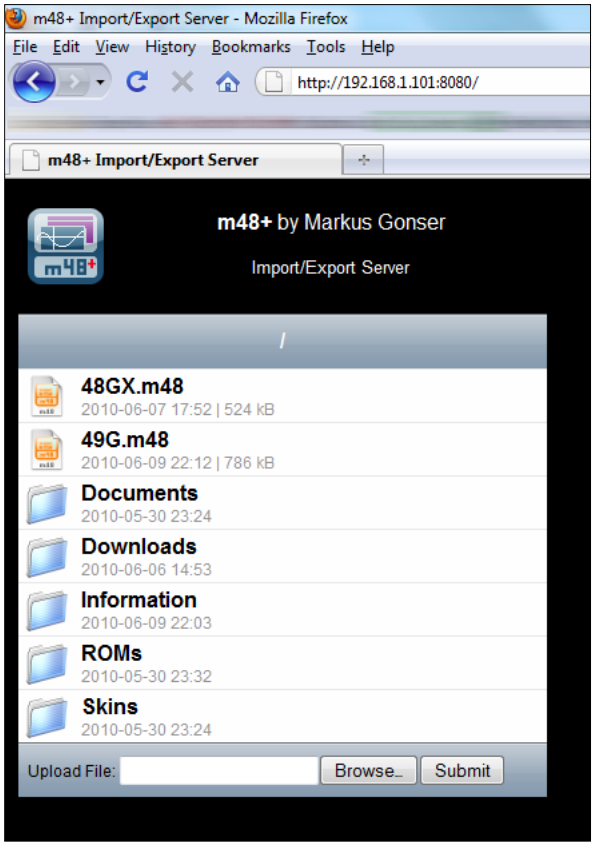
To update ***COGO+ Lt*** with SD Card, first delete the existing libraries from Port 0, 1 or 2 then follow the same instructions as for a fresh installation. To delete a library from a Port, enter the Port and Library ID in the format :Port:LibID, for example :0:930, followed by the PURGE command. Repeat this step for libraries 931 and 932. LIBRARIES MAY ALSO BE DELETED BY USING THE FILE MANAGER.

1.5 Install COGO+ Lt on m48+ for iPhone

Installation requirements:

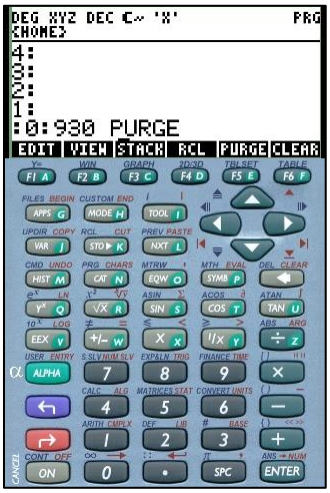
1. Internet connection to download files
2. Software to unzip *.zip files, such as 7-Zip
3. iPhone, iPod Touch or iPad
4. m48+ App installed on your device, available at the App Store
5. HP 49g calculator setup on m48+ as per the instructions under "Tips'n'tricks …"
6. Minimum 100KB of free space in the HOME directory of your m48+ calculator
7. PC or Mac with Wi-Fi internet connection

Step	Description
Step 1	Download and save the COGOlt48.zip file on your computer.
Step 2	Extract the contents of the zip file. This can usually be achieved by 'right-clicking' on the file and selecting "Extract here" or "Extract files" or similar. THE RESULT SHOULD BE A DIRECTORY NAMED COGOPLUS WITH FILES AND SUB-DIRECTORIES WITHIN IT. MAKE A NOTE OF WHERE YOU SAVED THIS DIRECTORY.
Step 3	Under "Settings" within the m48+ App "Enable on WLAN" for the Import/Export Server. The server IP address will be visible when you return back to the "Menu".  

Step 4	Enter the IP address into your browser to start the Import/Export. Next open the directory within the Import/Export Server window where you wish to save the files to, for example a 'Downloads' directory. Next click "Browse.." to locate the COGOPLUS directory that was extracted earlier. Open the directory and select one of the files (L930.HP, L931.HP or L932.HP) and click "Submit". Repeat for the other files so that all three files are transferred. You may disable "Enable on WLAN" once all files are transferred.	
Step 5	Select 'Load Object' from the Menu and find the L930.HP, L931.HP and L932.HP files.	 

Step 6	Select one of the files and return to the calculator to store it into Port 0 and then repeat for the other files.	 
Step 7	Reboot (warmstart) the calculator to complete the installation. HOLD DOWN THE ON KEY AND PRESS THE F3 C KEY, THEN RELEASE BOTH TO REBOOT.	

Update on m48+



To update ***COGO+ Lt*** on m48+, first delete the existing libraries from Port 0 then follow the same instructions as for a fresh installation. To delete a library from a Port, enter the Port and Library ID in the format :Port:LibID, for example :0:930, followed by the PURGE command. Repeat this step for libraries 931 and 932. LIBRARIES MAY ALSO BE DELETED BY USING THE FILE MANAGER.

1.6 Install COGO+ Lt on Emu48 for Windows

Installation requirements:

1. Internet connection to download files
2. Software to unzip *.zip files, such as 7-Zip
3. Emu48 installed on your Windows PC, Emu48 is included with Debug4x
4. HP 48gii or 49g calculator setup on Emu48
5. Minimum 100KB of free space in the HOME directory of your Emu48 calculator

Step	Description
Step 1	Download and save the COGOlt.zip file on your computer.

Step 2	Extract the contents of the zip file. This can usually be achieved by 'right-clicking' on the file and selecting "Extract here" or "Extract files" or similar. THE RESULT SHOULD BE A DIRECTORY NAMED COGOPLUS WITH FILES AND SUB-DIRECTORIES WITHIN IT. MAKE A NOTE OF WHERE YOU SAVED THIS DIRECTORY.
Step 3	Open Emu48 and load your 48gii or 49g calculator
Step 4	From the "Edit" drop-down menu select "Load Object…" and browse to the COGOPLUS directory. Select one of the files and return to the calculator to store it into Port 0 and then repeat for the other files. 
Step 5	Reboot (warmstart) the calculator to complete the installation. CLICK THE [ON] KEY AND PRESS THE [F3 C] KEY, THEN RELEASE BOTH TO REBOOT.

Update on Emu48

To update ***COGO+ Lt*** on Emu48, first delete the existing libraries from Port 0 then follow the same instructions as for a fresh installation. To delete a library from a Port, enter the Port and Library ID in the format :Port:LibID, for example :0:930, followed by the PURGE command. Repeat this step for libraries 931 and 932. LIBRARIES MAY ALSO BE DELETED BY USING THE FILE MANAGER.

1.7 Running COGO+

Once installed, there are several ways to run the software. All the options should work regardless of RPN or ALGebraic mode set and should be consistent across all three editions of ***COGO+***.

1. Open the library menu by using [↱] then [2]. This will display all the libraries installed on the calculator as softkeys. Find the softkey labeled **COGO+** and press it to reveal the available commands within the library. Press [F1] **COGO+** to start the software.
2. Lock Alpha mode and enter the command name ***COGO+*** directly.
3. Press the [APPS] key to open the applications menu. Somewhere near the bottom of the list will be an entry similar to *15.SGS COGO+ Pro*. The number in front of the name may vary.

1.8 COGO+ Library Menu

When you open the library menu by using [↱] then [2] and selecting **COGO+**, you will see a full row of softkeys. There are three pages of available commands, use the [NXT] key to cycle through the menu pages.

First Page Menu

1. [F1] **COGO+** - Starts the COGO+ software.
2. [F2] **DMS->** - Converts a number on the stack from DMS to decimal degrees.
3. [F3] **->DMS** – Converts a number on the stack from decimal degrees to DMS.
4. [F4] **DMS+** - Adds the DMS number on Level 1 of the stack to the DMS number on Level 2 of the stack.
5. [F5] **DMS-** - Subtracts the DMS number on Level 1 of the stack from the DMS number on Level 2 of the stack.
6. [F6] **DMSx** - Multiplies the DMS number on Level 2 of the stack by the factor (decimal) on Level 1 of the stack.

Second Page Menu

1. [F1] **DMS/** - Divides the DMS number on Level 2 of the stack by the factor (decimal) on Level 1 of the stack.
2. [F2] **BACKU** - Launches the BACKUP.HP program from the COGOPLUS directory on the SD card to create a calculator backup. The full command name is **BACKUPsgs**. SD CARD WITH THE COGOPLUS DIRECTORY IS REQUIRED.

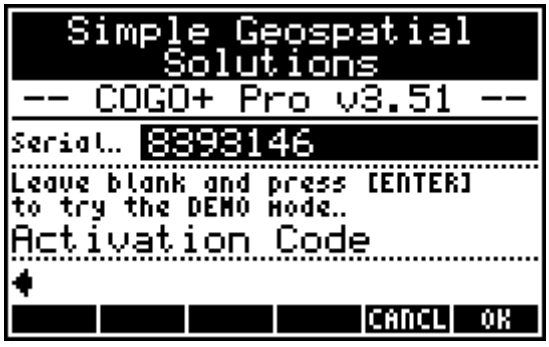
3. F3 **RESTO** - Launches the RESTORE.HP program from the COGOPLUS directory on the SD card to restore a previously saved backup. The full command name is **RESTOREsgs**. SD CARD WITH THE COGOPLUS DIRECTORY IS REQUIRED.
4. F4 **UPDAT** - Launches the INSTALL.HP program from the COGOPLUS directory on the SD card to update ***COGO+*** to the latest files that are stored in the COGOPLUS/PROGRAM directory, the full command name is **UPDATEsgs**. SD CARD WITH THE COGOPLUS DIRECTORY IS REQUIRED.
5. F5 **RCLsg** - Recalls the 3D coordinates of a point number in the current ***COGO+*** job. With a point number on Level 1 of the stack, invoke this command to return the Northing on Level 4 of the stack, the Easting on Level 3 of the stack, the Elevation on Level 2 of the stack, and the number 1 on Level 1 of the stack to indicate a successful operation. When the point does not exist, only the number 0 is returned on Level 1 of the stack. The full command name is **RCLsgs**.
6. F5 **STOsg** - Stores the 3D coordinates from the stack to a point in the current ***COGO+*** job. With the Northing on Level 4 of the stack, the Easting on Level 3 of the stack, the Elevation on Level 2 of the stack, and the point number on Level 1 of the stack; this command will store the coordinates. A overwrite prompt ensures existing points are not accidentally overwritten, and all points stored this way will receive the point descriptor SGSsto. The full command name is **STOsgs**.

Third Page Menu

1. F1 **op911** - Emergency 2 step data recovery operation that attempts to correct corrupt memory issues on the calculator. All ***COGO+*** data will be lost during this operation, however the user variables in the HOME directory should be intact after the operation is complete. Step 1 saves all the data from HOME to a temporary place on the SD card, the user then performs a hard reset and runs Step 2 to restore the HOME directory. This method does not guarantee success, but is recommended to try to save the HOME directory before performing a hard reset to restore the calculator to factory settings. SD CARD IS REQUIRED.
2. F2 **SGS** - Displays the ***Simple Geospatial Solutions*** logo on the screen.
3. F3 **about** - Displays information about the installed ***COGO+*** version, the calculator serial number and activation code and contact information for ***Simple Geospatial Solutions***. The full command name is **aboutCOGO+**.

1.9 Activation Code

An activation screen appears when you run the software for the first time, or any time prior to activation. Enter your code to activate the software or leave blank to try the DEMO mode.



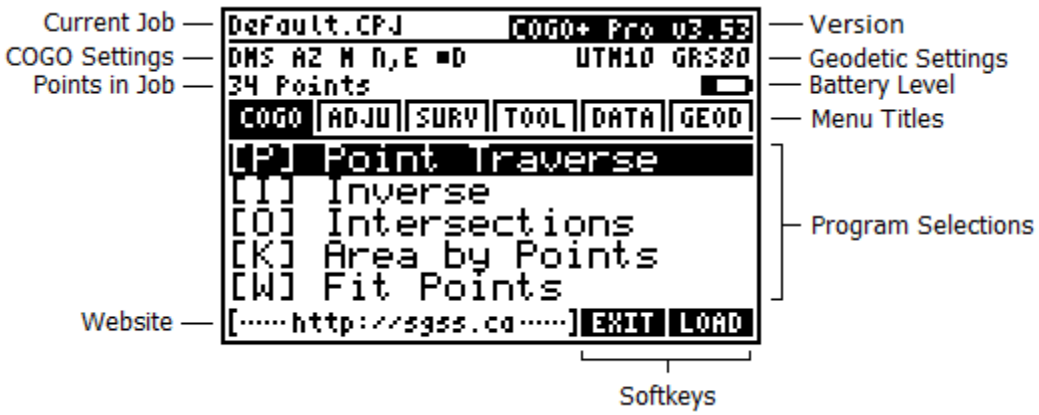
The serial number required to generate the activation code is displayed on this screen. ***You will need this serial number when you purchase the activation code.***

THE DEMO MODE PROVIDES LIMITED FUNCTIONALITY AND IS INTENDED TO ALLOW AN EVALUATION OF THE SOFTWARE PRIOR TO PURCHASING AN ACTIVATION CODE.

2 User Interface

2.1 Screen

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



Item	Description
Current Job	Displays the current job name. ALL JOBS ARE AUTOMATICALLY SAVED WITH A *.CPJ EXTENSION.
Version	Displays the version number of the installed COGO+ software.
COGO Settings	Displays some of the available user settings. ▪ **DMS** (360° ‘ “) **DEG** (360° decimal) **GRD** (400 gons) indicates current Angle Unit setting. ▪ **AZ** (North Azimuth) **SA** (South Azimuth) **QB** (Quadrant Bearings) indicates current direction reference setting. ▪ **M** (Metres) **F** (Feet) indicates the current Primary Distance Unit setting. ▪ **N,E** (Northing Easting) **E,N** (Easting Northing) **X,Y** (X-Coord, Y-Coord) indicates current coordinate order and label setting. ▪ **■D** (Descriptions ON) **_D** (Descriptions OFF) indicates if the description prompt toggle is set ON or OFF.
Geodetic Settings	Displays the coordinate system and reference ellipsoid set.
Points in Job	Displays the number of points stored in the current job.
Battery Level	Displays the battery level or **USB.** USB power source is possible for HP 50g only.

Menu Titles	Displays the short titles of all menus, with the current menu name highlighted. ▪ **COGO** menu ▪ **ADJU**stments menu ▪ **SURV**eying menu ▪ **TOOL**s menu ▪ **DATA** Manager menu ▪ **GEOD**etic menu
Program Selections	Displays the available programs within each menu, with the currently selected program name highlighted.
Website	Displays the ***Simple Geospatial Solutions*** website address. The website provides software updates and documentation.
Softkeys	Displays the two softkeys available from the main user interface. F5 **EXIT** exits ***COGO+***, while F6 **LOAD** loads the currently selected program.

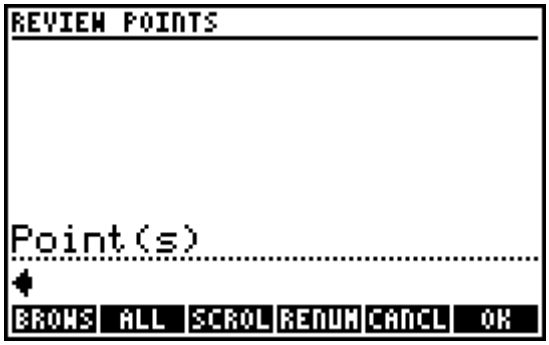
2.2 Keyboard

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. Pressing ENTER or F6 **LOAD** will load the currently selected program, pressing ON or F5 **EXIT** will exit ***COGO+***. Each of the programs is also directly available through shortcut keys to eliminate the need to navigate the menus. The following table lists the shortcuts in alphabetic/numeric order:

Key	Program	Key	Program
F1 A	Not Assigned	SIN S	Alignments
F2 B	Bearing <> Azimuth Conversions	COS T	Traverse Plus
F3 C	Grid <> Geodetic Conversions	TAN U	Plot Points
F4 D	Ellipsoid Calculations	EEX V	Vertical Curve Solver
APPS G	Triangle Solver	+/- W	Fit Points
MODE H	Horizontal Curve Solver	X X	Import/Export ASCII files
TOOL I	Inverse	1/X Y	Configure Settings
VAR J	Job Manager	÷ Z	Inaccessible Point
STO▶ K	Area by Points	1	Compass Rule Adjustments
NXT L	Levelling	2	Rotate Points
HIST M	Not Assigned	3	Shift/Average Points
EVAL N	Store/Edit Points	4	Scale Points
' O	Intersections	5	Helmert Transformation
SYMB P	Point Traverse		
Y^x Q	Delete Points		
$\sqrt{X}$ R	Recall Points		

2.3 Input Screens

Input screens accept a single line of user input. Some input screens feature a softmenu with additional options. Point numbers, directions, angles, and distances are common input types. NOTE: THE FONT SIZE TOGGLE SETTING CONTROLS THE FONT SIZE OF INPUT LABELS, FOR EXAMPLE *Points(s)* IN THE SCREEN CAPTURE.



Point Numbers

A single point number can be input by simply entering the number. The F1 **BROWS** softkey opens the point browser to review and/or select an existing point in the current job. 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.
- Often a softkey labelled **ALL** is available to select all points in the current job.

Directions

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

- Enter a 360°'" azimuth 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'.

Angles

Angles work in a similar fashion as azimuths/bearings except that the input MUST be a real number or a complex calculation involving only real numbers. In some cases a softkey labelled **CALC** or similar will allow the angle to be calculated in a separate input form.

Distances

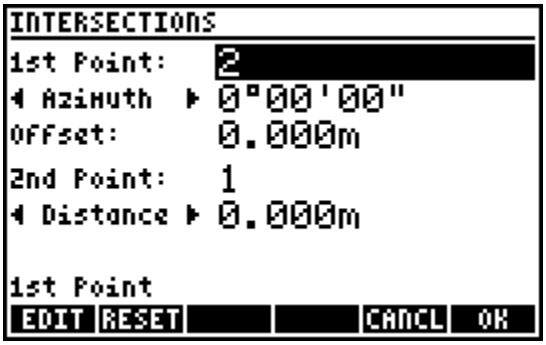
Distance input is similar to direction input:

- 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.

NOTE: With a complex input entered in the command line of an input screen, you can press the EVAL key to EVALuate the input before using it. This allows the user to see the result of a calculation input before proceeding.

2.4 Input Forms

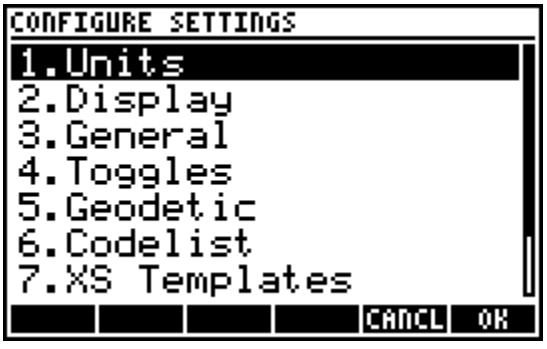
Input forms accept multiple inputs on one screen. Each field in an input form behaves differently depending on the type of input. Point numbers, directions, angles and distances are all entered the same as in input screens. Current display settings control the appearance of each field.

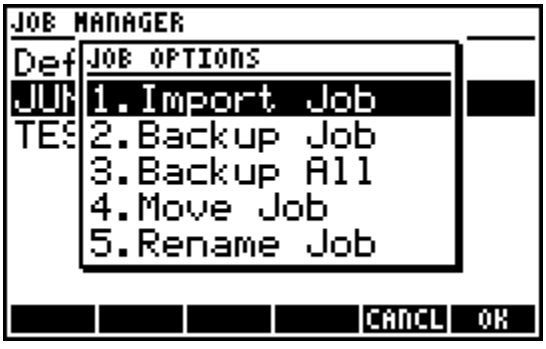


- Some field labels contain arrows to indicate that there are different possible inputs for that field. For example, the *< Azimuth >* and *< Distance >* labels in the screen capture above. The ◀ and ▶ cursor keys toggle between the available selections which changes the field label.
- The menu may change dynamically when the current field changes or when the command line becomes active, to allow for calculations, etc.
- If the current field is a choose field, then a F2 **CHOOS** softkey is displayed. The ◀ and ▶ cursor keys also toggle choose field selections.
- The menus in the input forms often offer a range of options that may not be directly available in the form itself, including jumping to a different input form, etc.

2.5 Choose Boxes

Choose boxes present a list of multiple options from which to choose. Some choose boxes are full screen while others are not. The CONFIGURE SETTINGS choose box is an example of a full screen choose box, while the JOB OPTIONS choose box in the Job Manager is the pop-up style. The ▲ and ▼ cursor keys change the selection, F6 **OK** or ENTER loads the selection and F5 **CANCL** or ON closes the choose box. NOTE: THE FONT SIZE TOGGLE SETTING CONTROLS THE FONT SIZE OF THE CHOOSE ITEMS.



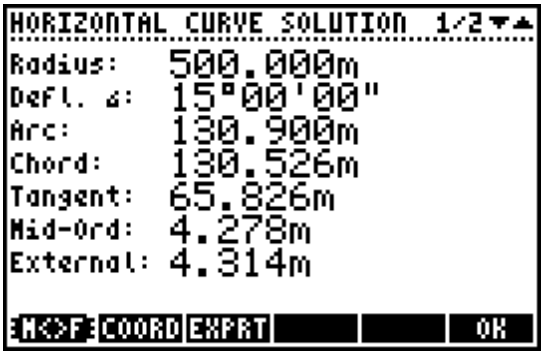


2.6 Output Screens

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 F6 **OK** softkey. Some output screens consist of multiple pages; use the ▲ and ▼ cursor keys to change the current page. Output screens with multiple pages have a label on the upper right-hand corner of the screen displaying the current page and the total number of pages.

Most output screens allow the user to adjust the number of displayed decimals.

- Use the + and − keys to adjust the distance decimals.
- Use the ← followed by + or − to adjust the azimuth/bearing decimals.
- Use → followed by + or − to adjust the coordinate decimals.



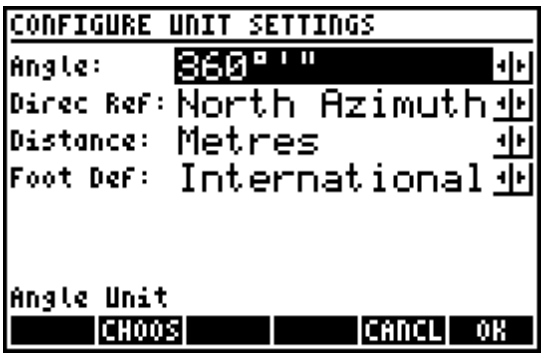
Adjusting the decimal display settings from an output screen has only **temporary** effect until the output screen is closed. To permanently adjust the decimals that are displayed by default, changes are required to be made to the display settings or using the above key combinations in the main menu.

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 Units

Unit settings affect input interpretation and representation.



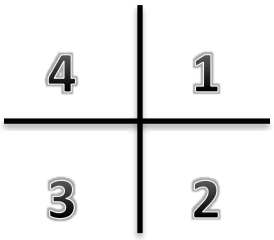
Angle Unit

The angle unit may be set to 360°’” (DMS), 360° dec (DEG) or 400 gon (GRD). Angular and directional input and output will honour this setting for all functions.

Direction Reference

Direction reference may be set to North Azimuth (AZ), South Azimuth (SA), or Quadrant Bearings (QB).

- North azimuths are defined by declaring north to be 0° (or 0g) while south azimuths are defined by declaring south to be 0° (or 0g), and then measuring the full circle in a clockwise direction. Azimuth 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.



Primary Distance Unit

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

The primary distance unit setting DOES NOT AFFECT JOB COORDINATES. The primary distance unit is for input/output display only. The setting changes what happens when a unit conversion is performed and affects geodetic<>grid input/output. To change a job from metric to imperial or vice versa it is required that you scale all points. This behaviour is consistent with how a CAD drawing operates. The coordinates are essentially unit-less and this setting determines how the coordinates will be handled for input and output.

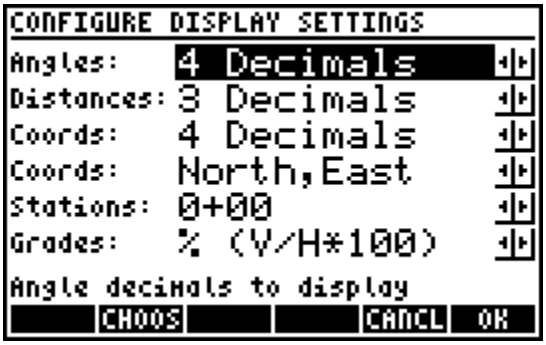
Foot Definition

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.

3.2 Display

Display settings change the displayed precision of numbers, the order of coordinates and the formats of stations and grades.



Angle Decimals

Angle decimals may be set to display between 4 and 7 decimals. A DMS example of 4 decimals is 0°00'00" and of 7 decimals is 0°00'00.000". Modify the precision of angle decimals from the main menu by using the [◄┐] key followed by the [+] or [−] key.

Distance Decimals

Distance decimals may be set to display between 1 and 7 decimals. Modify the precision of distance decimals from the main menu by using the [+] or [−] keys. This setting also applies to stations and grades.

Coordinate Decimals

Coordinate decimals may be set to display between 1 and 7 decimals. Modify the precision of distance decimals from the main menu by using [┌►] key followed by the [+] or [−] key.

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.

Stationing Display

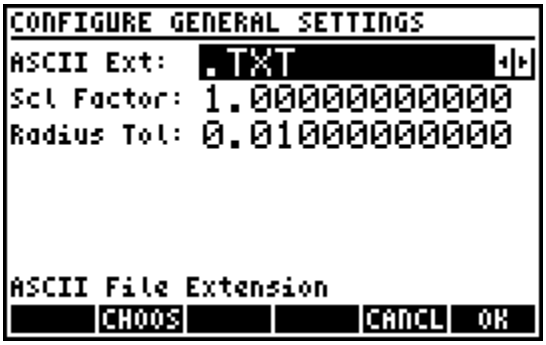
The stationing display format may be set to display stations in the format 0+00, 0+000 or without any formatting.

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.

3.3 General

General settings control the default ASCII file extension, allow the user to enter a user-defined scale factor and define a radius tolerance distance for curves.



ASCII File Extension

Choose the file extension to use when exporting ASCII files to the SD card.

Scale Factor

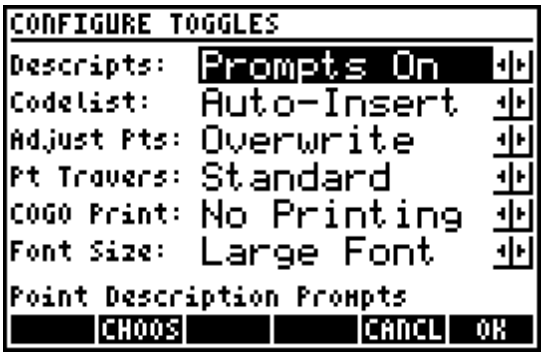
Various applications support a user-defined scale factor. Softkeys labelled **xUSF** or **/USF** allow distance input to be multiplied or divided by this scale factor.

Radius Tolerance

Enter a value to set the radius tolerance between 0 and 0.1 units, 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 always used as the radius for a curve.

3.4 Toggles

Toggles are used to turn on/off certain features, including point description prompts, codelist translation, adjusted points numbering and **Point Traverse** mode selection



Description Prompts

Point description prompts are optional. This setting controls the presence of point description prompts when storing point coordinates.

Codelist Translation

Version 3.59 introduced an updated codelist system that allows the user to create a list of codes with associated description attributes. This toggle controls whether the program will automatically translate a code to its description. For example, with the toggle ON, a user could enter the code 19 as a point

description and the program would automatically insert the description for that code. With the toggle OFF, the description input is left as entered.

Adjusted Points

Adjusted points are points that have been somehow manipulated (scale, rotate, mirror, compass rule, shift, transformed, etc.). This toggle controls whether the adjusted coordinates will overwrite the original coordinates, or if new re-numbered points with an additive number are stored. For example, consider a case where you wish to scale a point with coordinates 1000,1000 by a factor of 2 from the origin, and let us assume that the point number is 1. When the setting is set to "overwrite", the coordinates of point 1 will be overwritten with 2000,2000. When the setting is set to "re-number" and an additive number of 100 is provided, a new point 101 is created with coordinates 2000,2000.

Point Traverse Mode

Point Traverse features a *Standard* and a *Sideshot* operating mode. This setting controls how the **Point Traverse** program will operate when you run it. See the Point Traverse section for more details.

COGO Print

Toggle automatic printing to an infrared printer when using the **Point Traverse**, **Inverse**, **Intersections** and **Area by Points** programs. When set to *Auto Print*, the calculator will send print commands to the printer when completing calculations. This toggle should only be set when using a printer.

Font Size

Sets the font size of input screen prompts and choose box items. The large font is the same font size as the main menu items, while the small font is the system mini font.

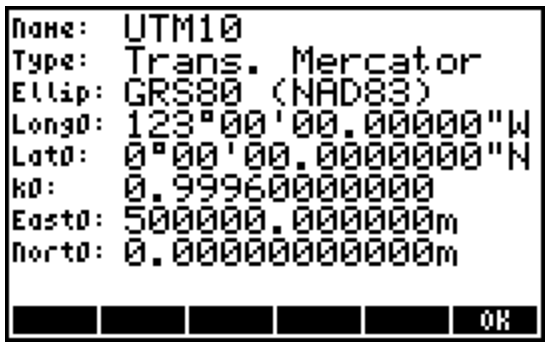
3.5 Geodetic

Geodetic settings allow the selection of a coordinate system with pre-defined projection parameters for grid<>geodetic conversions, geodesic ellipsoid calculations and KML file export. Coordinate systems are grouped by region and projection type. Available reference ellipsoids vary depending on the coordinate system selected.

Coordinate Groups

The available coordinate groups include:

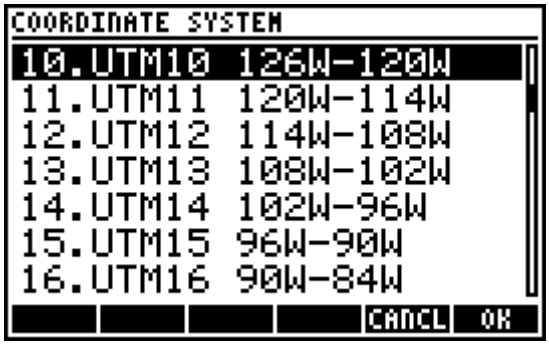
1. UTM
2. US State Plane
3. Other US
4. Canadian
5. European
6. Australia, New Zealand
7. South American
8. Central American
9. African
10. Middle East
11. Gauss-Krüger 3° Zones
12. Gauss-Krüger 6° Zones
13. Custom Projections



Note the F1 **Cur?** softkey. This option displays the projection parameters of the currently selected coordinate system.

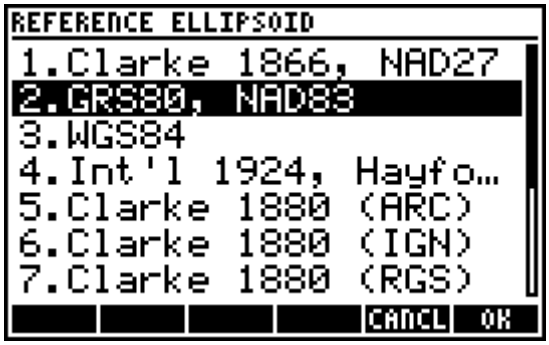
Coordinate Systems

The projection parameters for each coordinate system available within each group are completely pre-defined. Most of the coordinate systems are based on the widely used Transverse Mercator and Lambert Conformal Conic projections.



Reference Ellipsoid

Reference ellipsoids in use for many regions of the world have undergone revisions over time for numerous reasons. The available reference ellipsoids include:

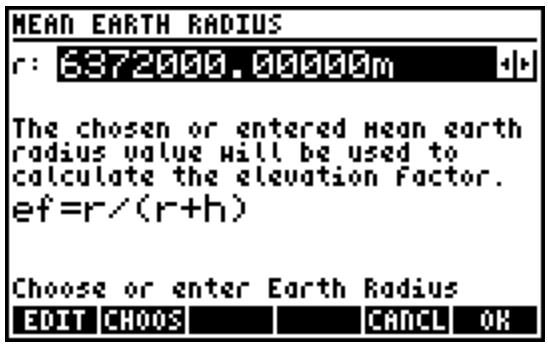


1. Clarke 1866 (NAD27)
2. GRS80 (NAD83)
3. WGS84
4. International 1924 (Hayford)
5. Clarke 1880 (ARC)
6. Clarke 1880 (IGN)
7. Clarke 1880 (RGS)
8. Airy 1830
9. Australian National Spheroid
10. Krassovsky 1940
11. Bessel 1841
12. Parametry Zemli 1990 (PZ-90)
13. UserDef Ellipsoid

Choosing the appropriate reference ellipsoid is very important. Some coordinate systems limit the available reference ellipsoid selections to ensure a correct selection. WHEN WORKING WITH CUSTOM PROJECTIONS IT IS ALSO POSSIBLE TO CREATE A USER-DEFINED ELLIPSOID. Appendix A LISTS THE ELLIPSOID PARAMETERS.

Mean Earth Radius

Choose or enter the mean earth radius to use for elevation factor calculations. Options include:

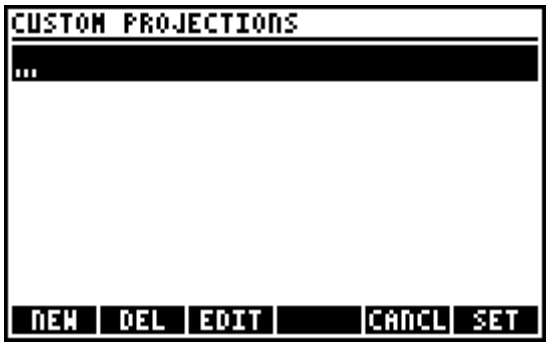


- 6372000m – Commonly used mean earth radius. THIS SHOULD BE CONSIDERED THE DEFAULT VALUE.
- Geometric Mean – Calculate the geometrical mean earth radius for each point, using the formula: $r = \frac{a \times \sqrt{1-e^2}}{1-e^2 \times (\sin \emptyset)^2}$ where a = semi-major axis (radius at equator) e^2 = eccentricity squared and $\emptyset$ = geodetic latitude.
- Enter a mean earth radius. SOME REGIONS HAVE ADOPTED A MEAN EARTH RADIUS THAT BEST FITS THEIR REGION.

Custom Projections

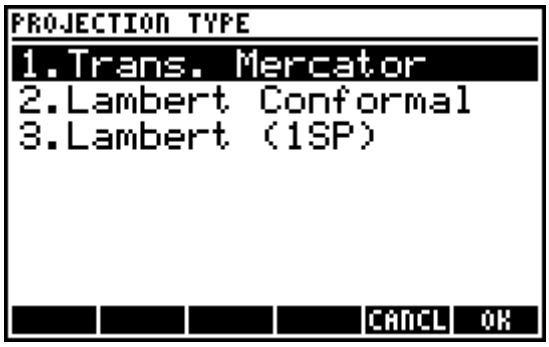
Define your own custom projections for your local area by entering the projection zone parameters and choosing or defining the appropriate ellipsoid. SINCE THERE ARE MANY WAYS OF INCORRECTLY DEFINING A CUSTOM PROJECTION, IT IS HIGHLY RECOMMENDED TO CROSS-REFERENCE CONVERSION RESULTS WITH PUBLISHED DATA OR WITH ANOTHER TRUSTED SOURCE TO ENSURE ALL REQUIRED PARAMETERS HAVE BEEN ENTERED CORRECTLY.

Multiple custom projections and user-defined ellipsoids may be created. From the COORDINATE GROUP choose box select *13.Custom Projections* to open the main CUSTOM PROJECTIONS screen where you can add, delete, edit or set a custom projection.



Add a New Projection

Press F1 **NEW** to create a new custom projection. Creating a new projection consists of choosing the projection type, entering the parameters, and naming the projection. The three possible types of projections are Transverse Mercator, Lambert Conformal Conic (2SP), and Lambert Conformal Conic (1SP). ALL CUSTOM PROJECTIONS ARE SAVED WITH A *.CPP EXTENSION.



Transverse Mercator

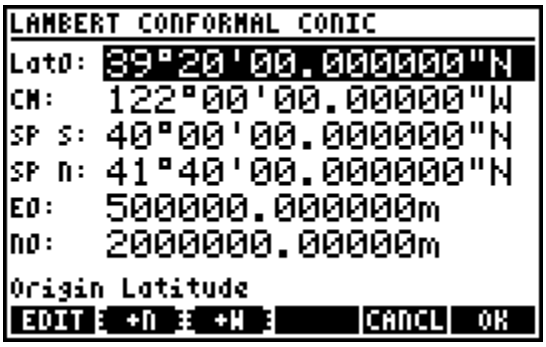
The required parameters for a Transverse Mercator projection are:

- Origin Latitude
- Central Meridian
- Scale Factor along Central Meridian
- False Easting
- False Northing

The screen capture shows the parameters entered for UTM zone 10, North Hemisphere.

Lambert Conformal Conic (2SP)

This is a common projection type used in many US State Plane zones and elsewhere around the wold. The required parameters for this projection are:

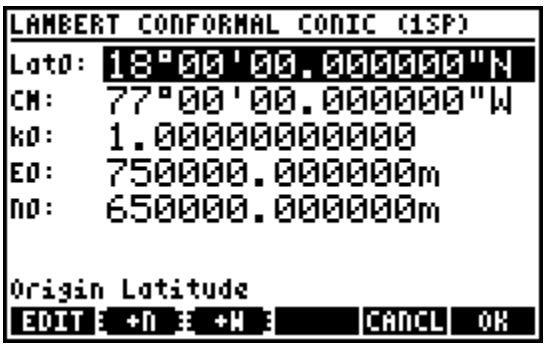


- Origin Latitude
- Central Meridian
- Standard Parallel South
- Standard Parallel North
- False Easting
- False Northing

The screen capture shows the parameters entered for State Plane zone 0401.California 1.

Lambert Conformal Conic (1SP)

This is not a very common projection type. The required parameters are:



- Origin Latitude
- Central Meridian
- Scale Factor
- False Easting
- False Northing

The screen capture shows the parameters entered for the JAD2001 Jamaica National Grid.

Delete a Projection

Press F2 **DEL** to delete the selected projection. It is possible to delete a custom projection that is currently set; in such a case, the parameters remain current until changed to a different projection.

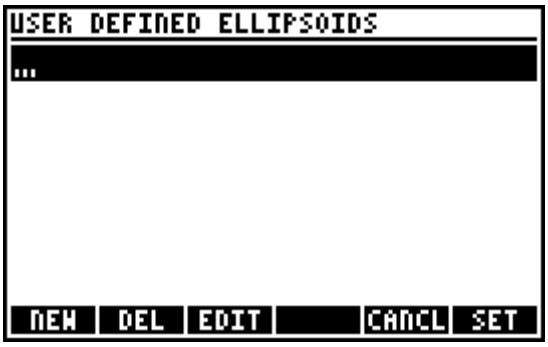
Edit a Projection

Press F3 **EDIT** to edit the selected projection. The same input form opens as when defining a new projection, and any of the parameters can be changed. AFTER EDITING A PROJECTION IT IS REQUIRED TO SET THE PROJECTION FOR THE CHANGES TO TAKE EFFECT. EDITING ALONE WILL NOT CHANGE THE CURRENT GEODETIC SETTINGS.

Set a Projection

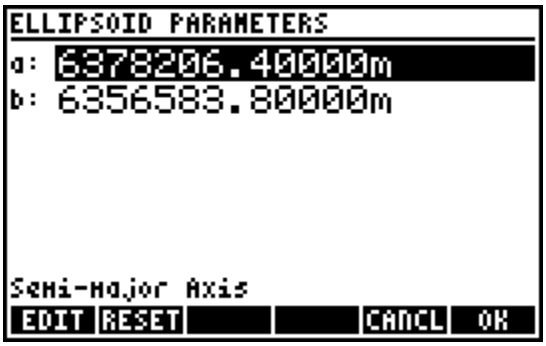
Press F6 **SET** or ENTER to set the selected projection. The entire process needs to complete for any new settings to take effect. You may be prompted to choose the Hemisphere, North or South.

From the REFERENCE ELLIPSOIDS choose box select one of the pre-defined ellipsoids to use, or select *13.UserDef Ellipsoid* to open the main USER DEFINED ELLIPSOIDS screen where you can add, delete, edit or set a user-defined ellipsoid. SELECTING AN EXISTING ELLIPSOID FROM THE REFERENCE ELLIPSOIDS CHOOSE BOX COMPLETES THE PROCESS OF SETTING A CUSTOM PROJECTION ACTIVE.



Add a New User-defined Ellipsoid

Press F1 **NEW** to define a new ellipsoid. The required parameters are the semi-major axis and semi-minor axis of the ellipsoid, and a name for the ellipsoid. IT MAY BE NECESSARY TO CALCULATE THE SEMI-MINOR AXIS FROM ANOTHER PARAMETER, SEE Appendix A FOR APPLICABLE EQUATIONS. ALL USER-DEFINED ELLIPSOIDS ARE SAVED WITH A *.CPE EXTENSION.



Delete a User-defined Ellipsoid

Press F2 **DEL** to delete the selected ellipsoid. As with a custom projection, it is possible to delete a user-defined ellipsoid that is currently set. The parameters will remain current until changed.

Edit a User-defined Ellipsoid

Press F3 **EDIT** to edit the selected ellipsoid. The same input form opens as when defining a new ellipsoid, and the parameters can be changed. AFTER EDITING AN ELLIPSOID, IT IS REQUIRED TO SET THE ELLIPSOID FOR THE CHANGES TO TAKE EFFECT. EDITING ALONE WILL NOT CHANGE THE CURRENT GEODETIC SETTINGS.

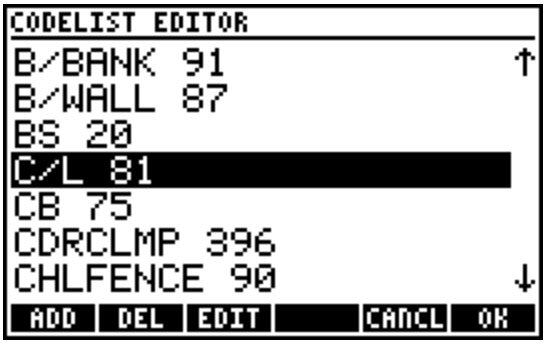
Set a User-defined Ellipsoid

Press F6 **SET** or ENTER to set the selected ellipsoid.

When the custom projection has been set, the main menu screen will display the name of the custom projection (up to 8 characters) and the name of the reference ellipsoid (up to 5 characters).

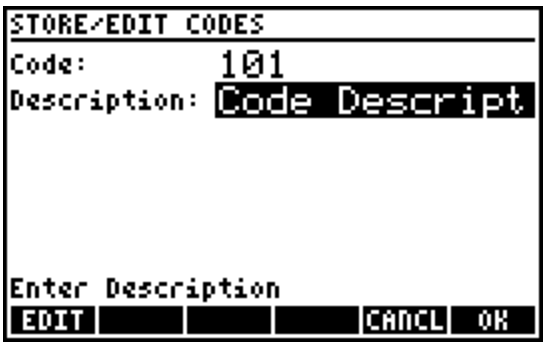
3.6 Codelist

The codelist is a list of codes with associated descriptions. The codelist editor displays the codelist sorted by description. Use [ALPHA] followed by an alpha character to jump to the first description starting with that character. It is possible to enter a code in any point description input and have the description automatically inserted when the codelist translation toggle is enabled.



