TPS1100 Professional Series

Application Programs Reference Manual

Version 2.2
English

Leica Geosystems

Congratulations on your purchase of your programs for a TPS1100 Professional Series.

For safe system use, pay attention to the important safety regulations in the "System" instructions *(refer to chapter "Safety directions")*. Read carefully through the User's Manual before you switch on the instrument.

The instrument model and serial number of your product are indicated on the label in the battery compartment.
Enter the model and serial number in your manual and always refer to this **information** when you need to contact your **agency** or authorized **service workshop**.

Type: _____ Serial no.: _____

SW version: _____ Language: _____

The symbols used in this User's Manual have the following meanings:

DANGER:
Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.

WARNING:
Indicates a potentially hazardous situation or an unintended use which, if not avoided, could result in death or serious injury.

CAUTION:
Indicates a potentially hazardous situation or an unintended use which, if not avoided, may result in minor or moderate injury and / or appreciable material, financial and environmental damage.

Important paragraphs which must be adhered to in practice as they enable the product to be used in a technically correct and efficient manner.

Contents

The electronic theodolites and total stations in the TPS System 1100 are equipped with programs for processing field data and control-point coordinates. The systems are therefore highly functional and classical survey tasks are simplified appreciably.

All program sequences are based on a unified structure. The clearly-designed display with the function keys makes learning easy. Each program has a configuration dialog. In this dialog, the user can match program-specific parameters to changes in requirements and sequences. The various possibilites are described in the instructions for the individual programs.

Calling up a program

The TPS1100 keyboard is equipped with a program key: PROG

Pressing this key will display a menu with all programs installed on your instrument.

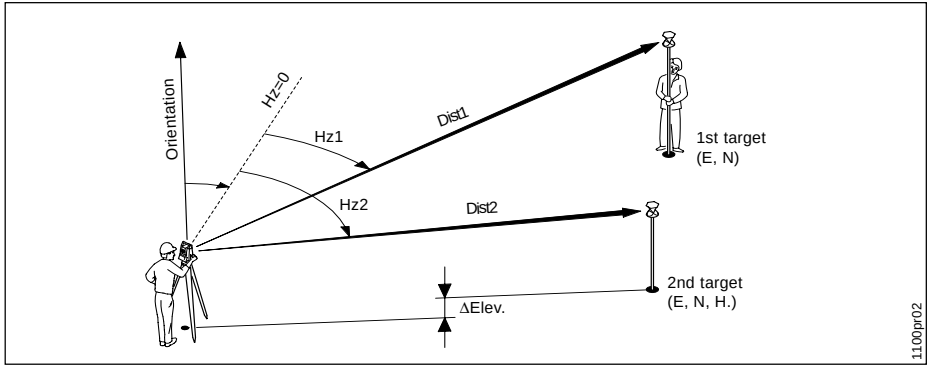
Licence Code

When starting certain programs, it can happen that a licence code is requested. The licence code is needed to run the program with full functionality.
Without licence code, you can run the programs in a demonstration version, but you will not be able to calculate and store the results.

The licence code is available from your Leica Geosystems agency, who will inform you about licence fees for code protected programs.

Introduction

This manual describes the "Orientation and Height Transfer" program of the TPS1100 Professional series.

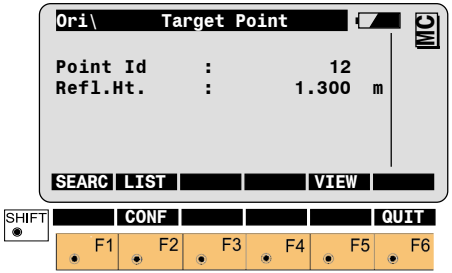


The instrument must be set up on a known point. The program "ORIENTATION" calculates an angular correction for the instruments horizontal circle, so that 0.0000 of the horizontal circle corresponds with grid north (Orientation correction), using reference points with known Easting and Northing.

For simultaneous determination of the station elevation, height of instrument and height of reflector must already have been input and the elevation of the target points must be known. You may use target points with elevation only.
The program handles a maximum of 10 points.

Target Point

Enter the target point number and height of the reflector



F1 Retrieve the coordinates of the target point. Search the coordinates of the point entered in the active data job and go to the measure mode.

F2 Define a list of target points and the measurement sequence. For further use: selection of points from the list is possible.

F3 Displays the previous point from the list of points entered. Note that this key will not be available until there is at least one point in the list.

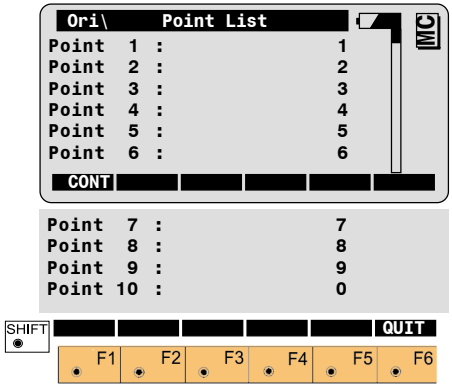
F4 Displays the next point in the list of points entered. Note that this key will not be available until there is at least one point in the list.

F5 Search and display the coordinates of the point found in the active data job.

F6 Run the calculation. Note, the F6 key will be assigned after the first measurement.

SHIFT F2 Start the "CONFIGURATION"

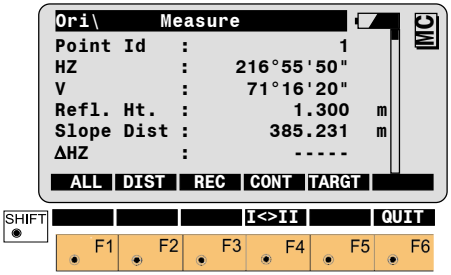
Enter a maximum of 10 points. The same point can be retrieved several times.



F1 Return to the dialog "Target Point".

This dialog is similar to the TPS 1000's basic "Measure Mode" dialog. Once a measurement is taken, the program will return to the dialog "Target Point" to acquire the next point for measuring.

If the orientation correction can be calculated successfully from any of the first measurements, the ΔHz and ΔV values are displayed for further entered target point. Motorized theodolites will automatically drive the telescope to the target point.



F1 Simultaneously measure and record data on the active recording device.
Return to the dialog "Target Point".

F2 Measure a distance.

F3 Record the measurement on the active recording device.
Return to the dialog "Target Point".

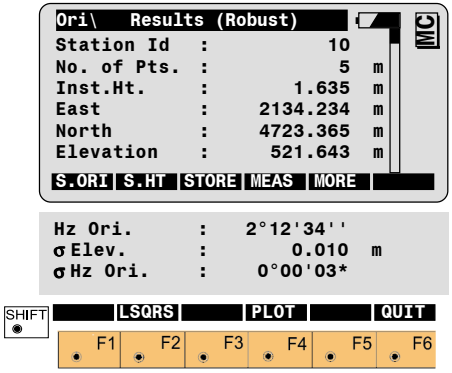
F4 Accept the measurement and return to the dialog "Target Point".

