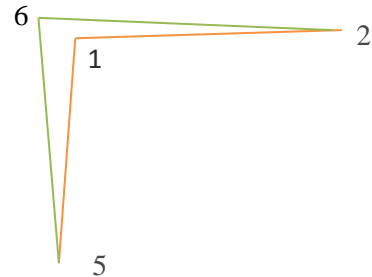


perimeter that the traverse points were entered, either clockwise or counter-clockwise. The third choose field asks how the closing angle is determined, either 'User Entered' or 'Compute Average'. When this option is set to 'User Entered' then the interior closing angle is required in the fourth field. 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.

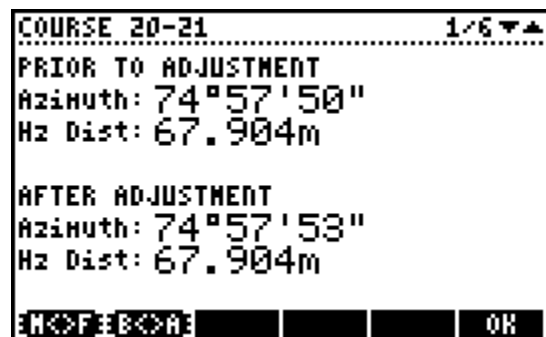
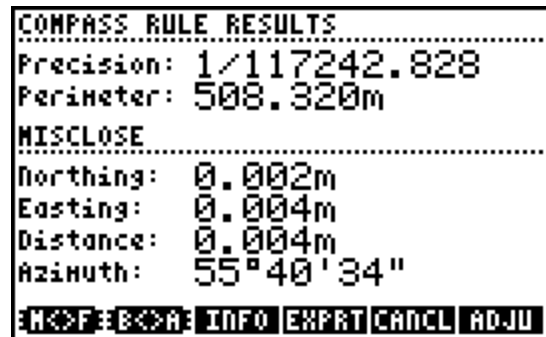
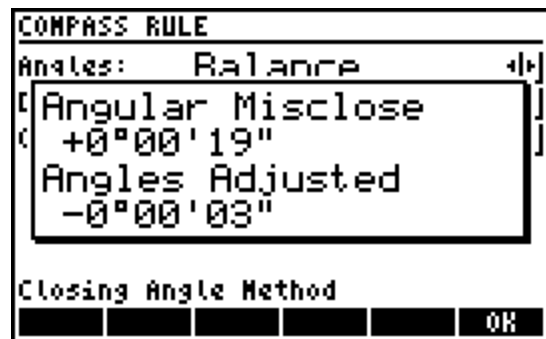


The angle balancing results show the total angular misclose, and the angular correction that will be applied to each angle.

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

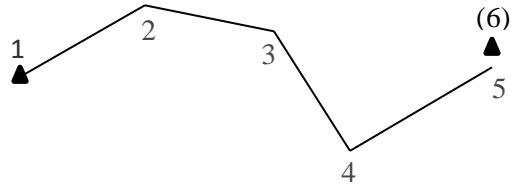
The menu:

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, an input screen will ask for the point number of the fixed point.

```

COMPASS RULE
-----
Fixed Point
*
-----
BROWS          CANCL  OK
    
```

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

```

COMPASS RULE RESULTS
-----
Precision:  1/38047.842
Length:     325.081m
MISCLOSE
-----
Northing:  -0.008m
Easting:    0.003m
Distance:   0.009m
Azimuth:    159°26'38"
-----
INFO  EXPRT  CANCL  ADJU
    
```

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.

```

COURSE 32-33          3/4
-----
PRIOR TO ADJUSTMENT
Azimuth: 106°42'02"
Hz Dist: 93.903m
-----
AFTER ADJUSTMENT
Azimuth: 106°42'07"
Hz Dist: 93.904m
-----
INFO  EXPRT  CANCL  OK
    
```

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.

ROTATE POINTS

Base Point.....