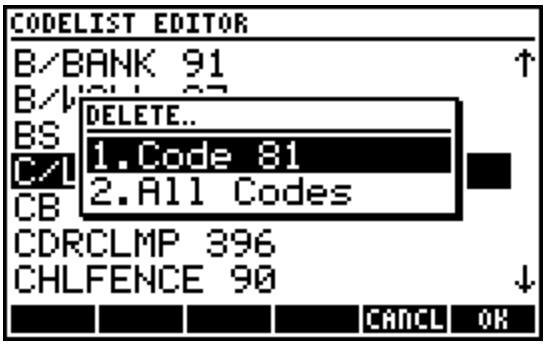
Add a Code

Press [F1] **ADD** to enter a new code and description. It is possible to have multiple codes with the same description, but each code can only exist once. New codes are sorted by description and added to the Codelist.



Delete a Code

Press [F2] **DEL** to delete the selected code or to delete all codes. A choose box prompts the user to select the operation.



Edit a Code

Press [F3] **EDIT** to edit the selected code and/or description. If necessary, the modified code is re-sorted within the codelist after editing.

3.7 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.

Create a new Template

Press F1 **NEW** to create a new template. Select either *1.Hz Width + Slope* to define the cross section by entering horizontal widths and slopes of each segment away from the centerline, or select *2.Hz Width + Vt Chnge* to define the cross section by entering the horizontal widths and the vertical elevation changes of each segment. Next, enter a name for the template to create a new blank template, which added to the list of templates in the Template Manager.

Delete a Template

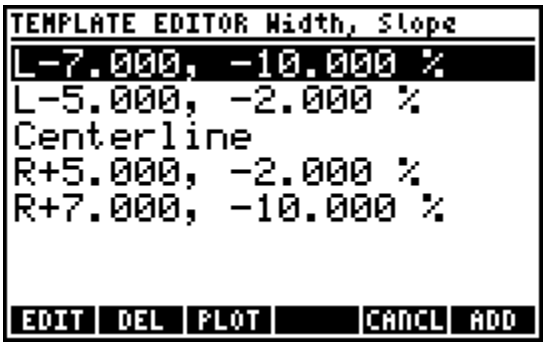
Press F2 **DEL** to delete the selected template. It is not possible to delete a template currently assigned to an alignment.

Exit the Template Manager

Press F5 **CANCL** or ON to exit the template manager and return to the main program interface.

Edit a Template

Press F6 **EDIT** or ENTER to edit the selected template. A new screen appears listing all the components of the template from Left to Right. A new blank template contains only the Centerline entry. The options available for the template editor are described on the following page.



Edit a Segement

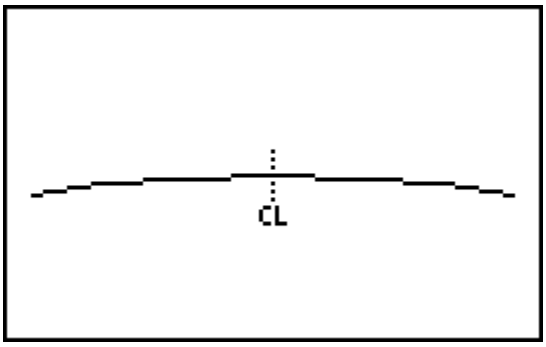
Press F1 **EDIT** to edit the selected template segment. It is possible to change the width and slope/elevation change of a segment.

Delete a Segment

Press F2 **DEL** to delete the selected segment from the template. It is only possible to delete segments starting from the outer edges and going in towards the centerline.

Plot the Template

Press F3 **PLOT** to plot the cross section template on the screen for a visual confirmation of the entered segments. The vertical components of the cross section are exaggerated somewhat to aid in the illustration of the direction of the slopes.

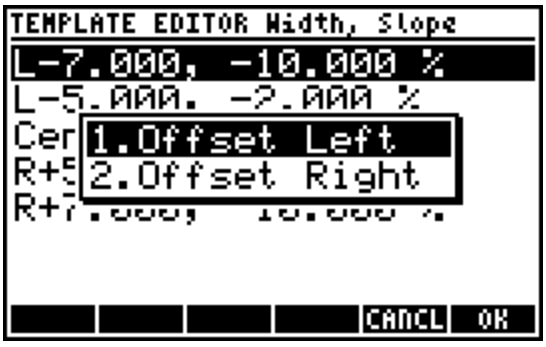


Exit the Template Editor

Press F5 **CANCL** or ON to exit the template editor and return to the template manager screen.

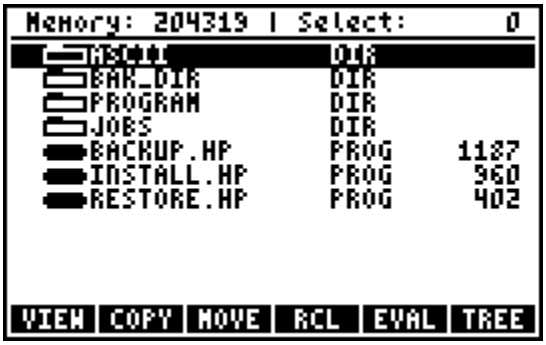
Add a Segment

Press F6 **ADD** or ENTER to add a new segment to the template. Specify if the new segment is an offset to the left or to the right of the centerline, then enter the width and slope (or vertical elevation change) of the segment. Each segment added will be going "outwards" from the centerline, and the slope is always away from the centerline, therefore negative and positive sign of the slope (or vertical elevation change) is important to enter correctly. A negative slope goes downward from the centerline, while a positive slope goes upward from the centerline.



4 BACKUP.HP and RESTORE.HP

Within the COGOPLUS directories for COGO+ Pro and COGO+ Std are three *.HP files. INSTALL.HP installs and updates the ***COGO+*** software. The other two files, BACKUP.HP and RESTORE.HP, can be used to backup and restore calculator memory. These programs can also be run from the library menu.



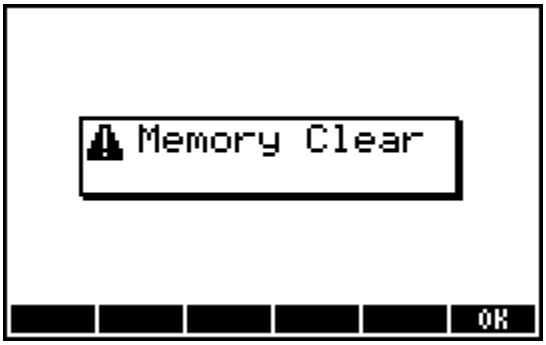
4.1 Backup

Select BACKUP.HP and press F5 **EVAL** to create a backup. You will be prompted to enter a name for the backup, which should be an alpha-numeric name no longer than 8 characters. The backup will be stored in the COGOPLUS\BAK_DIR sub-directory as a *.BAK file. Flag settings are also stored in the sub-directory as a variable called FLAGS.

Every time you install or update COGO+ you will be given the option to create a backup. It is highly recommended to create a backup at least each time you perform an update, but the BACKUP.HP program allows you to create a new backup at any time.

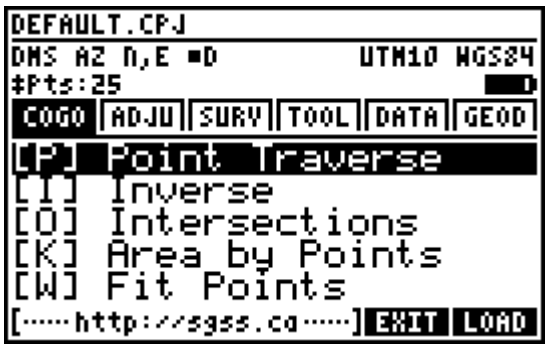
4.2 Restore

Select RESTORE.HP and press F5 **EVAL** to restore a previously created backup. A list of all available backups will be presented to allow the user to choose which backup to restore. Should a crash occur, this program allows you to return your calculator to a previous state.



In some cases, it may be desirable to clear the calculator memory and return it to factory settings. To accomplish this, simultaneously press the ON, F1 and F6 keys and release. When asked to recover memory, choose “NO”. This procedure is called a “hard reset”.

5 COGO Menu



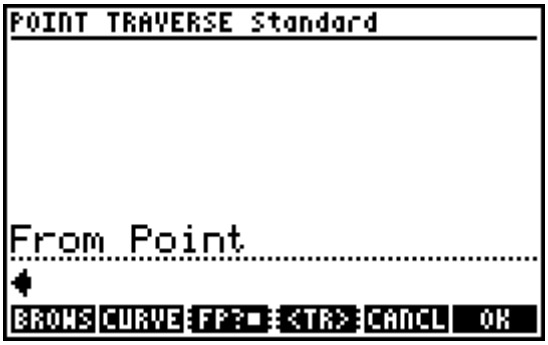
5.1 Point Traverse

Point Traverse is the main COGO application and is available in two modes, the *Standard* mode and the *Sideshot* mode. The two modes operate completely different. The *Standard* mode is more powerful while the *Sideshot* mode is in some ways simpler to learn/use.

Standard Mode

Point Traverse *Standard* is a complete COGO solution with **Inverse** and **Intersections** built into the command line interface. Input screens within this application often take multiple types of input to allow a wide variety of possible uses.

'From Point' Screen



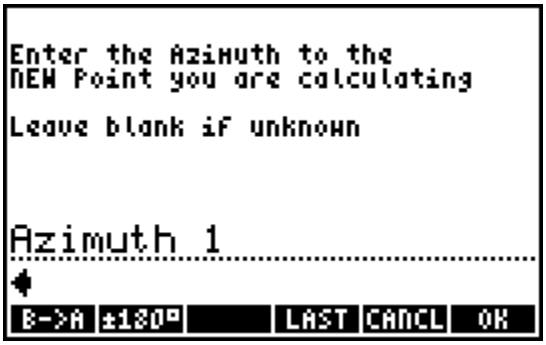
The *From Point* input screen prompts the user to input a point number to use as a starting point for further calculations. Input types accepted:

1. An existing point number – The program ensures the point exists, and then displays the next screen.
2. A non-existing point number – The user may enter a point number that has not yet been stored in the database. An input form will open to allow the user to enter coordinates for the new point.
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.
7. F1 **BROWS** – Opens the Point Browser to review points in the job and pick one from a list.
8. F2 **CURVE** – Starts the Curve Traverse program.
9. F3 **FP?■** – Toggles the *From Point* number suggestion setting. When the square is displayed after the "FP?", the setting is enabled and the program will suggest a point number automatically, otherwise no suggestions are made.
10. F4 **<TR>** or **<SS>** – Works in tandem with the **FP?** softkey to suggest point numbers by TRAVERSE or SIDESHOT methods. TRAVERSE always suggests the last saved point, while SIDESHOT keeps the point unchanged until changed by the user.
11. F5 **CANCL** – Exits the **Point Traverse** *Standard* program, the same as pressing the ON key.
12. F6 **OK** – Accepts the input provided, the same as pressing the ENTER key.
13. All other input is ignored or results in an error message.

'Azimuth 1' or 'Bearing 1' Screen



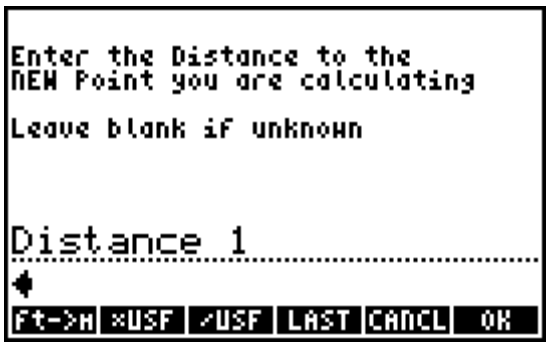
The direction reference setting determines whether *Azimuth* or *Bearing* is displayed. This screen prompts the user to input the azimuth or bearing to the new point from the FROM POINT. Input types accepted:

1. Azimuth or 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. Any of the above input options followed by "++Offset" or "--Offset" – Define a parallel offset from the FROM POINT. The '++' denotes an offset 'right' while '--' denotes an offset 'left'. For example, input *15.3025++5.5* to enter a parallel offset of 5.5 units to the 'right' of the FROM POINT and perpendicular to the entered azimuth 15°30'25".
4. Leave blank, no input – Signals that the azimuth or bearing to the new point is unknown, which leaves the possibility of a Distance-Azimuth, a Distance-Distance, or a Distance-Angle intersection.
5. F1 **B->A** or **A->B** – Converts the input between bearings and azimuths. The appearance and action of this softkey varies depending on your direction reference setting.
6. F2 **±180°** – Flips the direction of the number in the command line by adding/subtracting 180 degrees (or 200 gons). THIS OPTION IS ONLY AVAILABLE WHEN AZIMUTHS ARE SET AS THE DIRECTION REFERENCE.
7. F4 **LAST** – Inserts the most recent azimuth or bearing input into the command line.
8. F5 **CANCL** – Cancels the traverse and returns the program to the FROM POINT screen.
9. F6 **OK** – Accepts the input as provided.

'Distance 1' Screen

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

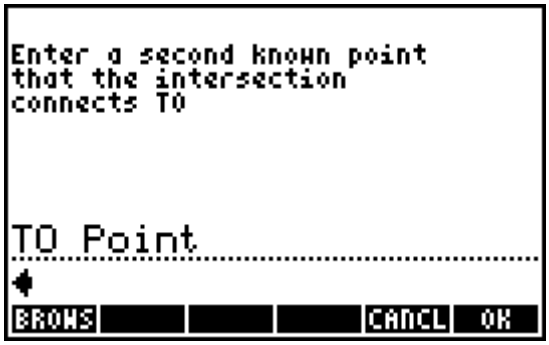


1. A distance – The number entered is used as the distance and the next screen is displayed.
2. Any of the standard distances input options.
3. Leave blank, no input – Signals that the distance to the new point is unknown, which leaves the possibility of an Azimuth-Azimuth or an Azimuth-Distance intersection, provided that the *Azimuth 1* input was given.
4. F1 **F->M** or **M->F** – Converts the input between metric and imperial units. The appearance and action of this softkey varies depending on your primary distance unit setting.
5. F2 **xUSF** – Multiplies the input by the user defined scale factor. THIS CAN BE USED FOR SCALING VALUES GRID<>GROUND AS YOU GO, OR COULD BE AN ALTERNATIVE METHOD TO CONVERT BETWEEN UNITS.
6. F3 **/USF** – Divides the input by the user defined scale factor.
7. F4 **LAST** – Inserts the most recent distance input into the command line.

8. F5 **CANCL** – Cancels the traverse and returns the program to the FROM POINT screen.
9. F6 **OK** – Accepts the input as provided.

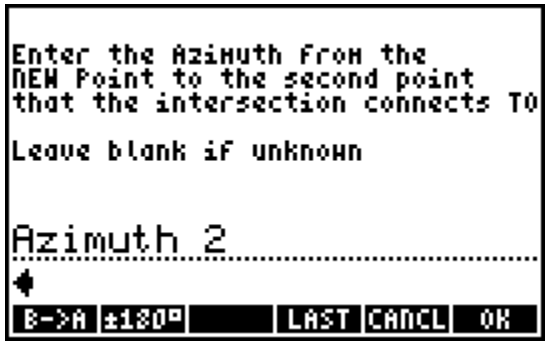
'TO Point' Screen

This screen accepts the point number of a second known point that an intersection connected **to**. This screen appears when either the *Azimuth 1* or *Distance 1* inputs are unknown and left blank.

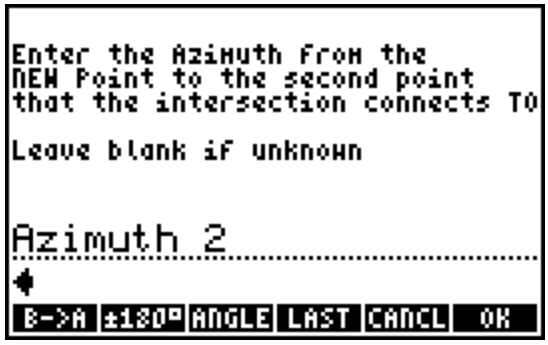


'Azimuth 2' or 'Bearing 2' Screen

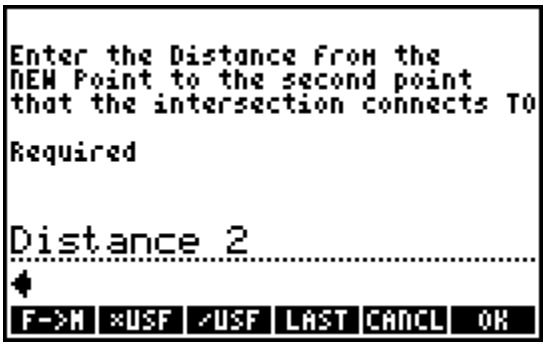
This screen has two possible variations depending on whether *Azimuth 1* or *Distance 1* is known. In both cases the screen prompts the user to enter the azimuth or bearing from the new point that is being calculated TO the second known point. This screen accepts the same input types as the Azimuth 1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



With a known *Distance 1* input there exists a possibility to perform a Distance-Angle intersection. This option is available through the F3 **ANGLE** softkey. The included angle TO the second known point at a certain distance from the FROM POINT is required for this type of intersection.

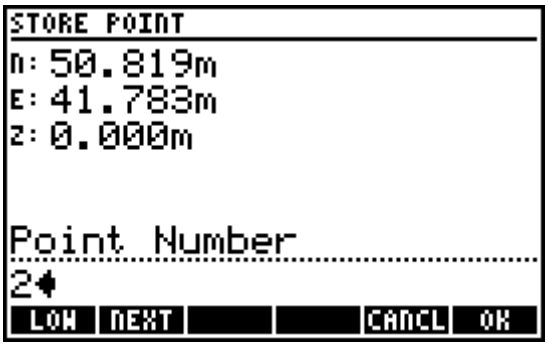


'Distance 2' Screen



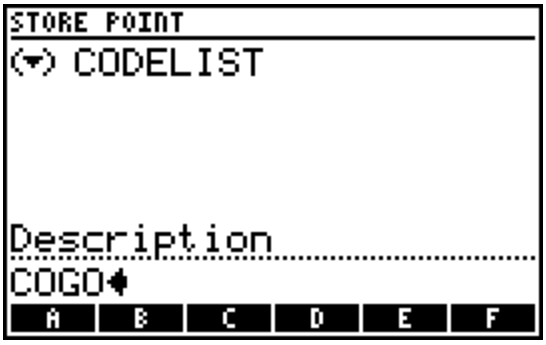
This screen prompts the user to enter the distance from the new point that is being calculated TO the second known point. This screen accepts the same input types as the Distance 1 screen.

STORE POINT Screen



The STORE POINT screen displays the coordinates of the solved point and prompts the user to enter a point number. The menu features a few point searching capabilities:

1. F1 **LOW** – Inserts the lowest unused point number into the command line.
2. F2 **NEXT** – Inserts the next lowest unused point number starting from the currently entered value.

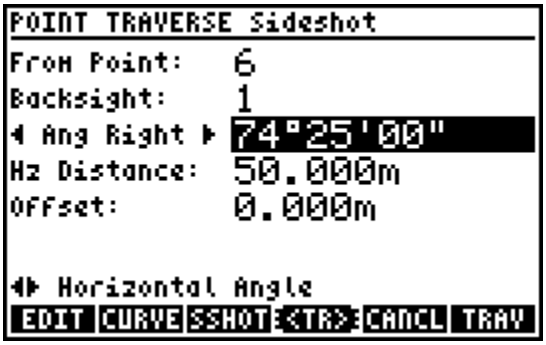


A screen prompting to enter a point description will follow if the description prompts toggle is set. Alpha mode is automatically set when this screen becomes active and the menu labels display the Alpha characters. The ⊙ cursor key opens the codelist to select a point description. When the codelist translation toggle is set, the user can enter any defined code in the codelist and the program will automatically look up the description and store the code's description.

Sideshot Mode

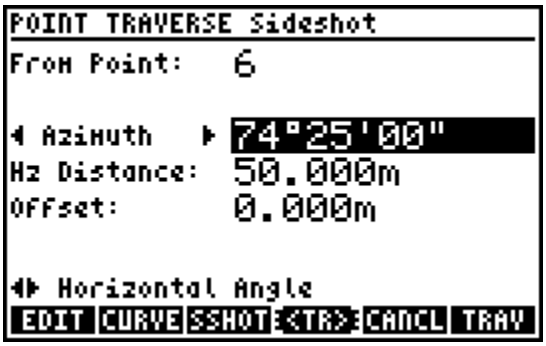
Point Traverse *Sideshot* is a COGO application that accepts all input within a single input form with a few variations of possible input types.

'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 open an input form to allow the user to enter coordinates for the new point.

'Backsight' Field



This field requires an existing point number to use as the backsight point. This field disappears when the horizontal angle field label is set to *Azimuth* or *Bearing* since it becomes unnecessary, but is required for an *Angle Right* or *Angle Left* calculation.

'Angle Right' / 'Angle Left' / 'Azimuth' or 'Bearing' Field

The label for this field changes when the user toggles the input types for this field with the ◀ and ▶ cursor keys. This field requires a real number angle when *Angle Right* or *Angle Left* is selected. Input types accepted when *Azimuth* or *Bearing* is selected:

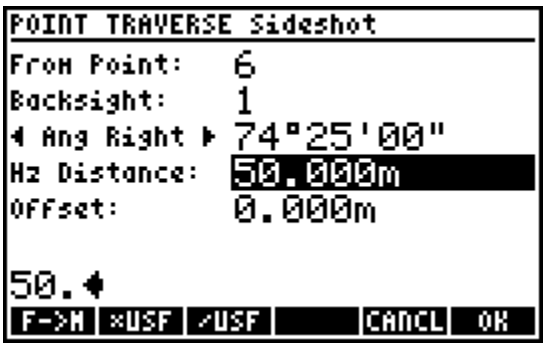
1. Azimuth or Bearing – The real number entered is interpreted based on the current angle unit and direction reference user settings.
2. Any of the standard directions input options.

'Hz 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.

When the command line becomes active, i.e. a distance is being entered or edited, the softmenu will update to show more options:

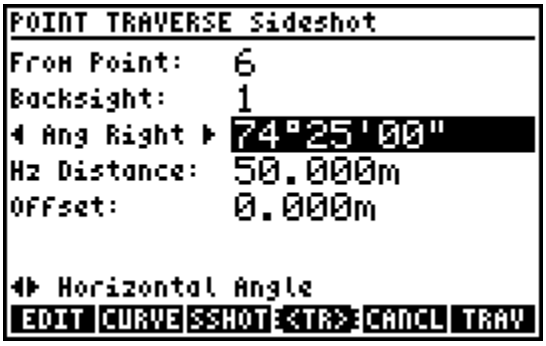


1. F1 **F->M** or **M->F** – Converts the input between metric and imperial units. The appearance of this softkey varies depending on your primary distance unit setting.
2. F2 **xUSF** – Multiplies the input by the user defined scale factor. THIS CAN BE USED FOR SCALING VALUES GRID<>GROUND AS YOU GO, OR COULD BE AN ALTERNATIVE METHOD TO CONVERT BETWEEN UNITS.
3. F3 **/USF** – Divides the input by the user defined scale factor.

'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 *Hz Distance* field.

The Menu



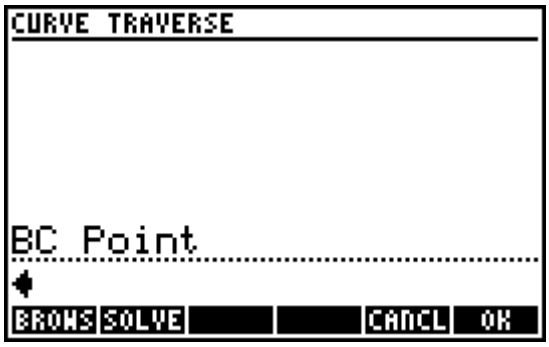
The **Point Traverse** *Sideshot* input form menu:

1. F1 **EDIT** – Edits the currently selected field by copying the field's contents to the command line and activating the command line.
2. F2 **CURVE** – Starts the Curve Traverse program.
3. F3 or F6 **SSHOT** – Takes the input provided and attempts to store the information as a sideshot. When successful, the STORE POINT screen is displayed to store the new point and the original **Point Traverse** *Sideshot* input form is re-displayed, unchanged.
4. F4 **<TR>** or **<SS>** – Toggles the location of the **TRAV** and **SSHOT** softkeys between F3 and F6.
5. F5 **CANCL** – Exits the **Point Traverse** *Sideshot* program.
6. F6 or F3 **TRAV** – Takes the input provided and attempts to store the information as a traverse point. When successful, the STORE POINT screen is displayed to store the new point and the original **Point Traverse** *Sideshot* input form is re-displayed, with the newly stored point in the *From Point* field, and the previous FROM POINT set as the BACKSIGHT point.

Curve Traverse

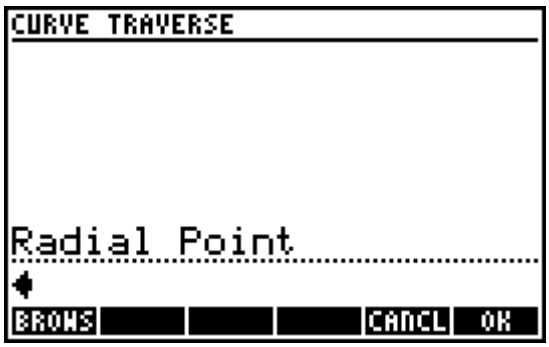
The **Curve Traverse** program is accessible from the main screen of **Point Traverse** *Standard* and **Point Traverse** *Sideshot*. The program allows the user to enter a beginning of curve (BC) point and a radius point, then enter a known curve element and curve direction to solve the end of curve (EC) point.

'BC Point' Screen



This screen prompts the user to 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. F2 **SOLVE** opens the horizontal curve solver.

'Radial Point' Screen



This screen prompts the user to enter the radius point number. The radius point input is remembered for the next use until the user quits the **Curve Traverse** program.

CURVE TRAVERSE Form

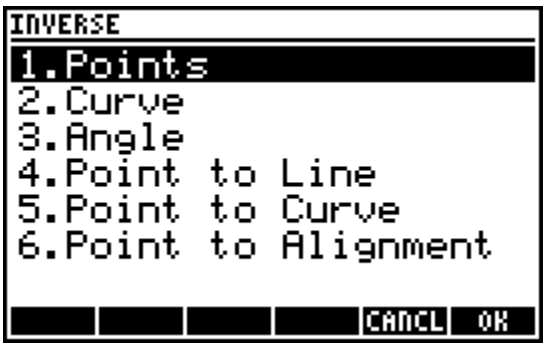
This input form accepts the known element of the curve and the curve direction.

The label for the first field changes when the user toggles the input types for this field with the ◀ and ▶ cursor keys. Available input options include the curve deflection angle, arc length, chord length or the tangent length.

The second field is a Right or Left option for the curve direction. Direction 'Right' is always clockwise, while 'Left' is counter clockwise.

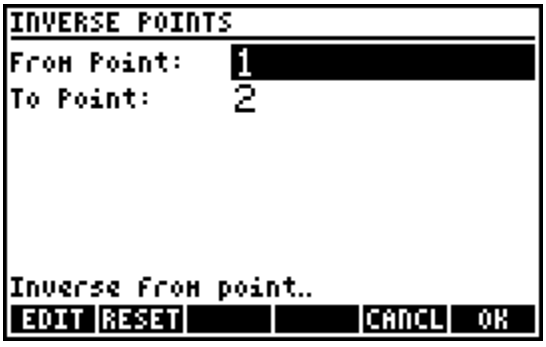
The standard STORE POINT screen follows valid input to store the EC point. The **Curve Traverse** program continues until cancelled.

5.2 Inverse



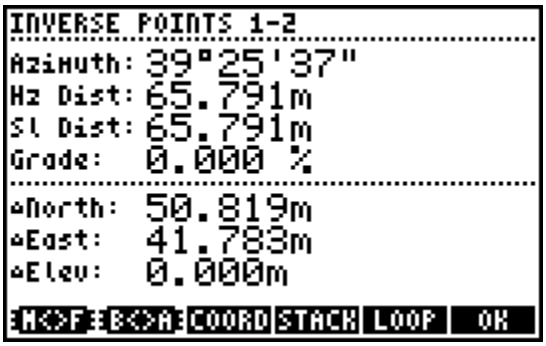
Inverse Points, **Inverse Curve**, **Inverse Angle**, **Inverse Point to Line**, **Inverse Point to Curve** and **Inverse Point to Alignment** are available options for inversing with point coordinates in the current job database.

Inverse Points



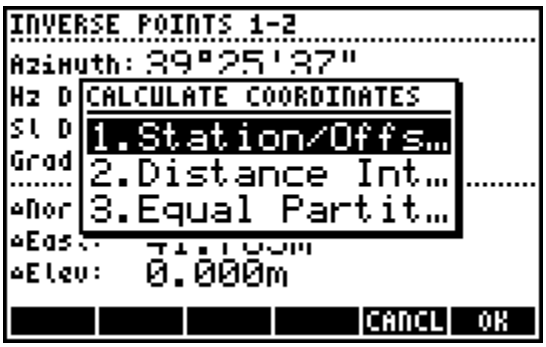
Enter the *From Point* and *To Point* to calculate the inverse information between any two points in the job database.

The results screen displays the azimuth/bearing, horizontal distance, slope distance, slope grade, and coordinate differences between the two points. The menu:



1. F1 **M<>F** – Toggles metric/imperial.
2. F2 **B<>A** – Toggles bearings/azimuths.
3. F3 **COORD** – Presents three options to solve coordinates between the two points. The options are by **Station/Offset**, by **Distance Interval**, or by **Equal Partitions**.
4. F4 **STACK** – Exports the direction, horizontal and slope distances to the stack.
5. F5 **LOOP** - Loops through the current job database inversing sets of two points in the order they were stored.

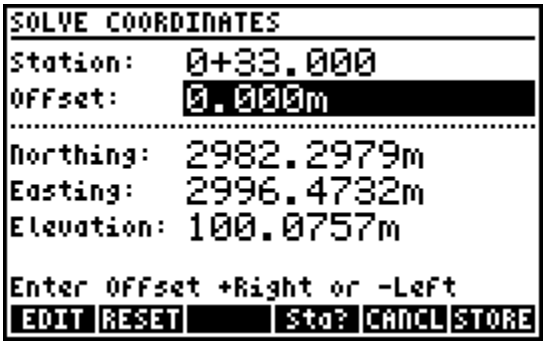
Solve COORDinates



Pick this option to calculate coordinates between the two points. **Station/Offset** accepts any station and offset to calculate the coordinate of a point, **Distance Interval** will store points at the given distance interval, and **Equal Partitions** will divide the line into equal partitions, storing a point at each calculated partition.

Station/Offset

The first input form requires the selection of a *Known Station,* either the beginning (*From Point*) or the end (*To Point*) of the straight line, and a *Station* input at that point to calculate coordinates at any station and offset between the two points.



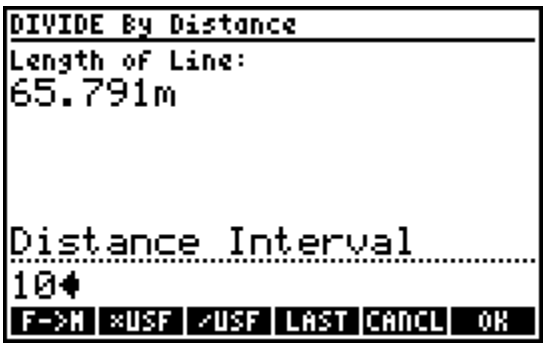
The second input form accepts a *Station* and a perpendicular *Offset* from the line. A positive offset is to the right while a negative offset is to the left. The 3D coordinates of the calculated point are immediately displayed on the screen. The menu:

1. F4 **Sta?** – Select a position to jump to on the line; beginning, mid-point or end of the line. Sets the *Station* field value to the selected station and sets the *Offset* field to zero.
2. F6 **STORE** – Stores the calculated coordinates as a point in the job database.

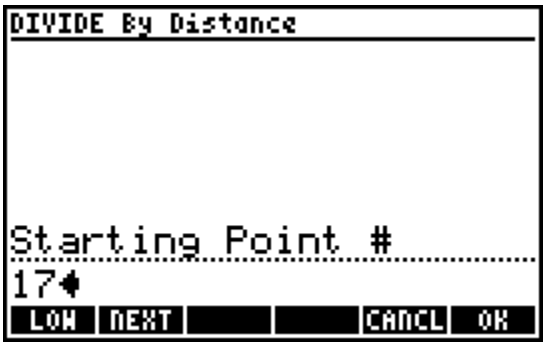
NOTE: Stations are displayed with a "<" character preceding the station when the station is less than the station of the beginning of the line, and displayed with a ">" character preceding the station when the station is greater than the end of the line. Coordinates can be calculated for any station along the projection of the defined line.

Distance Interval

The first input screen will display the length of the line and accept a distance interval value. Points will be created every specified distance starting at the *From Point* of the line until the remainder to the *To Point* of the line is less than or equal to the distance interval specified.

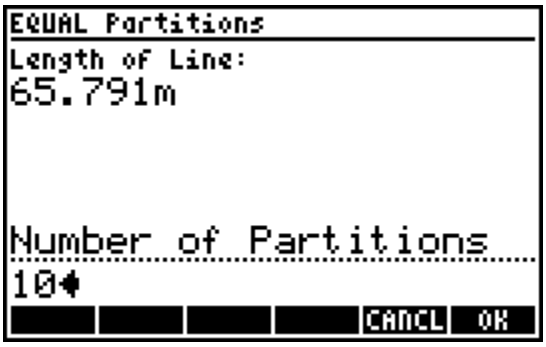


The second input screen prompts for a Starting Point Number to be used for storing the points that will be calculated. Unused point number will be assigned to the positions starting at the specified point number. Point coordinates are calculated in three dimensions between the *From Point* and *To Point*.

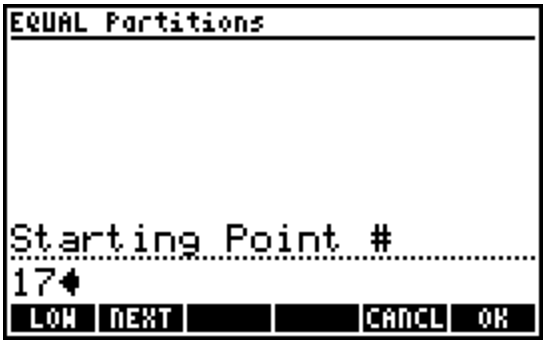


Equal Partitions

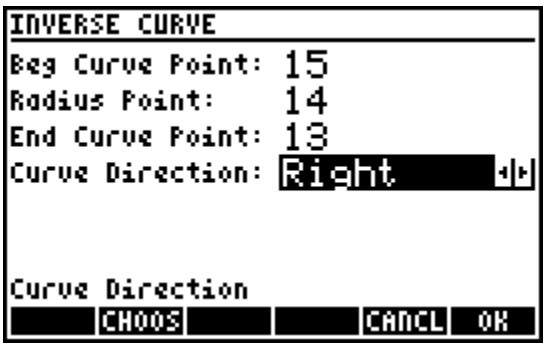
The first input screen will display the length of the line and accept the number of partitions to divide the line into. Points will be created at the calculated interval so that the specified number of equal partitions will be created between the *From Point* and *To Point*.



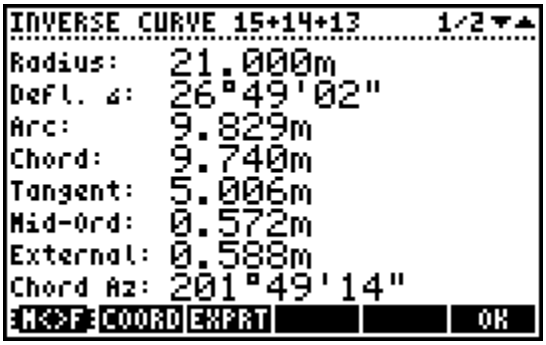
The second input screen prompts for a Starting Point Number to be used for storing the points that will be calculated. Unused point number will be assigned to the positions starting at the specified point number. Point coordinates are calculated in three dimensions between the *From Point* and *To Point*.



Inverse Curve



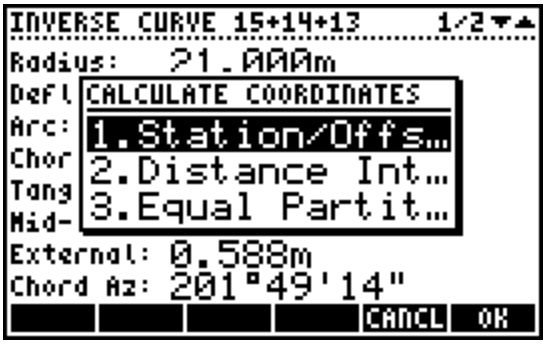
Enter the *Beginning of Curve Point*, the *Radius Point* and the *End of Curve Point*, and choose the *Curve Direction* to calculate the curve information.



The results screen displays the radius, deflection angle, arc length, chord length, tangent length, mid-ordinate length and the external length. Use the ⊙ and ⊙ keys to toggle between the first and second page of the results. Page 2 displays the sector, segment and fillet areas of the curve. The menu:

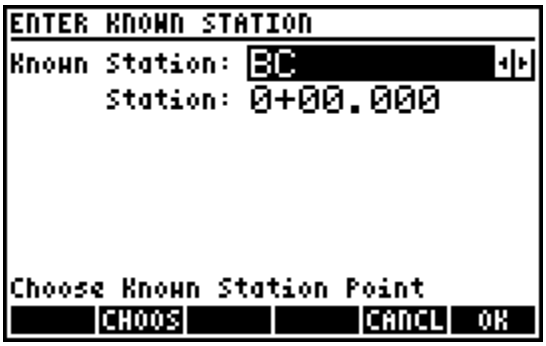
1. F1 **M<>F** – Toggles metric/imperial.
2. F2 **COORD** – Presents three options to solve coordinates between the end points along the curve. The options are by **Station/Offset**, by **Distance Interval**, or by **Equal Partitions**.
3. F3 **EXPRT** – Exports the results to the stack, to an ASCII file, or copy to the clipboard.

Solve COORDinates



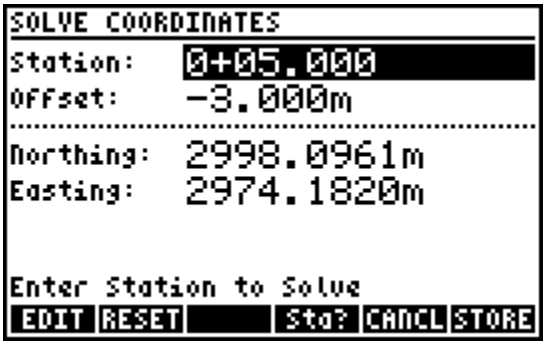
Pick this option to calculate coordinates between the end points of the curve. **Station/Offset** accepts any station and offset to calculate the coordinates of a point, **Distance Interval** will store points at the given distance interval, and **Equal Partitions** will divide the curve into equal partitions, storing a point at each calculated partition.

Station/Offset



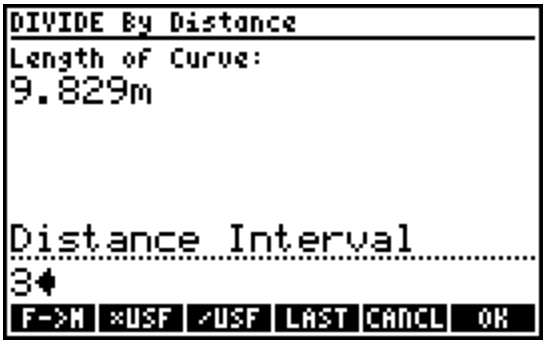
The first input form requires the selection of a *Known Station* (BC, PI or EC) on the curve, and a *Station* input at that point to calculate coordinates at any station and offset along the curve.

The second input form accepts a *Station* and a perpendicular *Offset* from the curve. A positive offset is to the right while a negative offset is to the left. The coordinates of the point are immediately displayed on the screen. The menu:

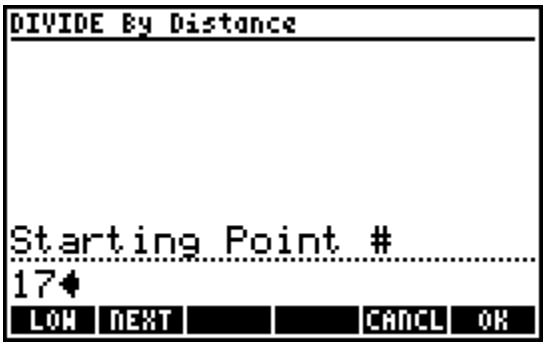


1. F4 **Sta?** – Select a position to jump to on the curve; BC, PI, EC, mid-point of curve, or the Radius Point. Sets the *Station* field to the selected station and sets the *Offset* field to zero. NOTE: THE PI STATION IS NOT ON THE CURVE.
2. F5 **STORE** – Stores the calculated coordinates as a point in the job database.

Distance Interval

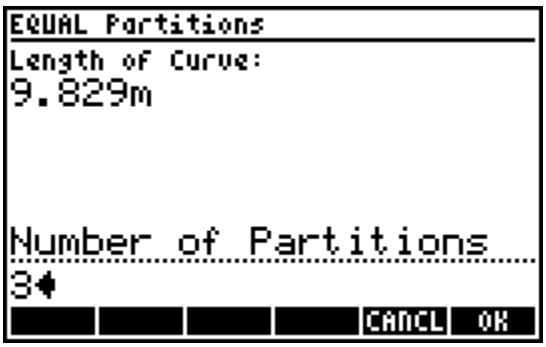


The first input screen will display the length of the curve and accept a distance interval value. Points will be created every specified distance starting at the *Beginning of Curve Point* until the remainder to the *End of Curve Point* is less than or equal to the distance interval specified.

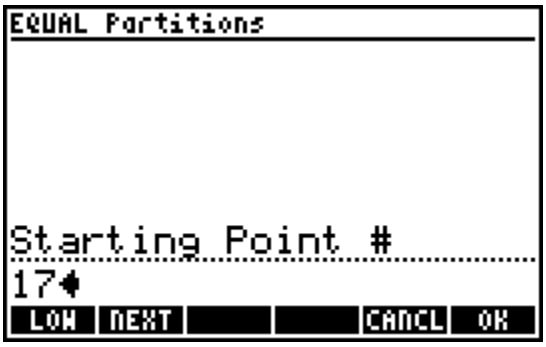


The second input screen prompts for a Starting Point Number to be used for storing the points that will be calculated. Unused point number will be assigned to the positions starting at the specified point number. Point coordinates are calculated in three dimensions between the *Beginning of Curve Point* and *End of Curve Point*.

Equal Partitions



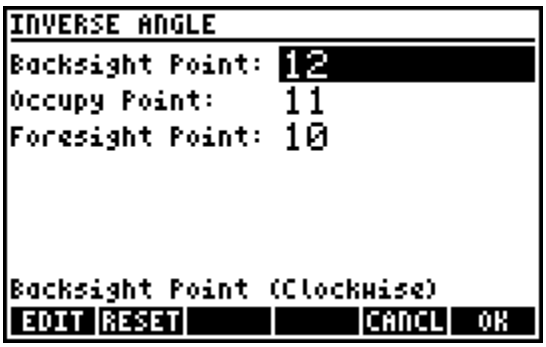
The first input screen will display the length of the curve and accept the number of partitions to divide the curve into. Points will be created at the calculated interval so that the specified number of equal partitions will be created between the *Beginning of Curve Point* and *End of Curve Point*.