F5 Enter target data.
(see User Manual)

SHIFT F4 Change the theodolite face.

SHIFT F6 Exit the program.

Calculates the orientation, the elevation and the respective standard deviations.



Station Id.
Point number assigned to the station

No. of Pts.
Number of points measured

Inst.Height
Instrument Height

East
Easting of the station

North
Northing of the station

Elevation
Calculated elevation of the station

Orientation
Oriented direction

σ Elevation
Standard deviation of the Elevation

σ Orient
Standard deviation of the Orientation

F1 Set orientation on the instrument.
Note that once this key has been pressed it will not be possible to execute more measurements.

F2 Set station elevation on the instrument.
Note that once this key has been pressed it will not be possible to execute more measurements.

F3 Record the following results into the active measurement job

WI 11	Station Point Number
WI 25	Orientation correction
WI 84	Station Easting
WI 85	Station Northing
WI 86	Station Elevation
WI 87	Last reflector height used
WI 88	Instrument Height

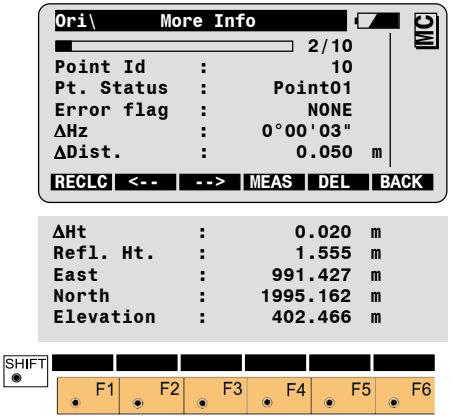
F4 Measure more points. The program will recall the "TARGET POINT" dialog.

F5 Show the results of individual measurements on the screen (*see dialog "More Information"*).

SHIFT F2 Select between the "Robust" method and the "Least Square" method.

SHIFT F4 Sketch of the station and the reference points used.

Display the residuals of individual measurements. You can also disable points from the calculation of orientation or height as well as delete erroneous measured points.



2/10
Sequence number of the current point and total number of points in the measurement set. The scroll bar shows the sequential position of the measurements, graphically.

Status
Use this measurement for calculation (ON/OFF).

Pt. Status
ON Measurements to target point used for calculation.
Ignore Elev.
Target point elevation disabled: measurements for elevation determination not used in calculation.
OFF Target point disabled: measurements to point NOT used for calculation.

Error Flag
Identified erroneous measurements. Possible values are:

NONE	measurement is OK
HZ	horizontal angle error
DIST	distance error
HT	height difference error

The flags may also be combined, i.e. DIST + HZ

Δ Hz.
Difference between calculated and measured horizontal angle

Δ Distance
Difference between calculated and measured distance

Δ Height
Difference between calculated and measured height
Refl. Ht.: Reflector height used for the target point
Easting, Northing, Elevation: Target coordinates used

Refl. Ht.
Reflector height used for the target point

East, North, Elevation
Target coordinates used.

F1 Recalculate the result.

F2 Scroll to the measurements of the previous point.

F3 Scroll to the measurements of the following point.

F4 Measure more points. Return to the dialog "Target Point".

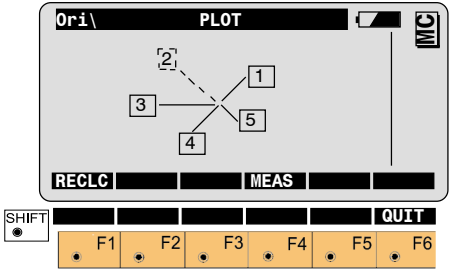
F5 Delete a point from the set of measurements. You can now measure a new point in its place.

F6 Return to the results dialog without changes.

SHIFT F6 Exit the program.

Plot

Generates a plot showing the measurement configuration.
The station point is in the center and the top of the sketch shows the direction of grid north. The sketch is true in angular but not true in distances.
Points are numbered sequentially in the order in witch they were measured.
Points not used in the calculation are marked with a dotted line.



F1 Recalculate the result and return to the dialog "CALCULATION RESULTS".

F4 Measure more points. The program will recall the "TARGET POINT" dialog.

0 ... 9 Toggle any point ON or OFF by pressing the numeric key corresponding to the sequence number of the point.

Note, that 0 represents point 10.

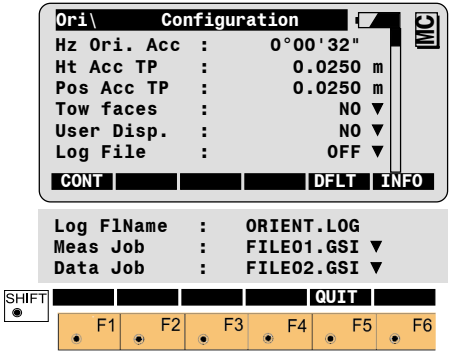
Exit the program.

Configuration

Depending on the configuration that is loaded onto your TPS1100 instrument, you may not see some or all of the options referred to below. See your Leica Geosystems dealer for more information about the configuration of your instrument.

Configuration Editor

SHIFT F2 Start the "Configuration Editor" from the "TARGET POINT" dialog.



The "Configuration Editor "sets parameters for further program operations:

Hz Ori Acc
Limit for the standard deviation of the orientation. The orientation is regarded as "error free", if the computed standard deviation of the orientation is within twice the entered value.

Ht Acc TP
Height accuracy of the target points. The entered value, is used as an "a priori" accuracy in the calculation. The height is regarded as "error free", if the computed standard deviation is within twice the entered value.

Pos Acc TP
Position accuracy of the target points. The entered value, is used as an "a priori" accuracy in the calculation. The position is regarded as "error free", if the computed standard deviation is within twice the entered value.

Two Faces
YES for dual-face measurement, NO for single-face.

User Disp
YES: The same display mask as the one used in the system measurement dialog (MEAS) is used for measurements with "Orientation and Height Transfer".

NO: The "Orientation and Height Transfer" default display applies.

Log File
ON, records measurements in a Log-File. The format is described in *chapter "Log file".*

Log FIName
Enter the Log File Name.

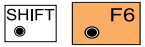
Meas. Job
Selection of the measurement job for recording measurements.

Data Job
Selection of the data job containing the fix point coordinates (control data).

Store the current configuration and proceed to the dialog "TARGET POINT".

Set the values to default.

Displays date and version.



Exit the program.

In the dual-face mode, the program will prompt for measurements in both faces. When both measurements are taken, the program will check the difference between the two. If the difference in angle is within **27' (0.5 gon)** and the difference of two measured distances is within **0.5 m (1.64 ft)**, the observations will be averaged. These tolerances are used to avoid errors in target identification. If exceeded an error message will be displayed.

If **"Log File"** is set to **"ON"** the measurements and the results are stored in the ASCII-file specified within the "Configuration Editor". This file is created in the directory LOG on the memory card. Subsequently, you can read the memory card on your PC and obtain a hard copy of the Log-file.

Data will always be appended to the specified Log-file.