↓

BROWS 0,0 MIRRO CANCL OK

ROTATE POINTS

Rotation Angle.....

↓

CALC CANCL OK

ROTATION ANGLE

Old Azimuth: 0°00'00"

New Azimuth: 0°00'00"

Existing Azimuth

EDIT CANCL OK

ROTATE POINTS

Point(s).....

↓

BROWS ALL CANCL OK

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.

```
MIRROR POINTS
Baseline P1: 1
Baseline P2: 2

Baseline Point 1
EDIT RESET          CANCL OK
```

```
MIRROR POINTS

Point(s).....
*
BROWS ALL          CANCL OK
```

6.3 Shift/Average Points

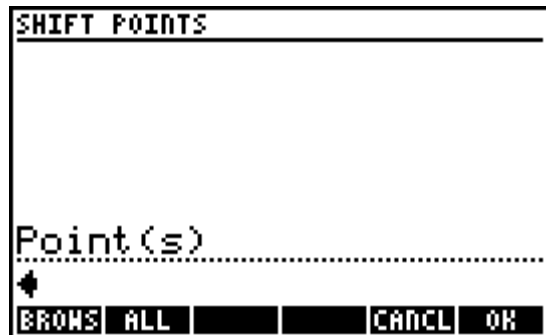
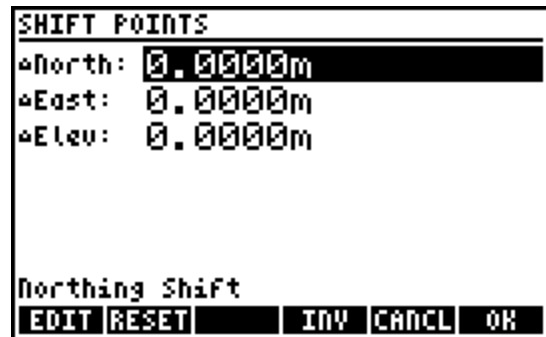
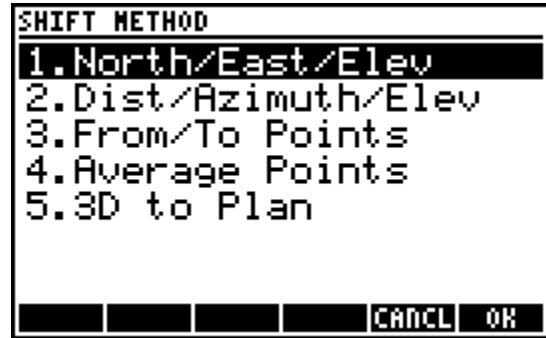
Point coordinates can be shifted by using one of three possible methods, and a range of point coordinates can be averaged to create a new point at the calculated average position. The 3D to Plan option transforms 3D measurements to 2D plan cross sections.

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.

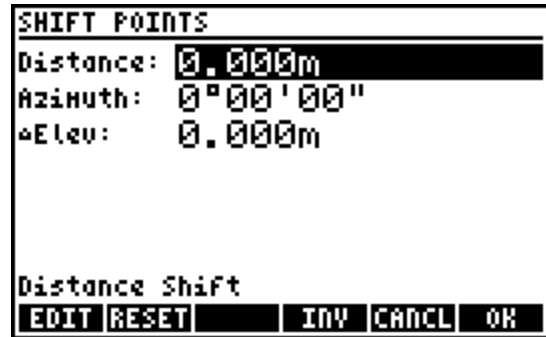
Next, enter the points to shift and the program will either update the existing point coordinates, which overwrites the existing points, or calculate new points re-numbered with an additive point number. The [adjusted points](#) setting controls the behaviour of overwrite/re-number.