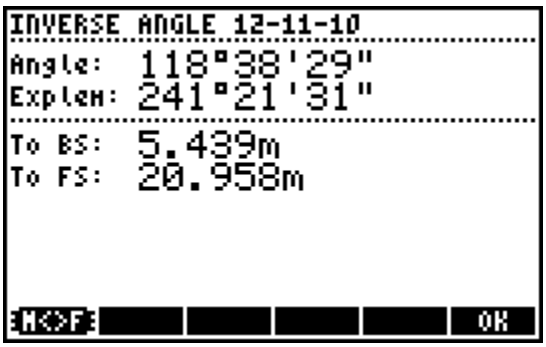
The second input screen prompts for a Starting Point Number to be used for storing the points that will be calculated. Unused point number will be assigned to the positions starting at the specified point number. Point coordinates are calculated in three dimensions between the *Beginning of Curve Point* and *End of Curve Point*.

Inverse Angle

Enter the *Backsight Point*, the *Occupy Point* and the *Foresight Point* to calculate the included angle. The *Backsight Point* is always from clockwise resulting in an "angle right" calculation.

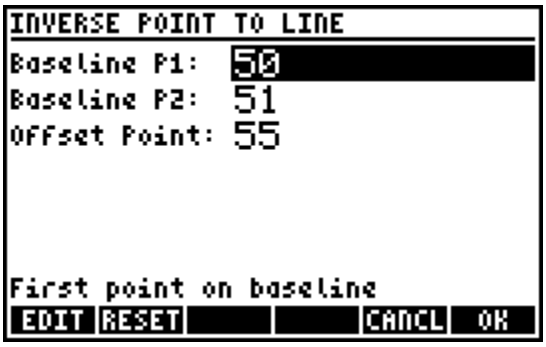


The results screen displays the turned angle and its explementary angle as well as the distances to the backsight and foresight points from the occupy point. Use F1 **M<>F** to convert the distance results between metric and imperial units.

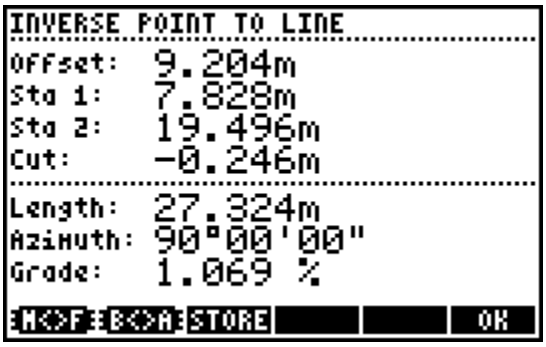


Inverse Point to Line

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.



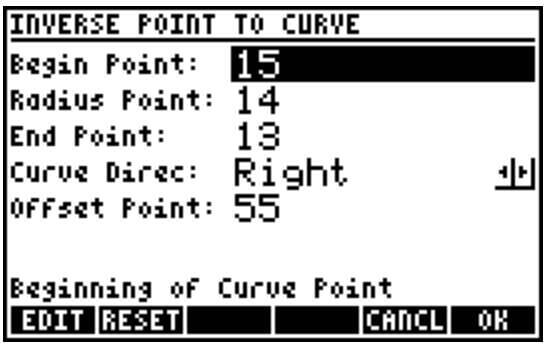
The results screen displays the offset from the baseline, Station 1 from *Baseline P1* to a point along the baseline that is perpendicular to the offset point, Station 2 to the same point from *Baseline P2*, the cut/fill to the baseline and the length, direction and the grade of the baseline. The menu:



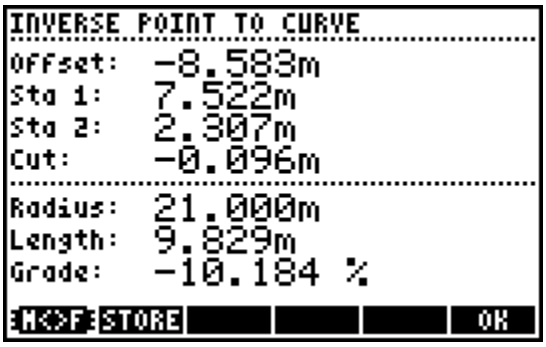
1. F1 **M<>F** – Toggles metric/imperial.
2. F2 **B<>A** – Toggles bearings/azimuths.
3. F3 **STORE** – Stores the coordinates of the point along the baseline perpendicular to the offset point as a point in the job database.

Inverse Point to Curve

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

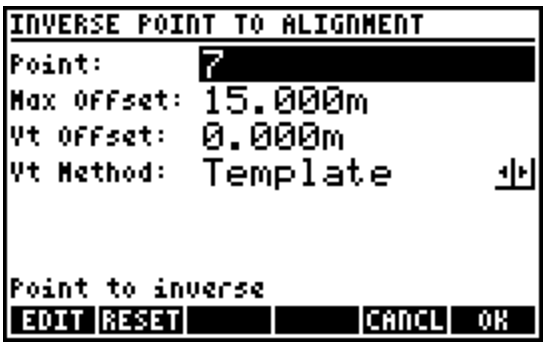


The results screen displays the offset from the curve, Station 1 from the *Beginning of Curve* to a point along the curve that is perpendicular to the offset point, Station 2 to the same point from the *End of Curve*, the cut/fill to the curve, and the radius, length and grade of the curve. The menu:



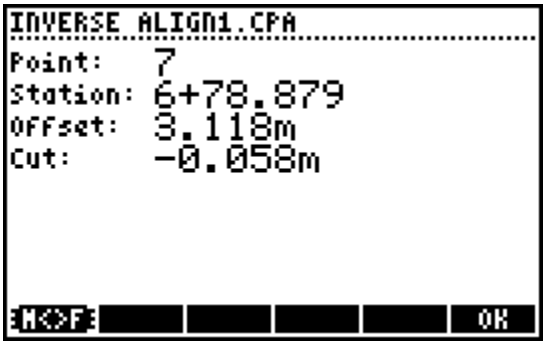
1. F1 **M<>F** – Toggles metric/imperial.
2. F2 **STORE** – Stores the coordinates of the point along the curve perpendicular to the offset point as a point in the job database.

Inverse Point to Alignment



Choose an alignment from the list of available alignments to inverse a point to the alignment and determine the station, offset and cut/fill of the point in relation to the alignment design.

Enter a point number to inverse to the selected alignment, and specify a maximum offset from centerline. Optionally specify a vertical offset constant from the alignment design, and choose whether elevation values are calculated to the cross section template or to the centerline of the alignment.

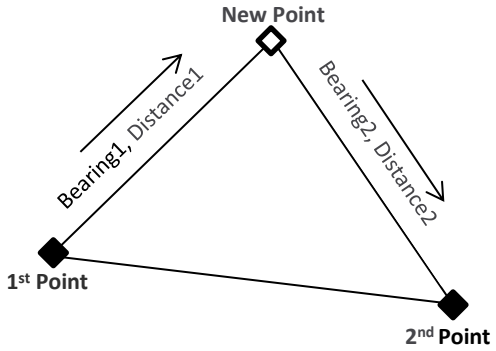


The maximum offset value is used to eliminate erroneous inverse results that may occur when alignments have significant geometry changes which could in turn provide offsets that are valid but not for the desired station.

The result includes the point number entered, the calculated station, offset and cut/fill. Use F1 **M<>F** to toggle the offset and cut/fill between metric/imperial.

5.3 Intersections

The **Intersections** program exclusively handles all types of intersections from a single input form. The words "Bearing" and "Azimuth" are interchangeable for naming the intersection types. In the diagram shown, the '1st Point' and "2nd Point' points are always known points and the 'New Point' point can be calculated when BEARING1 or DISTANCE1 **and** BEARING2 or DISTANCE2 is known.

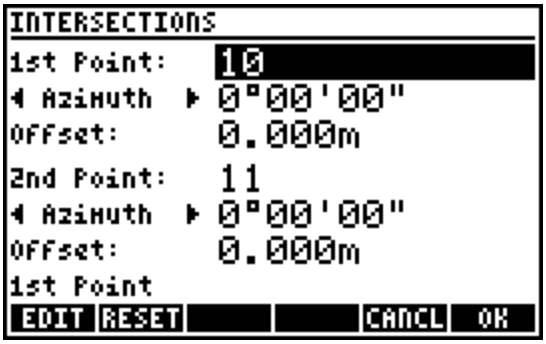


'1st Point' and '2nd Point' Fields

Both of these fields require an existing point number.

'Azimuth' or 'Bearing' / 'Distance' Fields

The labels for these fields change when the user toggles the input types for these fields with the ◀ and ▶ cursor keys. The label indicates how the input will be processed:



1. Azimuth/Bearing input is accepted using any of the standard directions input options.
2. Distance input is accepted using any of the standard distances input options.

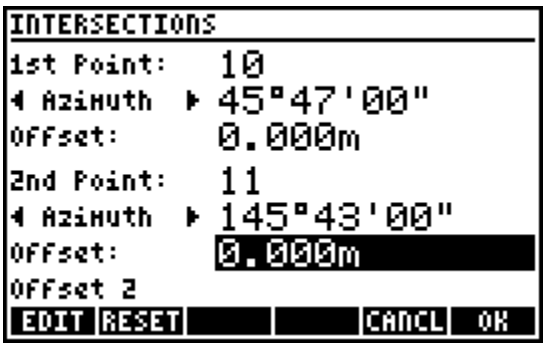
'Offset' Fields

These fields are only visible when the corresponding AZIMUTH or BEARING is the selected known component. Enter offsets using any of the standard distances input options.

NOTE: THE DIRECTIONS OF BEARING1 AND BEARING2 MAY BE FLIPPED 180° WITHOUT CONSEQUENCE, HOWEVER IF YOU ENTER ANY OFFSETS, THESE OFFSETS WILL ALWAYS BE RELATIVE TO YOUR DIRECTION ENTERED (LEFT OR RIGHT).

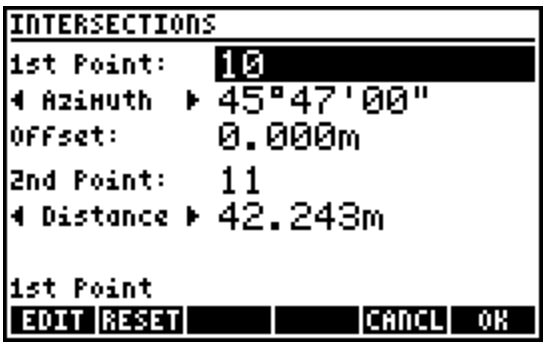
Bearing-Bearing

A bearing-bearing intersection can be solved when BEARING1 and BEARING2 are known. Offsets may be entered for both azimuth/bearing inputs. Entering offsets makes it possible to create an offset intersection, for example.



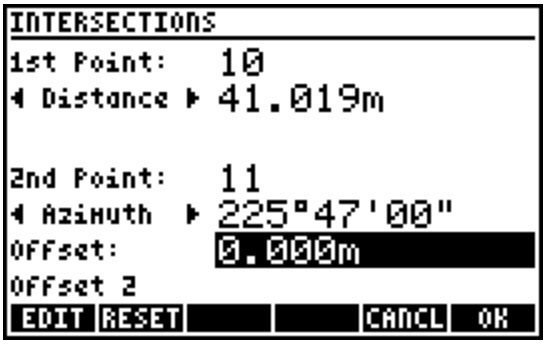
Bearing-Distance

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.



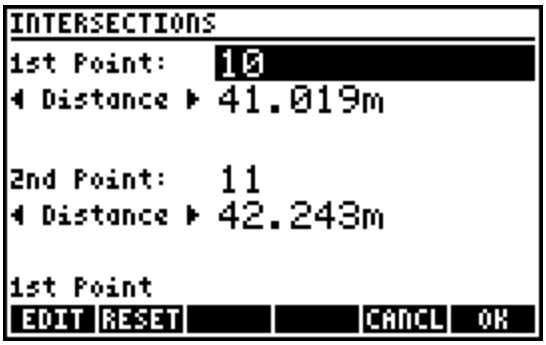
Distance-Bearing

A distance-bearing intersection can be solved when DISTANCE1 and BEARING2 are known. This type of intersection is similar to a bearing-distance intersection but started from the opposite direction, and usually also has two possible solutions. The user is prompted to choose which of the two solutions is desired by selecting one of the two possible Bearing1 solutions.



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 BEARING1 solutions.



5.4 Area by Points

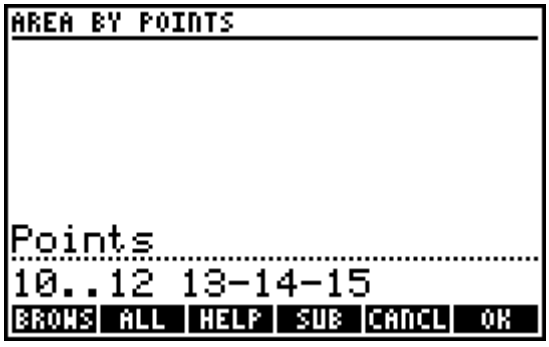
The **Area by Points** program calculates the area of a polygon when the points along the perimeter of the polygon are entered in sequence. The polygon can consist of straight segments and curves.

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.



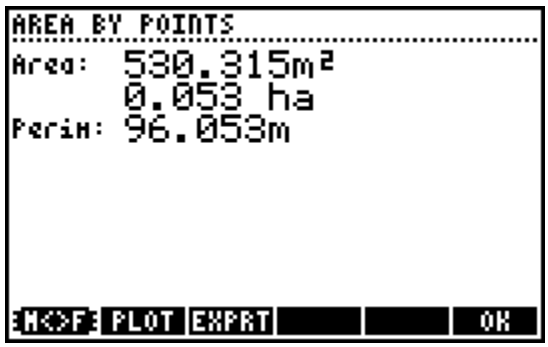
NOTE: AN ERROR OCCURS WHEN THE POINTS PROVIDED AS CURVE POINTS DO NOT ACTUALLY DEFINE A CURVE, I.E. THE RADIUS DIFFERS BY MORE THAN THE radius tolerance SETTING.

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 menu on the input screen:

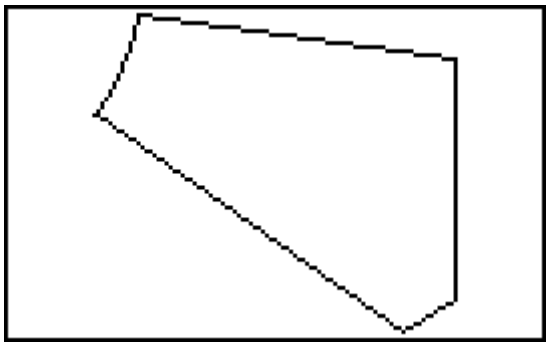
1. F1 **BROWS** - Opens the point browser to select/review points.
2. F2 **ALL** - Use all points in the current job, the points will be used in the sequence they were created. NOTE: BE CAREFUL WITH THIS OPTION, THIS OPTION COULD PROVIDE RESULTS YOU DO NOT EXPECT OR IT COULD TAKE SOME TIME TO CALCULATE WHEN SEVERAL HUNDRED POINTS EXIST.
3. F3 **HELP** - Displays a summary of how input is accepted.
4. F4 **SUB** - Subdivide a pre-determined area.

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.



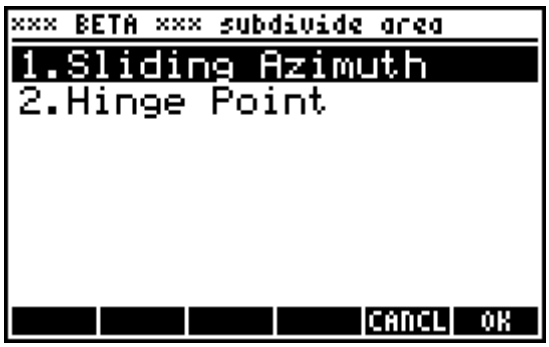
The menu on the results screen:

1. F1 **M<>F** - Toggles metric/imperial.
2. F2 **PLOT** - Draws the area polygon on the screen.
3. F3 **EXPRT** - Writes a DXF file of the polygon linework to save to the SD card COGOPLUS\ASCII directory or to the HOME directory on the calculator. DXF files can be opened with a CAD program.



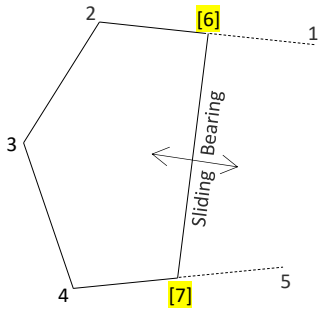
Area Subdivisions

COGO+ Pro Version 3.57 introduced two BETA editions of area subdivision programs. Coordinates of the missing point(s) are calculated to complete the fixed-area polygon.



Sliding Bearing/Azimuth

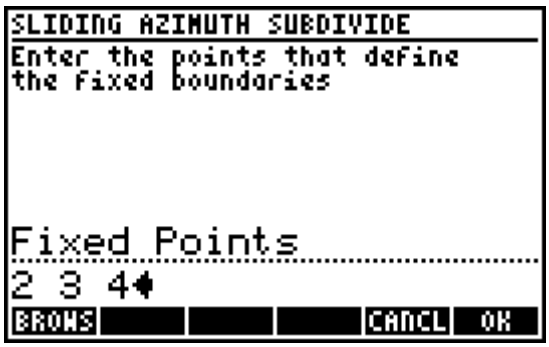
Calculate a specified area by sliding a line of fixed bearing/azimuth. For the diagram on the right, assume the known coordinates as listed and the fixed azimuth line to be 6°10'35" with a desired area of 100m². The program will calculate the coordinates for highlighted points 6 and 7 shown.

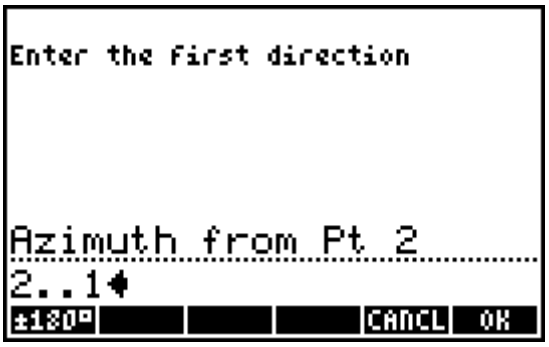


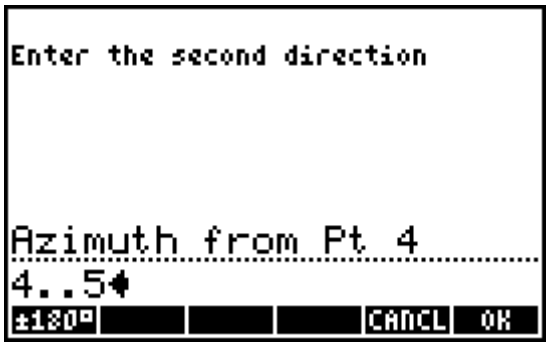
P,N,E Coordinates
1,100,100
2,101,90
3,96,86
4,89,89
5,90,99

First, enter the points that define the fixed boundaries, in this example those points are 2, 3 and 4.

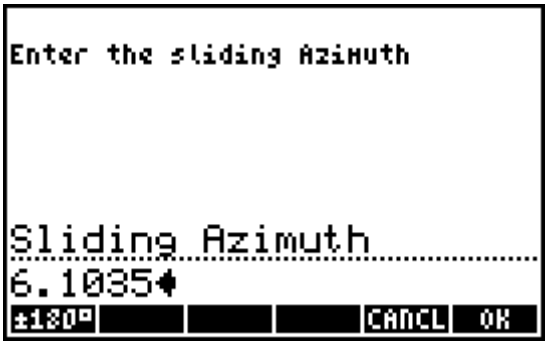
Next, enter the directions from the first and from the last point that you entered for the fixed points. Use any of the standard directions input options.

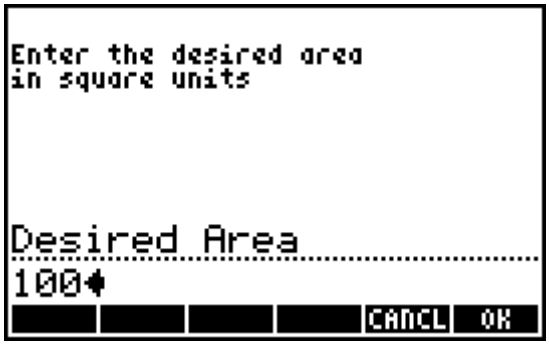




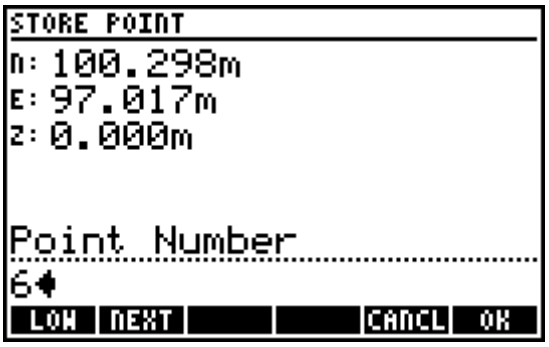


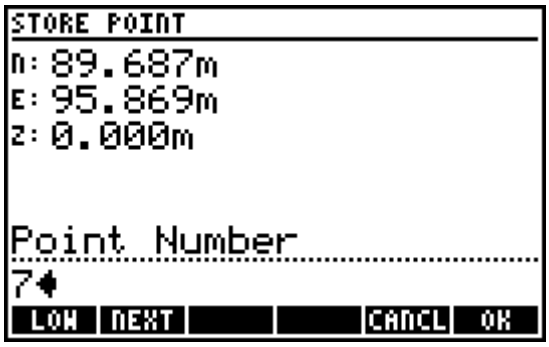
Next, enter the sliding azimuth/bearing followed by the desired area.





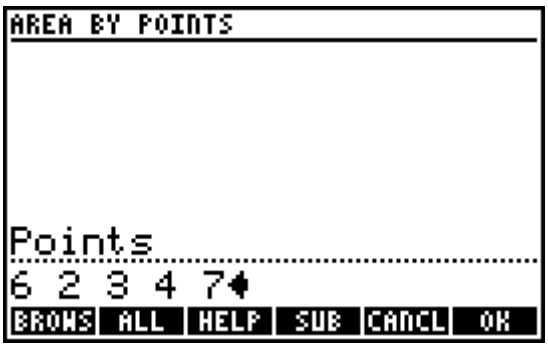
The solution for each point is presented on the standard STORE POINT screen.



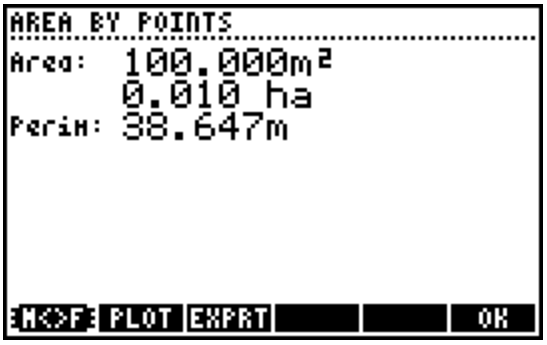


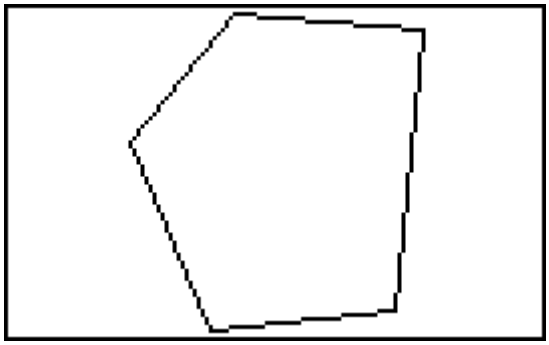
When both points are stored in the job database a message appears on the screen "New Area String copied to Clipboard…". This allows the user to paste the clipboard contents into the Area by Points program to confirm the solution.

Use [↱] followed by [PASTE] to paste the clipboard contents into the Area by Points input screen.



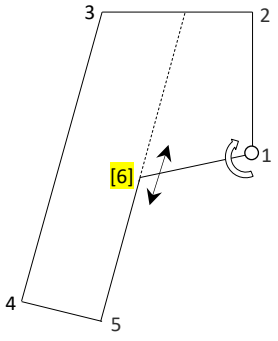
The solution and plot should be as shown below.





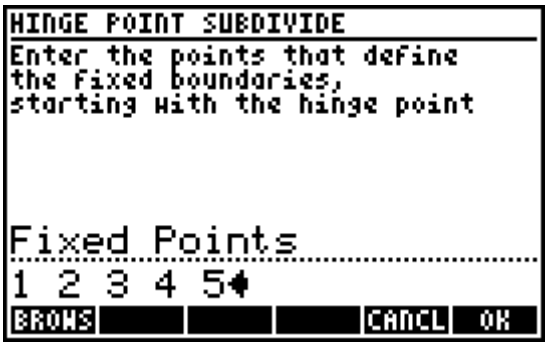
Hinge Point

Calculate a specified area by swinging a line from a hinge point into another line of fixed bearing/azimuth. For the diagram on the right, assume the known coordinates as listed and the direction from Point 5 to be parallel to the line 4-3 with a desired area of 180m². The program will calculate the coordinates for highlighted point 6 shown.

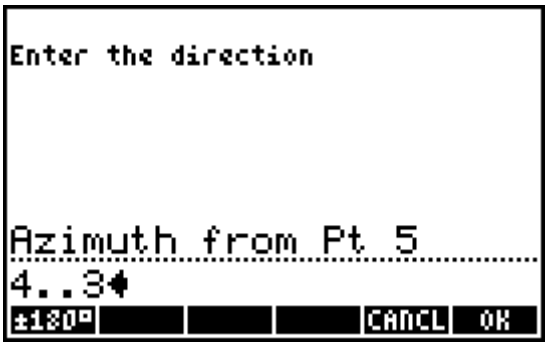


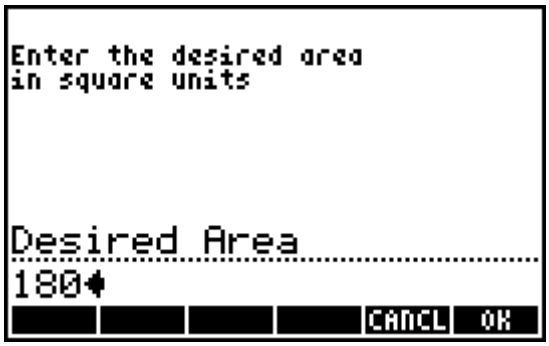
P,N,E Coordinates
1,20,20
2,30,20
3,30,10
4,11,3
5,9,8

First, enter the points that define the fixed boundaries, starting with the hinge point. In this example those points are 1, 2, 3, 4 and 5.



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

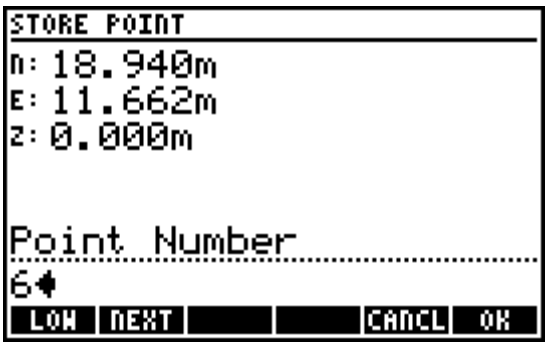


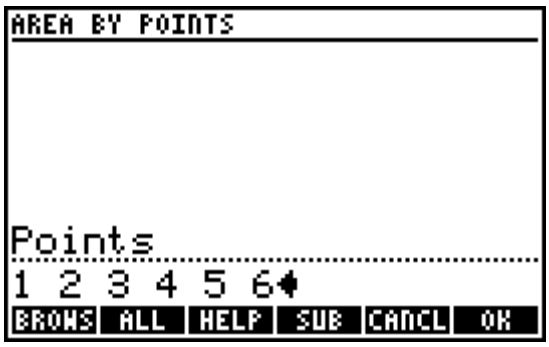


The solution for the point is presented on the standard STORE POINT screen.

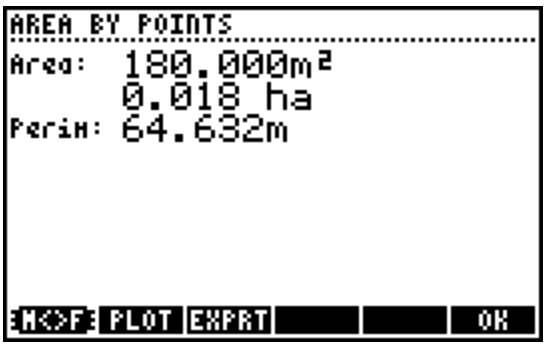
When the point is stored in the job database a message appears on the screen "New Area String copied to Clipboard…". This allows the user to paste the clipboard contents into the Area by Points program to check to confirm the solution.

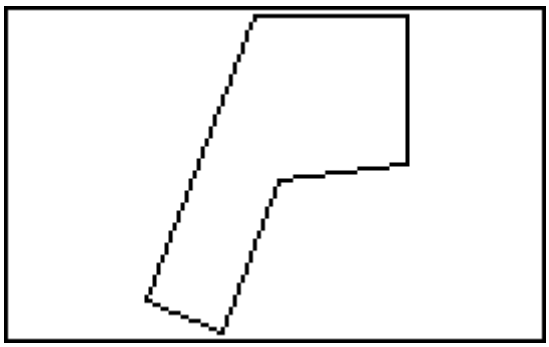
Use [↱] followed by [PASTE] to paste the clipboard contents into the Area by Points input screen.





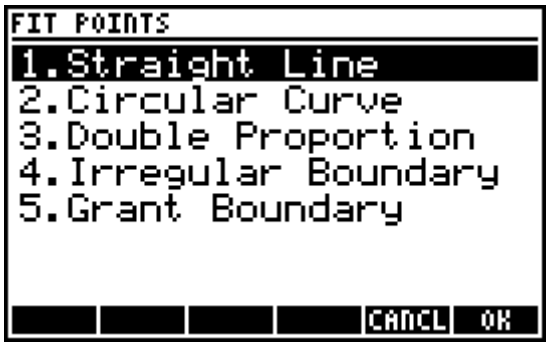
The solution and plot should be as shown below.





5.5 Fit Points

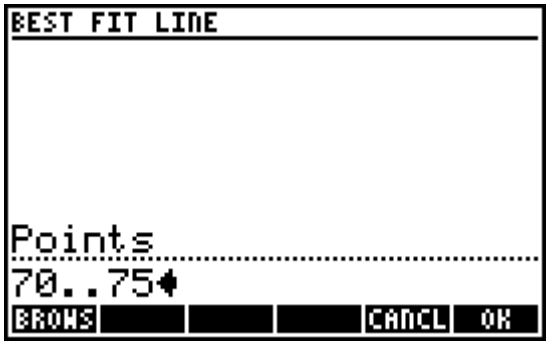
The **Fit Points** program consists of:



1. Best fit points to a straight line, linear regression.
2. Best fit points to a curve, similar to 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**.

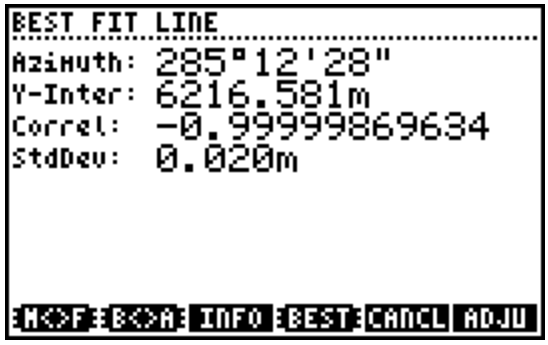
Best Fit Line

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.

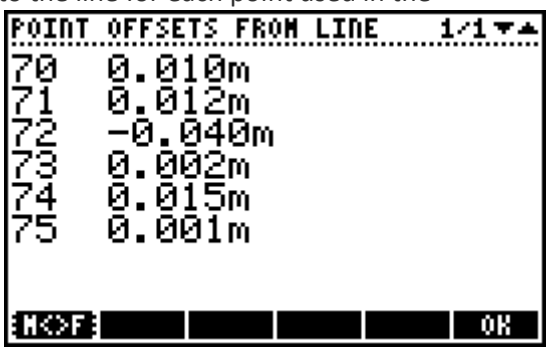


An un-weighted linear regression method that minimizes BOTH X and Y residuals simultaneously is used to calculate the line.

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:



1. F1 **M<>F** – Toggles metric/imperial.
2. F2 **B<>A** – Toggles bearings/azimuths.
3. F3 **INFO** – Displays the perpendicular offsets to the line for each point used in the computation.



4. F4 **BEST** or **FIX** – The menu label indicates whether the calculation represents a best-fit line or a line with a fixed direction. It is possible to enter a direction for the line that

differs from the best-fit direction and recalculate with the fixed parameter.

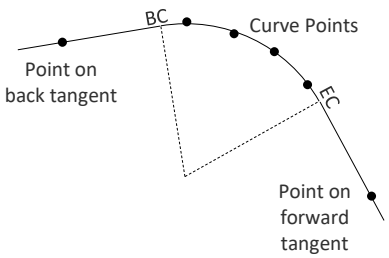
5. F5 **CANCL** – Return to the points input screen without adjusting the points.
6. F6 **ADJU** – Proceed with adjusting the points.

Choosing to apply the solution will either shift the points to fall on the line, which overwrites the existing points, or calculate new points re-numbered with an additive point number. The adjusted points setting controls the behaviour of overwrite/re-number.

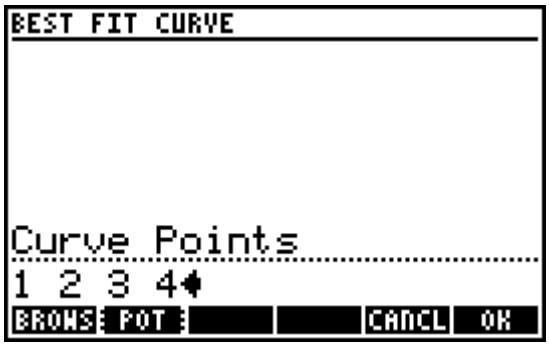
Points are always shifted perpendicular to the best-fit line to minimize the shift.

Best Fit 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.

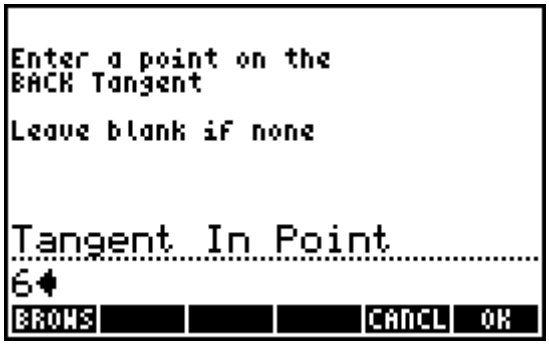


In the main input form, enter a series of points along the curve to compute the circle that best fits the points. Enter point numbers using any of the point numbers input options. The menu:

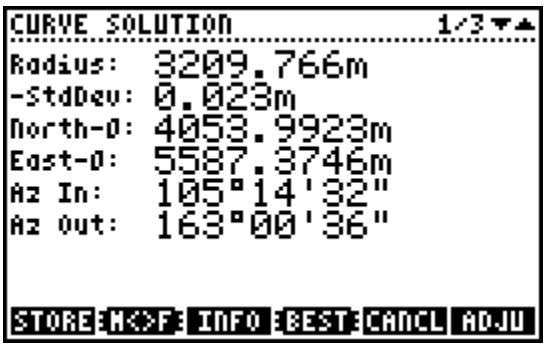


1. F1 **BROWS** - Opens the point browser to select/review points.
2. F2 **POT** - Toggle "Points On Tangents" input option. When enabled, the program will prompt for points on the back and forward tangent.

When the POT toggle is set, the program will also ask the user to choose the curve direction Right/Left.



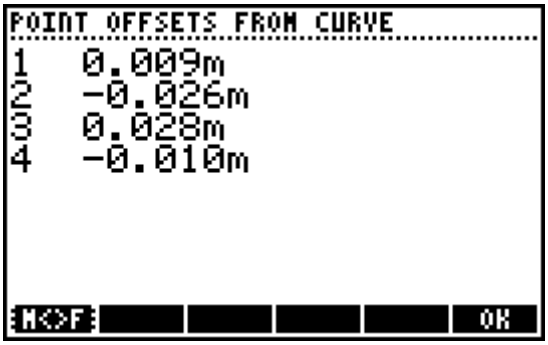
The first page of the curve solution displays the computed radius, the radius standard deviation, the coordinates of the radius point, and if applicable, the azimuths/bearings of the back and forward tangents.



The second page of the curve solution displays the coordinates of the BC and EC points if possible to solve with the input provided. THIS PAGE IS NOT APPLICABLE WHEN THE POT TOGGLE IS NOT SET.

The third page of the curve solution displays the curve elements: radius, deflection angle, arc, chord, tangent, mid-ordinate and external values. THIS PAGE IS ONLY DISPLAYED WHEN BOTH POT INPUTS ARE PROVIDED. The menu:

1. F1 **STORE** – Stores the computed radius point coordinates as a point in the job database, or when possible to store BC and/or EC points, will ask the user to choose which point to store.
2. F2 **M<>F** – Toggles metric/imperial.
3. F3 **INFO** – Displays the radial offsets to the curve for each point used in the computation.



4. F4 **BEST** or **FIX** – The menu label indicates whether the calculation represents a best-fit radius or a curve with a fixed radius. It is possible to enter a radius for the curve that differs from the best-fit radius and recalculate a new least squares circle with the fixed parameter.
5. F5 **CANCL** – Return to the points input screen without adjusting the points.
6. F6 **ADJU** – Proceed with adjusting the points.

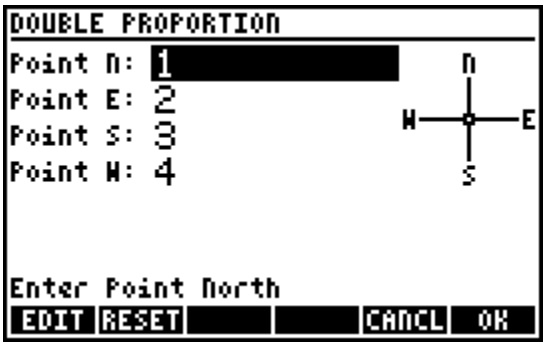
Choosing to apply the solution will either shift the points to fall on the curve, which overwrites the existing points, or calculate new points re-numbered with an additive point number. The adjusted points setting controls the behaviour of overwrite/re-number.

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

Double Proportion

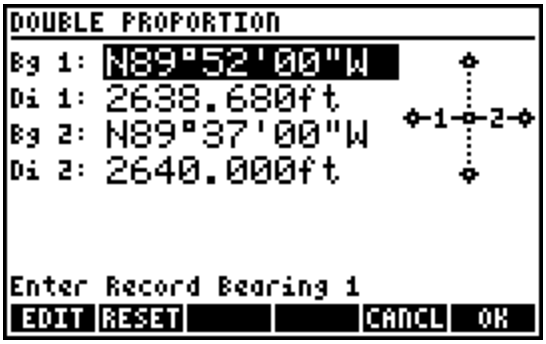
"The term 'double proportionate measurement' is applied to a new measurement made between four known corners, two each on intersecting meridional and latitudinal lines, for the purpose of relating the cardinal equivalent intersection to both." (Page 166, BLM Manual of Surveying Instructions 2009).

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.

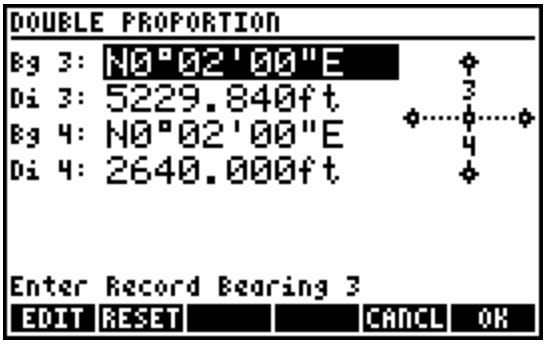
The second input form requires the **record** bearings and distances to the known corners west and east of the lost corner. When entering or editing a distance the menu offers the following functions:



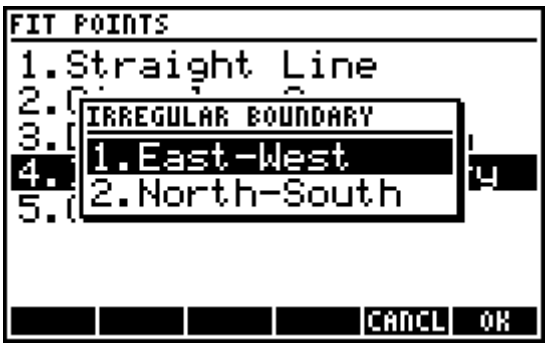
1. F1 **F->M** or **M->F** – Converts the input between metric and imperial units. The appearance of this softkey varies depending on your primary distance unit setting.
2. F2 **xUSF** – Multiplies the input by the user defined scale factor.
3. F3 **/USF** – Divides the input by the user defined scale factor.

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

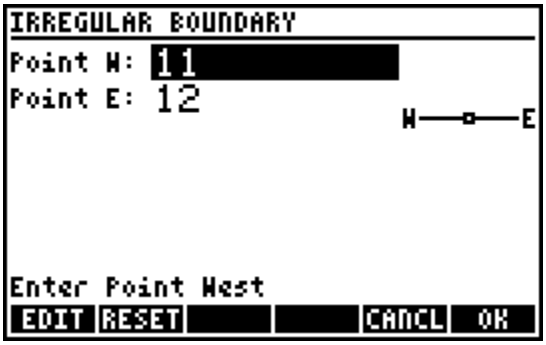
Following input, the coordinates of the lost corner are calculated and the point may be stored to the job database.



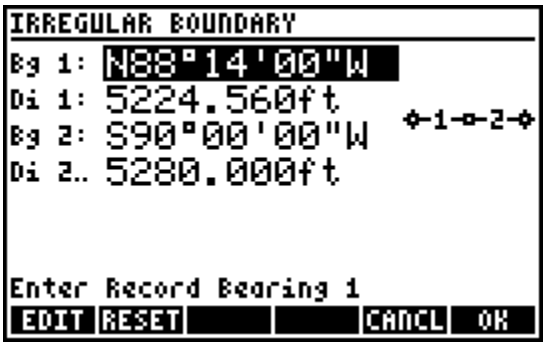
Irregular Boundary Adjustment



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.

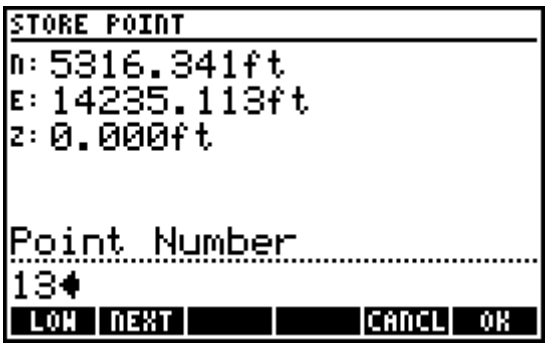


The **Irregular Boundary** program prompts for the direction of the line, and then the first input form requires the point numbers for the surveyed points (W + E, or N + S).



The second input form requires the **record** dimensions to the corners on either side of the lost corner. When entering or editing a distance the menu offers the following functions:

1. F1 **F->M** or **N->F** – Converts the input between metric and imperial units. The appearance of this softkey varies depending on your primary distance unit setting.
2. F2 **xUSF** – Multiplies the input by the user defined scale factor.
3. F3 **/USF** – Divides the input by the user defined scale factor.