The Log-file contains the following information:

Header
The header line will contain the program used, information about the instrument, the name of the data file as well as date and time.

Record
For each measurement, a record will be stored containing:

- Station coordinates
- station height,
- orientation correction
- standard deviations for height and orientation correction

The residuals for:

- horizontal angles,
- heights and
- measured distances

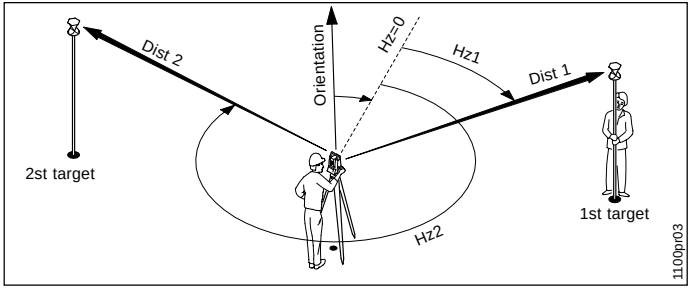
are also listed.

```
Leica Geosystems  Program Orientation and Height Transfer V 1.00
Instrument              :     TCA1103, Serial 102999
Meas. File              :     MYFILE.GSI
Program Start           :     20/04/1998 at 09:42

Station no.             :     2000
                              E= -0.0006m  N= -0.0002m  ELV= 398.3961m
                              hi= 1.6000m

Using Robust Solution

Station Elev.           :     398.3929m
Ori.Corr.               :     40'36"
S.Dev. Elev.            :     0.0035m
S.Dev. Orient.          :     0°00'04"

3 point(s) measured     :

##  Point no.        Δ Hz          Δ Height     Δ Distance     Error Flag
1   500          -0°00'55"        0.0026m       0.0020m          NONE
2   501          -0°00'48"        0.0044m       0.0016m          NONE
3   502           0°00'52"       -0.0070m      -0.0000m          NONE
```

Typical log file entry in the "Orientation and Height Transfer" program

Introduction

This manual describes the "Resection" program of the TPS1100 Professional Series.



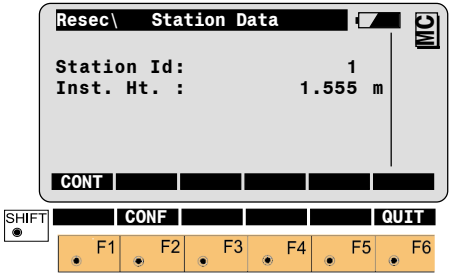
The program can be used to reduce the three-dimensional coordinates for the instrument station and the orientation of the horizontal circle from measurements to 2 target points with know Easting and Northing. To compute the position coordinates, at least the distances and the directions for both points are necessary.

For simultaneous determination of the station elevation, height of instrument and height of reflector must already have been input and the elevation of the target points must be known.

The program allows measurement in single or dual-face mode.

Station Data

Enter station point number and height of the instrument.

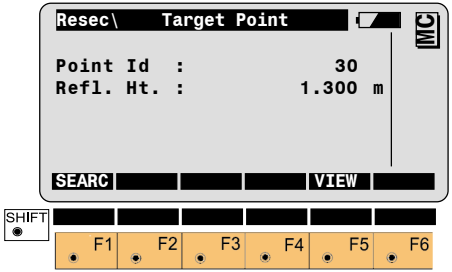


F1 Proceed to the dialog "Target Point".

SHIFT F2 Start the "Configuration".

Target Point

Enter the target point number and height of the reflector.

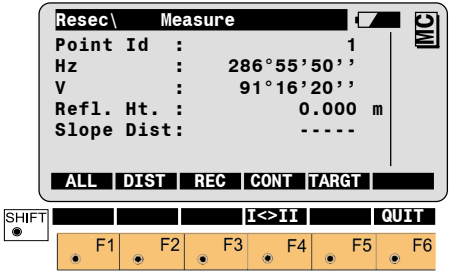


F1 Search the coordinates of the point entered from the active data job and go to the measure mode.

F5 Search and display the coordinates of the point found in the active data job.

Measure Mode

This dialog is similar to the TPS1100's basic "Measure Mode" dialog. Once a measurement is taken, the program will return to the dialog "Target Point" to acquire the next point for measuring.



F1 Simultaneously measure and record data in the active measurement job. Return to the dialog "TARGET POINT".

F2 Measure a distance.

F3 Record the measurement in the active measurement job. Return to the dialog "TARGET POINT".

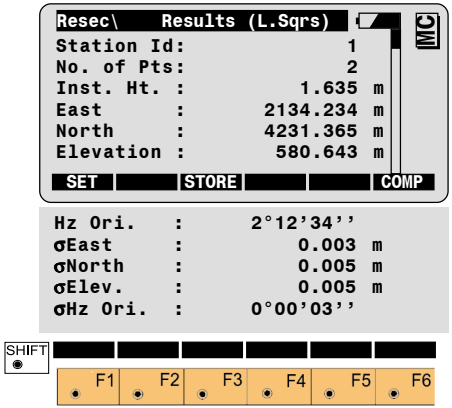
F4 Accept the measurement and return to the dialog "Target Point".

F5 Enter target data. (See User Manual)

SHIFT F4 Change the theodolite face.

SHIFT F6 Exit the program.

In this dialog the calculated station coordinates are shown with the orientation.



Station Id
Station point number

No. of Pts
Number of points measured

Inst.Ht.
Instrument Height

East
Calculated Easting for the station.

North
Calculated Northing for the station.

Elevation
Calculated elevation for the station

Hz Ori.
Oriented direction

σEast
Standard deviation of Easting

σNorth
Standard deviation of Northing

σElev
Standard deviation of the Elevation

σHz Ori.
Standard deviation of the Orientation

F1 Set orientation and station coordinates on the instrument.

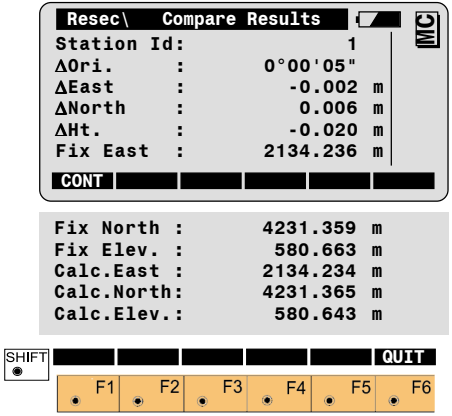
F3 Record the following results in the active measurement job:

WI 11	Station Point Number
WI 25	Orientation correction
WI 84	Station Easting
WI 85	Station Northing
WI 86	Station Elevation
WI 87	Last reflector height used
WI 88	Instrument Height

F6 Compare the Resection results to the station coordinates and orientation currently set in the instrument.

SHIFT F6 Exit the program.

The comparison function compares the station coordinates and the orientation calculated by the program to the station coordinates and the orientation currently set in the instrument.



ΔOri
Orientation difference between the calculated orientation and the orientation set in the instrument.