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



```
SHIFT POINTS
-----
Distance: 0.000m
Azimuth: 0°00'00"
ΔElev: 0.000m

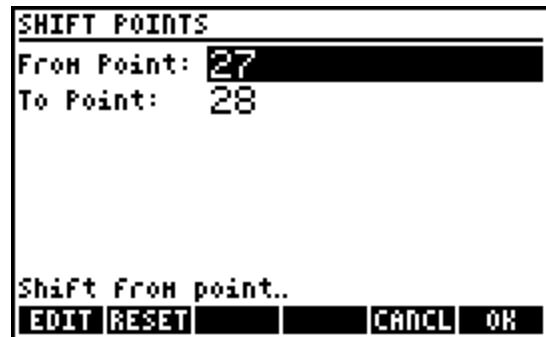
Distance Shift
EDIT RESET INV CANCL OK
```

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.



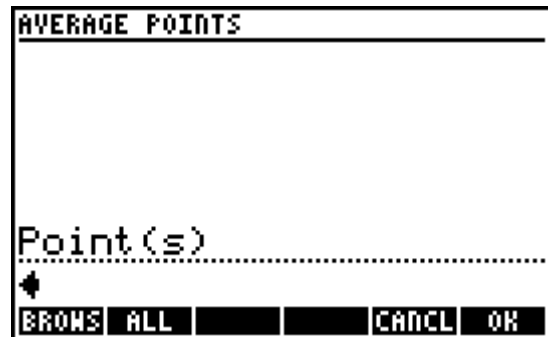
```
SHIFT POINTS
-----
From Point: 27
To Point: 28

Shift from point..
EDIT RESET CANCL OK
```

Average Points

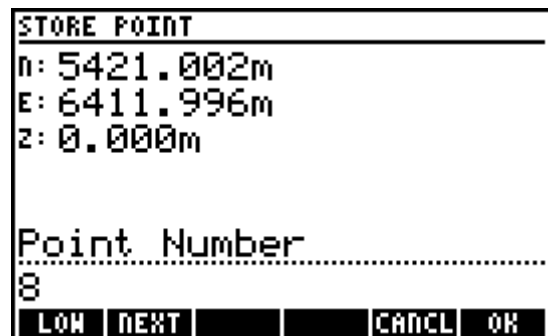
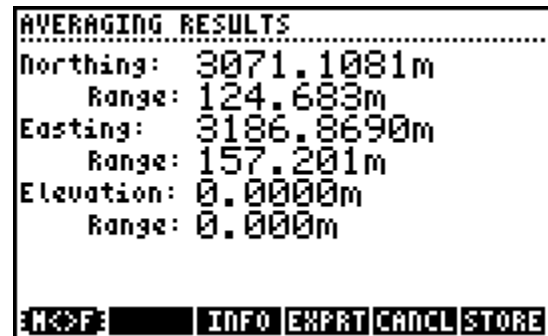
Enter a series of points to compute their arithmetic mean coordinate values. Point numbers can be entered using any of the [point numbers](#) input options. At minimum two points are required to calculate average values. The menu:

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.



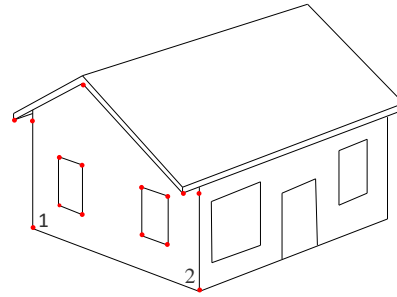
The solution displays the calculated coordinates and the range in coordinate values. The menu:

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.