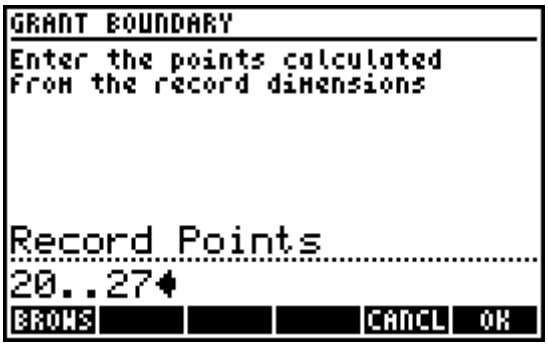


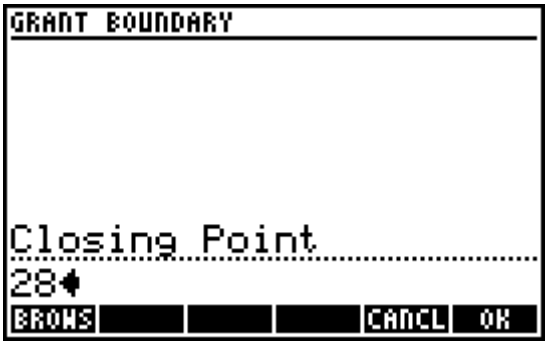
Following input, the coordinates of the lost corner are calculated and the point may be stored to the job database.

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)

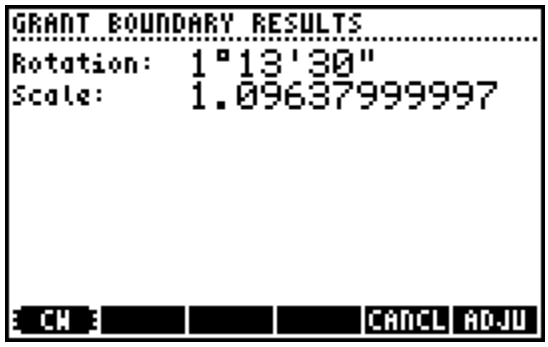
The **Grant Boundary** program requires a series of points that define the grant boundary, starting with a known (found) point followed by calculated points using **record** dimensions. The first input screen asks for these points. The second input screen asks for a *Closing Point*, which is a found 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.



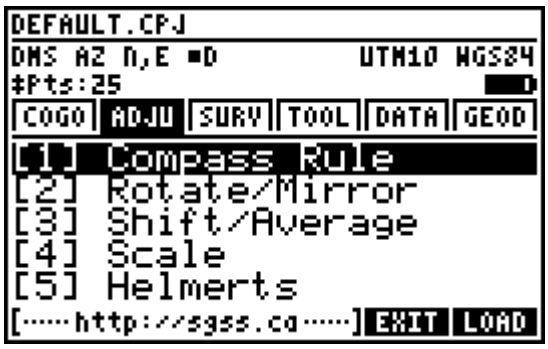


The calculated rotation and scale are displayed on the results screen. The menu:

1. F1 **CW** or **CCW** – Toggles the rotation displayed as being clockwise or counter-clockwise.
2. F5 **CANCL** – Cancel the adjustment and return to the input screen.
3. F6 **ADJU** - Adjusts the record points. The adjustment will either update the existing point coordinates, which overwrites the existing points, or calculate new points re-numbered with an additive point number. The adjusted points setting controls the behaviour of overwrite/re-number.

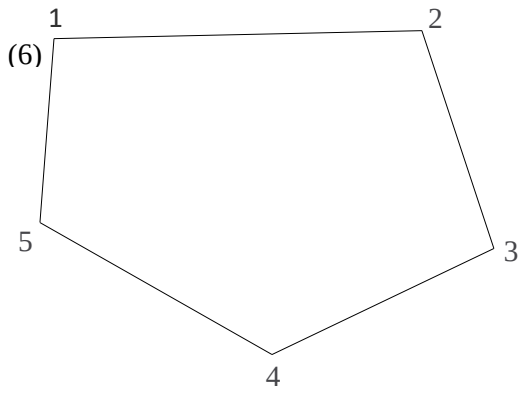


6 Adjustments Menu



6.1 Compass Rule

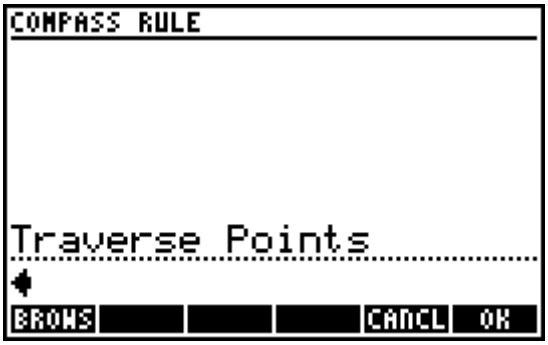
A "compass rule" or "bowditch rule" adjustment distributes the linear misclose of a traverse proportionally throughout each leg of a traverse. A 'closed figure' traverse ends back on the starting point while a 'close to fixed point' traverse ends on a known control point that is held fixed. This type of adjustment is very limited but is useful for some scenarios. A rigorous least squares adjustment is recommended to adjust traverse networks.



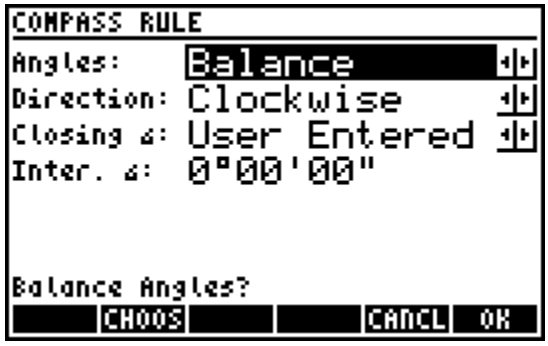
Closed Figure

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.

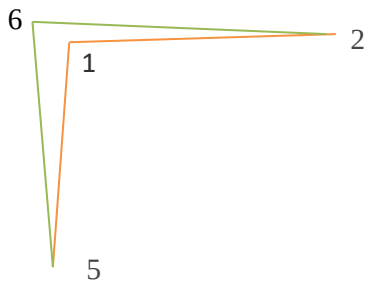
In the *Traverse Points* input screen, enter the point numbers using any of the point numbers input options. Next, select the type of traverse as being a 'closed figure'.



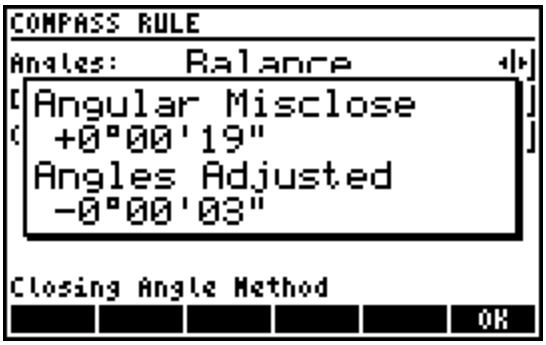
The next screen allows the user to set angle balancing parameters. Choose 'Balance' or 'No Balance' for the first choose field to turn angle balancing on/off. When angle balancing is turned off (No Balance), the remaining fields disappear since they are no longer needed. When angle balancing is on (Balance) more input is required. The second choose field asks for a direction around the



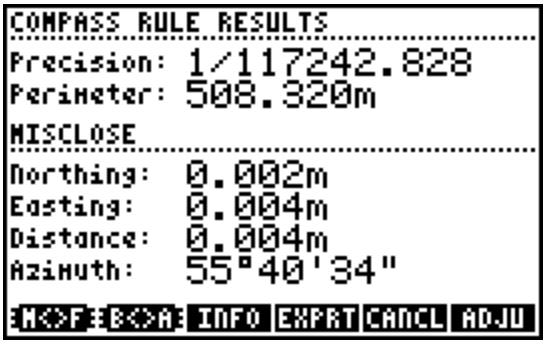
perimeter that the traverse points were entered, either clockwise or counter-clockwise. The third choose field asks how the closing angle is determined, either 'User Entered' or 'Compute Average'. When this option is set to 'User Entered' then the interior closing angle is required in the fourth field. When this option is set to 'Compute Average' then an average closing angle is computed using the average of two possible closing angles based on the point coordinates used. The diagram on the right illustrates how this angle is computed, with reference to the diagram on the previous page. The angles are computed for angle 2-1-5 and for angle 2-6-5 and then averaged.



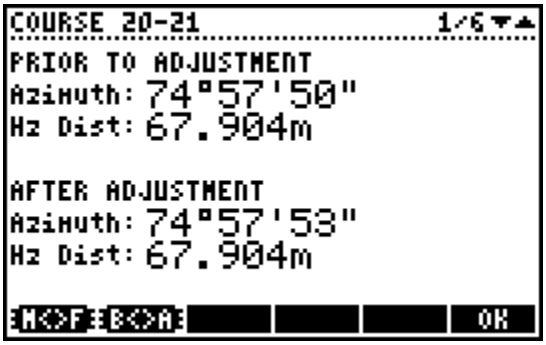
The angle balancing results show the total angular misclose, and the angular correction that will be applied to each angle.



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

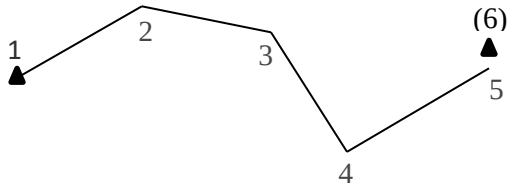


1. F1 **M<>F** – Toggles metric/imperial.
2. F2 **B<>A** – Toggles bearings/azimuths.
3. F3 **INFO** – Displays information about each course of the traverse prior and after adjustment.
4. F4 **EXPRT** – Allows the results to be exported to the stack or to an ASCII file.
5. F5 **CANCL** – Cancels the adjustment and returns to the traverse point input screen.
6. F6 **ADJU** – Proceeds with the adjustment which will either update the existing point coordinates, (overwriting them), or calculate new points re-numbered with an additive point number. The adjusted points setting controls the behaviour of overwrite/re-number.

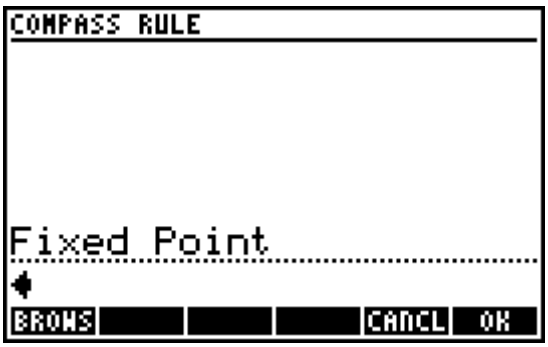


Close to Fixed Point

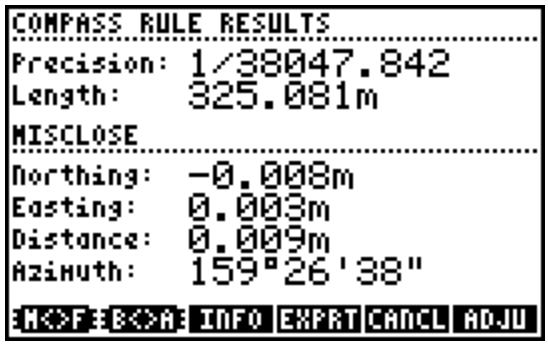
A close to fixed point traverse begins on a known control point followed by a series of intermediate points and ends on a second known control point which will be held fixed. The difference between the measured ending point coordinates and the fixed values will be distributed proportionally through each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



In the *Traverse Points* input screen enter the point numbers using any of the point numbers input options. Next, select the type of traverse as being a 'close to fixed point'. When a 'close to fixed point' selection is made, a input screen will ask for the point number of the fixed point.

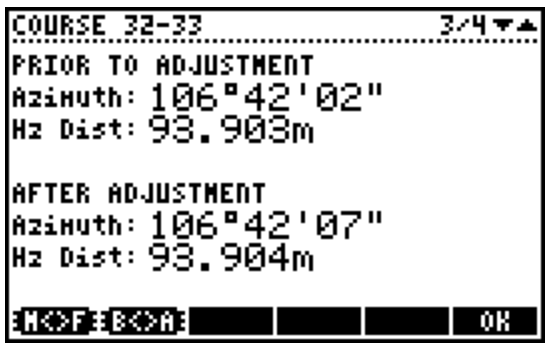


The COMPASS RULE RESULTS screen displays information about the adjustment including the precision, the perimeter of the figure, and the misclose information.



The menu:

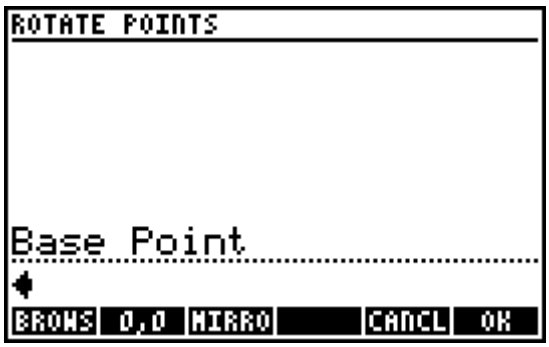
1. F1 **M<>F** – Toggles metric/imperial.
2. F2 **B<>A** – Toggles bearings/azimuths.
3. F3 **INFO** – Displays information about each course of the traverse, prior and after adjustment.



4. F4 **EXPRT** – Allows the results to be exported to the stack or to an ASCII file.
5. F5 **CANCL** – Cancels the adjustment and returns to the traverse point input screen.
6. F6 **ADJU** – Proceeds with the adjustment which will either update the existing point coordinates, (overwriting them), or calculate new points re-numbered with an additive point number. The adjusted points setting controls the behaviour of overwrite/re-number.

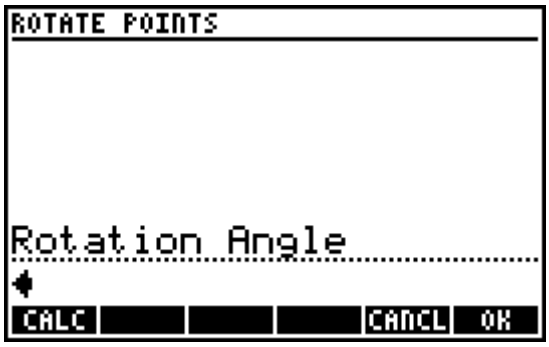
6.2 Rotate/Mirror Points

Rotate Points rotates point coordinates around a base point while **Mirror Points** mirrors points along a baseline. The **Mirror Points** program is a sub-program within the **Rotate Points** program.



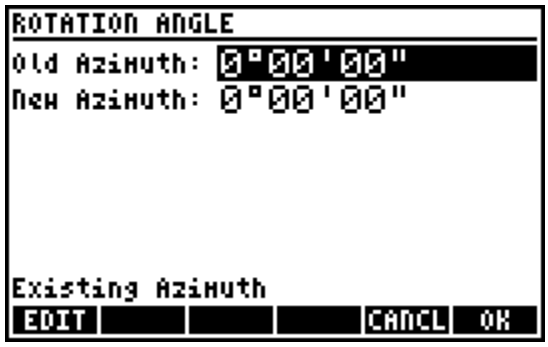
Rotate Points

Enter the point number to use as a base point for the rotation in the *Base Point* input screen. The menu:



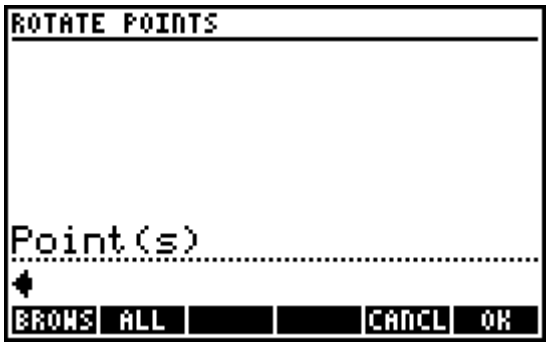
1. F1 **BROWS** – Open the Point Browser to browse/search for a specific point number.
2. F2 **0,0** – Sets the coordinate system origin (0,0) as the base point.
3. F3 **MIRRO** – Opens the Mirror Points program. By default the **Rotate Points** program always starts up, using F3 is the only way to start the **Mirror Points** program.

The next *Rotation Angle* input screen requires a rotation angle. Enter a positive angle for a clockwise rotation and a negative angle for a counter-clockwise rotation.



Use F1 **CALC** to calculate a rotation angle based on 'before' and 'after' azimuths/bearings. Enter values for *Old Azimuth* and *New Azimuth* to calculate the rotation. Use any of the standard directions input options for both of these fields. The calculated rotation value is copied to the *Rotation Angle* input screen.

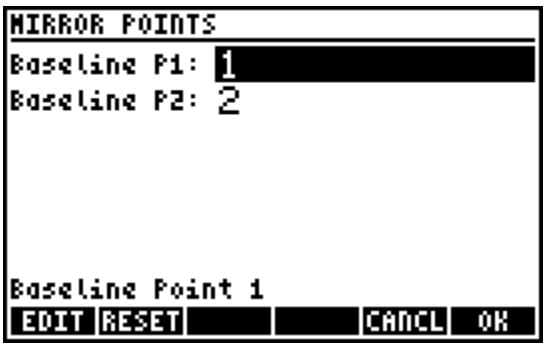
Next, enter the points to rotate and the program will either update the existing point coordinates, which overwrites the existing points, or calculate new points re-numbered with an additive point number. The adjusted points setting controls the behaviour of overwrite/re-number.

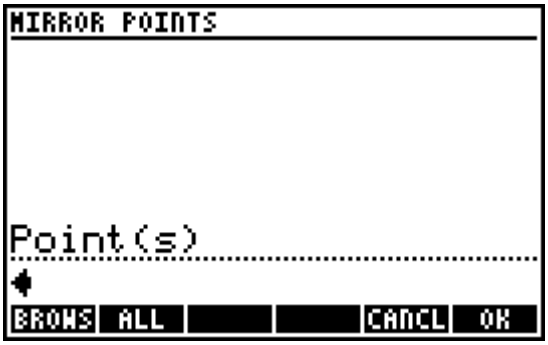


Mirror Points

In the first input form, enter two points to define a baseline.

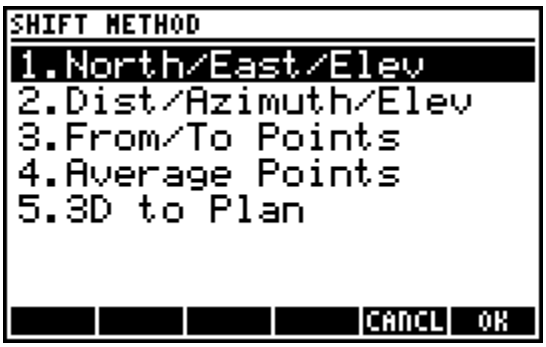
Next, enter the points to mirror and the program will either update the existing point coordinates, which overwrites the existing points, or calculate new points re-numbered with an additive point number. The adjusted points setting controls the behaviour of overwrite/re-number.





6.3 Shift/Average Points

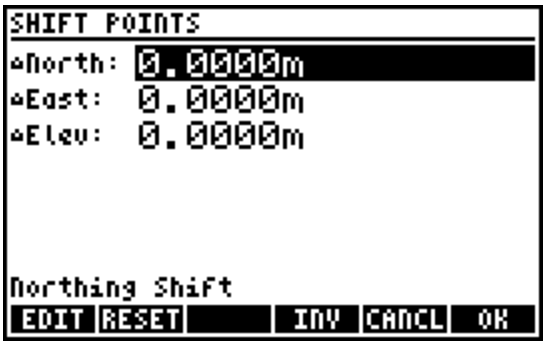
Point coordinates can be shifted by using one of three possible methods, and a range of point coordinates can be averaged to create a new point at the calculated average position. The 3D to Plan option transforms 3D measurements to 2D plan cross sections.



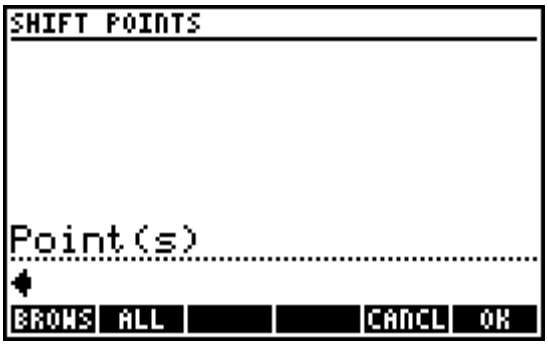
Shift Points by Northing/Easting/Elevation

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

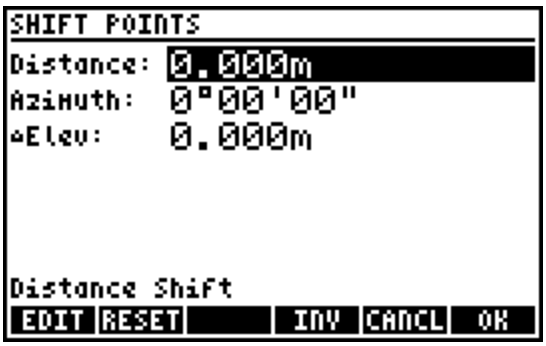
1. F4 **INV** – Inverse between points in the job to calculate their coordinate change for the current field.



Next, enter the points to shift and the program will either update the existing point coordinates, which overwrites the existing points, or calculate new points re-numbered with an additive point number. The adjusted points setting controls the behaviour of overwrite/re-number.



Shift Points by Distance/Direction/Elevation

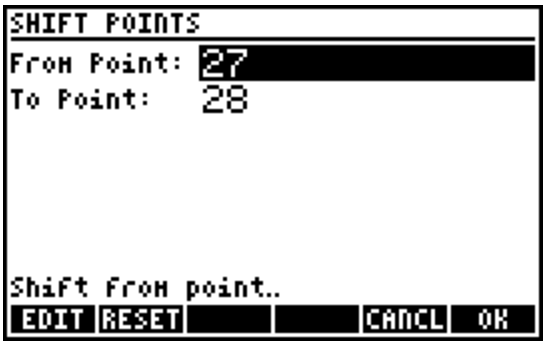


Enter the horizontal *Distance*, the *Azimuth* or *Bearing* and the change in *Elevation* to define the shift parameters. Use any of the standard distances and directions input options. The menu:

1. F4 **INV** – Inverse between points in the job to calculate the value of the current field.

Next, enter the points to shift and the program will either update the existing point coordinates, which overwrites the existing points, or calculate new points re-numbered with an additive point number. The adjusted points setting controls the behaviour of overwrite/re-number.

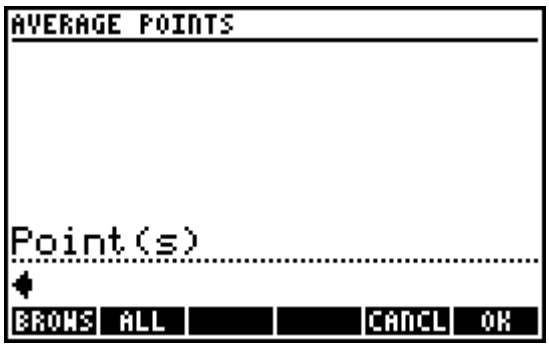
Shift Points by From/To Points



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

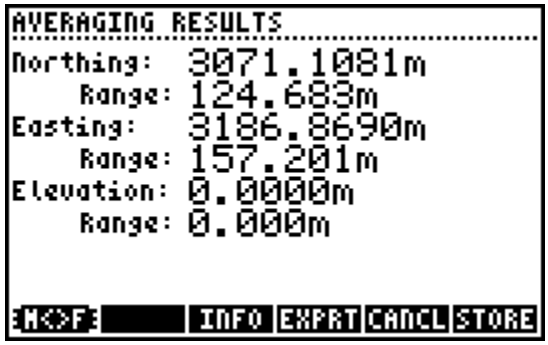
Next, enter the points to shift and the program will either update the existing point coordinates, which overwrites the existing points, or calculate new points re-numbered with an additive point number. The adjusted points setting controls the behaviour of overwrite/re-number.

Average Points



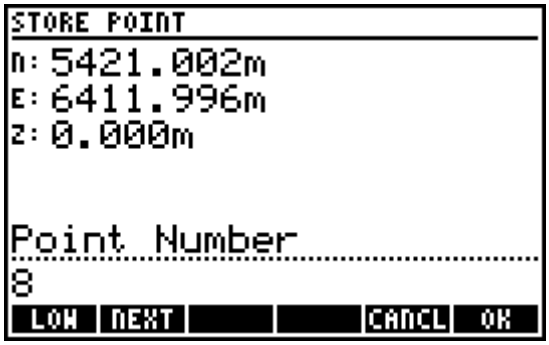
Enter a series of points to compute their arithmetic mean coordinate values. Point numbers can be entered using any of the point numbers input options. At minimum two points are required to calculate average values. The menu:

1. F1 **BROWS** – Open the Point Browser to browse/search for specific point numbers.
2. F2 **ALL** – Calculate the average coordinate values of all the points in the current job.



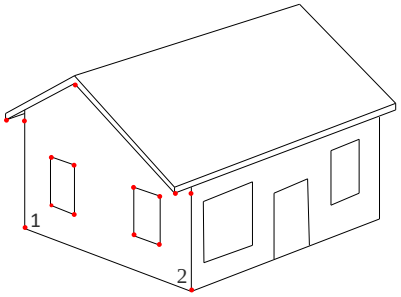
The solution displays the calculated coordinates and the range in coordinate values. The menu:

1. F1 **M<>F** - Toggles metric/imperial.
2. F3 **INFO** - Displays radial inverse information from the calculated average position to each of the points used in the calculation.
3. F4 **EXPRT** - Writes a ASCII report of the results.
4. F5 **CANCL** – Returns to the point numbers input screen.
5. F6 **STORE** - Store the solution with the standard STORE POINT screen.

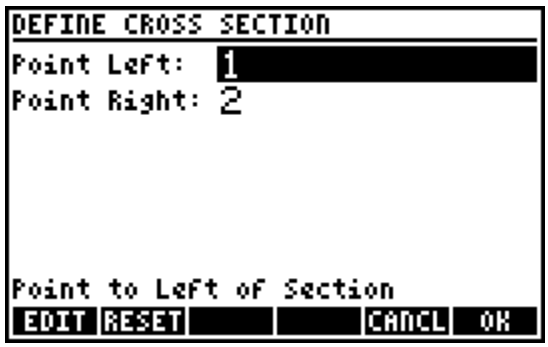


3D to Plan

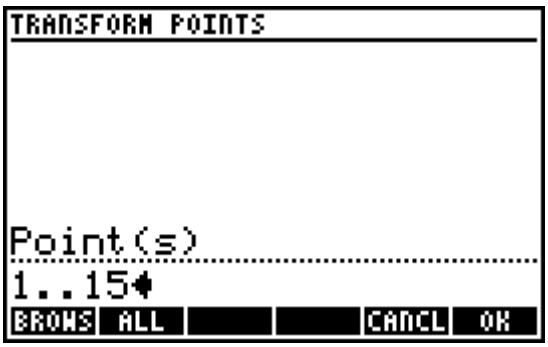
In the diagram on the right, consider the red dots shown as being reflector-less measurements made with a total station. The goal is to calculate the ratio of glass surface area to total surface area of the wall. The 3D to Plan program transforms the 3D measured coordinates into 2D plan points to create 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 1 on the left and Point 2 on the right.



Next, enter the points you wish to transform and the program will either update the existing point coordinates, which overwrites the existing points, or calculate new points re-numbered with an additive point number. The adjusted points setting controls the behaviour of overwrite/re-number.

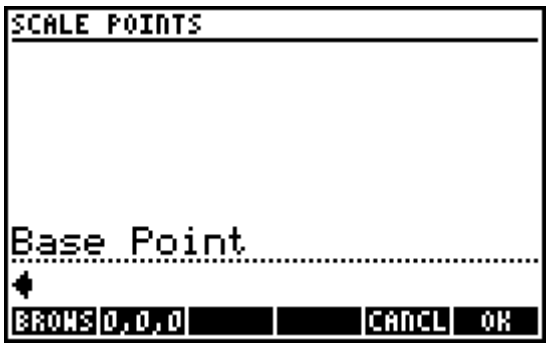


The coordinates below, points 1 to 15, are the sample original 3D coordinates (P,N,E,Z in feet), and the transformed coordinates are 201 to 215 (An additive of 200 was used to re-number the adjusted points). With two simple intersection calculations, the surface areas can easily be calculated.

```
1,5000.000,5000.000,68.743
2,4982.603,5019.322,68.743
3,5000.000,5000.000,77.743
4,4982.603,5019.322,76.743
5,4997.323,5002.973,71.743
6,4994.647,5005.945,71.743
7,4997.323,5002.973,75.743
8,4994.647,5005.945,75.743
9,4987.956,5013.377,71.743
10,4985.279,5016.349,71.743
11,4987.956,5013.377,75.743
12,4985.279,5016.349,75.743
13,4999.852,4997.175,78.243
14,4979.778,5019.470,78.243
15,4989.815,5008.323,84.493
```

```
201,68.743,0.000,0.000
202,68.743,26.000,0.000
203,77.743,0.000,0.000
204,76.743,26.000,0.000
205,71.743,4.000,0.000
206,71.743,8.000,0.000
207,75.743,4.000,0.000
208,75.743,8.000,0.000
209,71.743,18.000,0.000
210,71.743,22.000,0.000
211,75.743,18.000,0.000
212,75.743,22.000,0.000
213,78.243,-2.000,0.000
214,78.243,28.000,0.000
215,84.493,13.000,0.000
```

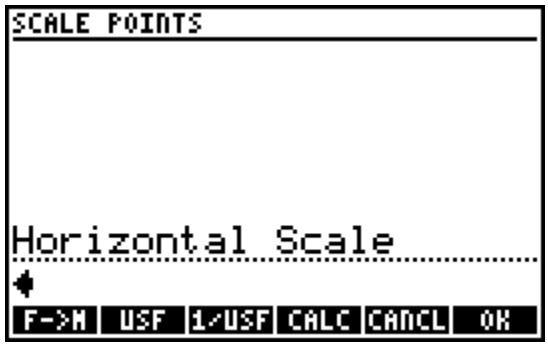
6.4 Scale Points



Point coordinates can be scaled from a base point with separate scale factors for the horizontal and vertical components. For both scale factors it is possible to enter a math operation such as 1/0.99962051 and use the EVAL key to parse the input.

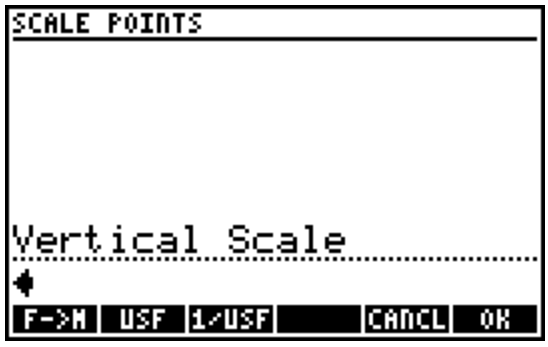
First, enter the point number to use as the *Base Point*. The menu:

1. F1 **BROWS** – Open the Point Browser to browse/search for a specific point number.
2. F2 **0,0,0** – Set the coordinate system origin (0,0,0) as the base point.



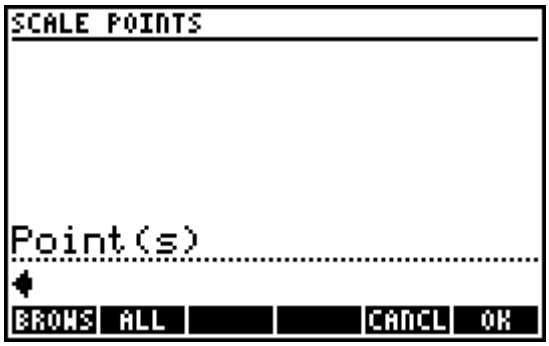
Next, enter the *Horizontal Scale* factor. The menu:

1. F1 **F->M** or **M->F** – Inserts the scale factor to scale to your primary distance unit.
2. F2 **USF** – Inserts the user defined scale factor.
3. F3 **1/USF** – Inserts the inverse of the user defined scale factor.
4. F4 **CALC** – Calculates the scale factor based on “Old” and “New” distances.



Next, enter the *Vertical Scale* factor. The menu: is identical to the *Horizontal Scale* input screen with the exception of the F4 **CALC** softkey.

Next, enter the points to scale and the program will either update the existing point coordinates, which overwrites the existing points, or calculate new points re-numbered with an additive point number. The adjusted points setting controls the behaviour of overwrite/re-number.



6.5 Helmerts

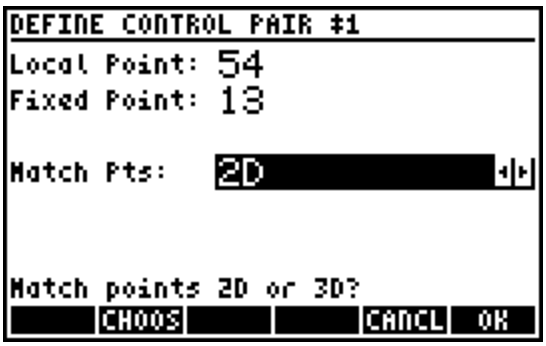
The **Helmerts** program is a powerful least squares coordinate transformation program that allows the user to transform points from one coordinate system to another. A two-dimensional conformal coordinate transformation (aka four-parameter similarity transformation) is used to calculate the least squares 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 **Helmerts** screen accepts all input through the menu:

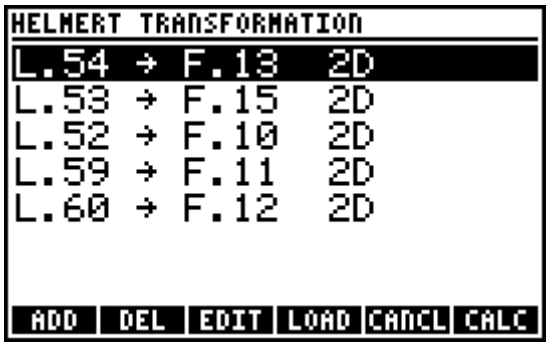
1. F1 **ADD** – Add control pairs to be used for the calculation.
2. F2 **DEL** – Delete the selected control pair from the calculation. NOTE: ONLY WORKS WHEN CONTROL PAIRS ARE DISPLAYED ON THE SCREEN.
3. F3 **EDIT** – Edit the selected control pair. NOTE: CAN BE USED TO CORRECT ERRONEOUS INPUT SUCH AS SPECIFYING A DIFFERENT CONTROL POINT THAN INTENDED.
4. F4 **LOAD** – Load previously saved transformation parameters. NOTE: A SET OF PARAMETERS MUST HAVE BEEN SAVED FROM A PREVIOUS CALCULATION FOR THIS FEATURE TO WORK, SEE THE Calculate Solution SECTION ON HOW TO SAVE TRANSFORMATION PARAMETERS.

Add Control Pairs



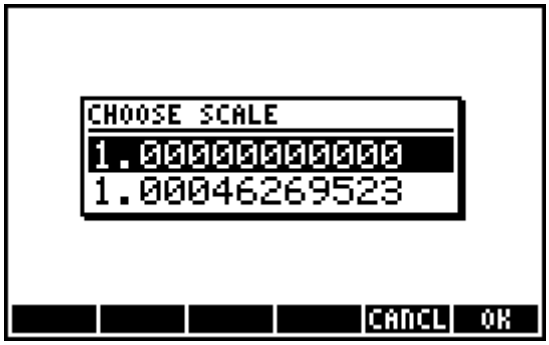
From the main **Helmerts** screen press F1 to begin adding control pairs. The *Local Point* is in the coordinate system that you wish to transform, while the *Fixed Point* is in the coordinate system that is not changing. Points can be matched in 2D or 3D. You may continue entering all your control pairs without leaving the DEFINE CONTROL PAIRS input form. When all control pairs are defined, use F5 **CANCL** to return to the main **Helmerts** screen.

Delete or Edit Control Pairs



Control pairs can be deleted or edited when necessary. From the main **Helmerts** screen, select a control pair and use F2 **DEL** to delete or F3 **EDIT** to edit the selected control points. The screen updates immediately to reflect the changes made.

Calculate Solution

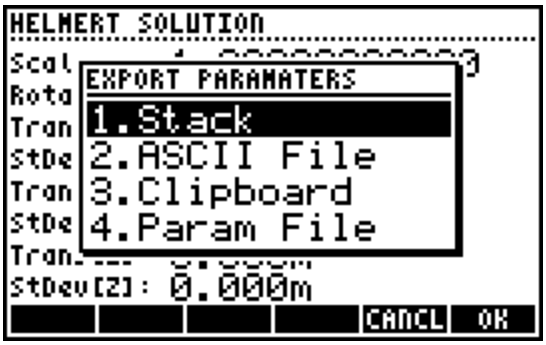


Use F6 **CALC** to calculate the transformation parameters based on the defined control pairs. A choose box will pop up to prompt a scale selection. Select scale 1.00000000000 to eliminate the scale factor, otherwise the coordinates of the transformed points will be scaled by the best-fit scale parameter.

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:

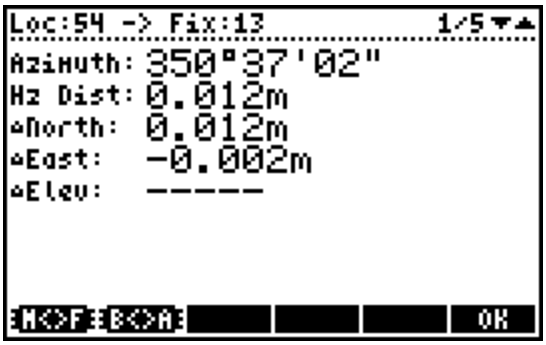
1. F1 **M<>F** – Toggles metric/imperial.

2. F2 **RESID** – Display the residuals between all the control pair coordinates. NOTE: THESE ARE THE COORDINATE DIFFERENCES POST-TRANSFORMATION BETWEEN THE LOCAL AND FIXED POINTS.
3. F3 **EXPRT** – Export the solution text to the stack or to an ASCII file, copy any of the solved parameters to the clipboard for pasting elsewhere, or save the parameters to a Parameter file that can be loaded for future use.



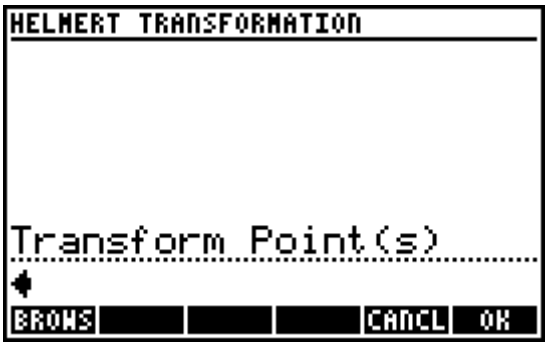
4. F4 **CW** or **CCW** – Toggle clockwise or counter-clockwise rotation display.
5. F5 **BACK** – Return to the main **Helmerts** screen to make some adjustments to the control pairs used, or to cancel the transformation.
6. F6 **CONT** – Accept the solution and continue with the transformation.

Reviewing the residuals with F2 **RESID** is an excellent way to isolate a poor fit or an outlier within the control points that are used. It may be necessary to experiment with using different combinations of control points to achieve the desired results.

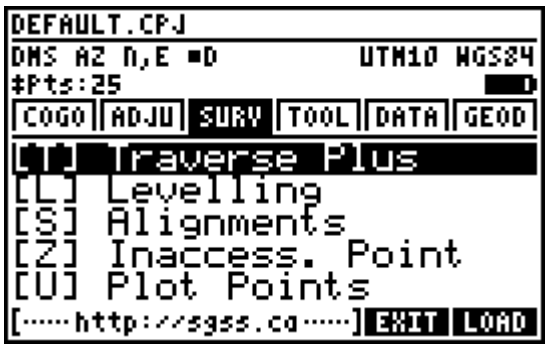


Apply Transformation

Use F6 **CONT** when ready to apply the transformation. Enter the points to transform and the program will either update the existing point coordinates, which overwrites the existing points, or calculate new points re-numbered with an additive point number. The adjusted points setting controls the behaviour of overwrite/re-number



7 Surveying Menu



7.1 Traverse Plus

Traverse Plus simulates data collection and field calculations based on input of measured values.

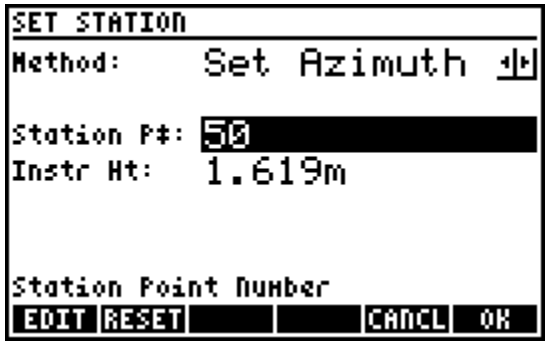
Setup

Similar to a total station workflow, Traverse Plus requires a station and orientation. Three different setup methods are possible:

1. Set Azimuth
2. Known Backsight Point
3. Resection
4. Helmerts

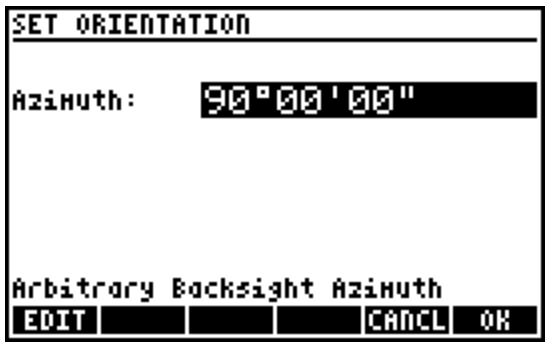
Set Azimuth

A "Set Azimuth" setup method refers to setting up on a point with known coordinates and sighting a known or unknown point and setting an arbitrary azimuth to this point.



Select "Set Azimuth" as the setup *Method* and input the *Station Point Number* and *Height of Instrument*.

NOTE: AN INPUT FORM WILL OPEN TO ALLOW ENTERING COORDINATES FOR THE STATION POINT IF THE POINT DOES NOT EXIST IN THE CURRENT JOB.

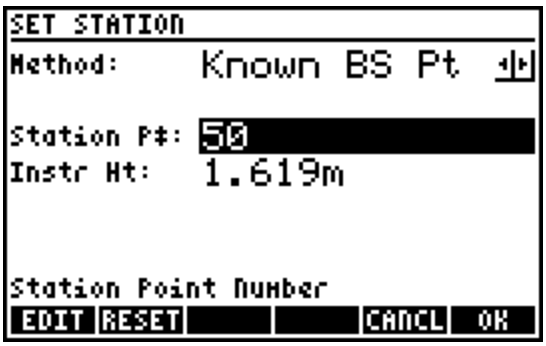


Next, enter an arbitrary backsight azimuth to set your orientation.

This setup method is generally used on the first setup of a survey when control does not exist in the survey area.

Known Backsight Point

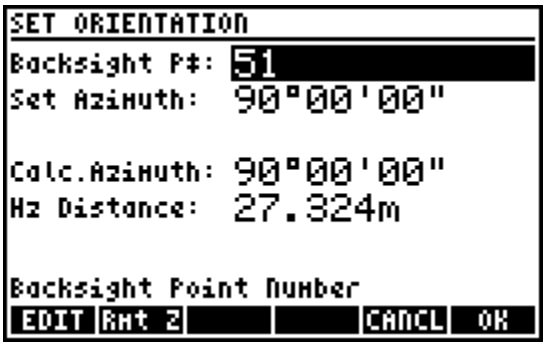
A "Known Backsight Point" setup method refers to setting up on a point with known coordinates and sighting another known point.