ΔEast
Difference between the calculated Easting of the station and the Easting set in the intrument.
(Calc. East - Fix East)

ΔNorth
Difference between the calculated Northing of the station and the Northing set in the intrument.
(Calc.North - Fix North)

ΔHt.
Difference between the calculated Elevation of the station and the Elevation set in the intrument.
(Calc.Elev. - Fix Elev.)

Fix East
Easting coordinate of the station currently set in the intrument.

Fix North
Northing coordinate of the station currently set in the intrument.

Fix Elev.
Elevation of the station currently set in the intrument.

Calc. East
Easting coordinate of the station calculated with resection.

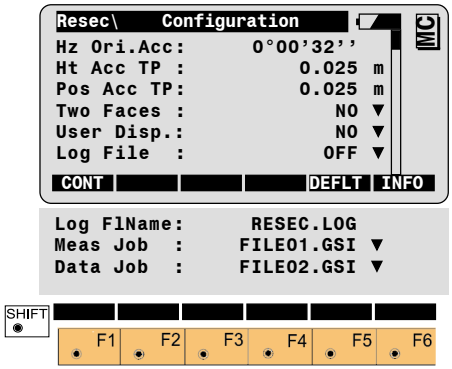
Calc.North
Northing coordinate of the station calculated with resection.

Calc.Elev.
Elevation of the station calculated with resection.

Return to the results dialog.

Depending on the configuration that is loaded onto your TPS1100 instrument, you may not see some or all of the options referred to below. See your Leica Geosystems dealer for more information about the configuration of your instrument.

SHIFT F2 Start the "Configuration Editor" from the "Station DATA" dialog.



The "Configuration Editor" sets parameters for further program operations:

Hz Ori Acc
Limit for the standard deviation of the orientation. The orientation is regarded as "error free", if the computed standard deviation of the orientation is within twice the entered value.

Ht Acc TP
Height accuracy of the target points. The entered value, is used as an "a priori" accuracy in the calculation. The height is regarded as "error free", if the computed standard deviation is within twice the entered value.

Posn Acc TP
Position accuracy of the target points. The entered value, is used as an "a priori" accuracy in the calculation. The position is regarded as "error free", if the computed standard deviation is within twice the entered value.

Two Faces
YES for dual-face measurement,
NO for single-face.

UserDisp.

YES The same display mask as the one used in the system measurement dialog (MEAS) is used for measurements with "RESECTION".

NO The "RESECTION" default display applies.

Log File

Set to **ON**, the program will record measurement data in a log file as described in *chapter "Log File"*.

Log FlName

Enter the Log File Name.

Meas. Job

Selection of the measurement job for recording measurements.

Data Job

Selection of the data job containing the fix point coordinates (control data).

F1 Store the current configuration and proceed to the dialog "STATION DATA".

F5 Set the value to the default

F6 Displays date and version.

SHIFT F6 Exit the program.

In the dual-face mode, the program will prompt for measurements in both faces. When both measurements are taken, the program will check the difference between the two. If the difference in angle is within **27' (0.5 gon)** and the difference of two measured distances is within **0.5 m (1.64 ft)**, the observations will be averaged.

These tolerances are used to avoid errors in target identification.

If exceeded an error message will be displayed.

If "Log File" is set to "ON" the measurements and the results are stored in the ASCII-file specified within the "Configuration Editor". This file is created in the directory LOG on the memory card. Subsequently, you can read the memory card on your PC and obtain a hard copy of the Log-file.

Data will always be appended to the specified Log-file.

The Log-file contains the following information:

Header
The header line will contain the program used, information about the instrument, the name of the data file as well as date and time.

Record
For each measurement, a record will be stored containing:
Station coordinates and orientation correction, standard deviation for Easting, Northing, Height of station and orientation correction.
The residuals for horizontal angles, heights and measured distances are also listed.

```
Leica Geosystems  Program Resection V 1.00
Instrument              :    TCA1103, Serial 102999
Meas. File              :    MYFILE.GSI
Program Start           :    20/04/1998 at 09:42

Using Least-Squares Solution

Station no.             :    2000
                             E= -0.0011m  N= -0.0006m  ELV= 398.3951m
                             hi= 1.6000m

Ori.Corr.               ;    240°50'51"
S.Dev. East             :     0.0003m
S.Dev. North            :     0.0003m
S.Dev. Elev.            :     0.0047m
S.Dev. Orient.          :      0°00'49"

2 point(s) measured:

##  Point no.          Δ Hz        Δ Height        Δ Distance        Error Flag
1   500            -0°00'55"       0.0047m          0.0001m              NONE
2   501            -0°00'18"      -0.0047m          0.0002m              NONE
```

Typical log file entry in the "Resection" program

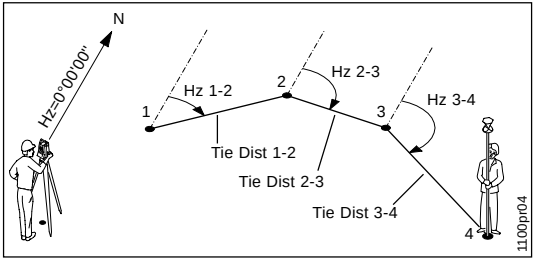
Introduction

This manual describes the "Tie Distance" program of the TPS 1100 Professional series.
The program calculates the length and azimuth of a line connecting two points.
Polygonal or Radial methods can be used as shown in the illustrations.

The data for the points can either be measured or retrieved from the selected data job. Measured points and points retrieved from the selected data job can be used together in the calculations, if the station coordinates and orientation are set correctly.

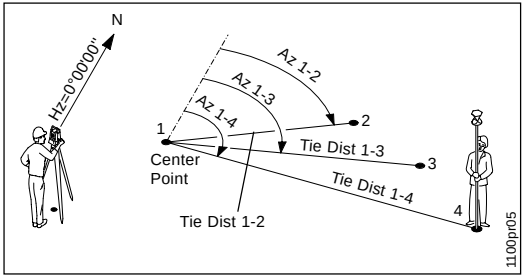
Polygonal Mode

In Polygonal Mode, the program will calculate the distance between the last two points measured (eg. Pt3 - Pt4).



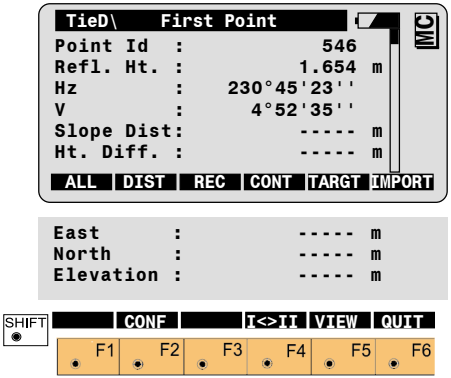
Radial Mode

In Radial Mode, the program will calculate the distance between the last point measured (called a Radial Point) (Pt2, Pt3 ...) and a fixed Center Point (Pt1).



Toggling between Polygonal and Radial Mode at any time while working is possible.