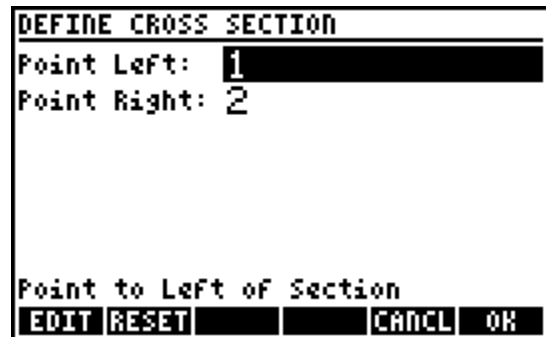


3D to Plan

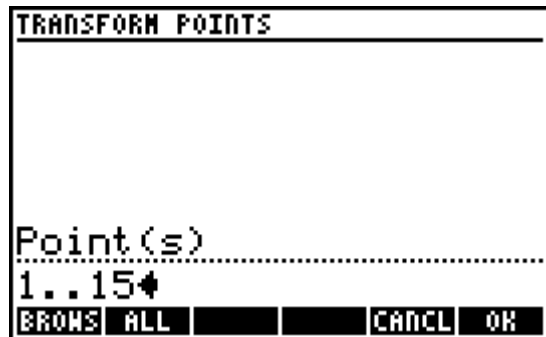
In the diagram on the right, consider the red dots shown as being reflector-less measurements made with a total station. The goal is to calculate the ratio of glass surface area to total surface area of the wall. The 3D to Plan program transforms the 3D measured coordinates into 2D plan points to create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

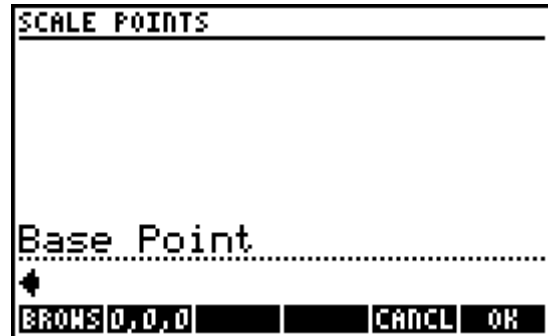
transformed coordinates are 201 to 215 (An additive of 200 was used to re-number the adjusted points).

With two simple intersection calculations, the surface areas can easily be calculated.

1, 5000.000, 5000.000, 68.743	201, 68.743, 0.000, 0.000
2, 4982.603, 5019.322, 68.743	202, 68.743, 26.000, 0.000
3, 5000.000, 5000.000, 77.743	203, 77.743, 0.000, 0.000
4, 4982.603, 5019.322, 76.743	204, 76.743, 26.000, 0.000
5, 4997.323, 5002.973, 71.743	205, 71.743, 4.000, 0.000
6, 4994.647, 5005.945, 71.743	206, 71.743, 8.000, 0.000
7, 4997.323, 5002.973, 75.743	207, 75.743, 4.000, 0.000
8, 4994.647, 5005.945, 75.743	208, 75.743, 8.000, 0.000
9, 4987.956, 5013.377, 71.743	209, 71.743, 18.000, 0.000
10, 4985.279, 5016.349, 71.743	210, 71.743, 22.000, 0.000
11, 4987.956, 5013.377, 75.743	211, 75.743, 18.000, 0.000
12, 4985.279, 5016.349, 75.743	212, 75.743, 22.000, 0.000
13, 4999.852, 4997.175, 78.243	213, 78.243, -2.000, 0.000
14, 4979.778, 5019.470, 78.243	214, 78.243, 28.000, 0.000
15, 4989.815, 5008.323, 84.493	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.

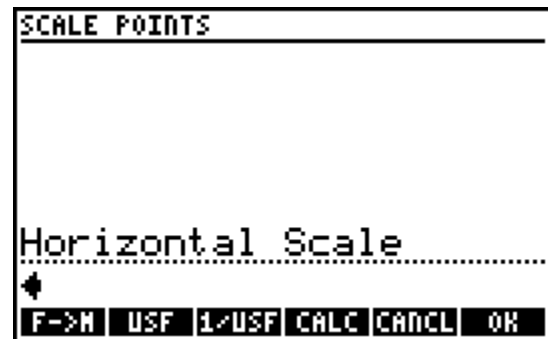


First, enter the point number to use as the *Base Point*. The menu:

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.