Select "Known BS Pt" as the setup *Method* and input the *Station Point Number* and *Height of Instrument*.

NOTE: AN INPUT FORM WILL OPEN TO ALLOW ENTERING COORDINATES FOR THE STATION POINT IF THE POINT DOES NOT EXIST IN THE CURRENT JOB; HOWEVER, THE STATION AND BACKSIGHT POINTS SHOULD BOTH EXIST IN THE CURRENT JOB FOR THIS SETUP METHOD.

Next, enter the *Backsight Point Number* to calculate the azimuth and distance to the backsight point. The calculated information is displayed on the screen for reference. A *Set Azimuth* field is provided should the user wish to set an azimuth to the backsight that differs from the calculated azimuth.

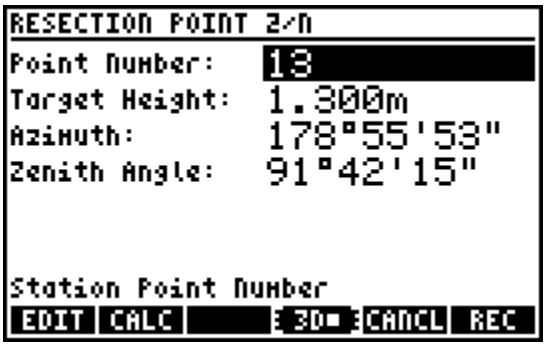


Resection

A "Resection" setup method refers to setting up on an unknown point and sighting at least three known points to compute the station point coordinates. When more than three points are used in a resection, an iterative least squares adjustment method is used to calculate the best estimates for the station coordinates.

Select "Resection" as the setup *Method* and input a *Station Point Number* and *Height of Instrument*. The point number entered for the *Station Point Number* cannot exist in the current job database.

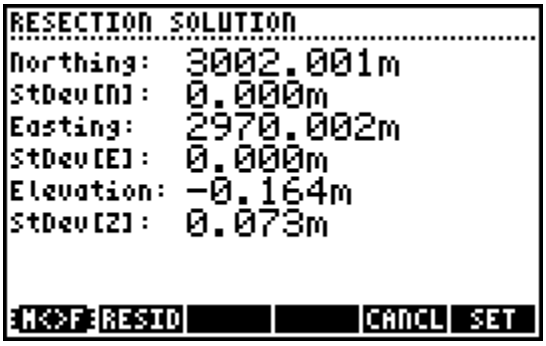
Observation Input Screen



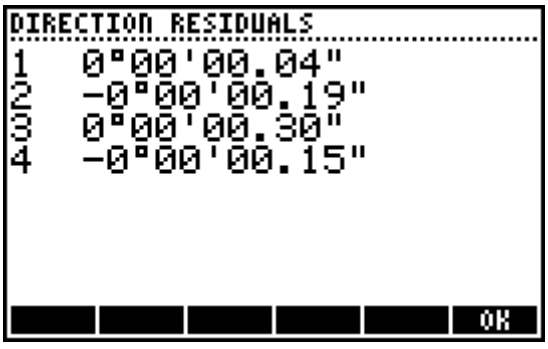
The input screen displays the count of the current input at the top of the screen. Enter a known control point number and the arbitrary observed azimuth to the point. The menu:

1. F1 **EDIT** – Edit the current field.
2. F2 **CALC** – When all observations have been entered press this softkey to calculate the resection.
3. F4 **2D** or **3D** – Toggle between 2D and 3D mode. The 3D mode allows zenith observations to be entered which will be used to calculate an elevation for the station.
4. F5 **CANCL** – Exit the observation input screen and return to the main Set Station screen.
5. F6 **REC** – Record the observation as entered to use in the resection calculation.

Resection Solution

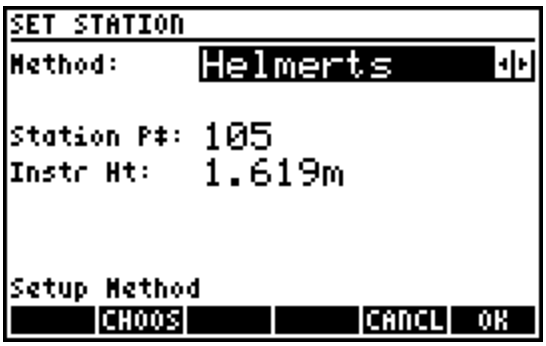


The current iteration is displayed when a least squares adjustment is possible. If a solution fails to converge in 10 iterations, the program displays the error and returns to the Set Station screen. When a solution does not converge, it is most likely due to incorrect control points entered for the observed azimuth(s). The solution coordinates and their standard deviations are displayed. The menu:



1. F1 **M<>F** - Toggles metric/imperial.
2. F2 **RESID** - Display the direction residuals to each observed control point.
3. F5 **CANCL** - Cancel the resection and return the main Set Station screen.
4. F6 **SET** - Store the station with the solved coordinates and return to the main Setup screen where a suggested "Known BS Pt" setup *Method* is set. Generally, at this time one of the control points used in the resection would be used as the known backsight point to complete the orientation.

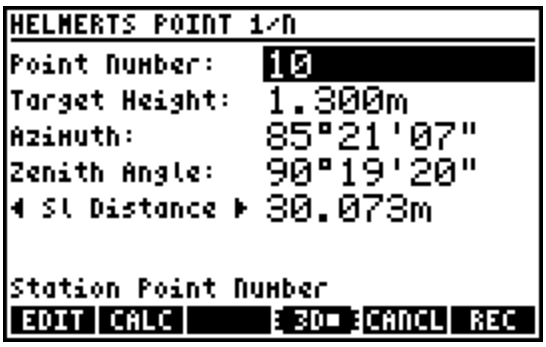
Helmerts



A "Helmerts" setup method refers to setting up on an unknown point and measuring at least two known points to compute the station point coordinates. A coordinate transformation is computed from the measurements for a least squares best-fit to the known points.

Select "Helmerts" as the setup *Method* and input a *Station Point Number* and *Height of Instrument*. The point number entered for the *Station Point Number* cannot exist in the current job database.

Observation Input Screen



The input screen displays the count of the current input at the top of the screen. Enter a known control point number and the measured observations to the point.

The menu:

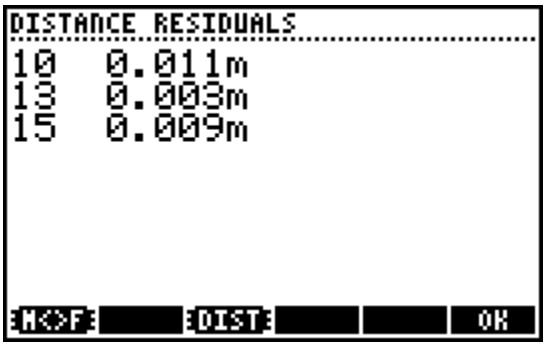
1. F1 **EDIT** – Edit the current field.
2. F2 **CALC** – When all observations have been entered press this softkey to calculate the Helmerts solution
3. F4 **2D** or **3D** – Toggle between 2D and 3D mode. The 3D mode allows zenith observations and the option of entering slope or horizontal distance to be entered which will be used to calculate an elevation for the station.
4. F5 **CANCL** – Exit the observation input screen and return to the main Set Station screen.
5. F6 **REC** – Record the observation as entered to use in the Helmerts calculation.

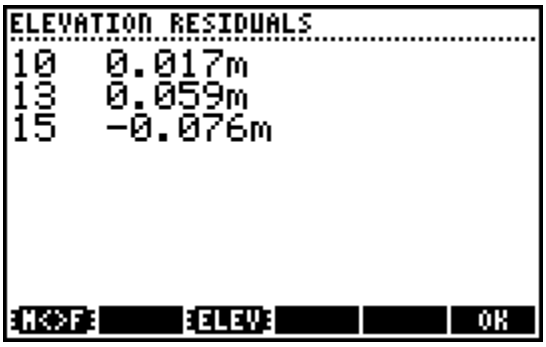
Helmerts Solution

The solution coordinates and their standard deviations are displayed. The menu:

1. F1 **M<>F** - Toggles metric/imperial.
2. F2 **RESID** - Display the distance and, if applicable, the elevation residuals to each observed control point.
3. F5 **CANCL** - Cancel the Helmerts and return the main Set Station screen.

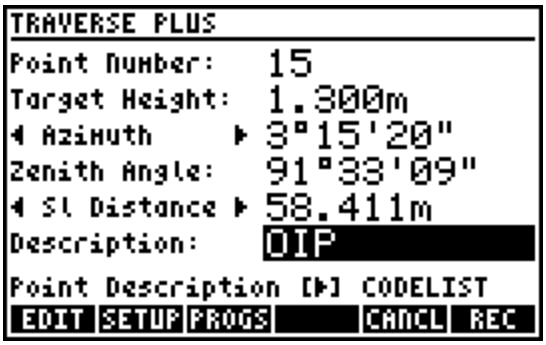
4. F6 **SET** - Store the station with the solved coordinates and return to the main Setup screen where a suggested "Known BS Pt" setup *Method* is set. Generally, at this time one of the control points used in the resection would be used as the known backsight point to complete the orientation.





Enter and Record

Enter measurement data in the main **Traverse Plus** input form to calculate and record 3D coordinates. It is possible to toggle three of the six input fields to accept different types of input.



'Point Number' Field

This field accepts the point number to use for the next record and automatically increments the number by one after each record.

"Target Height' Field

This field accepts the height of the target. The value does not change unless changed by the user.

'Azimuth' / 'Angle Right' / 'Angle Left' Field

The ◀ and ▶ cursor keys toggle this field between three possible input types. An *Azimuth* measurement is the true azimuth within the coordinate system unless a backsight azimuth different from the calculated azimuth was set during a "Known BS Pt" setup method. The backsight point provides the basis for *Angle Right* or *Angle Left* measurements.

'Zenith' Field

A *Zenith* measurement is the vertical angle measured from the zenith.

‘Hz Distance’ / ‘Sl Distance’ Field

The ◀ and ▶ cursor keys toggle this field between two possible input types. A *Hz Distance* measurement is the horizontal distance from the instrument to the target. A *Sl Distance* measurement is the slope distance from the instrument to the target.

‘Description’ Field

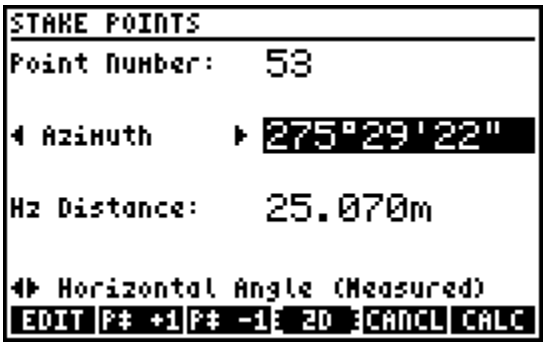
This field accepts a point description to be stored with the record. The ▶ cursor key opens the codelist to choose a code while this field is current. When the codelist translation toggle is set, the user can enter any defined code in the codelist and the program will automatically look up the description and store the code’s description.

The Menu

1. F1 **EDIT** – Edit the current field.
2. F2 **SETUP** – Perform a setup and orientation to update the station and backsight points.
3. F3 **PROGS** – Choose to open the Stake Points, Stake Alignment, Reference Line, or Reference Arc sub-program.
4. F5 **CANCL** – Exit **Traverse Plus** and return to the main interface.
5. F6 **REC** – Record a 3D point using the entered information.

Stake Points

Points that are stored in the current job can be staked from the station setup point. By entering the measured values to a position, the program will calculate orthogonal offsets to the stakeout point from the perspective of the station point. A 2D/3D toggle is available to adjust the number of input fields for the desired calculation.

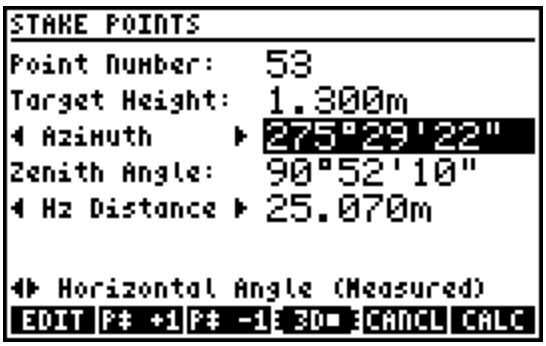


‘Point Number’ Field

This field accepts the point number to stake. A popup message box displays the calculated horizontal angle and distance to the stake point after a valid point number input. These calculated values are also automatically entered into the horizontal angle field and the distance field when a new point number is entered.

'Target Height' Field (3D mode only)

This field accepts the height of the target when 3D mode is enabled.



'Azimuth' / 'Angle Right' / 'Angle Left' Field

The ◀ and ▶ cursors keys toggle this field between three possible input types. Enter the horizontal angle to the current target position.

'Zenith' Field (3D mode only)

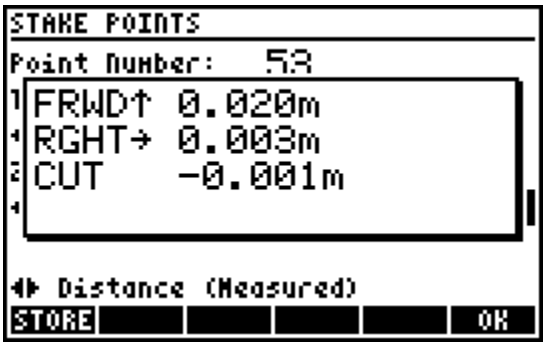
This field is only available in 3D mode. Enter the vertical angle to the target.

Distance Field

The ◀ and ▶ cursor keys toggle this field between *Hz Distance* and *Sl Distance* when in 3D mode. Only *Hz Distance* is available in 2D mode. Enter the distance to the target.

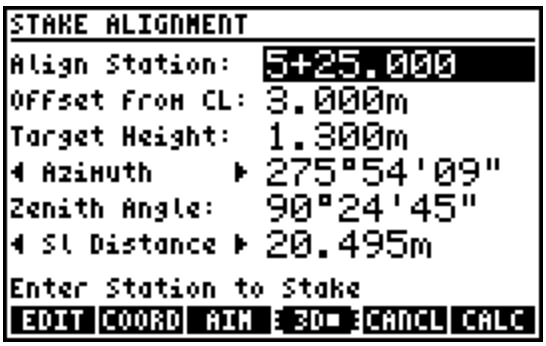
The Menu

1. F1 **EDIT** – Edit the current field.
2. F2 **P# +1** – Increase the stake *Point Number* by one and updates the horizontal angle and distance fields with newly calculated values.
3. F3 **P# -1** – Decrease the stake *Point Number* by one and updates the horizontal angle and distance fields with newly calculated values.
4. F4 **2D** or **3D** – Toggle between 2D and 3D mode.
5. F5 **CANCL** – Exit the Stake Point sub-program and return to the main **Traverse Plus** program.
6. F6 **CALC** – Calculate orthogonal offsets, *FRWD↑ / BACK↓*, *RGHT→ / LEFT←* and *CUT / FILL*, to the stake points when all input is entered. Offsets are from the perspective of the setup point. Press F1 **STORE** to store the current position as a point in the job database.



Stake Alignment

Choose an existing alignment to stake any station. Essentially this program works very much like the Stake Points program but instead of staking a coordinate value from stored points, you enter a station and offset along an alignment. The program calculates the coordinate values for the parameters given and features a different menu from the Stake Points program.



'Align Station' Field

This field accepts any station value, which must be within the limits of the alignment to perform calculations.

'Offset from CL' Field

This field accepts an offset from centerline value, +Right, or –Left. For 3D calculations, this value must be within the width of the cross section template assigned.

'Target Height' Field (3D mode only)

This field accepts the height of the target when 3D mode is enabled.

'Azimuth' / 'Angle Right' / 'Angle Left' Field

The ◀ and ▶ cursors keys toggle this field between three possible input types. Enter the horizontal angle to the current target position.

'Zenith' Field (3D mode only)

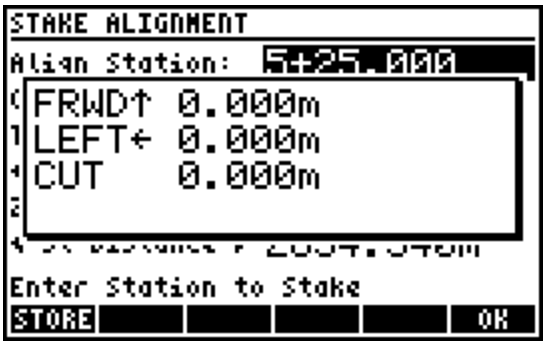
This field is only available in 3D mode. Enter the vertical angle to the target.

Distance Field

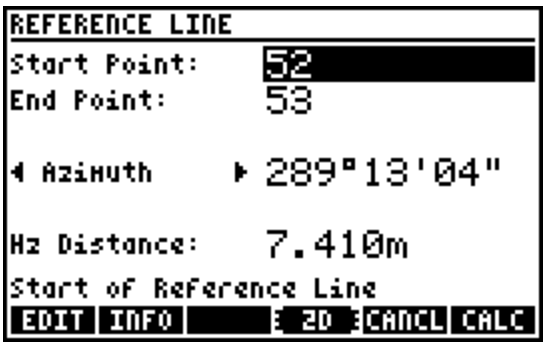
The ◀ and ▶ cursor keys toggle this field between *Hz Distance* and *Sl Distance* when in 3D mode. Only *Hz Distance* is available in 2D mode. Enter the distance to the target.

The Menu

1. F1 **EDIT** - Edit the current field.
2. F2 **COORD** - Displays the coordinates for the station and offset entered.
3. F3 **AIM** - Calculates the horizontal and vertical angles, and the distance to the calculated point on the alignment, and populates the input fields with the calculated values.
4. F4 **2D** or **3D** – Toggle between 2D and 3D mode.
5. F5 **CANCL** – Exit the Stake Alignment sub-program and return to the main **Traverse Plus** program.
6. F6 **CALC** – Calculate orthogonal offsets, *FRWD↑ / BACK↓*, *RGHT→ / LEFT←* and *CUT / FILL*, to the station when all input is entered. Offsets are from the perspective of the setup point. Press F1 **STORE** to store the current position as a point in the job database.



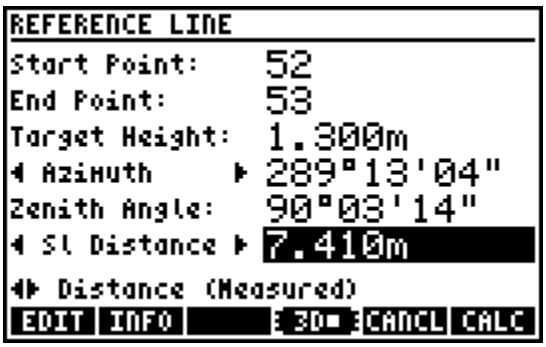
Reference Line



Positions can be calculated relative to a reference line as defined by two points in the job database. By entering the measured values to a position, the program will calculate the offset from the line and the distance along the line of the current position, as well as a distance along the entered horizontal angle to go forward or back to intersect the line. A 2D/3D toggle is available to adjust the number of input fields for the desired calculation. When 3D information is provided a cut/fill calculation is also performed.

'Start Point' Field

This field accepts the point number that defines the beginning of the reference line.



'End Point' Field

This field accepts the point number that defines the end of the reference line.

'Target Height' Field (3D mode only)

This field accepts the height of the target when 3D mode is enabled.

'Azimuth' / 'Angle Right' / 'Angle Left' Field

The ◀ and ▶ cursors keys toggle this field between three possible input types. Enter the horizontal angle to the current target position.

'Zenith' Field (3D mode only)

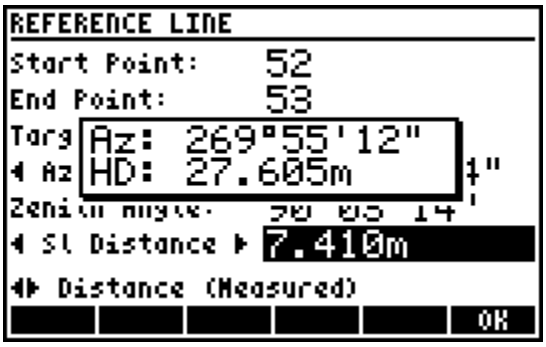
This field is only available in 3D mode. Enter the vertical angle to the target.

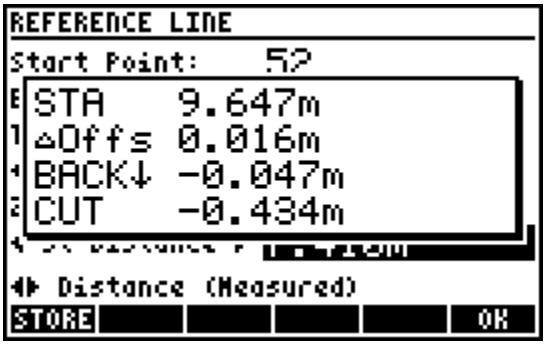
Distance Field

The ◀ and ▶ cursor keys toggle this field between *Hz Distance* and *Sl Distance* when in 3D mode. Only *Hz Distance* is available in 2D mode. Enter the distance to the target.

The Menu

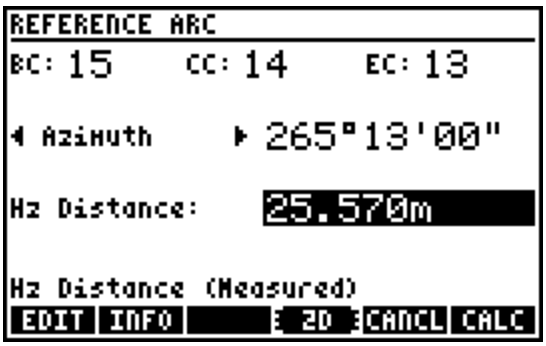
1. F1 **EDIT** – Edit the current field.
2. F2 **INFO** – Displays the azimuth/bearing and the horizontal distance of the reference line as defined by the *Start Point* and *End Point*.
3. F4 **2D** or **3D** – Toggle between 2D and 3D mode.
4. F5 **CANCL** – Exit the Reference Line sub-program and return to the main **Traverse Plus** program.
5. F6 **CALC** – Calculate the current position relative to the reference line. Some notes regarding the calculated values:





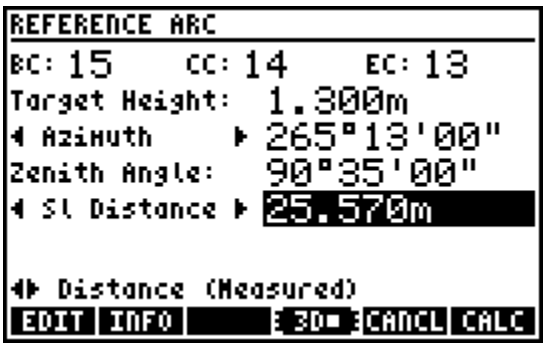
- ***STA*** – Is the distance along the reference line that the current position is perpendicular to, measured from the *Start Point*.
- ***ΔOffs*** – Is the perpendicular offset from the reference line to the current position. A positive distance indicates the current position is on the **RIGHT** side of the reference line while a negative distance indicates the current position is to the **LEFT** of the reference line.
- ***FRWD↑ / BACK↓*** – Is the distance along the current horizontal angle to go forward or back to intersect with the reference line.
- ***CUT / FILL*** – Is the cut or fill required to intersect with a 3D line of constant grade that passes through the *Start Point* and *End Point*.
- Press F1 **STORE** to store the current position as a point in the job database.

Reference Arc



Positions can be calculated relative to a reference arc as defined by two points on the arc (BC + EC) and a radius point (CC) in the job database. By entering the measured values to a position, the program will calculate the offset from the arc/circle and the distance along the arc/circle of the current position, as well as a distance along the entered horizontal angle to go forward or back to intersect the arc/circle. A 2D/3D toggle is available to adjust the number of input fields for the desired calculation. When 3D information is provided, a cut/fill calculation is also performed.

'BC' Field



This field accepts the point number that defines the beginning of the reference arc, or the first point on the circle.

'CC' Field

This field accepts the radius point, or curve center point.

'EC' Field

This field accepts the point number that defines the end of the reference arc, or the second point on the circle.

'Target Height' Field (3D mode only)

This field accepts the height of the target when 3D mode is enabled.

'Azimuth' / 'Angle Right' / 'Angle Left' Field

The ◀ and ▶ cursors keys toggle this field between three possible input types. Enter the horizontal angle to the current target position.

'Zenith' Field (3D mode only)

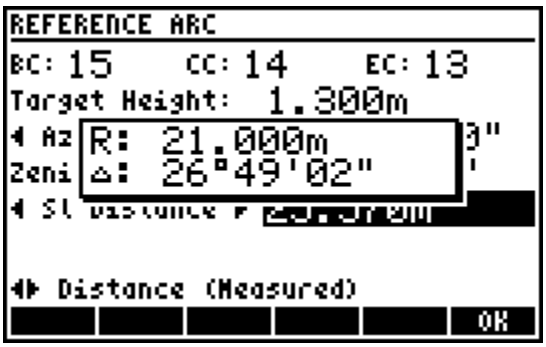
This field is only available in 3D mode. Enter the vertical angle to the target.

Distance Field

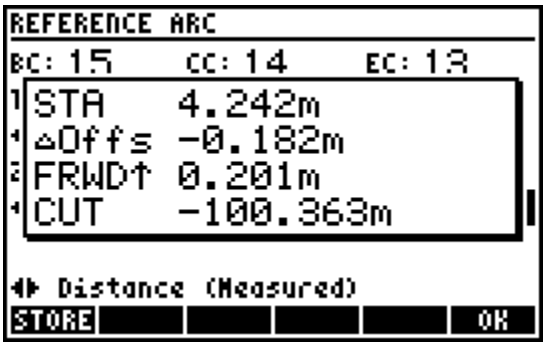
The ◀ and ▶ cursor keys toggle this field between *Hz Distance* and *Sl Distance* when in 3D mode. Only *Hz Distance* is available in 2D mode. Enter the distance to the target.

The Menu

1. F1 **EDIT** – Edit the current field.
2. F2 **INFO** – Displays the radius and deflection angle of the reference arc as defined by the BC, CC and EC points.



3. F4 **2D** or **3D** – Toggle between 2D and 3D mode.
4. F5 **CANCL** – Exit the Reference Arc sub-program and return to the main **Traverse Plus** program.
5. F6 **CALC** – Calculate the current position relative to the reference arc. Some notes regarding the calculated values:



- ***STA*** – Is the distance along the reference arc that the current position is perpendicular to, measured from the *BC* point.
- ***ΔOffs*** – Is the radial/perpendicular offset from the reference arc to the current position. A positive distance indicates the current position is on the **RIGHT** side of the reference arc (inside the circle in a clockwise defined curve) while a negative distance indicates the current position is to the **LEFT** of the reference arc (outside the circle in a clockwise defined curve).
- ***FRWD↑ / BACK↓*** – Is the distance along the current horizontal angle to go forward or back to intersect with the reference arc.
- ***CUT / FILL*** – Is the cut or fill required to intersect with a 3D curve of constant grade that passes through the *BC* and *EC* points.
- Press F1 **STORE** to store the current position as a point in the job database

7.2 Levelling

COGO+ Pro includes a **Levelling** program to manage multiple levelling jobs. Each job consists of backsight, foresight and intermediate foresight observations. Edit, review and adjust observations, and perform calculations such as cuts/fills using observed or adjusted data.

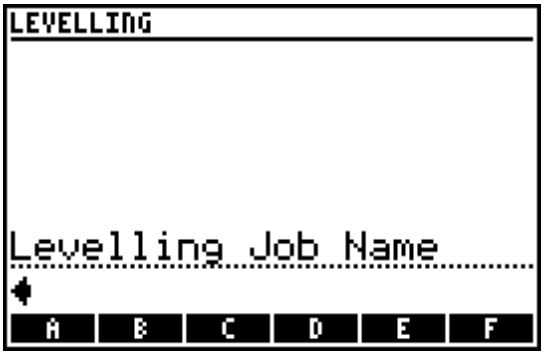
Manager

The Levelling Jobs manager always opens when running the **Levelling** program. Here you can create new jobs, delete existing jobs or load a job for editing and review. The menu:

1. F1 **NEW** – Create a new job.
2. F2 **DEL** – Delete the selected job.
3. F3 **INFO** – Display information about the selected job. The number of stations, start and end elevations, job file size and available memory are displayed.
4. F4 **OPTS** – Read and write jobs to and from the SD card COGOPLUS\JOBS directory, or rename an existing job.
5. F5 **CANCL** – Exit the Levelling program.
6. F6 **LOAD** – Load the selected job.

Create a New Job

Press F1 **NEW** to create a new job. Enter a name for your levelling job as prompted, and the new job will be created with a *.CPL name extension to differentiate it from a ***COGO+*** job or **Alignments** job.



Delete a Job

Press F2 **DEL** to delete the currently selected job. A confirmation is requested prior to the job actually being deleted.

Levelling Options

1. Import Level - Copy a levelling job from the SD card to the calculator.
2. Backup Level – Store a copy of the selected Levelling job to the COGOPLUS\JOBS directory.

3. Backup All – Stores copies of all the Levelling jobs created on the calculator to the COGOPLUS\JOBS directory.
4. Move Level – Move the selected Levelling job to the COGOPLUS\JOBS directory, thereby deleting the job from the calculator.
5. Rename Level – Rename the selected Levelling job.

Load a Job

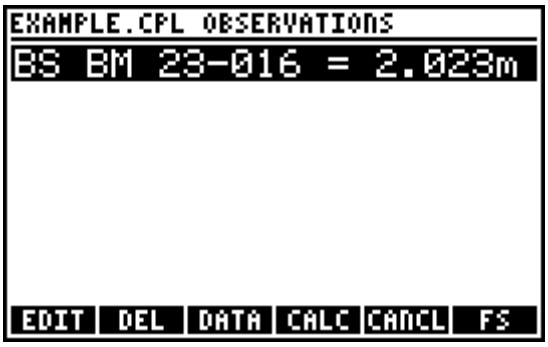
Press F6 **LOAD** to load the currently selected job for editing, reviewing and calculating.

Working with a Levelling Job

Loading a new Job

When loading a new job for the first time, it is necessary to initialize it by providing a starting station and elevation and an initial backsight reading to the starting station. NOTE: IT IS POSSIBLE TO EDIT THIS INFORMATION LATER IF NECESSARY.

Once the job is initialized the main observations screen is displayed showing the entered observations, which consists of just the backsight reading to the starting station when loading a new job for the first time. The menu:



1. F1 **EDIT** edits the currently selected observation.
2. F2 **DEL** deletes the currently selected observation.
3. F3 **DATA** brings up a few options to review data derived from the observations.
4. F4 **CALC** brings up a few calculation options.
5. F5 **CANCL** returns to the Levelling Manager screen.
6. F6 **FS** or **BS** opens up an input form to add a new foresight or backsight, depending on what the last entered observation was.

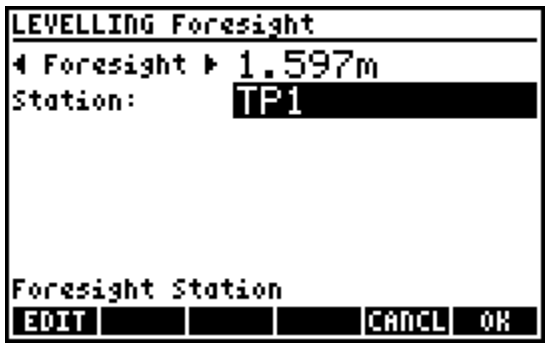
Adding Observations

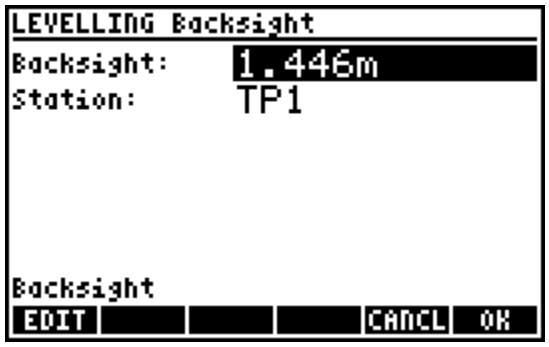
Since this action is the most commonly used action when working with a levelling job, it has been assigned to the F6 or ENTER key.

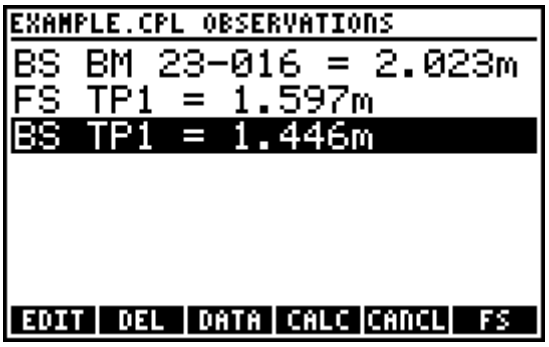
The label **FS** or **BS** on F6 depends on what the next possible observation is. When entering a foresight observation it is possible to define the observation as an *Intermediate Foresight* by using the ◀ and ▶ cursor keys to toggle the label on the first field of the input form. All intermediate foresight observations from a setup are entered prior to the foresight to the next turning point or benchmark. The F6 label will not change to **BS** until a foresight observation has been entered. The station name for each foresight and intermediate foresight can be entered as necessary, or the program will automatically suggest TP# names. The backsight station is always the last foresight station.

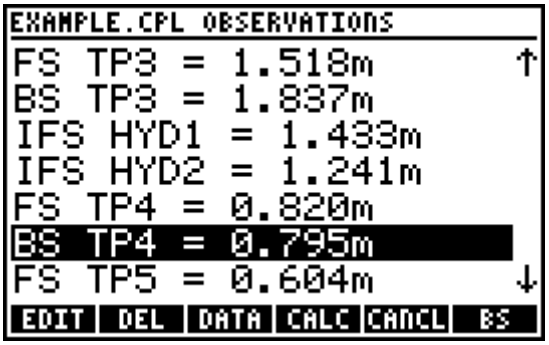
The observations screen updates to show each observation type, station and observation, for example:

- *FS TP1 = 1.597m* A foresight observation to station TP1 of 1.597m
- *BS TP1 = 1.446m* A backsight observation to station TP1 of 1.446m
- *IFS HYD1 = 1.433m* A intermediate foresight observation to HYD1 of 1.433m









Editing Observations

Select any observation to edit the observation. The station names can be changed for:

- The Starting Station
- Intermediate Foresights Stations
- Foresight Stations, which also updates the following backsight station name (if existing)

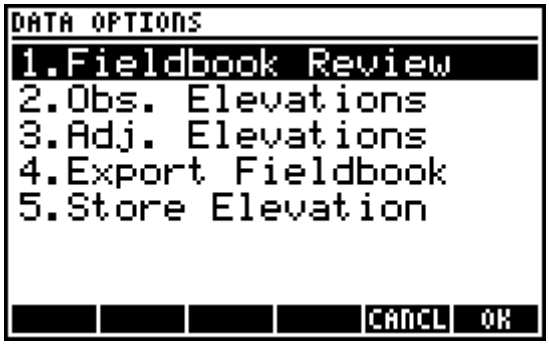
When an observation has been edited the entire dataset is recalculated to update elevations and heights of instrument at each setup, which is critical for data review and calculations.

Deleting Observations

Select an Intermediate Foresight observation or the last observation entered to delete it. A confirmation ensures that observations are not deleted unintentionally.

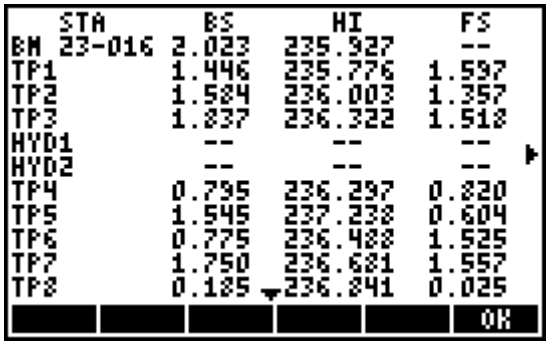
Data Review

Observations can be reviewed in a fieldbook style printout on the screen, observation derived elevations and adjusted elevations for all stations can be reviewed on the screen, a fieldbook ASCII file can be written to the SD card or the HOME directory, and station elevations can be stored to points in the current ***COGO+*** job.



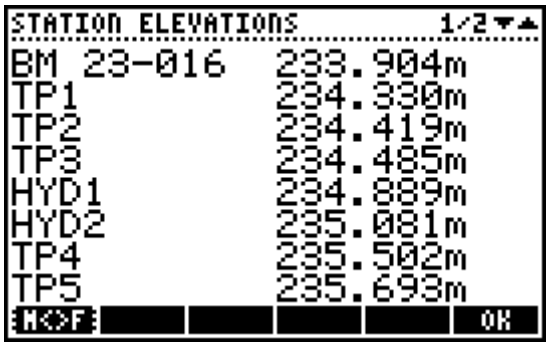
Fieldbook Review and Export Fieldbook

Both options create a formatted string of all the observations with HI's and Elevations (including adjusted if available) as would typically be entered into a fieldbook. The fieldbook review option displays data on the screen while the export fieldbook option exports the string as an ASCII file.



Observation Elevations

Displays every levelling station and its observed elevation. Multiple pages of results may exist depending on the number of stations. Use F1 **M<>F** to convert the elevations between metric and imperial.



Adjusted Elevations

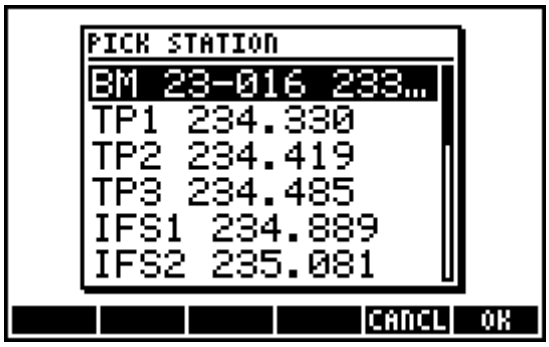
This option works in the same way as displaying observation elevations; except the adjusted elevations are displayed. NOTE: AN ADJUSTMENT CALCULATION IS REQUIRED TO BE DONE PRIOR TO REVIEWING THE ADJUSTED ELEVATIONS.

Store Elevation

Stores the observed or adjusted elevation of any station in the levelling job to a point in the current job database.

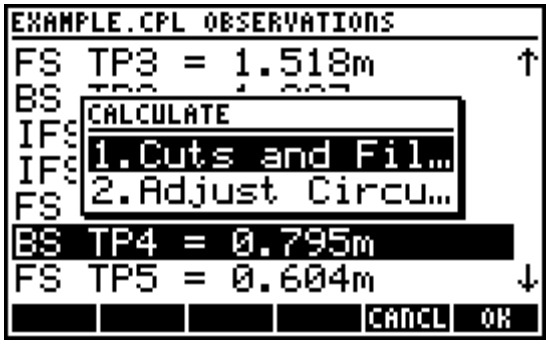
First, pick a station from a list of every station in the levelling job.

Next, enter the point number to store the selected station elevation to.



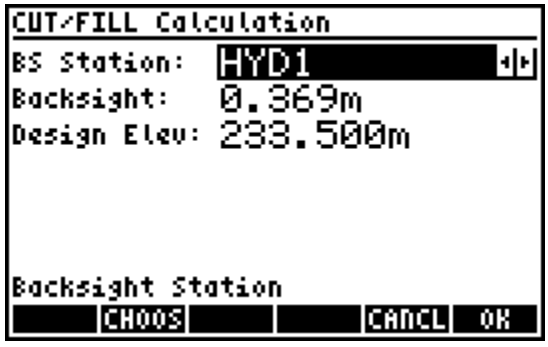
Calculations

Calculate cuts and fills by choosing any station from the available list of defined stations to backsight, or calculate the circuit error of a levelling circuit and adjust station elevations by distributing the error throughout the circuit.

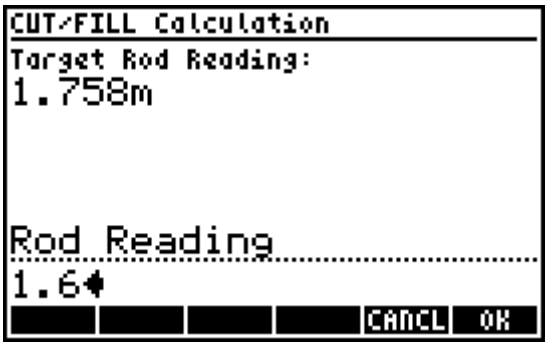


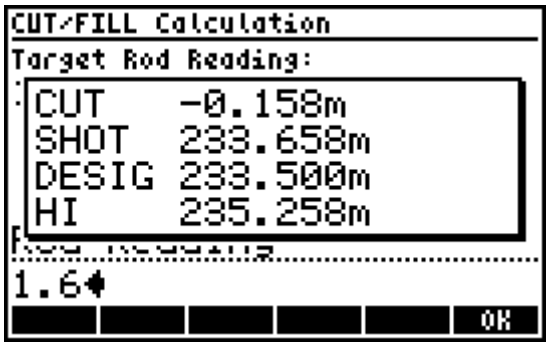
Cuts and Fills

Calculate cuts and fills from observed or adjusted elevations. When a circuit has been adjusted, the user is presented a choice of using observed elevations or adjusted elevations for cut/fill calculations. Next, choose the station to backsight, and enter the backsight rod reading and the design elevation. This sets up the parameters for the cut/fill calculations.



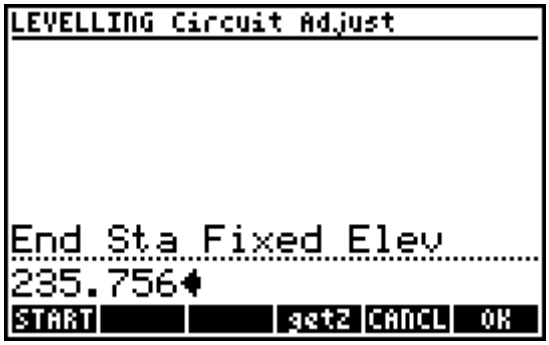
The following input screen displays the target rod reading to meet the design elevation, and prompts the user to input the actual rod reading. The calculation displays the CUT or FILL value and the observed SHOT elevation. The DESIGn elevation and HI values are also displayed for reference purposes.



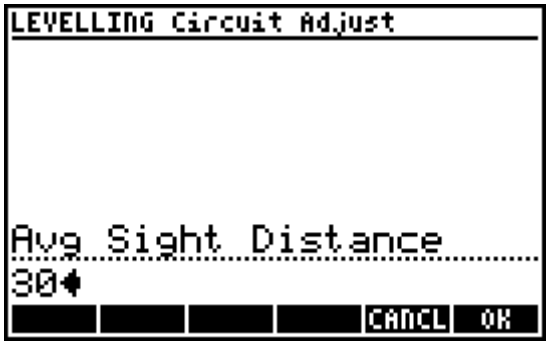


Adjust Circuit Error

The first input screen for the adjustment requires a fixed elevation for the end station. If adjusting a loop, this value will be the starting point elevation, a value that can automatically entered by pressing F1 **START** in the input screen. Use F4 **getZ** to retrieve an elevation from a point in the current job database.

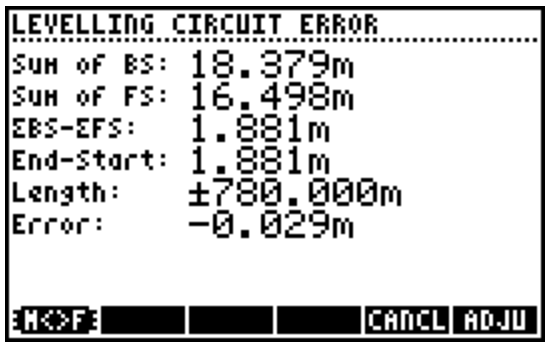


The second input screen asks for an average sight distance to calculate the approximate overall circuit length.