This dialog is used in accordance with the settings of the system function "Measure & Record" or according to the dialog shown below.



The input for the start point is only possible after the program start or with the function F2 in the dialog "RADIAL MODE".
For all following points the program requests (NEXT POINT).
The dialog for the following points is identical with dialog above, except for the title.

F1 Simultaneously measure and record in the active measurement job. Proceed with the dialog "NEXT POINT". If the second point has already been measured, the program will proceed to the "Result" dialog.

F2 F3 Measure a distance. Record the measurement in the active measurement job and proceed with the dialog "NEXT POINT". If the second point has already been measured, the program will proceed to the "RESULT" dialog.

F2 F4 Measure the distance. Accept the measurement without recording. If the second point has already been measured, the program will proceed with the "RESULT" dialog.

F5 Enter the target data. (see User Manual)

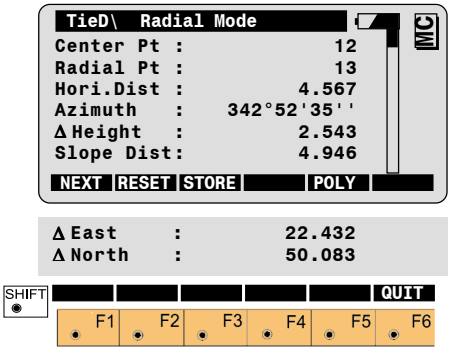
F6 Import target coordinates.

SHIFT F2 Start the "Configuration Editor".

SHIFT F4 Change the theodolite face.

SHIFT F6 Exit the program

This dialog shows the results computed from the last two points, which can be measured or retrieved from the active file. The same results are calculated for both methods. Using "Polygon Mode" the calculations are always based on the last two points, where as the "Radial Mode" always uses the first point as a reference point.



Center Pt.
Point number of the center point

Radial Pt.
Point number of the radial point

Hori.Dist
Horizontal distance between the two points

Azimuth
Azimuth from point 1 to point 2

Δ Height
Height difference between point 1 and point 2 (H2 - H1).

Slope Dist
Slope distance between the two points.

Δ East
Difference in Easting between point 1 and point 2 (E2 - E1).
The grid coordinates are only valid for oriented instruments set up on a known point.

Δ North
Difference Northing between point 1 and point 2 (N2 - N1).
Note, the grid coordinates are only relevant for oriented instruments set up on a known point.

F1 Return to the dialog "NEXT POINT" and measure the next point.

F2 Delete previous inputs. Proceed with the dialog "FIRST POINT" to enter a new reference point. This function is available for "RADIAL MODE" only.

F3 Record the following results in the active measurement job:

WI 11	Point number of point 2 or radial point number
WI 25	Azimuth from point1 to point 2
WI 35	Horizontal distance

WI 37 Height difference between point 1 and point 2
WI 39 Slope distance
WI 79 Point number of point 1 or center point number

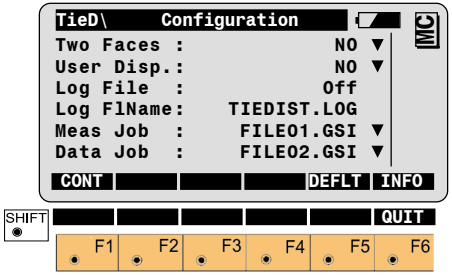
F5 Toggle between Radial/ Polygon Mode.

Configuration

Depending on the configuration that is loaded onto your TPS1100 instrument, you may not see some or all of the options referred to below. See your Leica Geosystems dealer for more information about the configuration of your instrument.

Configuration Editor

SHIFT F2 Start the "Configuration Editor" from the "First Point" dialog.



The "Configuration Editor" sets parameters for further program operations:

Two Faces
YES for dual-face measurement,
NO for single-face.

User Disp

YES The same display mask as the one used in the system measurement dialog (MEAS) is used for measurements with "Tie Distance".

NO The "Tie Distance" default display applies.

Log File

Set to **ON**, the program will record measurement data in the Log File according to the format described on *chapter "Log File"*.

Log FlName

Enter the Log File Name.

Meas. Job

Selection of the measurement job for recording measurements.

Data Job

Selection of the data job containing the fix point coordinates (control data).

F1 Store the current configuration and proceed to the dialog "MEASURE MODE".

F5 Set the values to default.

F6 Displays date and version of the running application.

SHIFT F6 Exit the program.

In the dual-face mode, the program will prompt for measurements in both faces. When both measurements are taken, the program will check the difference between the two. If the difference in angle is within **27' (0.5 gon)** and the difference of two measured distances is within **0.5 m (1.64 ft)**, the observations will be averaged. These tolerances are used to avoid errors in target identification. If exceeded an error message will be displayed.

If "Log File" is set to ON the measurements and the results are stored in the ASCII-file specified within the "Configuration Editor". This file is created in the directory LOG on the memory card. Subsequently, you can read the memory card on your PC and obtain a hard copy of the Log-file.

Data will always be appended to the specified Log-file.

The Log-file contains the following information:

Header
The header line will contain the program used, information about the instrument, the name of the data file as well as date and time.

Record
For each measurement, a record will be stored containing :
Point No 1, Point No. 2, Hori. Dist., Azimuth, Δ Height, Slope Dist.

```
Leica Geosystems  Program Tie Distance V 1.00
Instrument        :  TCA1103, Serial 102999
Meas. File        :  MYFILE.GSI
Program Start     :  20/04/1998 at 09:42
Station no.       :  1151
                     E=    0.0000m       N=    0.0000m       ELV= 400.0000m
                     hi=   0.0000m
Point No.1        :  1020
                     E=  -31.2368m       N=  -0.2083m ELV=  400.0626m
Point No.2        :  1030
                     E=  -30.5679m       N=  -17.8404m       ELV=  403.1198m
Point no.1        :  1020
Point no.2        :  1030
Hori.Dist.        :   17.6448m
Azimuth           :  197°58'40"
ΔHeight           :  3.0572m
Slope dist.       :  17.9077m
Point No.2        :  1040
                     E=  -57.7040m       N=   -0.4265m       H=  400.1028m
Point No. 1       :  1030
Point No.2        :  1040
Hori.Dist.        :   32.2430m
Azimuth           :  336°32'14"
ΔHeight           :   -3.0170m
Slope dist.       :  32.3839m
```

Typical log file entry in the "Tie Distance" program (Polygonal Mode)

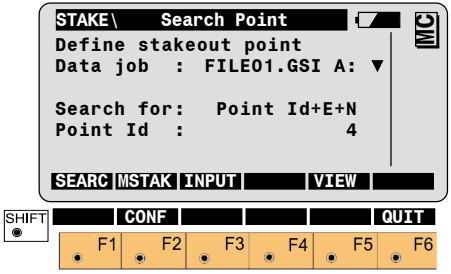
Introduction

This manual describes the "STAKEOUT" program of the TPS 1100 Professional series. The program is used to place marks in the field at predetermined points.