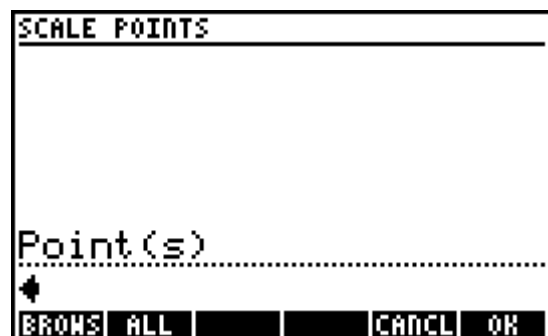
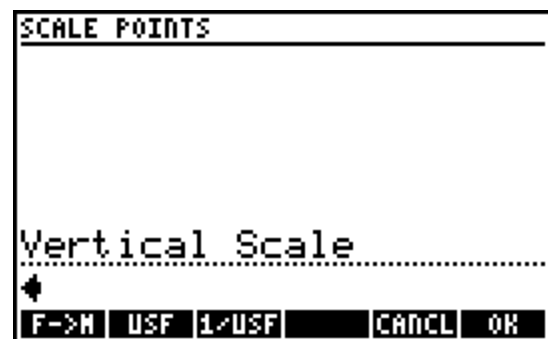
Next, enter the *Horizontal Scale* factor. The menu:

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.

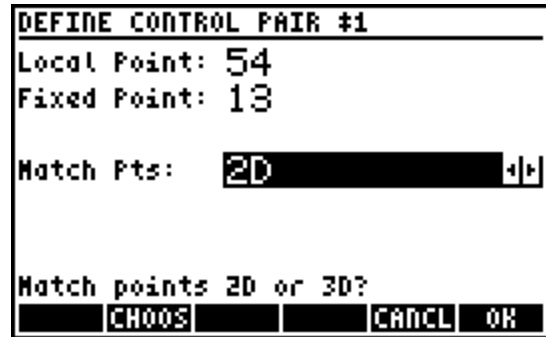
The main **Helmerts** screen accepts all input through the menu:

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.**



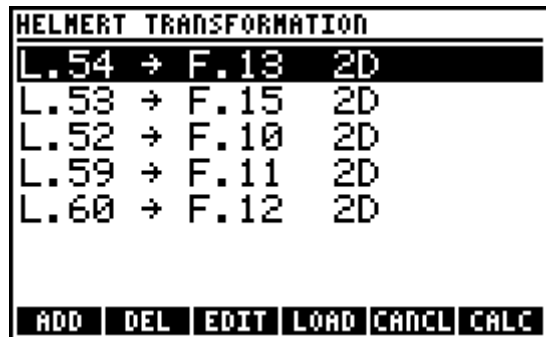
Add Control Pairs

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.



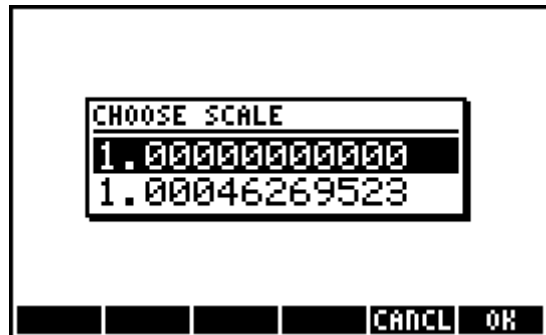
Delete or Edit Control Pairs

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.

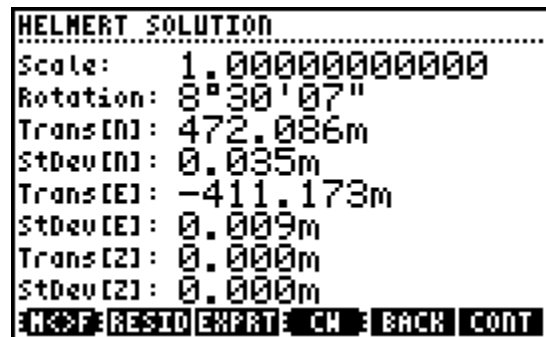


Calculate Solution

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 1.0000000000 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