The output screen displays the sum of all backsight observations, the sum of all foresight observations, the difference between the sums, the difference between the starting station elevation and end station elevation, the approximate circuit length and the circuit error.

Press F6 **ADJU** to calculate adjusted elevations for all the stations within the Levelling job circuit. The circuit error is distributed evenly through each leg of the circuit assuming equal sight distances.



7.3 Alignments

COGO+ Pro 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

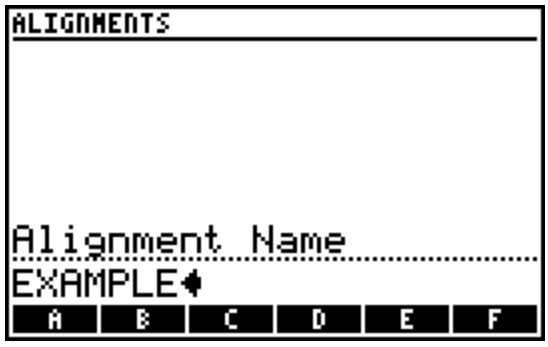
The Alignment Manager always opens when running the **Alignments** program. Here you can create new alignments, delete existing alignment or load an alignment for editing, review and calculations.

The menu:

1. F1 **NEW** – Create a new alignment.
2. F2 **DEL** – Delete the selected alignment.
3. F3 **INFO** – Display information about the selected alignment. The start and end stations, overall length, the number of horizontal, vertical and cross section parts defined, alignment file size and available memory are displayed.
4. F4 **OPTS** – Read and write alignments to and from the SD card COGOPLUS\JOBS directory, or rename an existing alignment.
5. F5 **CANCL** – Exit the **Alignments** program.
6. F6 **LOAD** – Load the selected alignment.

Create a New Alignment

Press F1 **NEW** to create a new alignment. Enter a name for your alignment as prompted, and the new alignment will be created with a *.CPA name extension to differentiate it from a ***COGO+*** job or **Levelling** job.



Delete an Alignment

Press F2 **DEL** to delete the currently selected alignment. A confirmation is requested prior to the alignment actually being deleted.

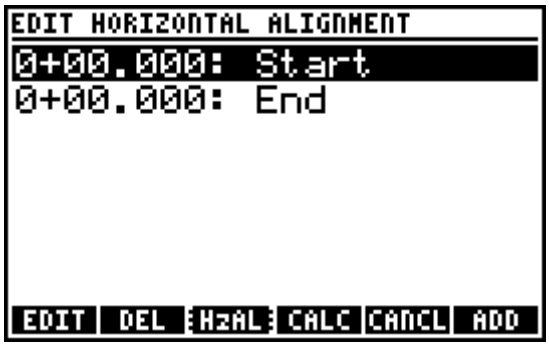
Alignment Options

1. Import Alignment – Copy an alignment from the SD card to the calculator.
2. Backup Alignment – Store a copy of the selected alignment to the COGOPLUS\JOBS directory.
3. Backup All – Stores copies of all the alignments created on the calculator to the COGOPLUS\JOBS directory.
4. Move Alignment – Move the selected alignment to the COGOPLUS\JOBS directory, thereby deleting the alignment from the calculator.
5. Rename Alignment – Rename the selected alignment.

Load an Alignment

Press F6 **LOAD** to load the currently selected alignment for editing, reviewing and calculating. A check is performed to ensure that any cross section assignments involve only templates that exist on the calculator. If an error message is displayed, create the missing template(s) to load the alignment.

Working with an Alignment



The EDIT HORIZONTAL ALIGNMENT screen is displayed by default when loading an alignment. You can toggle between editing horizontal, vertical and cross section components by pressing F3. The menus:

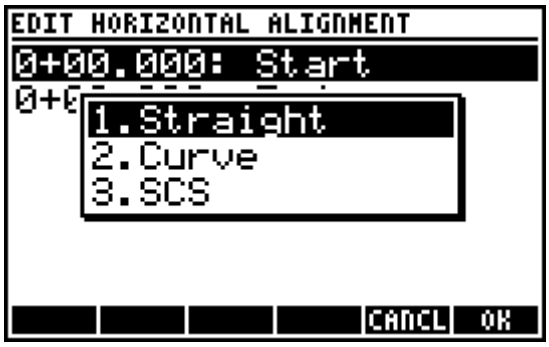
1. F1 **EDIT** – Edit the selected component.
2. F2 **DEL** – Delete the selected component.
3. F3 **HzAL** or **VtAL** or **XSec** – Toggles editing horizontal, vertical and cross sections.
4. F4 **CALC** – Perform calculations with the alignment data.
5. F5 **CANCL** – Return to the Alignment Manager.
6. F6 **ADD** – Add a component to the alignment. The available options reflect the current screen; horizontal, vertical or cross sections. The ENTER key does the same thing.

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 at 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 a Segment

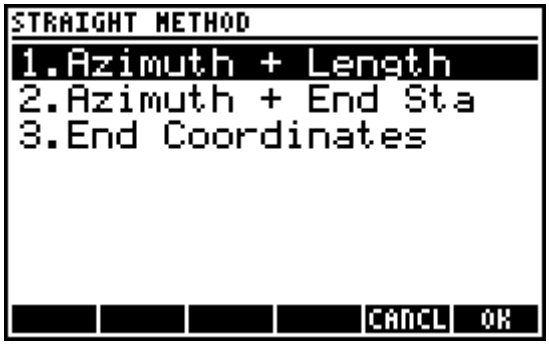
Press F6 **ADD** to add a new horizontal segment. All segment are added to the end of the list of already defined segments. The end coordinates of the existing alignment are used as the starting coordinates for the new segment. The available options for horizontal segments are Straight, Curve and Spiral-Curve-Spiral.



Straight

A straight segment consists of a starting point and an ending point. The end point can be defined by one of three methods:

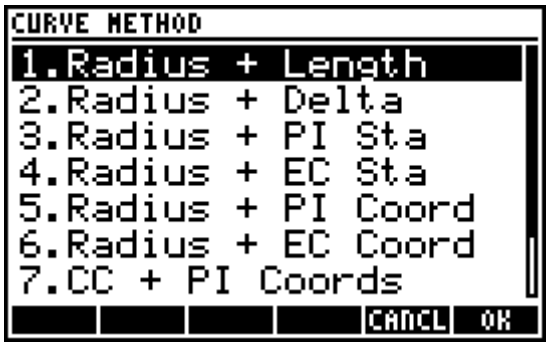
1. A azimuth/bearing and length
2. A azimuth/bearing and end station
3. End coordinates



For option 3 a softkey F4 **getXY** is available to retrieve coordinates from a point in the current job database to use as the coordinates for the end point.

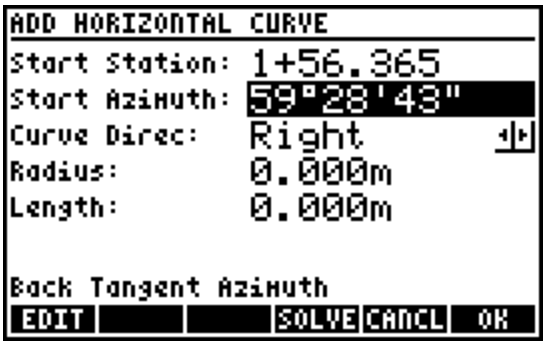
Curve

A curve segment consists of a starting point, curve direction, radius, and length. The curve parameters may be defined by one of nine methods:

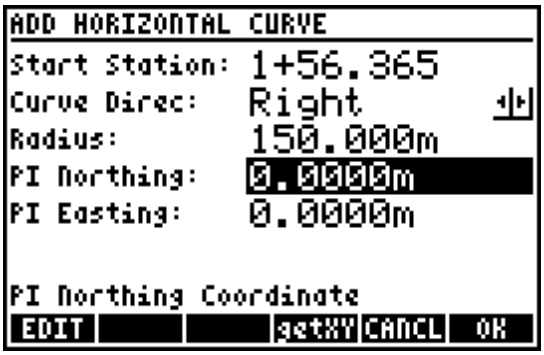


1. A radius and curve length. NOTE: ALSO REQUIRES THE BACK TANGENT AZIMUTH/BEARING AND THE CURVE DIRECTION RIGHT/LEFT.
2. A radius and curve delta angle. NOTE: ALSO REQUIRES THE BACK TANGENT AZIMUTH/BEARING AND THE CURVE DIRECTION RIGHT/LEFT.
3. A radius and the point of intersection station. NOTE: ALSO REQUIRES THE BACK TANGENT AZIMUTH/BEARING AND THE CURVE DIRECTION RIGHT/LEFT.
4. A radius and the end of curve station. NOTE: ALSO REQUIRES THE BACK TANGENT AZIMUTH/BEARING AND THE CURVE DIRECTION RIGHT/LEFT.

5. A radius and coordinates at the point of intersection. NOTE: ALSO REQUIRES THE CURVE DIRECTION RIGHT/LEFT.
6. A radius and coordinates at the end of curve. NOTE: ALSO REQUIRES THE CURVE DIRECTION RIGHT/LEFT.
7. Curve center and point of intersection coordinates
8. Curve center and end of curve coordinates
9. 3 point curve definition by providing coordinates at a point on the curve and the end of curve

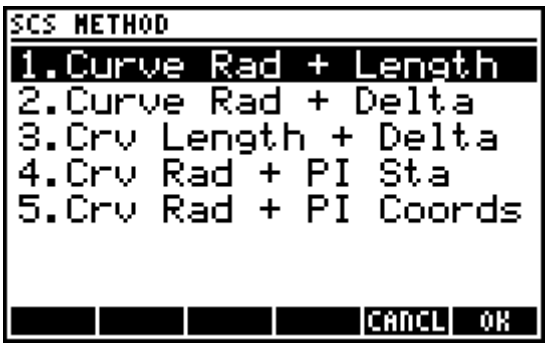


For curves, the back tangent azimuth/bearing is automatically calculated from the last segment in the alignment, unless the curve is the first segment defined in which case the value needs to be entered. This ensures curves are tangential to the preceding segment and only applies to methods 1 through 4 where the back tangent azimuth/bearing is user entered. Also for methods 1 through 4, a softkey F4 **SOLVE** is available to open the horizontal or vertical curve solver to solve for a value. From within the solvers it is possible to export solved values to the clipboard, which can then be pasted into any of the fields in the alignment definition input form.



For methods 5 through 9, a softkey F4 **getXY** is available to retrieve coordinates from a point in the current job database to use as the coordinates for the point whose northing or easting field is current. NOTE: FOR OPTIONS 7 THROUGH 9 THERE ARE TWO SETS OF COORDINATE PAIRS REQUIRED, YOU MUST SELECT THE NORTHING OR EASTING COORDINATE FIELD OF THE POINT YOU WISH TO RETRIEVE FROM THE DATABASE.

Spiral-Curve-Spiral



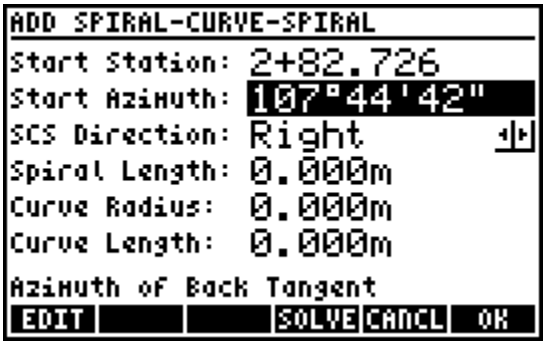
A spiral-curve-spiral transition curve consists of a starting point, curve direction, spiral length, circular curve radius and length. The spiral-curve-spiral parameters may be defined by one of five methods:

1. Circular curve radius and length
2. Circular curve radius and delta angle

3. Circular curve length and delta angle
4. Circular curve radius and point of intersection station of transition curve
5. Circular curve radius and point of intersection coordinates of transition curve

Each of the five methods also requires the back tangent azimuth/bearing, the curve direction and the spiral length. For spiral-curve-spiral transition curves, the back tangent azimuth/bearing is automatically calculated from the last segment in the alignment, unless the curve is the first segment defined in which case the value needs to be entered.

Each of the five methods also feature the softkey F4 **SOLVE** to open the horizontal or vertical curve solver to solve for a value. From within the solvers it is possible to export solved values to the clipboard, which can then be pasted into any of the fields in the alignment definition input form.



For method 5 a softkey F3 **getXY** is available to retrieve coordinates from a point in the current job database to use as the coordinates for the point of intersection.

Edit a Segment

Press F1 **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 segment are also updated. The relationships between segments are kept intact, any positional shifts or rotations are applied to all segments following the edited segment.

Delete a Segment

Press F2 **DEL** 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. ***No rotation is applied.***

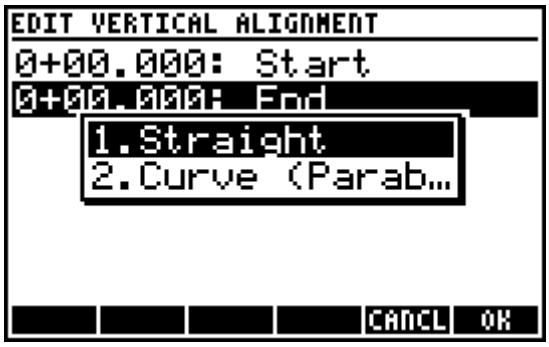
Vertical Alignment

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.

When editing the vertical alignment starting station a softkey F4 **HZsta** is available to match the vertical starting station to the horizontal starting station, and when editing the starting point elevation for the vertical alignment the softkey F4 **getZ** is available to retrieve an elevation from a point in the current job database.

Add a Segment

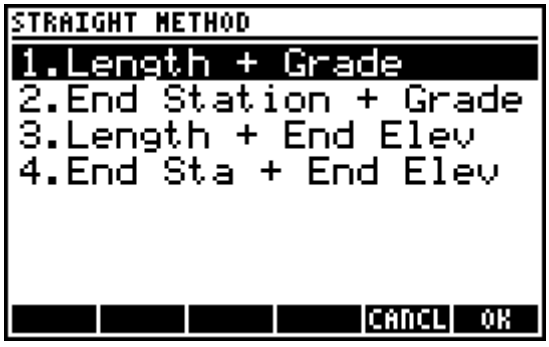
Press F6 **ADD** to add a new vertical segment. All segments are added to the end of the list of already defined segments. The end elevation of the existing vertical alignment is used as the starting elevation for the new segment. The available options for vertical segments are Straight and Curve (Parabola).



Straight

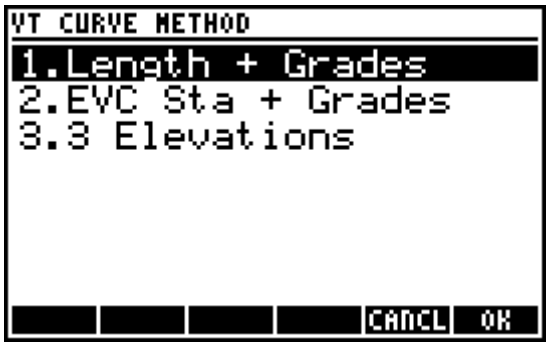
A vertical straight segment consists of a starting elevation, a length and a grade. The length and grade of the segment may be defined by one of four methods:

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



For each of the four methods; the length and end station fields feature a F4 **endHZ** softkey to automatically insert the length or end station to match the end of the horizontal alignment. For methods 3 and 4, the end elevation fields feature a F4 **getZ** softkey to retrieve an elevation from a point in the current job database.

Curve (Parabola)



A vertical curve consists of a starting elevation, a length, and entry and exit grades. The length and grades of the segment may be defined by one of three methods:

1. Vertical Curve Length and Grades
2. End of Vertical Curve Station and Grades
3. Three Elevations. Since the starting point station and elevation are known, an intermediate and end of vertical curve station and elevation are required. NOTE: PLEASE NOTE THAT THE INTERMEDIATE STATION AND ELEVATION ARE ON THE CURVE, NOT ON THE TANGENT.

Each of the three methods features a F4 **SOLVE** softkey to open the horizontal or vertical curve solver to solve for a value. From within the solvers it is possible to export solved values to the clipboard, which can then be pasted into any of the fields in the alignment definition input form.

Length and end station fields feature a F3 **endHZ** softkey to automatically insert the length or end station to match the end of the horizontal alignment. For method 3, the elevation fields feature a F3 **getZ** softkey to retrieve an elevation from a point in the current job database.

Edit a Segment

Press F1 **EDIT** to edit the selected vertical segment. For each segment type, straight or curve, 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 segment are also updated. The stations and elevations of any segment following the edited segment are updated to ensure continuity.

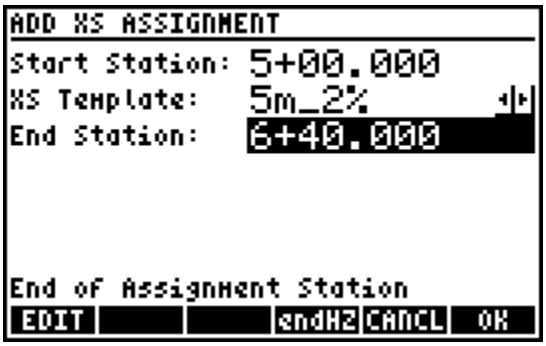
Delete a Segment

Press F2 **DEL** 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 Sections Assignments

Cross Section Templates are created as described in Chapter 3 of this manual. Cross section assignments are only honoured when a vertical alignment for a specified station is defined.

Add an Assignment



Press F6 **ADD** to add a new cross section assignment. Templates can be assigned to portions of alignments by entering a start and end station and choosing the template to use. The first assignment allows the user to enter a starting station, which by default is set to the starting station of the horizontal alignment, but can be changed to any station within or outside the alignment. Subsequent cross section assignments always have the start station set to the end station of the previous assignment.

The Start Station field features a F4 **HZsta** softkey to automatically insert the start station of the horizontal alignment.

The End Station field features a F4 **endHZ** softkey to automatically insert the end station of the horizontal alignment.

Edit an Assignment

Press F1 **EDIT** to edit the selected cross section assignment. When editing a cross section assignment it is possible to change the template and the end station. When the end station is changed, subsequent assignments are adjusted to keep a continuous chain of assignments.

Delete and Assignment

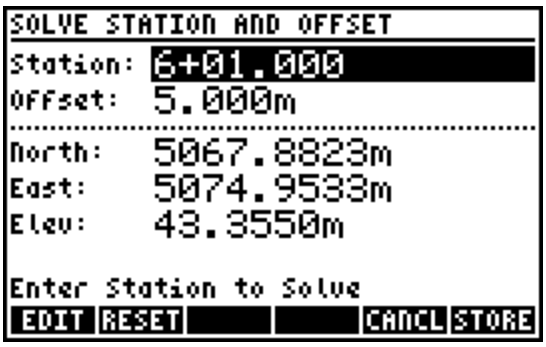
Press F2 **DEL** to delete the selected cross section assignment. When an assignment is deleted, subsequent assignments are adjusted to keep a continuous chain of assignments.

Calculations

Press F4 **CALC** from any of the alignment editing screens to perform calculations using the defined alignment parameters, or to plot the horizontal or vertical alignment. At minimum, a horizontal alignment is required to perform calculations.

Solve Station and Offset

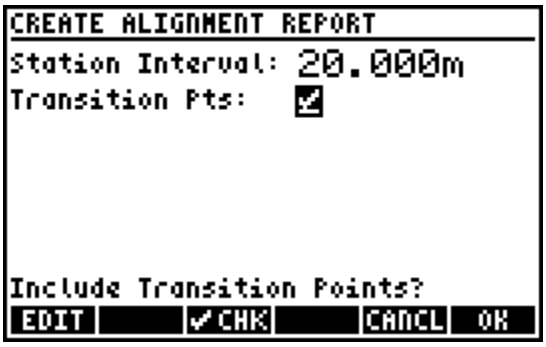
Solve the 3D coordinates for any station and offset simply by entering the station and offset. Some general function notes:



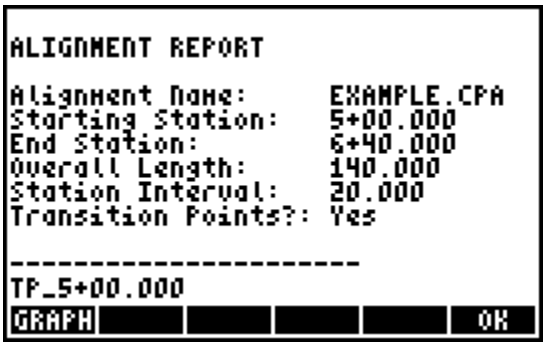
- Elevation values of zero are displayed when a vertical alignment has not been defined for the entered station.
- When the vertical alignment has been defined but no cross section assignment exists; the centerline elevation is displayed regardless of the offset value entered.
- When the vertical alignment and cross section assignment have been defined for a station, but the offset entered exceeds the width of the cross section template, the outermost elevation of the template for the station is displayed.

Press F6 **STORE** to save the solved coordinates as a point in the current job database.

Create a Report

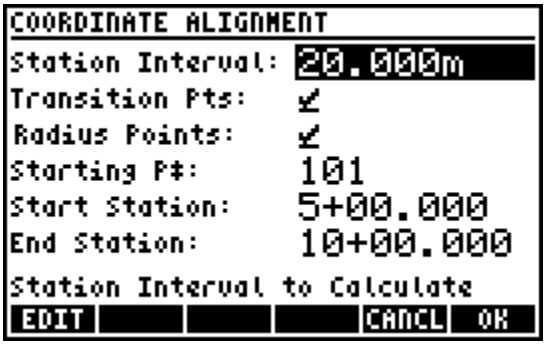


Enter a station interval and select whether or not to include transition points to create a report of the entire alignment. NOTE: TRANSITION POINTS ARE POINTS THAT ARE AT THE BEGINNING/END OF SEGMENTS THAT DO NOT FALL ON AN EVEN STATION INTERVAL. The report includes the coordinates for each offset point as defined by the cross section assignments (including centerline points) for every station at the interval specified, and at all transition points if selected.



The program displays the current station that is being written as the report is compiled. The report may be reviewed on the calculator screen or written to an ASCII file for viewing/printing on a computer.

Create Coordinates



Similar to creating a report, except this program creates points in the current job database for each offset point as defined by the cross section assignments (including centerline points) for every station at the interval specified, and at all transition points if selected. Optionally the curve radius points can also be created.

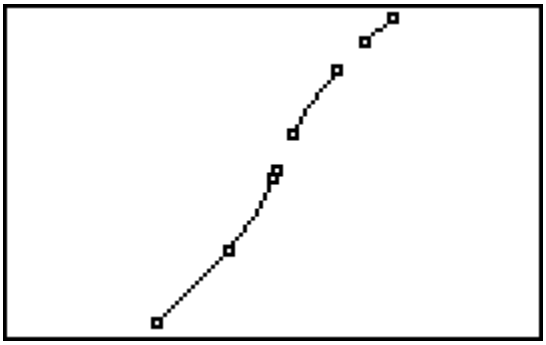
Enter the station interval, select whether or not to include transition points and radius points, enter a starting point number to use, and the start and end station that should be included. Point numbers will be assigned sequentially in a left-to-right pattern across each cross section, progressing from lowest station to highest. Point number conflicts result in the program using the next available number, no points will be overwritten however you may want to ensure that the starting point number you enter is appropriate.

The program displays the point numbers as they are created.

Plot Horizontal Alignments

Plot the horizontal alignment on the calculator screen for a visual confirmation of entered parameters.

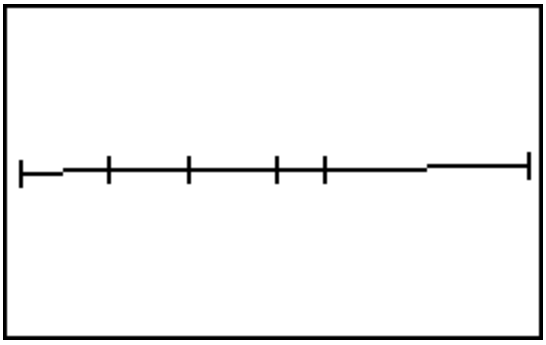
NOTE: Spiral portions of a Spiral-Curve-Spiral segment are not plotted. Transition points are marked with open square markers.



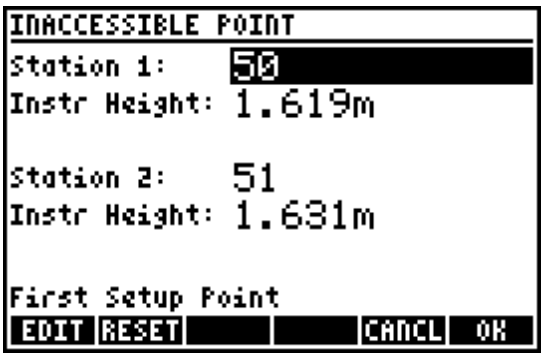
Plot Vertical Alignment

Plot the vertical alignment on the calculator screen for a visual confirmation of entered parameters.

NOTE: Vertical lines mark the transition points between vertical segments.

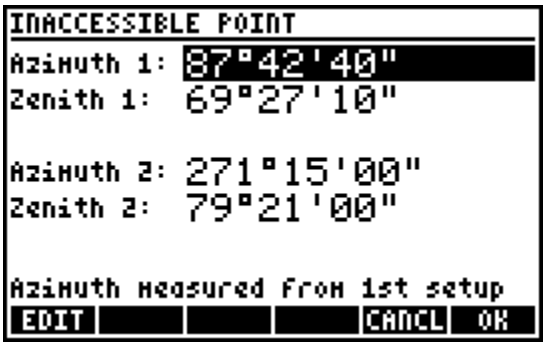


7.4 Inaccessible Point

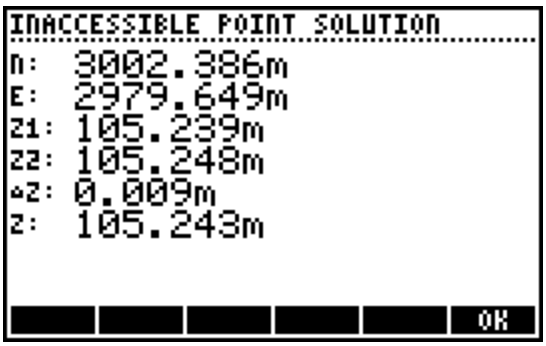


The **Inaccessible Point** program calculates 3D coordinates for points when horizontal and vertical angle observations to the inaccessible point are made from two separate setups.

Enter the point numbers for *Station 1* and *Station 2*, and the height of instrument at each setup in the first input form.

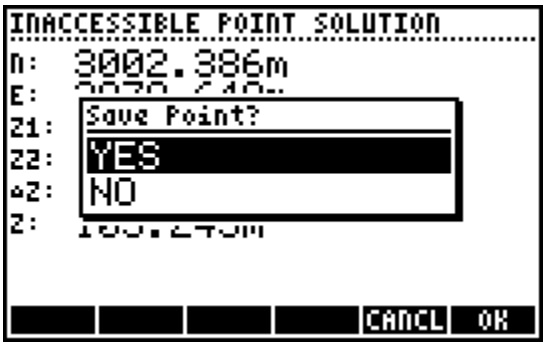


Enter the horizontal and vertical angle observations from each setup in the second input form. *Azimuth 1* and *Zenith 1* are the observations from *Station 1*, while *Azimuth 2* and *Zenith 2* are the observations from *Station 2*.

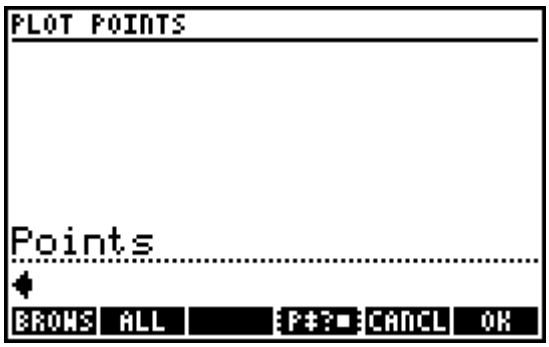


The solution screen displays the coordinates for the solved point, including the calculated elevation values from each observation, the discrepancy between the two calculated elevation values and the average elevation value. The average elevation value is used when storing the coordinates.

Press F6 **OK** to proceed from the solution screen. The option to save the solution as a point in the job database is presented, where choosing YES opens the standard STORE POINT screen to store the calculated point.



7.5 Plot Points

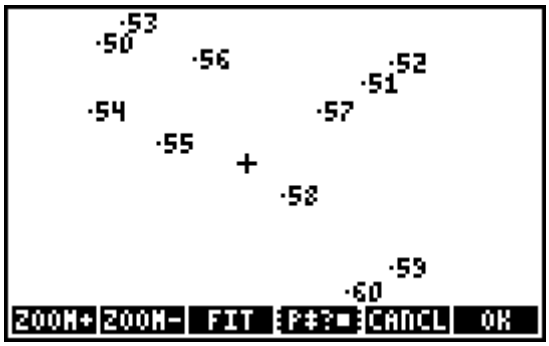


The **Plot Points** program graphically plots points on the screen. The interactive map supports zoom and pan functions, and point numbers can be turned on or off.

In the first input screen, enter the points you wish to plot using any of the point numbers input options. A minimum of two points are required to plot. The menu:

1. F1 **BROWS** – Open the Point Browser to browse/search for specific point numbers.
2. F2 **ALL** – Plot all the points in the current job.
3. F4 **P#?■** – Toggle point number plotting on or off.

Initially, the map plot shows all the points zoomed to fit the screen.



The Menu

The menu provides access to some of the interactive features:

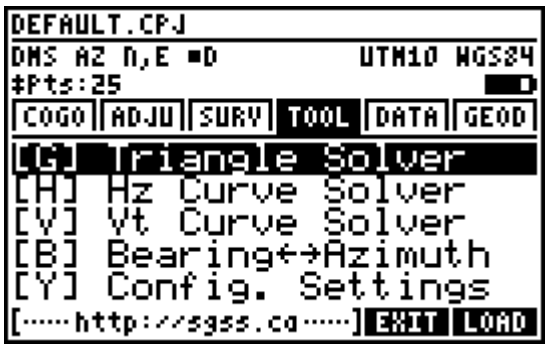
1. F1 **ZOOM+** – Zoom in, the crosshair symbol is the center of the zoom region.
2. F2 **ZOOM-** – Zoom out, the crosshairs symbol is the center of the zoom region.
3. F3 **FIT** – Zoom extents, fit all plotted points on the screen.
4. F4 **P#?■** – Toggle point number plotting on or off.
5. F5 **CANCL** – Exit the map and return to the first screen to enter points to plot.
6. F6 **OK** – Exit the map and the **Plot Points** program to return to the main interface.

Key Assignments

Some of the keys can be used for the interactive features of the map:

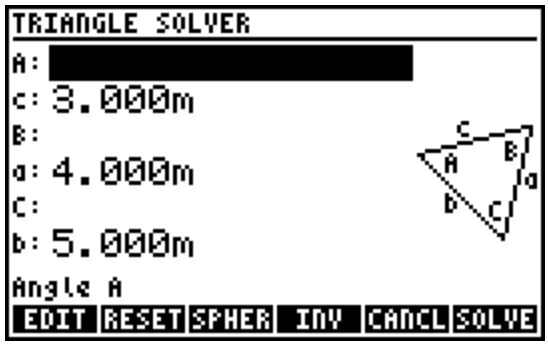
1. ▲ / ▼ / ◀ / ▶ cursor keys to pan around the map.
2. + to zoom in, same as F1.
3. − to zoom out, same as F2.
4. ON to exit the map and return to the first screen, same as F5.
5. ENTER to exit the map and the **Plot Points** program, same as F6.

8 Tools Menu



8.1 Triangle Solver

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



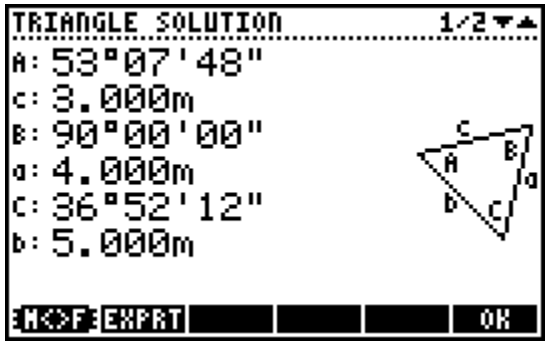
For side value inputs, any of the standard distances input options are accepted to allow the user to inverse points in the current job database to calculate distances for triangle sides, as well as any of the other operations.

The F3 **SPHER** softkey accesses the Spherical Triangle Solver.

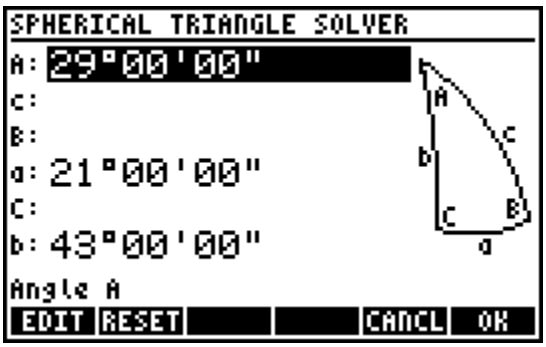
For angle value inputs, the F4 **INV** softkey allows the user to inverse an angle as defined by three points in the job database.

The output screen displays the solved values. The menu:

1. F1 **M<>F** toggles metric/imperial.
2. F1 **EXPRT** exports the solution to the stack or writes them to an ASCII file.



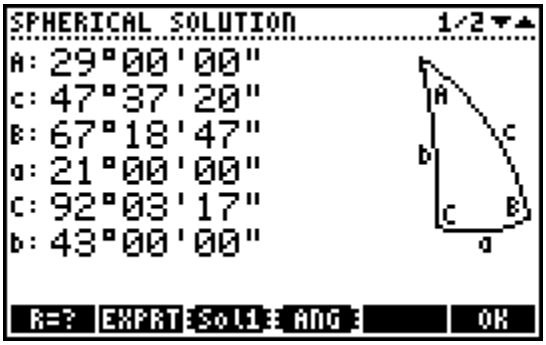
Spherical Triangle Solver



The spherical triangle solver accepts three known values to solve for the remaining values.

The radius value of the sphere is not a mandatory input, and therefore can be entered from the solutions screen.

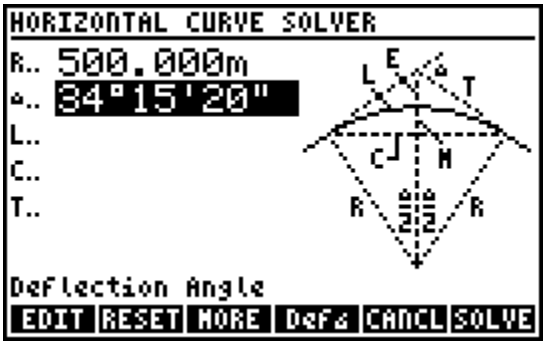
The menu on the solutions screen gives access to a few more options.



1. F1 **R=?** - Enter a radius value to facilitate the calculation of the surface area of the spherical triangle, and also to enable a toggle to show the "sides" of the spherical triangles as angular values or distance values computed from the radius of the sphere.
2. F2 **EXPRT** - Export the solution to the stack or write them to an ASCII file.
3. F3 **Sol1** or **Sol2** - When an ambiguous case is encountered, this softkey toggles between the two solutions.
4. F4 **ANG** or **DIST** - When a radius value has been entered, this softkey toggles the display of angles or distances for the "sides" of the spherical triangle.

8.2 Horizontal Curve Solver

The horizontal curve solver main interface solves simple circular curves and provides access to three additional solvers described below.

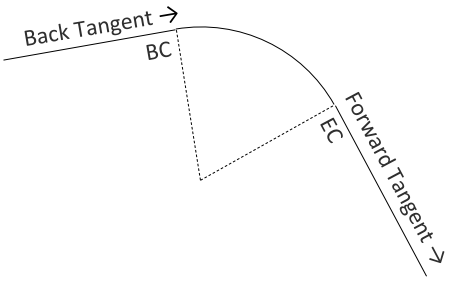


The solver requires two known curve elements and solves for the rest. Acceptable input combinations include:

- 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.

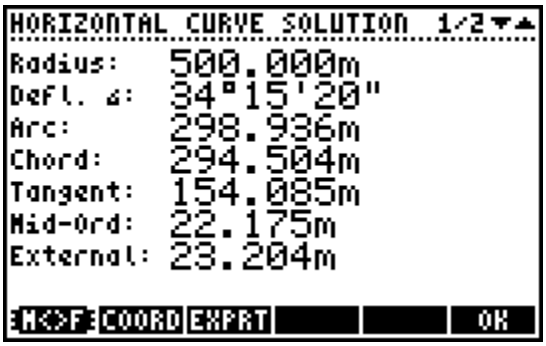
The F3 **MORE** softkey provides access to additional solvers as described on the following pages.

For the *Radius* field a softkey F4 **A/C** is available to solve for the radius using the arc definition or the chord definition. Enter the degree of curve to solve for the radius in a separate input form.



For the *Deflection Angle* field a softkey F4 **Def_** is available to calculate the deflection angle from the back and forward tangents and the curve direction.

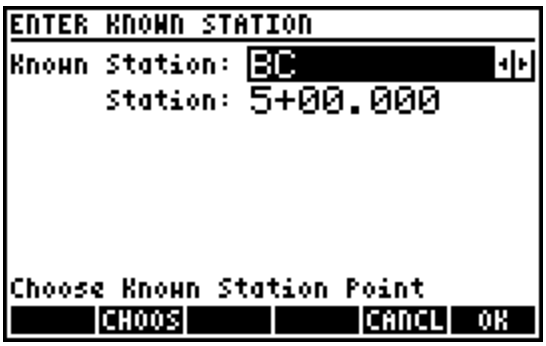
The solution is displayed on two pages. The first page lists all the elements of the circular curve, while the second page displays the sector, segment and fillet areas. The menu on the solution screens:



1. F1 **M<>F** toggles metric/imperial.
2. F2 **COORD** solves the coordinates for any station and offset on the curve.
3. F3 **EXPRT** exports the results to the stack, the calculator clipboard or to an ASCII file.

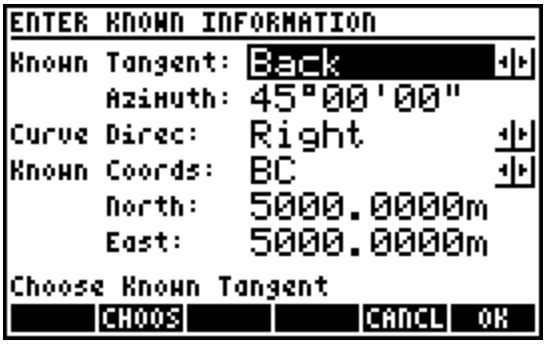
Solve COORDinates

By providing some defining parameters for the curve stationing and coordinates, it is possible to solve for the coordinates of any station and offset on the curve that was solved.

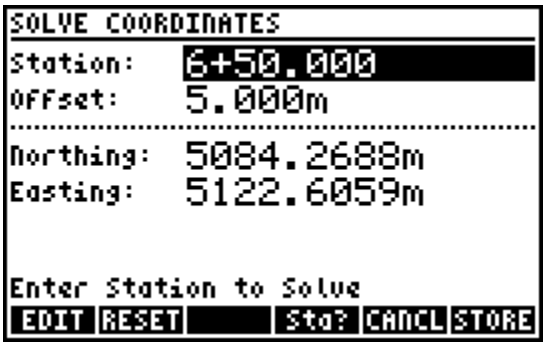


First, choose a known station, either the beginning of curve, point of intersection, or the end of curve, and then enter the station.

Next, choose the known tangent and enter the azimuth/bearing of the known tangent, choose the curve direction right/left, choose the station with known coordinates and enter the coordinates for the station. These parameters set up the required information to calculate any coordinates along the curve. NOTE: REFER TO THE DIAGRAM ON THE PREVIOUS PAGE FOR BACK/FORWARD TANGENT DIRECTION CONVENTION.



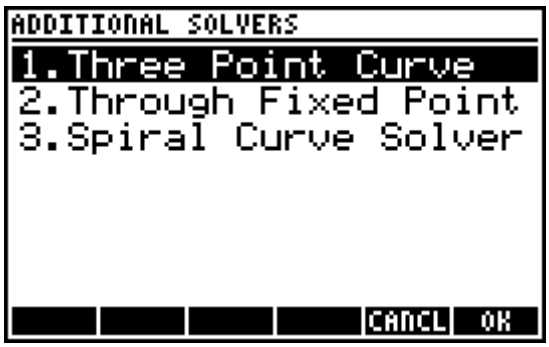
The solver input form accepts the station and offset to solve. The coordinates are displayed on the screen for the values entered.



Use F4 **Sta?** to choose the beginning of curve, point of intersection, end of curve, mid-point of curve or the radius point to solve. The station field is automatically updated to reflect the station that was chosen, and the label for the softkey displays which point was solved. The label changes back to **Sta?** as soon as changes are made to the input values.

Use F6 **STORE** to store the solved coordinates as a point in the current job database.

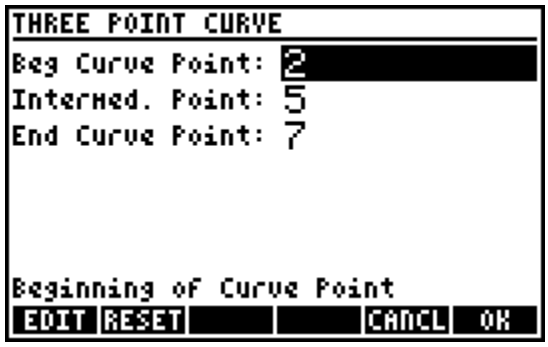
MORE Solvers



From the main horizontal curve solver screen select F3 **MORE** to run additional horizontal curve solvers. Available solvers include:

- Three Point Curve solver to solve a curve that passes through three points
- Through Fixed Point solver to solve a curve that passes through a fixed point, with known point of intersection coordinates and known tangent azimuths/bearings
- Spiral Curve Solver for solving spiral transition curves, including coordinates

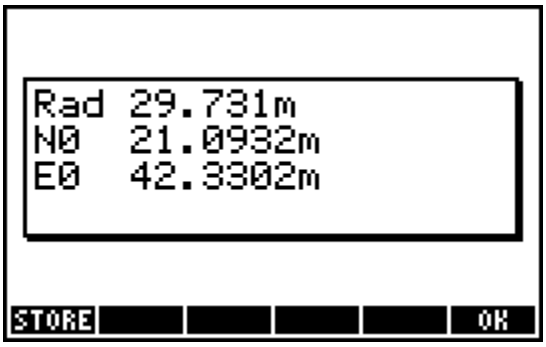
Three Point Curve Solver



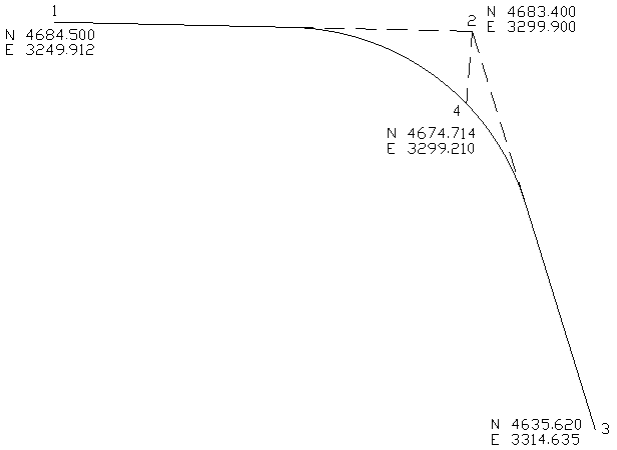
The Three Point Curve solver accepts three points that are stored in the current job database as input to solve for the radius and radius point coordinates of the circular curve that passes through the three points.