"STAKEOUT" requires the instrument to be set up on a known point with the instrument oriented. The station point can be determined also with the programs "FREE STATION" and "RESECTION".
The easting and the northing of the point to be staked must be known. The elevation is optional: the program permits selection of either 2D or 3D stakeout modes. It is also possible to stake out points given the azimuth and the distance from the station.
The points to be staked can either be retrieved from the selected data job or entered manually.

Search Point

The "SEARCH POINT" dialog informs about the active recording device, the active measurement job for data storage and the present point/code.



F1 Search the coordinates of the point entered in the active data job. Proceeds to the Coarse Positioning mode. Depending on the configuration of the stakeout method, the program may proceeds to the Stake mode.

F2 Manually enter the azimuth and the distance to the point to be staked.

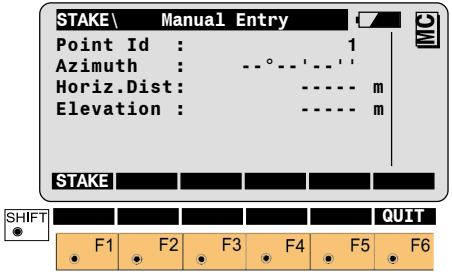
F3 Manually enter the stakeout point.

F5 Search and display the coordinates of the point found in the active data job.

SHIFT F2 Allows program configuration.

If the instrument is in LOCK-mode with EDM-mode TRK/RTRK and no Coarse Mode selected, pressing F1: SEARC starts the distance measurement.

Manual Stake allows to enter a point given the azimuth and the distance. The azimuth and the horizontal distance from the station to the point to be staked must be entered manually.



Point Id
point Id of the point to be staked.

Azimuth
Azimuth from the station to the point to be staked.

Horiz.Dist
Horizontal distance from the station to the point to staked.

Elevation
Elevation of the point to be staked.

F1 Confirms the entry and proceeds to the Coarse Positioning mode. Depending on the configuration of the stakeout method, the program may proceed to the Stake mode.

Once the coordinates of the stakeout point have been acquired, the program proceeds to "Coarse Positioning".

Coarse positioning is an optional step for approximate positioning, preceeding the iterative stakeout process. It may be used to direct the rod person from the point that has just been staked to the next point.

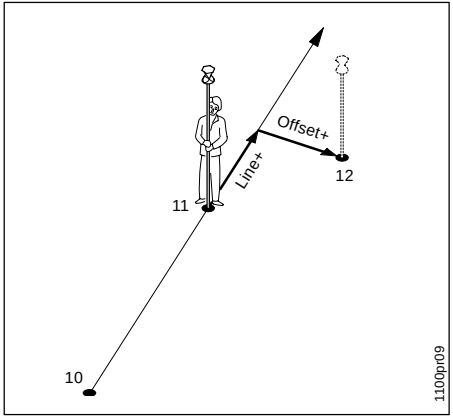
The "Coarse Positioning" calculates various displacements, depending on the selected mode.

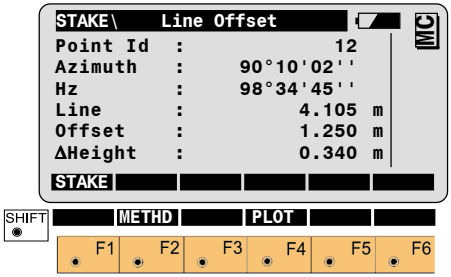
- Line Offset
- Orthogonal
- Azimuth and Distance

If instrument is in LOCK-mode with EDM-mode TRK/ RTRK, pressing F1: STAKE from a Coarse Mode starts a distance measurement.

The stakeout values of each point are computed in relation to the base formed by the last two points.
If the elevation is known for the point to be staked out, the height difference in relation to the last base point (Pt2), is displayed. In particular, this method is advantageous for long objects (traffic routes).

Values for positioning are only displayed after two stakeout points.





Point Id
Point Id of the point to be staked.

Azimuth
Azimuth from the station to the point to be staked.

Hz
Present theodolite direction. Note, if the instrument is oriented and the azimuth and Hz angle are corresponding, the instrument is pointing to the point to be staked.

Line
Distance along the line defined by the last two points staked.

Offset
Orthogonal offset from the defined line.

ΔHeight
Height difference from the last point staked.

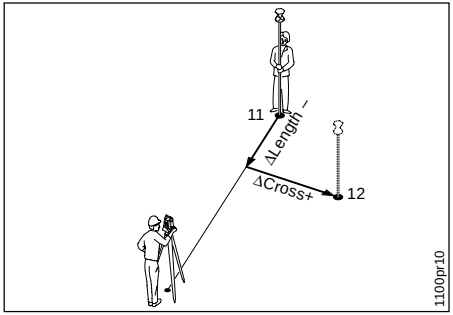
F1 Proceed to "STAKEOUT". Motorized theodolites can drive the telescope to the horizontal and vertical direction of the point to be staked.

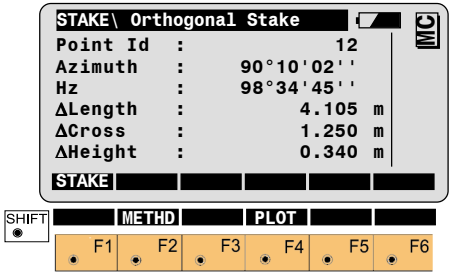
SHIFT F2 Change stakeout method. For more information refer to chapter "Select Stakeout Method".

SHIFT F4 Generate a plot of the stakeout data. For more information to chapter "Plot".

SHIFT F6 Exit the program.

Setting out values are computed as orthogonal coordinates to the baseline between instrument station and prism. If the elevation is also known, ΔH is given in relation to the last prism - point measured.
Note, data will be displayed if there is at least one point measured.





Point Id
Number of the point to be staked.

Azimuth
Azimuth from the station to the point to be staked.

Hz
Present theodolite direction. Note, if the instrument is oriented and the azimuth and Hz angle are corresponding, the instrument is pointing to the point to be staked.

ΔLength and **ΔCross** in relation to the baseline: last stakeout point - instrument station.

Δ Length
In-line distance **ΔLength** is positive for points further than the last prism position measured.

Δ Cross
Distance perpendicular to the baseline. **ΔCross** is positive for points on the right of the baseline.

Δ Height
Height difference from the last point measured.

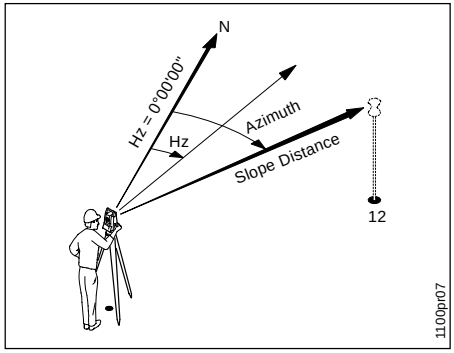
F1 Proceed to "STAKEOUT". Motorized theodolites can drive the telescope to the horizontal and vertical direction of the point to be placed.

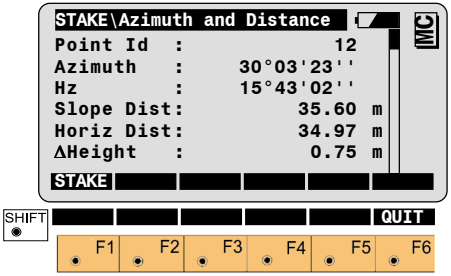
SHIFT F2 Change stakeout method.
For more information refer to *chapter "Select Stakeout Method".*

SHIFT F4 Generate a plot of the stakeout data.
For more information on *chapter "Plot".*

SHIFT F6 Exit the program.

This mode defines the point to be staked in terms of the azimuth and distance from the theodolite station to the point.





Point Id
Point Id of the point to be staked.

Azimuth
Azimuth from the station to the point to be staked.

Hz
Present theodolite direction.

Note, if the instrument is oriented and the azimuth and Hz angle are corresponding, the instrument is pointing to the point to be staked.

Slope Dist
Slope distance from the instrument station to the stakeout point.

Horiz. Dist
Horizontal distance from the instrument station to the stakeout point.

Δ Height
Height difference from the instrument station to the stakeout point.

F1 Proceed to "STAKEOUT". Motorized theodolites can drive the telescope to the horizontal and vertical direction of the point to be placed.

SHIFT F2 Change stakeout method.
For more information refer to chapter "Select Stakeout Method".

SHIFT F4 Generate a plot of the stakeout data. For more information to chapter "Plot".

SHIFT F6 Exit the program.

Polar Stakeout

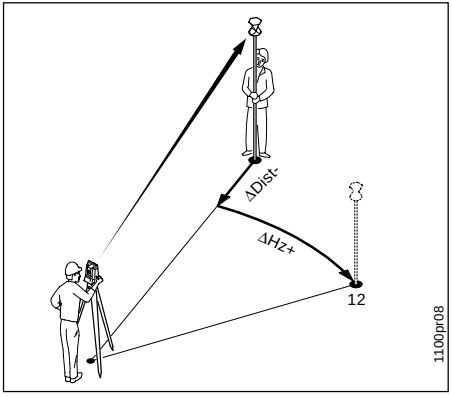
Various methods can be used, depending on the Stakeout Mode set.

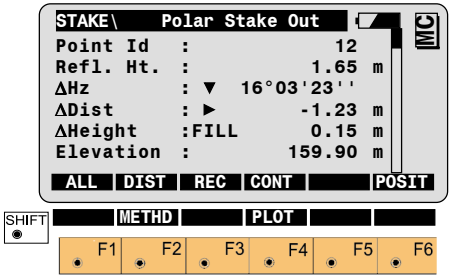
- Polar stakeout
- Orthogonal Stakeout
- Stakeout with auxiliary point
- Stakeout from Coordinates Differences (Grid coordinates)

For more information refer to chapter "Select Stakeout Method".
Motorized instruments can drive the telescope to the horizontal and vertical direction of the point to be staked.

After the first distance has been measured, the differences between calculated and measured direction and between calculated and measured horizontal distance are displayed.

If the elevation of the point to be staked is available, the height difference between the last measured reflector and the point to be staked is shown together with the measured elevation of the reflector point.





Values for ΔHz and ΔDist will be updated each time a new distance is measured.

Point Id
Point Id of the point to be staked.

Refl. Ht
Reflector height used at target point.

Δ Hz
Difference in Hz circle reading between the actual horizontal direction and the calculated direction.

Δ Dist
Difference in horizontal distance between the measured and calculated distance.

Δ Height
Difference in height between the measured reflector point and the stakeout point, expressed both numerically and as CUT/FILL.

Elevation
Elevation of the measured target point.

F1 Simultaneously measure and record data in the measurement job.

F2 Measure a distance.

F3 Record the measurement in the measurement job.

F4 Acquire the next point to stake.

F5 Enter target data.

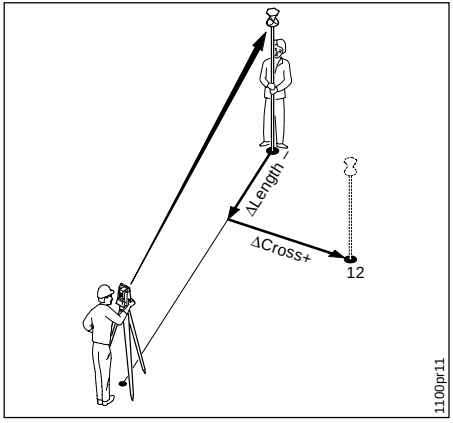
F6 Re-position the telescope on the target. Note, this function is only available for motorized theodolites.

SHIFT F2 Change stakeout method. For more information refer to chapter "Select Stakeout Method".

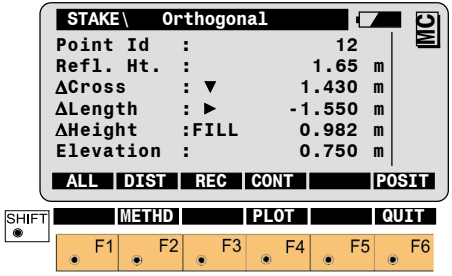
SHIFT F4 Generate a plot of the stakeout data. For more information refer to chapter "Plot".

SHIFT F6 Exit the program.

Orthogonal offsets are computed using the baseline between the last measured point and the instrument station.
After the first distance measurement, the transverse and longitudinal differences are displayed. If the elevation of the stakeout point is available, the height difference between the measured reflector and the point to be staked is shown, and also the measured elevation of the reflector point.



Values for ΔCross and ΔLength will be updated each time a new distance is measured.



Point Id
Point Id of the point to be staked.

Refl. Ht
Reflector height used at target point.

Δ Cross
Transversal displacement of the reflector. Positive in sign if point is right.

Δ Length
Longitudinal displacement of the reflector. Positive in sign if stakeout point is further away from station.

Δ Height
Difference in height between measured reflector point and the stakeout point. Positive in sign if stakeout point is higher than the reflector position.

Elevation
Elevation of the measured reflector point.

F1 Simultaneously measure and record data in the measurement job.

F2 Measure a distance.

F3 Record the measurement data in the measurement job.

F4 Acquire the next point to stake.

F5 Enter target data.

F6 Re-position the telescope on the target. Note, this function is only available for motorized theodolites.

SHIFT F2 Change stakeout method. For more information refer to chapter "Select Stakeout Method".

SHIFT F4 Generate a plot of the stakeout data. For more information refer to chapter "Plot".

SHIFT F6 Exit the program.