A solution is calculated when all three points are found in the current job and they are not in a straight line. The program displays the solution radius of the curve and the coordinates of the radius point.

Press F1 **STORE** to store the calculated coordinates as a point in the current job database.

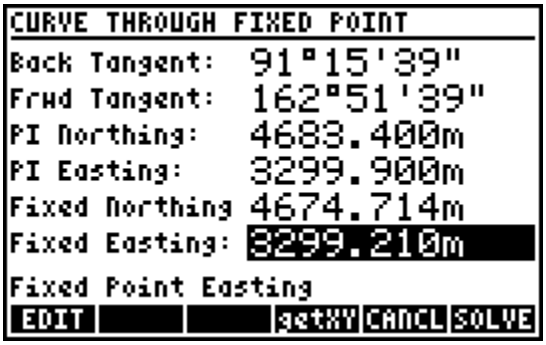


Curve through Fixed Point Solver

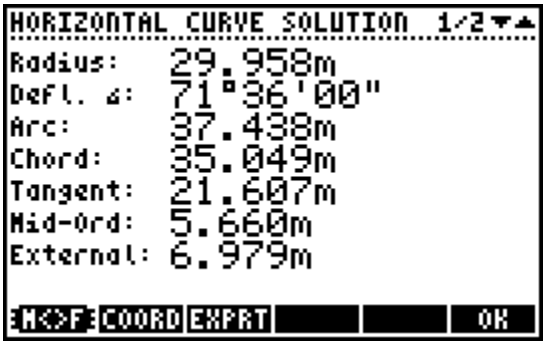


The Curve through Fixed Point solver solves a curve that is required to fit fixed tangents and a fixed point. In the diagram to the right, let's assume that the back tangent from Point 1 to Point 2 is a street curb line, and the forward tangent from Point 2 to Point 3 is also a street curb line. A curve 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 back and forward tangents using any of the standard directions input options, and enter the coordinates for the curve point of intersection (Point 2 in the diagram) and the coordinates for the fixed point (Point 4 in the diagram). For the coordinate entry fields use F4 **getXY** to retrieve the coordinates from a point stored in the current job database.



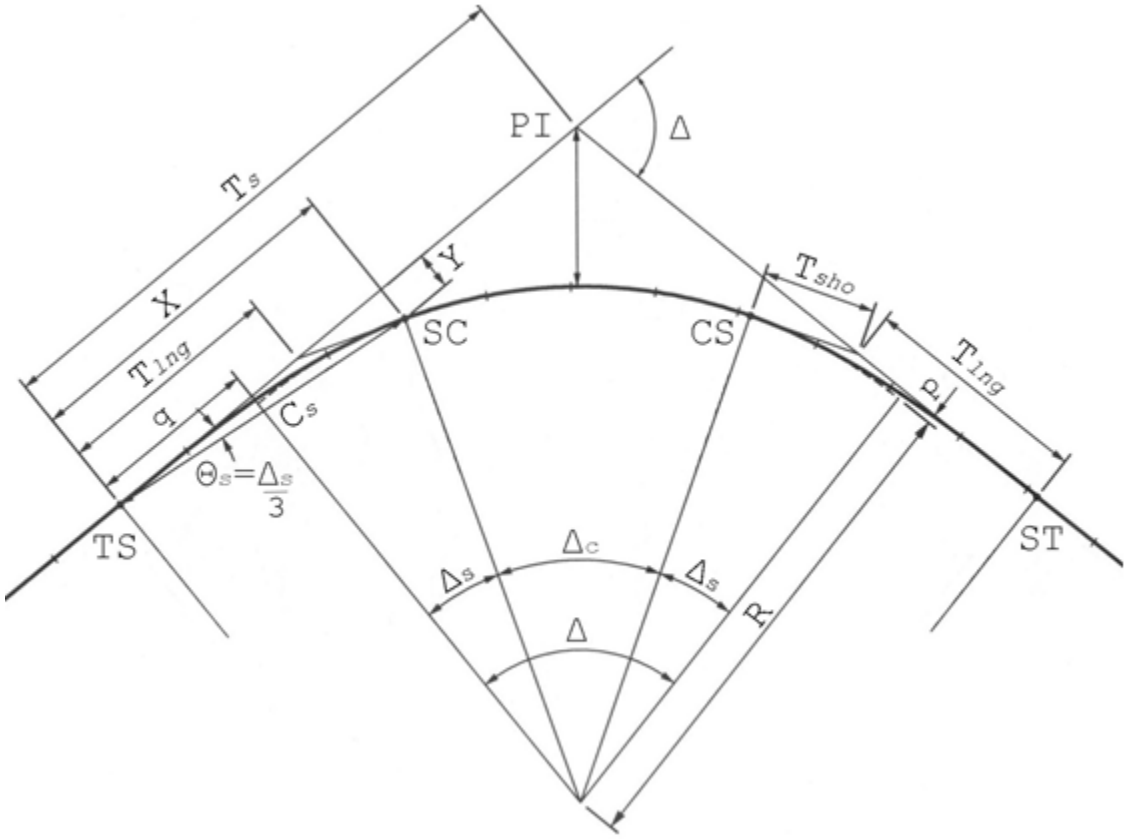
The curve solution is presented on two pages in the same manner as the standard horizontal curve solver. The first page lists all the elements of the circular curve, while the second page displays the sector, segment and fillet areas. The menu on the solution screens:



1. F1 **M<>F** toggles metric/imperial.
2. F2 **COORD** solves the coordinates for any station and offset on the curve.
3. F3 **EXPRT** exports the results to the stack, the calculator clipboard or to an ASCII file.

Spiral Curve Solver

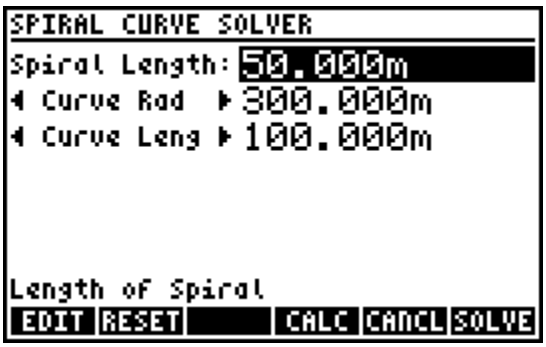
The Spiral Curve Solver solves spiral transition curves and is able to solve coordinates for any station and offset along the transition curve. The diagram below illustrates the spiral geometry and associated symbols.



Below is a table legend of the spiral parameter symbols.

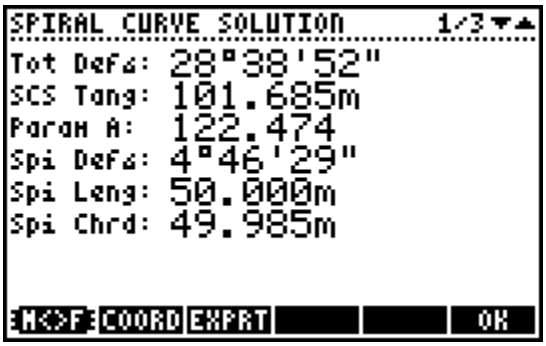
Ts	Tangent of Spiral-Curve-Spiral	**Cs**	Long Chord (Spiral)
X	Distance along Tangent from TS to Point at Right Angle to SC	**Cc**	Curve Chord (not labelled)
Y	Right Angle distance from Tangent to SC	**Δs**	Spiral Delta
Tlng	Long Tangent (Spiral)	**Δc**	Curve Delta
Tsho	Short Tangent (Spiral)	**Δ**	Total 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)		

The first input form requires some known parameters to solve the transition curve. There are numerous combinations accepted within three input fields.



1. The first input field requires the *Spiral Length*. The solver works with equal spiral lengths in a spiral-curve-spiral transition curve. Use F4 **CALC** to calculate the spiral length from Parameter A and the Curve Radius.
2. The second input field accepts either the *Curve Radius (R)* or *Parameter A*. Use the ◀ and ▶ cursor keys to toggle the input type accepted for this field.
3. The third input field accepts either the *Curve Delta Angle (Δc)*, the *Curve Length (Lc)*, or the *Spiral Tangent (Ts)*. Use the ◀ and ▶ cursor keys to toggle the input type accepted for this field.

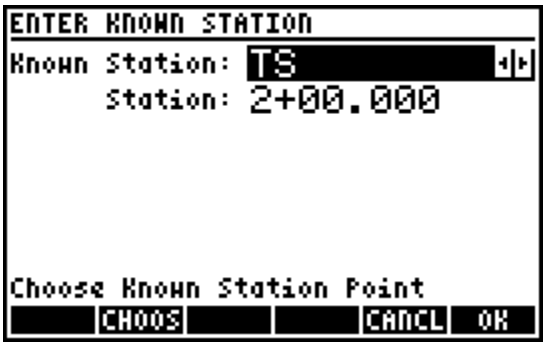
The solution is displayed on three pages. The first two pages report on the overall spiral-curve-spiral parameters and the spiral portion parameters, while the third page reports on the curve portion. The menu on the solution screens:



1. F1 **M<>F** toggles metric/imperial.
2. F2 **COORD** solves the coordinates for any station and offset on the transition curve.
3. F3 **EXPRT** exports the results to the stack, the calculator clipboard or to an ASCII file.

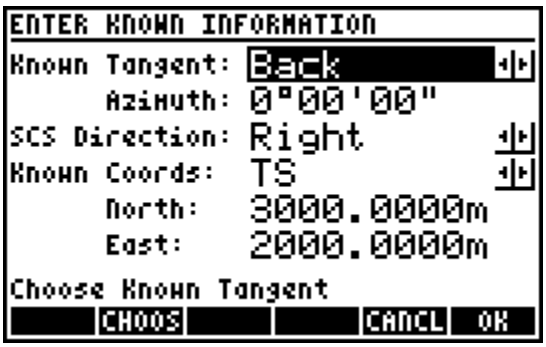
Solve COORDinates

By providing some defining parameters for the transition curve stationing and coordinates, it is possible to solve for the coordinates of any station and offset on the transition curve that was solved.



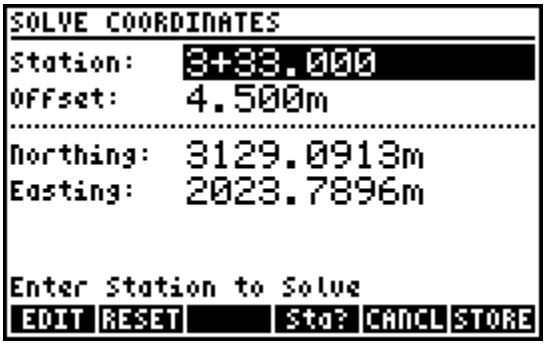
First, choose a known station, either the tangent-spiral (TS), spiral-curve (SC), point of intersection (PI), curve-spiral (CS), or spiral-tangent (ST), and then enter the station.

Next, choose the known tangent and enter the azimuth/bearing of the known tangent, choose the transition curve direction right/left, choose the station with known coordinates and enter the coordinates for the station. These parameters set up the required information to calculate any coordinates along the curve.



NOTE: REFER TO THE circular curve diagram FOR BACK/FORWARD TANGENT DIRECTION CONVENTION.

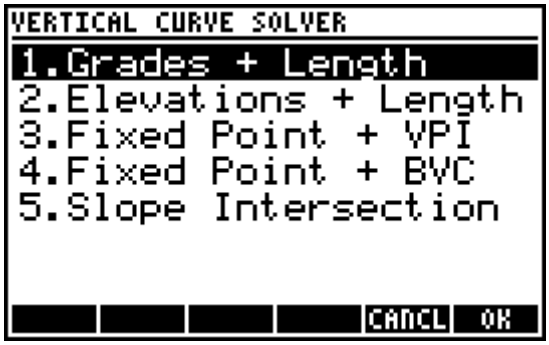
The solver input form accepts the station and offset to solve. The coordinates are displayed on the screen for the values entered.



Use F4 **Sta?** to choose the tangent-spiral (TS), spiral-curve (SC), point of intersection (PI), curve-spiral (CS), spiral-tangent (ST), mid-point of curve or the radius point to solve. The station field is automatically updated to reflect the station that was chosen, and the label for the softkey displays which point was solved. The label changes back to **Sta?** as soon as changes are made to the input values.

Use F6 **STORE** to store the solved coordinates as a point in the current job database.

8.3 Vertical Curve Solver

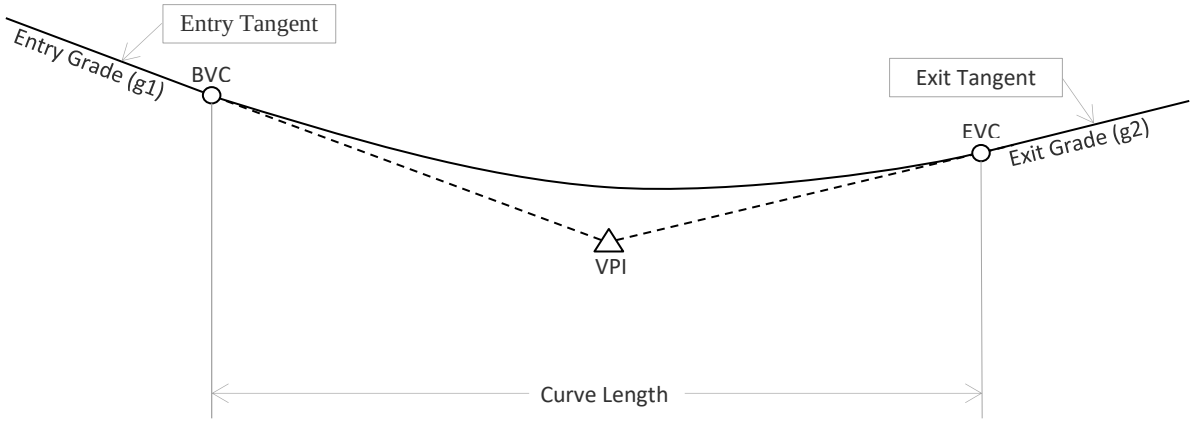


The Vertical Curve Solver solves vertical curves using various combinations of known parameters, including:

1. Grades + Length – 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 + Length – 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 – Requires the station and elevation at the VPI, a fixed point station and elevation, entry and exit grades.
4. Fixed Point + BVC – Requires the station and elevation at the BVC, a fixed point station and elevation, entry and exit grades.
5. Slope Intersection – 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.

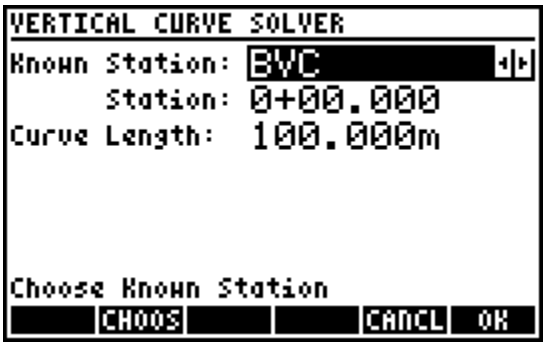
NOTE: BVC = BEGINNING OF VERTICAL CURVE, VPI = VERTICAL POINT OF INTERSECTION, AND EVC = END OF VERTICAL CURVE.

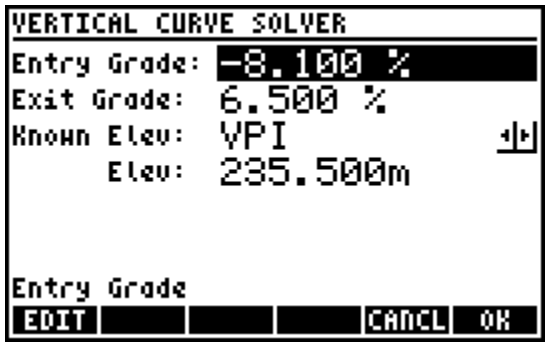
The diagram below illustrates the vertical curve geometry.



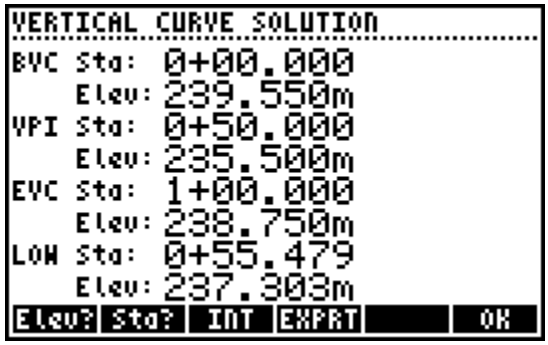
Grades + Length

Curve parameter input is taken in two input forms. In the first form choose a known station (BVC, VPI or EVC) then enter the station for this point, and enter the vertical curve length. The *Curve Length* field features a F4 **Sta?** softkey to calculate the curve length from a second known station. The calculation uses the current station information already entered in the first two fields.

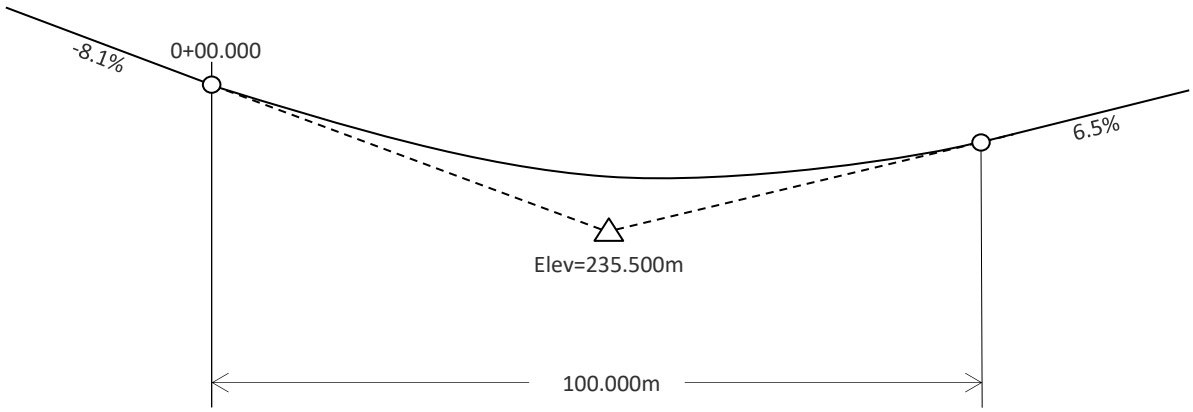




In the second input form enter the entry and exit grades, choose (or enter) a station for which the elevation is known and enter the elevation at the selected/entered station. When choosing a known station, the options are BVC, VPI, EVC or High/Low Point, but you may enter any known station also. The *Elevation* field features a F4 **getZ** softkey to retrieve the elevation from a point in the current job database.

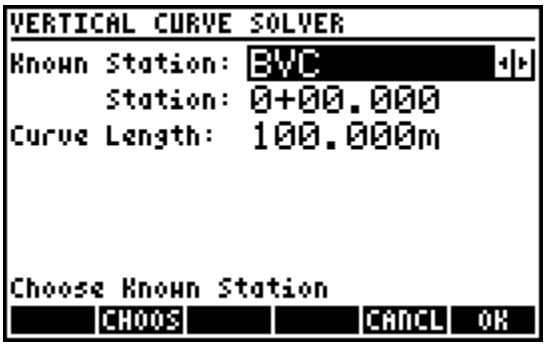


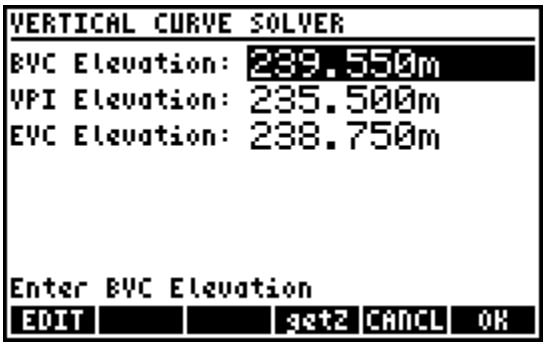
The solution displays the stations and elevations for each the BVC, VPI, EVC and High/Low Point. See the Solution Screen and Calculations section for more information.



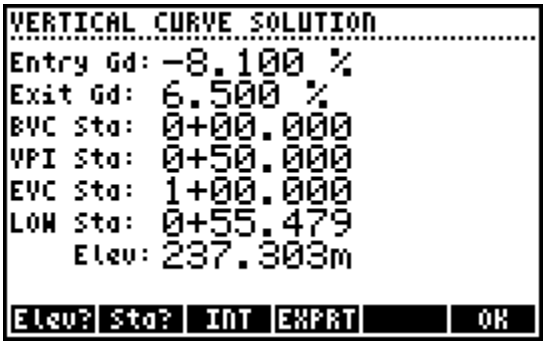
Elevations + Length

Curve parameter input is taken in two input forms. In the first form choose a known station (BVC, VPI or EVC) then enter the station for this point, and enter the vertical curve length. The *Curve Length* field features a F4 **Sta?** softkey to calculate the curve length from a second known station. The calculation uses the current station information already entered in the first two fields.

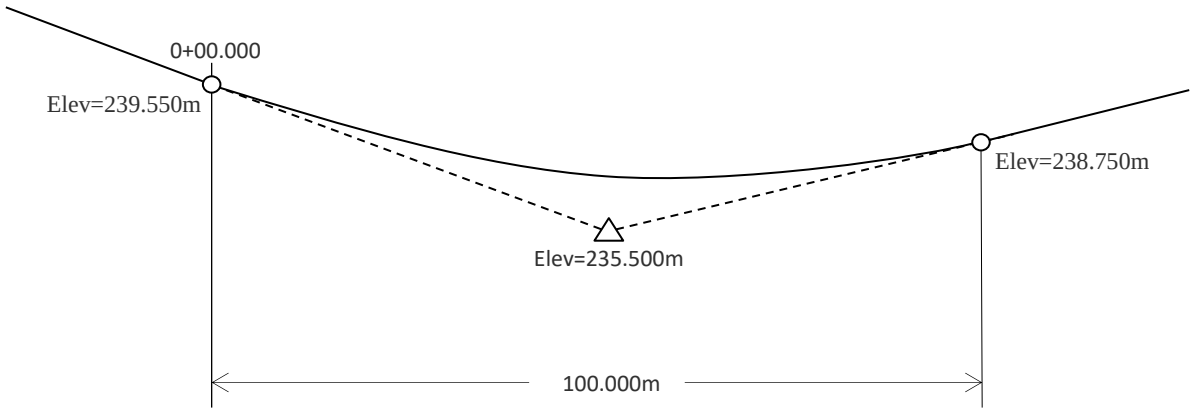




In the second input form enter the elevations for each the BVC, VPI and EVC. Use the F4 **getZ** softkey for each field to retrieve the elevation from a point in the current job database.

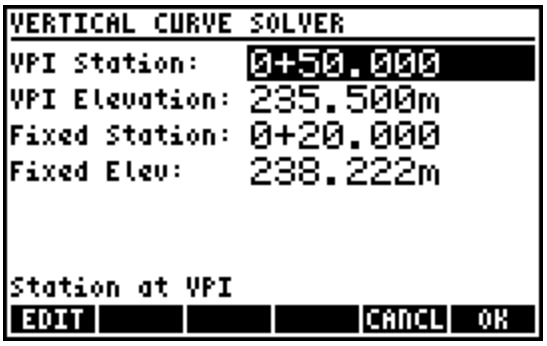


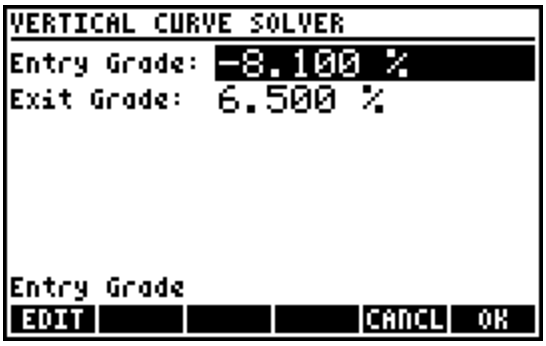
The solution displays the entry and exit grades, the stations for the BVC, VPI and EVC, and the High/Low Sation and elevation. See the Solution Screen and Calculations section for more information.



Fixed Point + VPI

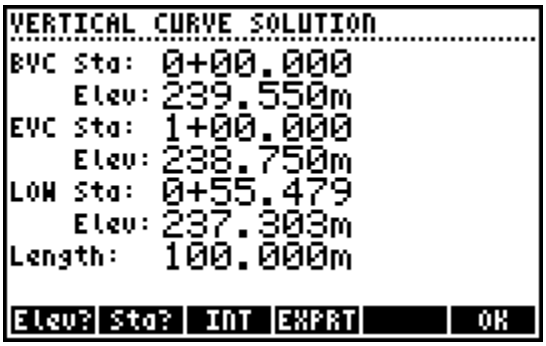
Curve parameter input is taken in two input forms. In the first input form enter the VPI station and elevation, and enter the fixed point station and elevation. A F4 **getZ** softkey is available for the Elevation fields to retrieve the elevation from a point in the current job database.

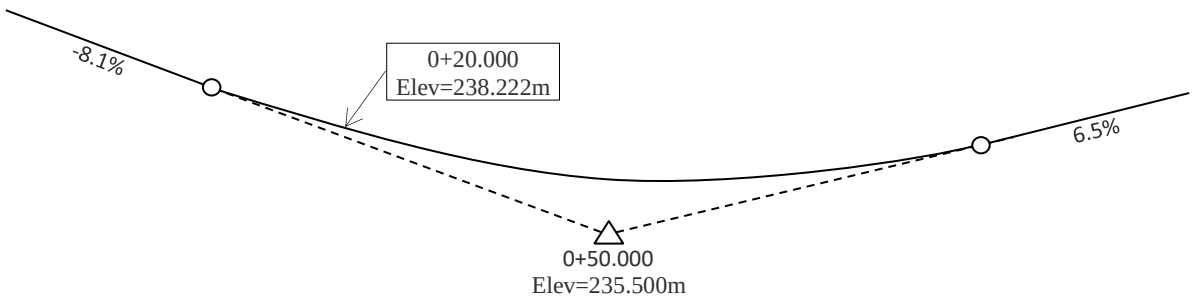




In the second input form enter the entry and exit grades.

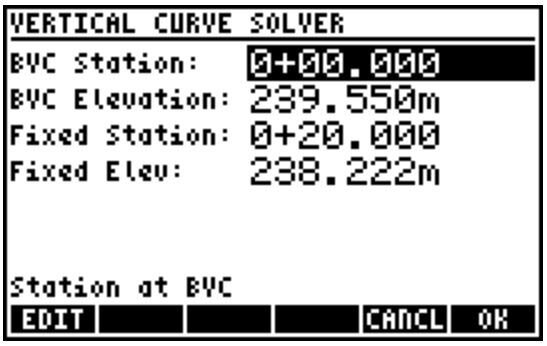
The solution displays the station and elevation for the BVC, EVC and the High/Low point, and the vertical curve length. See the Solution Screen and Calculations section for more information.

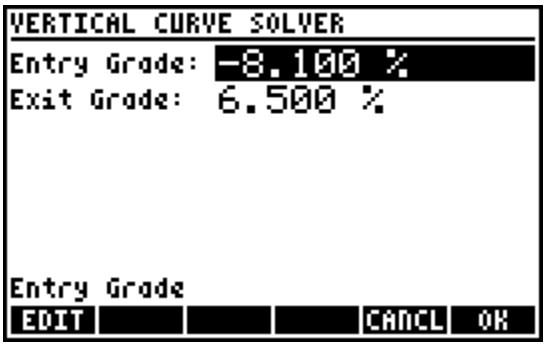




Fixed Point + BVC

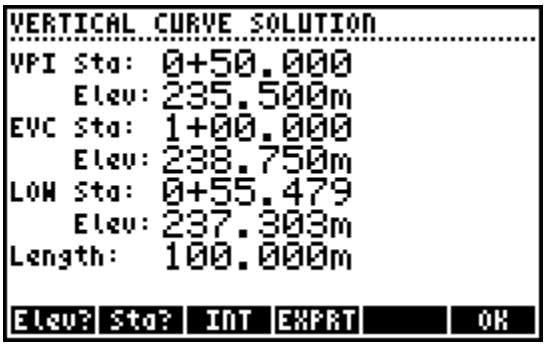
Curve parameter input is taken in two input forms. In the first input form enter the BVC station and elevation, and enter the fixed point station and elevation. A F4 **getZ** softkey is available for the Elevation fields to retrieve the elevation from a point in the current job database.

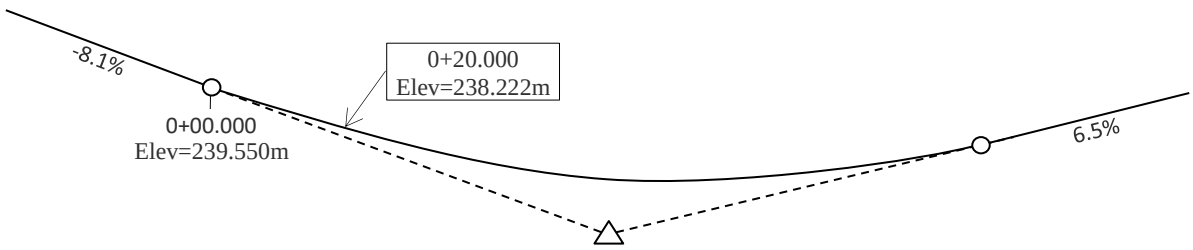




In the second input form enter the entry and exit grades.

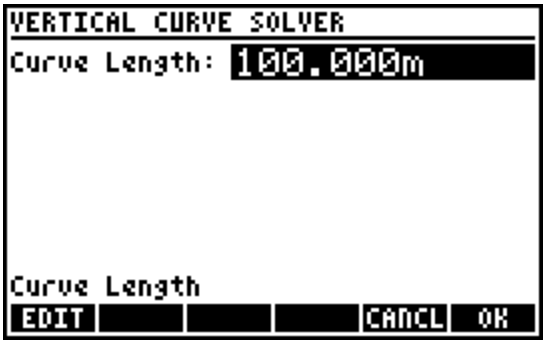
The solution displays the station and elevation for the VPI, EVC and the High/Low point, and the vertical curve length. See the Solution Screen and Calculations section for more information.

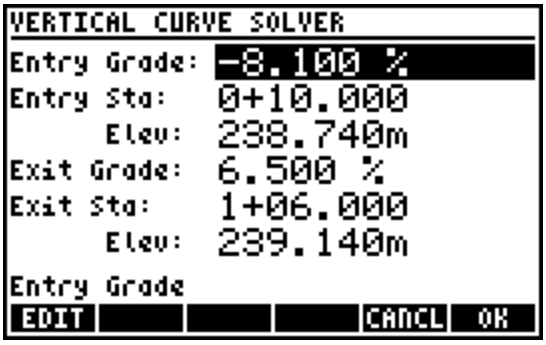




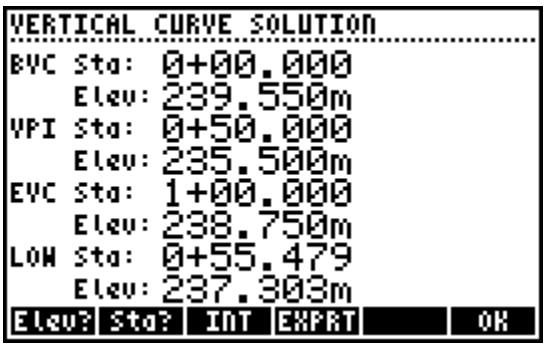
Slope Intersection

Curve parameter input is taken in two input forms. In the first input form enter the vertical curve length.

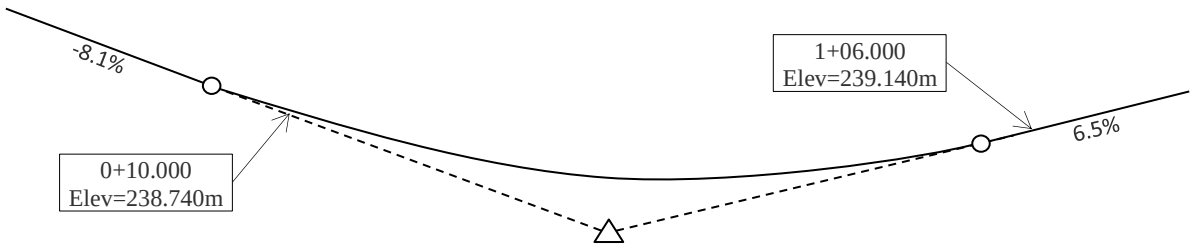




In the second input form enter the entry grade, a station along the entry tangent and the elevation at the station, the exit grade, a station along the exit tangent and the elevation at the station. The *Elevation* fields feature a F4 **getZ** softkey to retrieve the elevation from a point in the current job database. Stations along the entry and exit tangents can be inside or outside of the limits of the vertical curve.

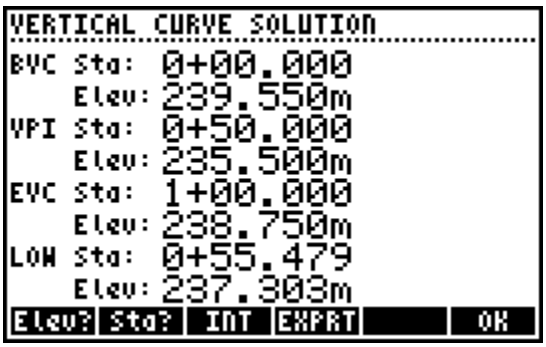


The solution displays the stations and elevations for each the BVC, VPI, EVC and High/Low Point. See the Solution Screen and Calculations section for more information.



Solution Screen and Calculations

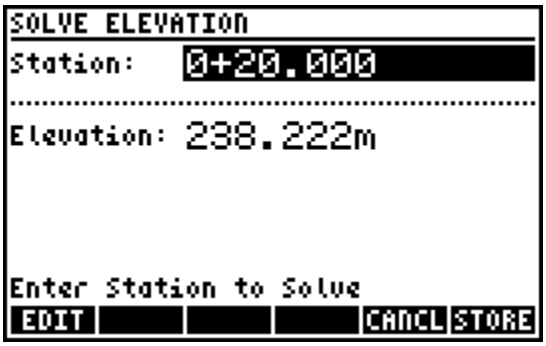
For each of the combinations of known parameters to solve a vertical curve; the solution screen displays the unknown solved parameters, and the menu on the solution screen is the same for all combinations, offering the same functionalities:



1. F1 **Elev?** – Calculate elevations on the vertical curve by entering a station.
2. F2 **Sta?** – Calculate stations on the vertical curve by entering an elevation.
3. F3 **INT** – Calculate elevations at all stations at a given interval.
4. F4 **EXPRT** – Export the solution to the stack, an ASCII file, or to the calculator clipboard.

Calculate Elevations

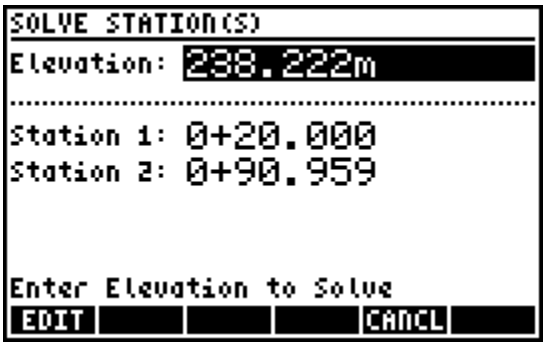
Enter any station to solve its elevation on the vertical curve. When entering a station lower than the BVC station, the elevation is preceded by the "<" character indicating that elevation is on the entry tangent before the BVC. Likewise, stations greater than the EVC will result in the elevation preceded by the ">" character indicating the elevation is on the exit tangent after the EVC.



Use F6 **STORE** to store the solved elevation to a point in the current job database.

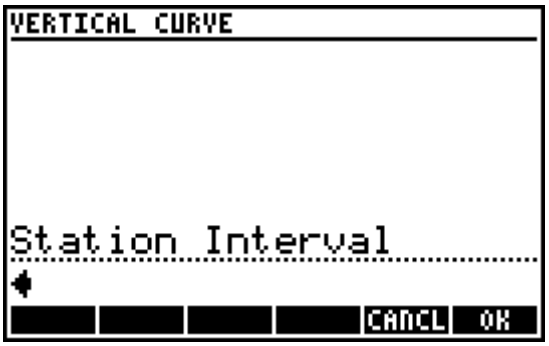
Calculate Stations

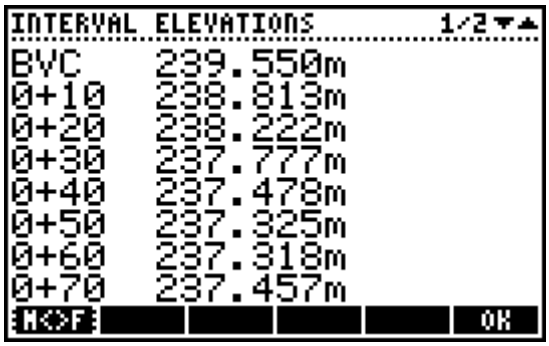
Enter an elevation to solve the station(s) on the vertical curve. Both solutions are displayed when two solutions exist. Only stations between the BVC and EVC are solved.



Calculate Intervals

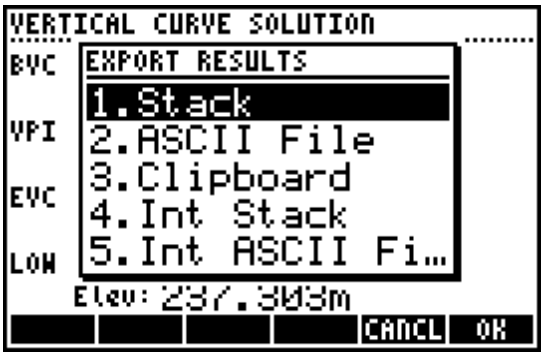
Enter a station interval to solve the elevations for each station at the given interval. The BVC and EVC elevations are always solved, regardless of their station. Results are displayed on as many pages as required, a maximum of eight stations per page. Use F1 **M<>F** to convert the elevations between metric and imperial.





Export Solution

The vertical curve solution may be exported in various ways for further use.



1. Export Solution to Stack – Places all the solved parameters on the calculator stack. Each parameter is tagged with a label.
2. Export Solution to ASCII file – Writes an ASCII file of the solved parameters to save to the SD card COGOPLUS\ASCII directory or to the HOME directory on the calculator.
3. Export to Clipboard – Choose any of the solved parameters to copy to the calculator clipboard. The value stored on the clipboard can be pasted into any input form or screen.
4. Export Intervals to Stack – Places a string of the solved interval elevations on the stack. This option is only available when an Interval Calculation has been performed.
5. Export Intervals to ASCII file – Writes an ASCII file of the solved interval elevations to save to the SD card COGOPLUS\ASCII directory or to the HOME directory on the calculator. This option is only available when an Interval Calculation has been performed.

8.4 Bearing<>Azimuth

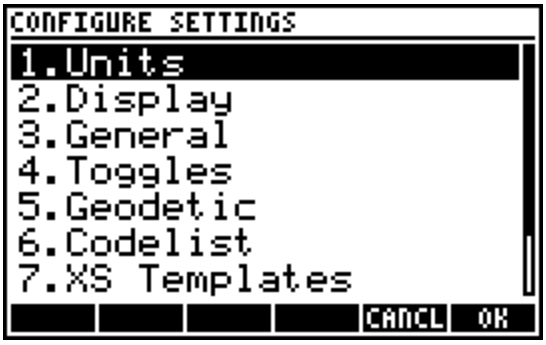
The **Bearing<>Azimuth** conversion program converts directions between quadrant bearings and azimuths.

Enter a value in the current field to convert to the corresponding direction format. Use any of the standard directions input options. The current field remains current until the field toggle is initiated.

The menu:

1. F1 **EDIT** – Edit the current field.
2. F5 **CANCL** – Exit the program.
3. F6 **B->A** or **A->B** – Toggle between bearing or azimuth input. When the command line is not active the ENTER key will do the same thing.

8.5 Configure Settings



User settings options 1 through 7 are described in Chapter 3.

Saving and restoring settings to and from Flash memory serves the purpose of quickly restoring ***COGO+*** settings following an intentional factory reset with ON + F1 + F6.

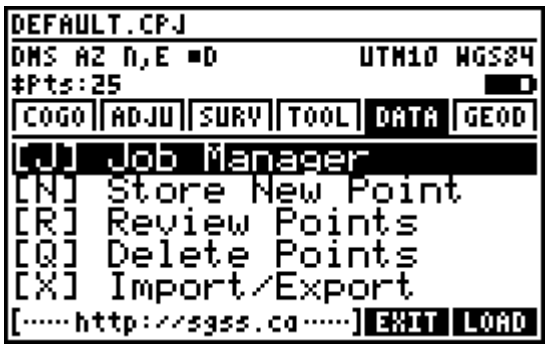
Save to Flash

This option stores all user settings to a safe place in Flash memory. A message indicates that the settings are stored to Flash. NOTE: THIS PROCEDURE SHOULD PRECEDE A HARD RESET.

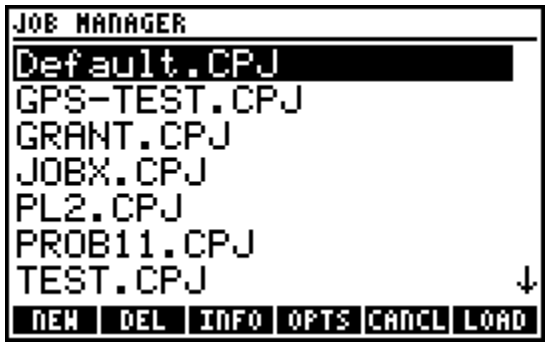
Restore from Flash

This option restores the previously saved user settings from Flash. A message indicates that the settings have been restored from Flash. NOTE: THIS PROCEDURE SHOULD FOLLOW A HARD RESET.

9 Data Menu



9.1 Job Manager



Easily manage multiple jobs on the calculator with the **Job Manager**, and move or copy jobs to and from the SD card. The main **Job Manager** screen displays all the jobs stored on the calculator, sorted alphabetically by name. The menu provides access to the available functions:

1. F1 **NEW** – Create a New Job.
2. F2 **DEL** – Delete a Job.
3. F3 **INFO** – Display Job Information.
4. F4 **OPTS** – Read and write jobs to and from the SD card COGOPLUS\JOBS directory, or rename an existing alignment
5. F5 **CANCL** – Exit the **Job Manager** and return to the main interface.
6. F6 **LOAD** – Load the selected job to make it current.

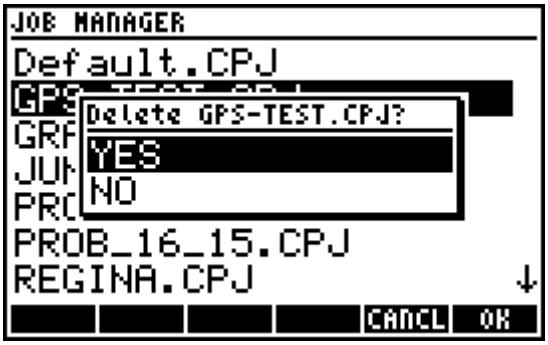
Create a New Job

From the main **Job Manager** screen press F1 to create a new job. Enter a job name containing numbers, letters or other special characters. The calculator operating system supports long filenames, however it is recommended to use the 8.3 filename convention if SD functions will be used. NOTE: ALL JOB NAMES AUTOMATICALLY RECEIVE A .CPJ EXTENSION.

Delete a Job

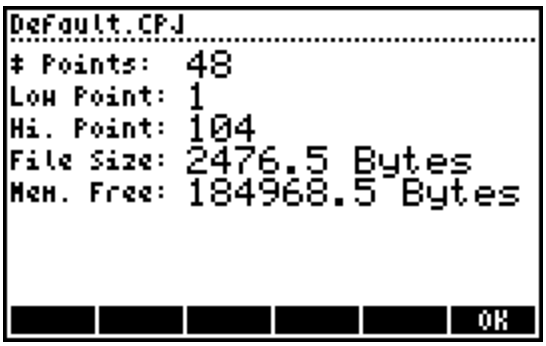
Select the job you wish to delete and press F2. A confirmation prompt prevents accidental deletions.

NOTE: IT IS NOT POSSIBLE TO DELETE THE CURRENT JOB.



Job Information

Select a job and press F3 to display job information. The job name, number of points stored within the job, the lowest used point number, the highest used point number, the file size of the job, and the available free memory on the calculator are displayed.



Job Options

Several options exist to make use of the SD card. NOTE: THE SD CARD FUNCTIONS ARE DESIGNED TO USE THE COGOPLUS\JOBS DIRECTORY ON THE SD CARD.

Import Job

Copy a job that was previously moved or copied to the SD card back to the calculator. NOTE: WHEN A JOB WITH THE SAME NAME ALREADY EXISTS ON THE CALCULATOR, A PROMPT ASKS WHETHER TO OVERWRITE THE EXISTING JOB.

Backup Job

Store a copy of the selected job within the COGOPLUS\JOBS directory. NOTE: WHEN A JOB WITH THE SAME NAME ALREADY EXISTS ON THE SD CARD, A PROMPT ASKS WHETHER TO OVERWRITE THE EXISTING JOB.

Backup All

Stories copies of all the jobs created on the calculator within the COGOPLUS\JOBS directory. NOTE: WHEN A JOB WITH THE SAME NAME ALREADY EXISTS ON THE SD CARD, A PROMPT ASKS WHETHER TO OVERWRITE THE EXISTING JOB.

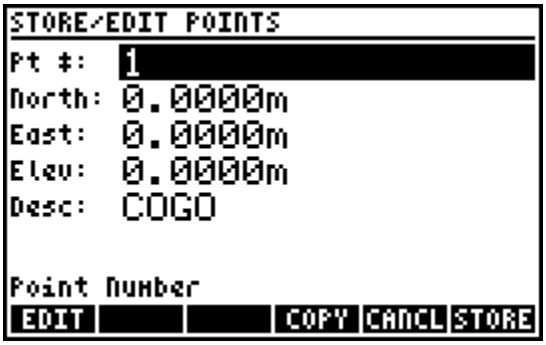
Move Job

Move the selected job to the COGOPLUS\JOBS directory, thereby deleting the job from the calculator. The current job cannot be moved. NOTE: WHEN A JOB WITH THE SAME NAME ALREADY EXISTS ON THE SD CARD, A PROMPT ASKS WHETHER TO OVERWRITE THE EXISTING JOB.

Rename Job

Rename the selected job. . NOTE: THE NEW NAME FOR A JOB CANNOT ALREADY EXIST, THERE IS NO OPTION TO OVERWRITE AND DELETE A JOB WITH THE SAME NAME.

9.2 Store New Point



It is possible to store and edit points in the same input form. The menu changes depending on the current field selected or edited. Available for all fields:

1. F1 **EDIT** – Edit the current field.
2. F4 **COPY** – Copy the coordinates and description from another point in the job.
3. F5 **CANCL** – Exit the **Store New Point** program and return to the main interface.
4. F6 **STORE** – Store the point with the entered values. A overwrite prompt informs the user of the coordinate changes when points are overwritten.

'Point Number' Field

Enter a point number 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:

1. F1 **BROWS** – Browse for an existing point to edit.
2. F2 **LOW** – Search for the lowest unused point number in the job.
3. F3 **NEXT** – Search for the lowest unused point number starting from the current value.

'Northing', 'Easting' and 'Elevation' Fields

Enter coordinate values for each field. All the standard distances input options are available for these fields. Options while editing these fields:

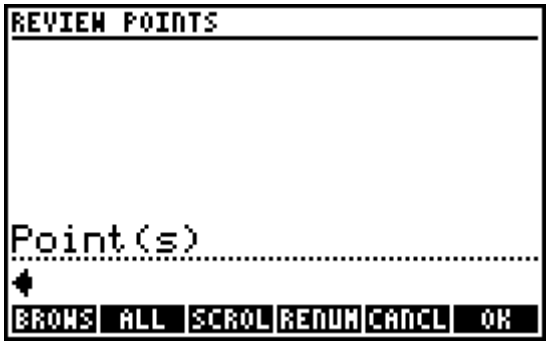
1. F1 **ft->m** or **m->ft** – Converts the input between metric and imperial units. The appearance of this softkey varies depending on your primary distance unit setting.
2. F2 **xUSF** – Multiplies the input by the user defined scale factor.
3. F3 **/USF** – Divides the input by the user defined scale factor.

'Description' Field

This field is only visible when the description prompts toggle is set. Alpha mode is automatically set when editing this field. The ▶ cursor key opens the codelist to choose a code while this field is current. When the codelist translation toggle is set, the user can enter any defined code in the codelist and the program will automatically look up the description and store the code's description.

9.3 Review Points

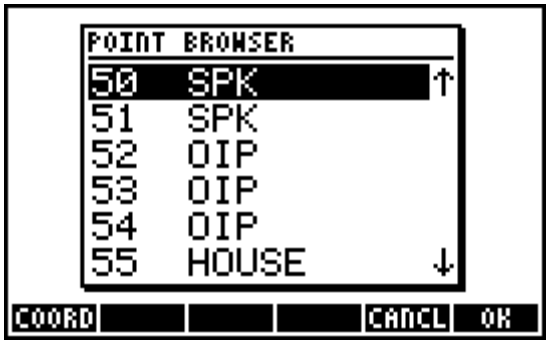
Review point coordinates using various methods and renumber points in the current job.

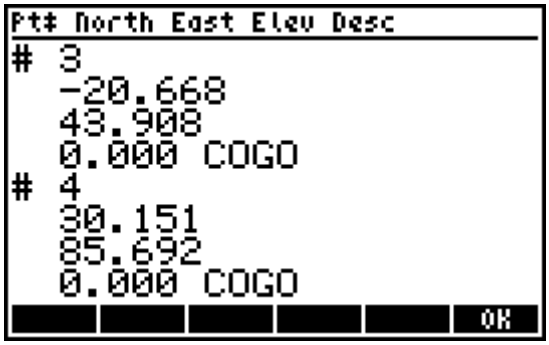


View Point Coordinates

To view coordinates of individual points or ranges of points, enter points using any of the point numbers input options. The menu:

1. F1 **BROWS** – Browse a list of all the points in the job. Use F1 **COORD** while browsing to view the coordinates of the selected point.
2. F2 **ALL** – View the coordinates of all points in the job.
3. F3 **SCROL** – Scroll through a coordinate listing of all the points in the job. The ▲ and ▼ cursor keys scroll up and down through the listing. Use ↱ followed by ▲ or ▼ to jump to the top or bottom of the point listing.
4. F4 **RENUM** – Renumber points, see below.

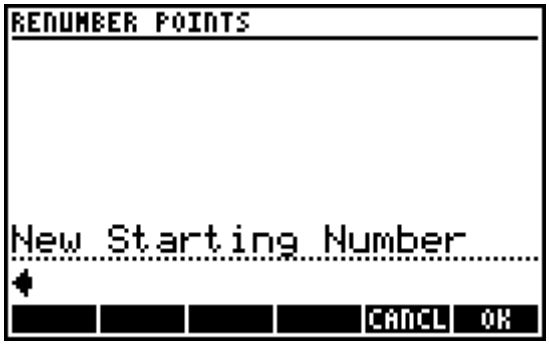




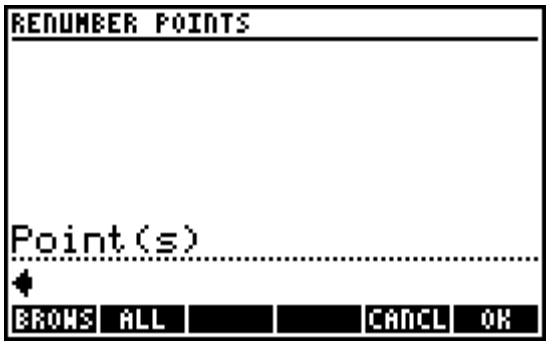
Renumber Points

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

Renumber by New Starting Number



In the first input screen, enter the new starting number 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.

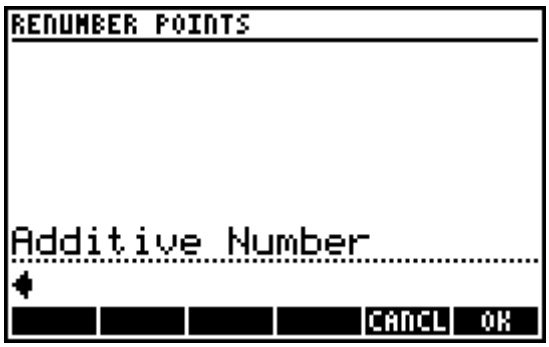


In the second input screen, enter the points to be renumbered using any of the point numbers input options, or use F1 **ALL** to renumber all the points in the current job.

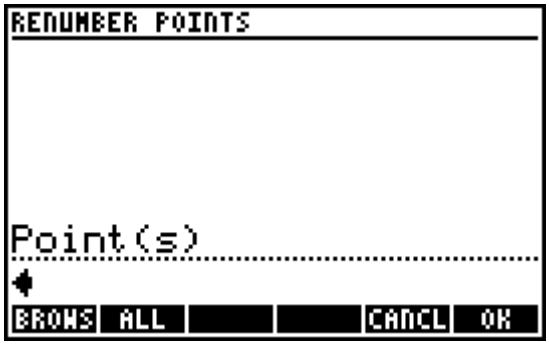
Some examples to illustrate this method of renumbering points:

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.

Renumber by Additive Number



In the first input screen, 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.



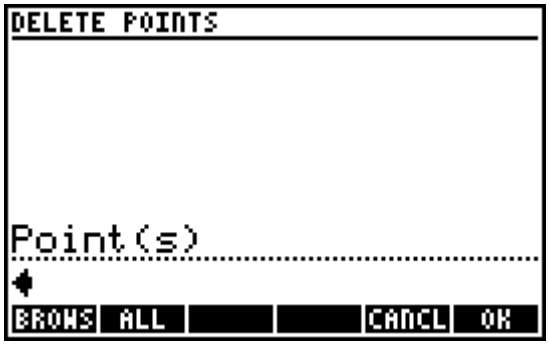
In the second input screen, enter the points to be renumbered using any of the point numbers input options, or use F1 **ALL** to renumber all the points in the current job.

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 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 104.

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

9.4 Delete Points



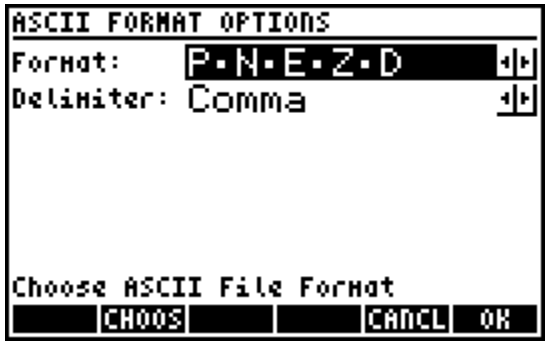
Delete individual points, a range of points or all the points from the current job. To delete individual points or ranges of points, enter points using any of the point numbers input options. The menu:

1. F1 **BROWS** – Browse a list of all points in the job to choose a single point or multiple points to delete.
2. F2 **ALL** – Delete all points from the job. A prompt asks to confirm the action.

9.5 Import/Export

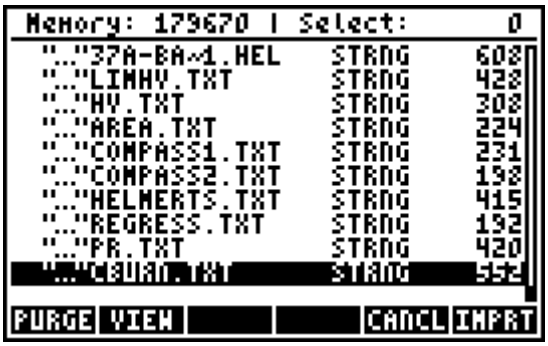
Import and Export ASCII files from/to the SD card or the HOME directory. NOTE: ALL SD CARD IMPORT/EXPORT OPERATIONS ARE DESIGNED TO USE THE COGOPLUS\ASCII DIRECTORY.

Import ASCII points



Import a delimited ASCII points file into the current ***COGO+*** job database.

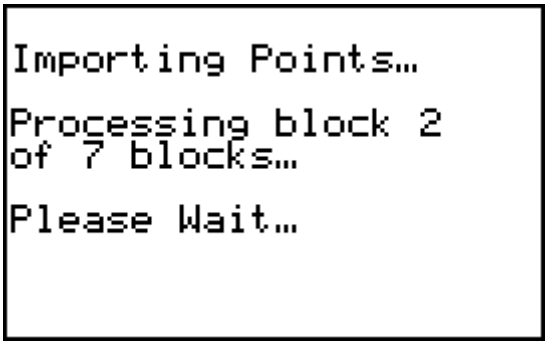
First, select the format and delimiter of the ASCII file you wish to import. NOTE: THIS STEP IS CRITICAL TO ENSURE THAT THE DATA IS STORED CORRECTLY.



When the SD card is present in the card slot, the software will automatically look for the COGOPLUS\ASCII directory and show its contents. When the SD card is not present or the required directory does not exist on the card, the software displays the HOME directory contents.

Select an ASCII file from the list to import. The menu:

1. F1 **PURGE** – Delete the selected file from the SD card.
2. F2 **VIEW** – View the file to inspect its contents.
3. F5 **CANCL** – Exit the **Import Points** program and return to the main interface.
4. F6 **IMPRT** – Import the selected file.

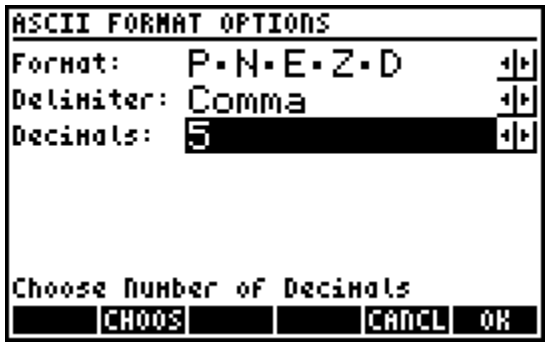


The selected file is parsed line by line and the coordinates are stored if valid data is found. Point number conflicts result in a screen showing the coordinate differences and *YES*/*NO*/*YES TO ALL*/*NO TO ALL* options to overwrite the existing point(s). The import progress is displayed while the file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

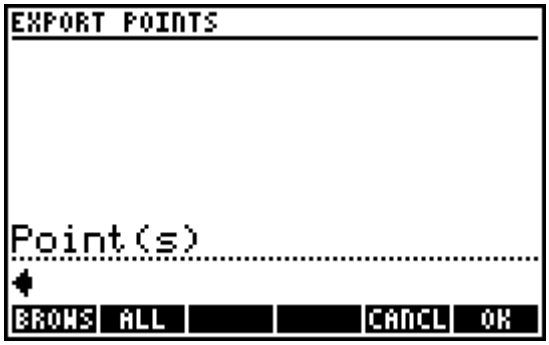
Export ASCII points

Write a delimited ASCII points file of points in the current job for archiving or importing into CAD software on your PC, or any number of other possible uses. ***It is highly recommended to have the optional SDfiler software installed for exporting ASCII files.***

First, select the ASCII file format, the delimiter and the number of decimals to export. NOTE: THE AVAILABLE NUMBER OF DECIMALS FOR SELECTION RANGES FROM 0 TO 11, HOWEVER IT SHOULD BE NOTED THAT 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.

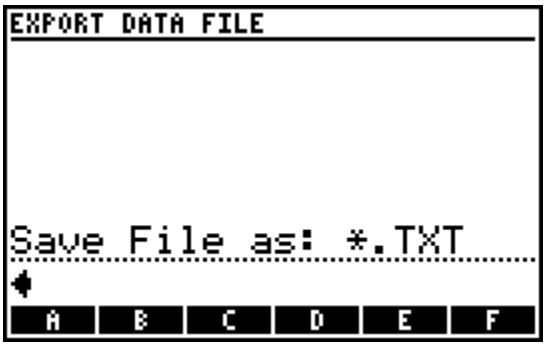


Next, enter the points you wish to export using any of the point numbers input options, or optionally select F2 **ALL** to export all points. The export progress is displayed while the program is working.



Next, enter a file name to save the exported points. The ASCII file extension is automatically added to the file name, and is displayed next to the *Save File as:* prompt.

Finally, choose the destination for the exported file, either the SD card or the HOME directory.

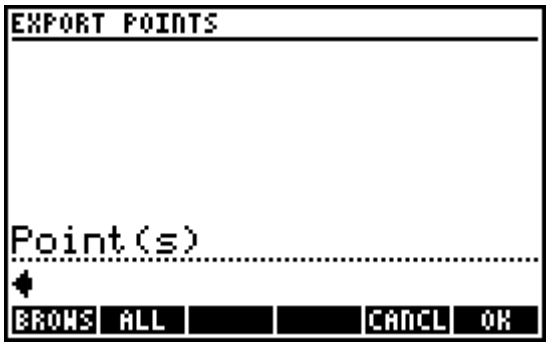


NOTE: WITH THE SD FILER SOFTWARE INSTALLED, A MESSAGE INFORMS THE USER THAT THE EXPORT IS COMPLETED WHEN WRITTEN TO THE SD CARD, HOWEVER WITHOUT SD FILER INSTALLED A MESSAGE REMINDS THE USER TO EDIT THE FILE ON THE PC USING NOTEPAD OR SIMILAR SOFTWARE TO DELETE THE FIRST LINE OF CHARACTERS.

SD Filer enables COGO+ to write a raw ASCII file without the HP header information included.

Export DXF File

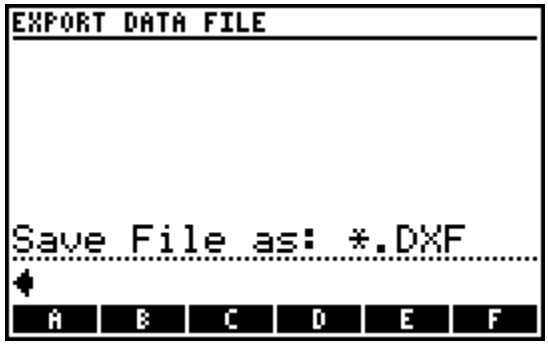
Points in the current job can be written to a DXF file, which can then be imported into CAD software on your PC. ***It is highly recommended to have the optional SDfiler software installed for exporting DXF files.***



First, enter the points you wish to export using any of the point numbers input options, or optionally select F2 **ALL** to export all points.

Next, choose whether to write the points as a 2D or 3D DXF file. This option determines whether the point nodes in the DXF file will be at a zero elevation or at the elevation that the point is stored in the job.

The export progress is displayed while the program is working.



Next, enter a file name to save the exported points. The .DXF extension is automatically added to the file name, and is displayed next to the *Save File as:* prompt.

Finally, choose the destination for the exported file, either the SD card or the HOME directory.

NOTE: WITH THE SD FILER SOFTWARE INSTALLED, A MESSAGE INFORMS THE USER THAT THE EXPORT IS COMPLETED WHEN WRITTEN TO THE SD CARD, HOWEVER WITHOUT SD FILER INSTALLED A MESSAGE REMINDS THE USER TO EDIT THE FILE ON THE PC USING NOTEPAD OR SIMILAR SOFTWARE TO DELETE THE FIRST LINE OF CHARACTERS.

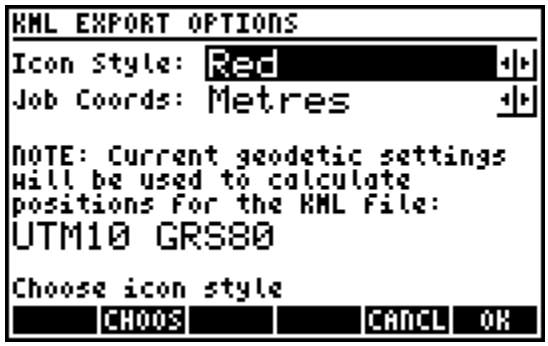
SD Filer enables COGO+ to write a raw ASCII file without the HP header information included.

Export KML File

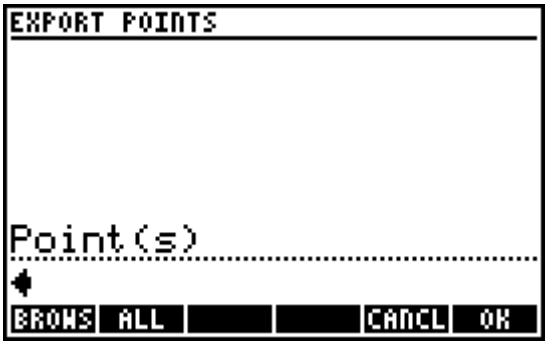
Points in the current job can be written to a KML file so that they may be viewed in Google Earth. ***It is highly recommended to have the optional SDfiler software installed for exporting KML files.***

The points exported to a KML file must be in a grid projection based on the GRS80 or WGS84 reference ellipsoid. NAD83 UTM or State Plane grid coordinates are an example of valid coordinates. A projection based on a different ellipsoid or coordinates in an assumed local coordinate system will result in incorrect positions written to the KML file.

First, select the icon style and coordinate units Available icon styles for the points to be displayed as in Google Earth are: red orange yellow green blue violet and white The unit selection must match the unit that the coordinates are in. A note reminds the user that the current settings will be used to export the point positons.

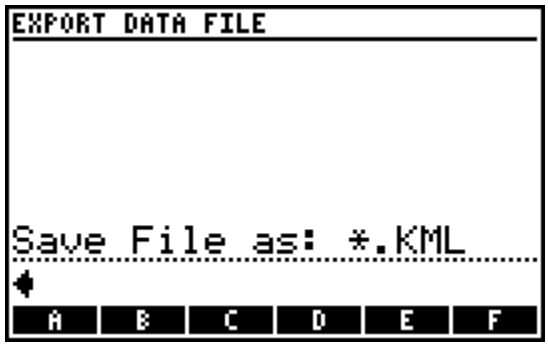


Next, enter the points you wish to export using any of the point numbers input options, or optionally select F2 **ALL** to export all points. The export progress is displayed while the program is working.



Next, enter a file name to save the exported points. The .KML extension is automatically added to the file name, and is displayed next to the *Save File as:* prompt.

Finally, choose the destination for the exported file, either the SD card or the HOME directory.



NOTE: WITH THE SD FILER SOFTWARE INSTALLED, A MESSAGE INFORMS THE USER THAT THE EXPORT IS COMPLETED WHEN WRITTEN TO THE SD CARD, HOWEVER WITHOUT SD FILER INSTALLED A MESSAGE REMINDS THE USER TO EDIT THE FILE ON THE PC USING NOTEPAD OR SIMILAR SOFTWARE TO DELETE THE FIRST LINE OF CHARACTERS.

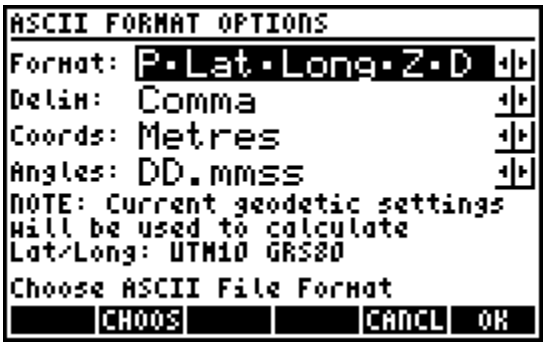
SD Filer enables COGO+ to write a raw KML file without the HP header information included.

Export Lat/Long ASCII File

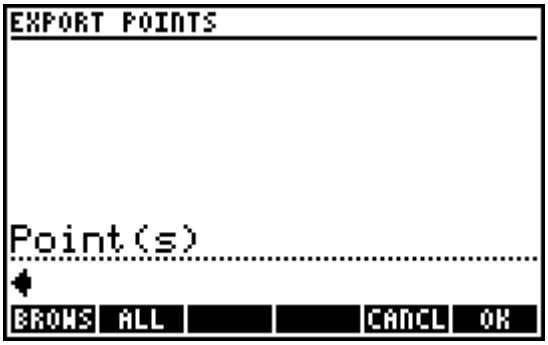
Points in the current job can be converted to Latitude/Longitude from their grid projection and written to a ASCII file. ***It is highly recommended to have the optional SDfiler software installed for exporting ASCII files.***

The points exported to a Lat/Long ASCII file must be in a grid projection. UTM or State Plane grid coordinates are an example of valid coordinates. The Lat/Long values will be calculated on the same ellipsoid that the projection is based on.

First, select the ASCII file format, the delimiter, the job coordinates unit, and the Lat/Long output mode. The unit selection must match the unit that the coordinates are in. A note reminds the user that the current settings will be used to export the point positons.

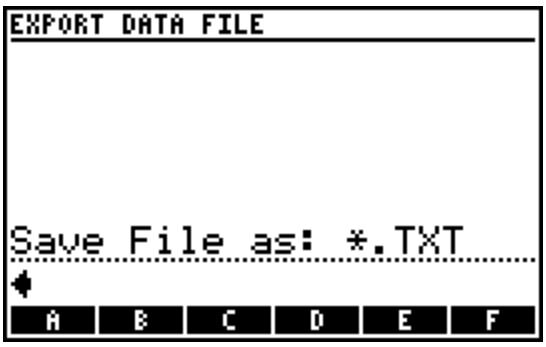


Next, enter the points you wish to export using any of the point numbers input options, or optionally select F2 **ALL** to export all points. The export progress is displayed while the program is working.



Next, enter a file name to save the exported points. The ASCII file extension is automatically added to the file name, and is displayed next to the *Save File as:* prompt.

Finally, choose the destination for the exported file, either the SD card or the HOME directory.



NOTE: WITH THE SD FILER SOFTWARE INSTALLED, A MESSAGE INFORMS THE USER THAT THE EXPORT IS COMPLETED WHEN WRITTEN TO THE SD CARD, HOWEVER WITHOUT SD FILER INSTALLED A MESSAGE REMINDS THE USER TO EDIT THE FILE ON THE PC USING NOTEPAD OR SIMILAR SOFTWARE TO DELETE THE FIRST LINE OF CHARACTERS.

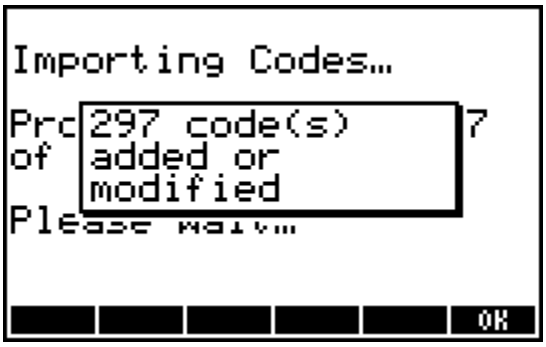
SD Filer enables COGO+ to write a raw ASCII file without the HP header information included.

Import Codelist

Codelists can be imported from comma-delimited ASCII files to save time entering the codes and descriptions. The codelist files **MUST** be in the format *Code,Description* where *Code* would generally be a numeric code and *Description* would be a longer point description, for example:

```
001,CodeDescription001
002,CodeDescription002
003,CodeDescription003
004,CodeDescription004
…
100,CodeDescription100
…
```

The imported codes will be added to the existing codelist and sorted by description for use on the calculator. The user is prompted to overwrite existing codes when duplicates are found. A message displays the number of codes that have been added to the codelist (or modified) when the process is complete.

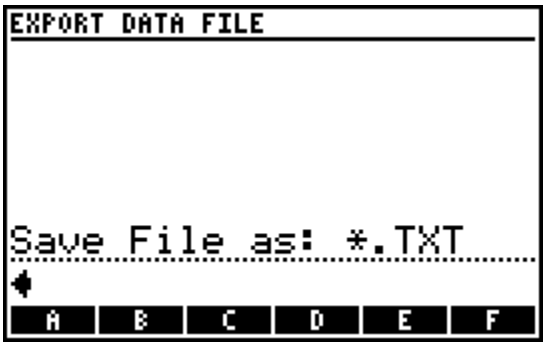


Export Codelist

Write your codelist to a comma-delimited ASCII file for archiving or for editing on a PC. The codelist file created will be in the same *Code,Description* format as required for importing. ***It is highly recommended to have the optional SDfiler software installed for exporting ASCII files.***

Enter a file name to save the exported codelist. The ASCII file extension is automatically added to the file name, and is displayed next to the *Save File as:* prompt.

Finally, choose the destination for the exported file, either the SD card or the HOME directory.



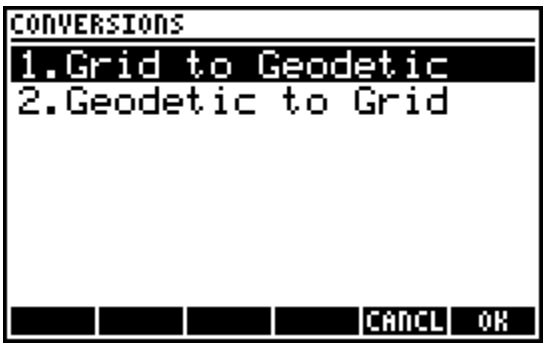
NOTE: WITH THE SD FILER SOFTWARE INSTALLED, A MESSAGE INFORMS THE USER THAT THE EXPORT IS COMPLETED WHEN WRITTEN TO THE SD CARD, HOWEVER WITHOUT SD FILER INSTALLED A MESSAGE REMINDS THE USER TO EDIT THE FILE ON THE PC USING NOTEPAD OR SIMILAR SOFTWARE TO DELETE THE FIRST LINE OF CHARACTERS.

SD Filer enables COGO+ to write a raw ASCII file without the HP header information included.

10 Geodetic Menu

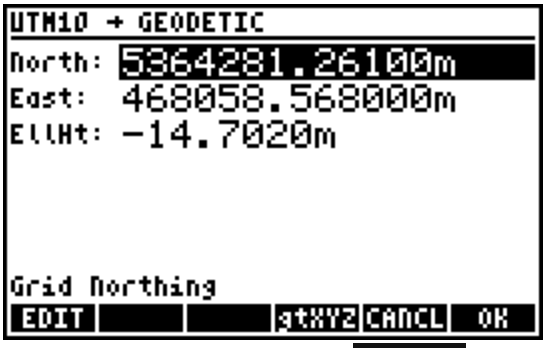
10.1 Conversions

Geodetic conversions work with the current geodetic settings. Convert grid coordinates to geodetic (Latitude/Longitude) or vice versa with any of the available projections. All results are displayed to the maximum precision (12 digits) possible. Positional calculations are accurate to better than 1mm based on tests performed.

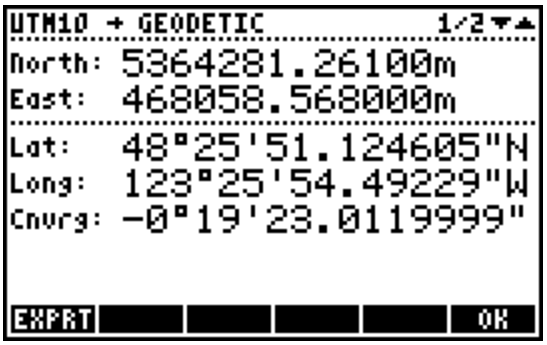


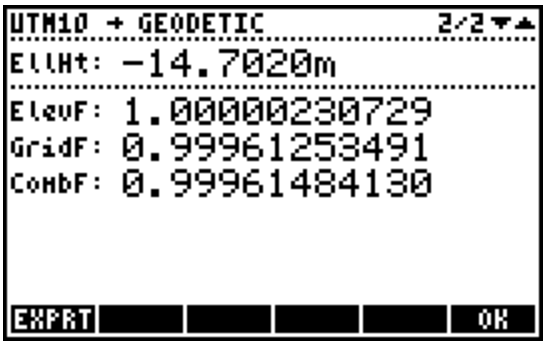
Grid to Geodetic

Enter the grid coordinates and ellipsoid height of any point within the current projection zone to calculate the Latitude, Longitude, convergence angle, and scale factors. Use F4 **gtXYZ** to retrieve the coordinates of a point in the current job database to use as the coordinates for the calculation.



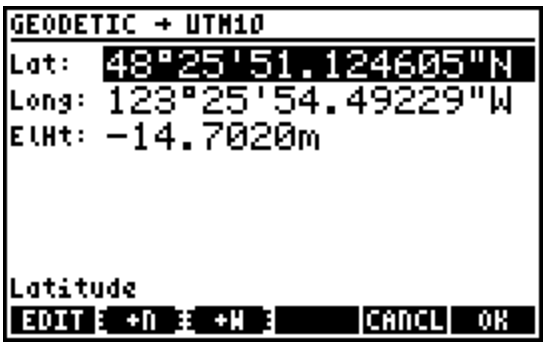
The solution also displays the input to allow checking the input for correctness. Use F1 **EXPRT** to export the solution to the stack or write them to an ASCII file to save to the SD card COGOPLUS\ASCII directory or to the HOME directory on the calculator.





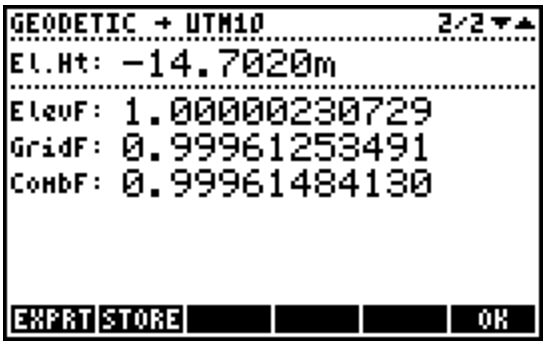
Geodetic to Grid

Enter the Latitude, Longitude and ellipsoid height of any point to calculate the grid coordinates of the point within the current projection zone, the convergence angle and elevation/grid/combined scale factors. The menu features two toggle softkeys to eliminate the need to enter negative latitude or longitude input:

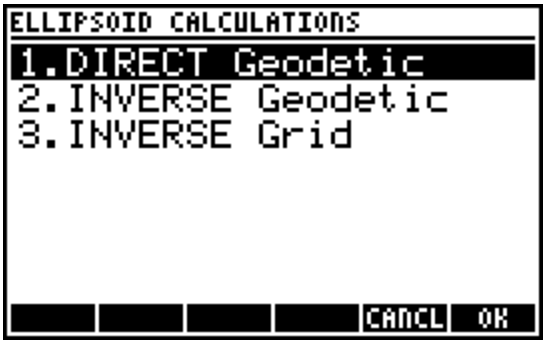


1. F2 **+N** or **+S** – Toggle positive Latitude input to be north or south.
2. F3 **+E** or **+W** – Toggle positive Longitude input to be east or west.

The solution also displays the input to allow checking the input for correctness. Use F1 **EXPRT** to export the solution to the stack or write them to an ASCII file to save to the SD card COGOPLUS\ASCII directory or to the HOME directory on the calculator. Use F2 **STORE** to store the solved grid coordinates and the entered ellipsoid height as a point in the current job database.

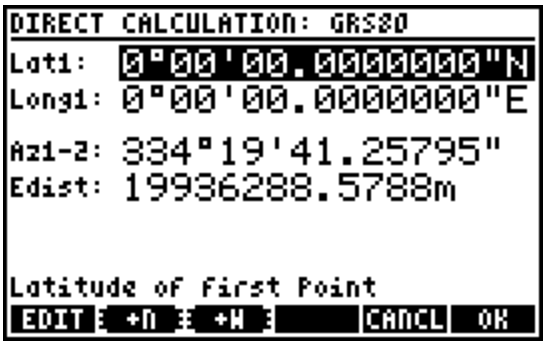


10.2 Ellipsoid Calculations



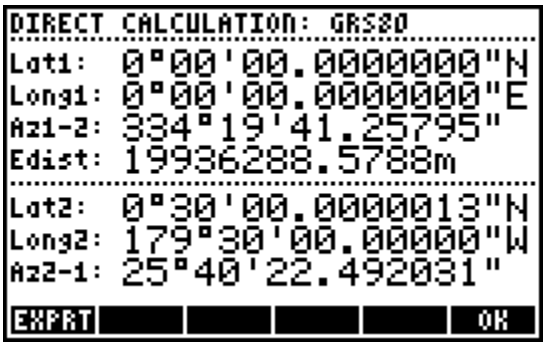
Direct and Inverse ellipsoid calculations are performed using Vincenty's equations. Both methods are iterative, and while most realistic calculations will converge in six iterations or less; there are certain scenarios that require many more iterations to converge. ***COGO+*** limits the iterations to 200, at which time a warning displays that the iteration maximum has been reached and the non-converged solution is displayed. The failure to converge involves antipodal or nearly antipodal inverse calculations.

Direct Calculation



For a direct calculation, enter the Latitude and Longitude of the first point, the azimuth of the geodesic line from the first point to the second point, and the ellipsoidal distance from the first point to the second point. The solution calculates the Latitude and Longitude of the second point and the azimuth of the geodesic line from the second point to the first point. The menu features two toggle softkeys to eliminate the need to enter negative latitude or longitude input:

1. F2 **+N** or **+S** – Toggle positive Latitude input to be north or south.
2. F3 **+E** or **+W** – Toggle positive Longitude input to be east or west.

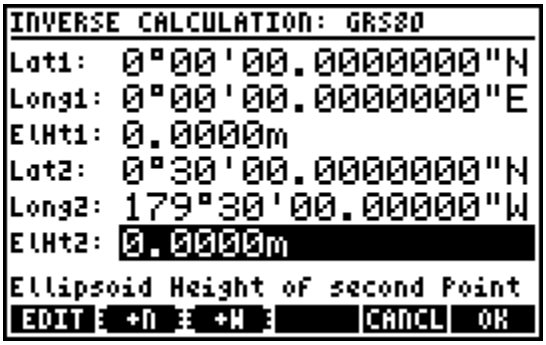


The solution also displays the input to allow checking the input for correctness. Use F1 **EXPRT** to export the solution to the calculator stack or write them to an ASCII file to save to the SD card COGOPLUS\ASCII directory or to the HOME directory on the calculator.

Inverse Calculation

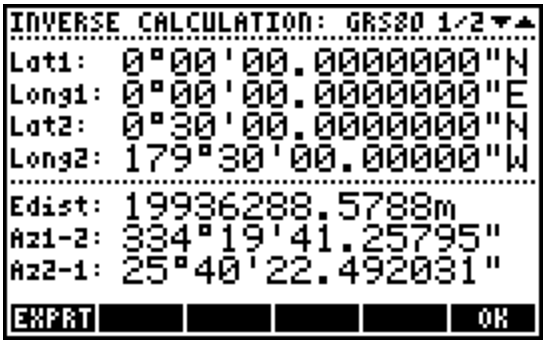
Inverse calculations are possible from geodetic coordinates and from grid coordinates.

Inverse Geodetic



Enter the Latitude and Longitude of two points to calculate the ellipsoidal distance between the two points and the azimuths of the geodesic lines in each direction. The menu features two toggle softkeys to eliminate the need to enter negative latitude or longitude input:

1. F2 **+N** or **+S** – Toggle positive Latitude input to be north or south.
2. F3 **+E** or **+W** – Toggle positive Longitude input to be east or west.



The solution also displays the input to allow checking the input for correctness. Use F1 **EXPRT** to export the solution to the calculator stack or write them to an ASCII file to save to the SD card COGOPLUS\ASCII directory or to the HOME directory on the calculator.

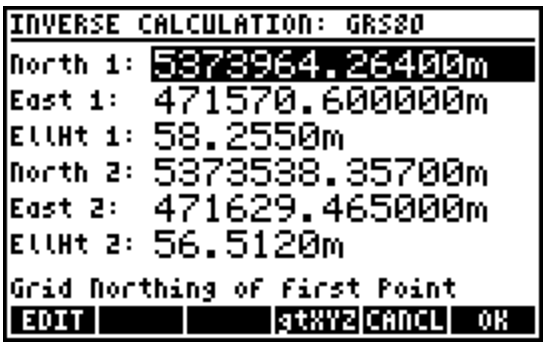
NOTE: THE EXAMPLE IN THE SCREEN CAPTURES IS A CASE WHERE THE SOLUTION FAILS TO CONVERGE IN 200 ITERATIONS. THE RESULTS HOWEVER AGREE VERY CLOSELY TO THE EXAMPLE INPUTS FOR THE DIRECT CALCULATION. THIS ILLUSTRATES THAT 200 ITERATIONS IS ADEQUATE FOR ALMOST EVERY IMAGINABLE SCENARIO.

The second page of the results (see next page for example) display the ellipsoidal heights of both points as provided, the averaged azimuth between the two points and ground-level distance between the two points. The ground-level distance is only accurate when accurate ellipsoidal elevations are provided.

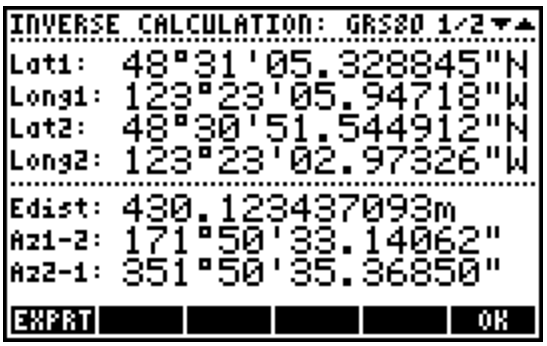
Please Note: The ellipsoidal elevation and the averaged azimuth are NOT related to grid distance and azimuth. Simply inverse the grid coordinates with Inverse Points program to obtain grid information.

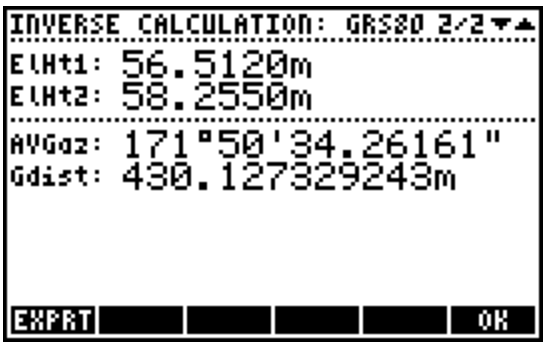
Inverse Grid

Enter the grid northings and eastings of two points to calculate the ellipsoidal distance between the two points and the azimuths of the geodesic lines in each direction. Optionally also enter the ellipsoidal heights for each point to allow a ground distance calculation. Use F4 **geXYZ** to retrieve the coordinates of a point in the current job.



The solution displays the input converted to geodetic coordinates. Use F1 **EXPRT** to export the solution to the calculator stack or write them to an ASCII file to save to the SD card COGOPLUS\ASCII directory or to the HOME directory on the calculator.





The second page of the results display the ellipsoidal heights of both points as provided, the averaged azimuth between the two points and ground-level distance between the two points. The ground-level distance is only accurate when accurate ellipsoidal elevations are provided.

Please Note: The ellipsoidal elevation and the averaged azimuth are NOT related to grid distance and azimuth. Simply inverse the grid coordinates with Inverse Points program to obtain grid information.

Appendix A

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

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

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

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**
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**