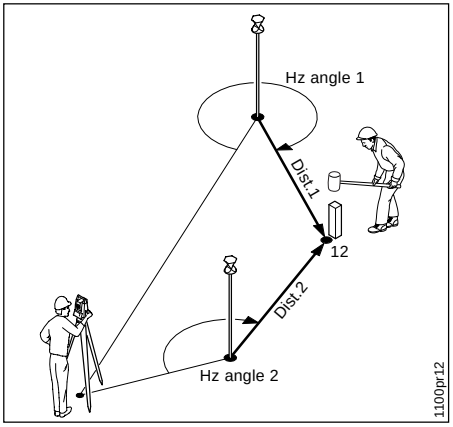
Stakeout with auxiliary points

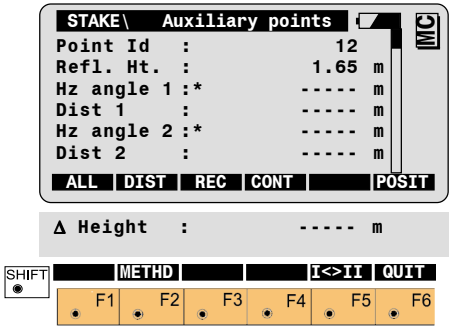
This mode computes values for points which cannot be sighted directly.

Measure to the auxiliary point Pt1. The distance "Dist 1" and angle "Hz angle 1" to the stakeout point are computed. Likewise proceed for auxiliary point Pt2. The stakeout point can be set out using the 2 calculated distances and/or angles from auxiliary points Pt1 and Pt2.

The program automatically updates both distance and angle values whenever a new point is measured. The previous point Pt2 becomes Pt1 and the new point Pt becomes Pt2.

Note, the auxiliary point to be measured will be marked with an asterisk (*).





Point Id
Point Id of the point to be staked.

Refl. Ht
Reflector height used at target point

Hz Angle 1
Angle from the first auxiliary point to the stakeout point.

Dist 1
Distance from the first auxiliary point to the stakeout point.

Hz Angle 2
Angle from the second auxiliary point to the stakeout point.

Dist 2
Distance from the second auxiliary point to the stakeout point.

Δ Height
Difference in height between the last measured reflector point and the stakeout point. Positive in sign if stakeout point is higher than the reflector position.

F1 Simultaneously measure and record data in the measurement job

F2 Measure a distance.

F3 Record the measurement in the measurement job.

F4 Acquire the next point to stake.

F5 Enter target data.

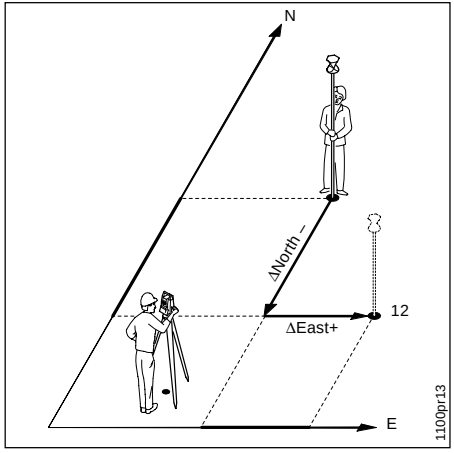
F6 Re-position the telescope on the target. Note, this function is only available for motorized theodolites.

SHIFT F2 Change stakeout method.
For more information refer to chapter "Select Stakeout Method".

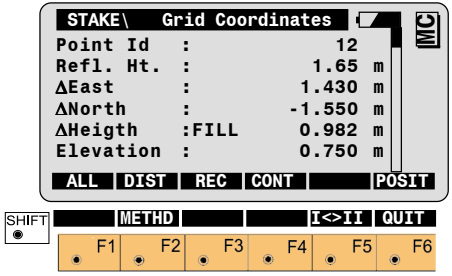
SHIFT F4 Generate a plot of the stakeout data. For more information refer to chapter "Plot".

SHIFT F6 Exit the program.

After the first distance measurement, the displacements along the grid coordinate axes are displayed. If the elevation of the point to be staked is available, the height difference between the measured reflector and the stakeout point is shown as well as the measured elevation of the reflector point.



Values for ΔEast and ΔNorth will be updated each time a new distance is measured.



Point Id
Point number of the point to be staked.

Refl. Ht
Reflector height used at target point

Δ East
Displacement of the reflector along the East-coordinate axis.

Δ North
Displacement of the reflector along the North-coordinate axis.

Δ Height
Difference in height between the measured reflector point and the stakeout point. Positive in sign if stakeout point is higher than the reflector position.

Elevation
Elevation of the measured reflector point.

F1 Simultaneously measure and record data in the measurement job.

F2 Measure a distance.

F3 Record the measurement in the measurement job.

F4 Acquire the next point to stake.

F5 Enter target data.

F6 Re-position the telescope on the target. Note, this function is only available for motorized theodolites.

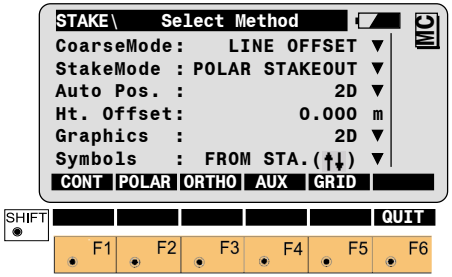
SHIFT F2 Change stakeout method.
For more information refer to chapter "Select Stakeout Method".

SHIFT F4 Generate a plot of the stakeout data. For more information refer to chapter "Plot".

SHIFT F6 Exit the program.

Select Stakeout Method

SHIFT F2 Select the stakeout method in any stakeout dialog.



Coarse Mode
Select the mode for "COARSE POSITIONING":

NONE	no Coarse mode used
LINE OFFSET	*see chapter "Line Offset"*
ORTHOGONAL	*see chapter "Orthogonal"*
AZIMUTH & DISTANCE	*see chapter "Azimuth and Distance"*

Choosing **NONE**, the program will automatically proceed to the selected "STAKEOUT METHOD" and bypass the "COARSE POSITIONIG" method after you selected a new stakeout point.

StakeMode
Select the mode for "STAKEOUT ":

POLAR STAKEOUT	*see chapter "Polar Stakeout"*
ORTHOGONAL STAKE	*see chapter "Orthogonal Stakeout"*
AUXILIARY POINTS	*see chapter "Stakeout with auxiliary points"*
GRID COORDINATES	*see chapter "Stakeout from Coordinate Differences"*

Auto Pos.
Select positioning method. (Motorized instruments only):

Off	Automatic positioning off
2D	Positioning of the horizontal drive
3D	Positioning vertical and horizontal drive

Ht. Offset
The height offset is added to the design elevations of the points to staked. CUT and FILL values refer to the elevations modified by the offset. The value can be changed only when you are in this dialog.

Graphics
Choose additional graphic displays: The graphics show the relative positions of the station (⌂), the reflector (+) and the required point (▯).

At the largest scale, the dimension of the graphics represents an actual value of about one metre. The scale is automatically altered in steps (5m, 20m etc.) in accordance with the distance of the reflector from the required point.

These graphics are particularly suitable for use in conjunction with the RCS1000 remote-control system. Depending on the particular application, the control unit at the target point can be moved towards the station or away from it, or orientated northwards or southwards. The direction from the current station (reflector) towards the required point is then the true one, and the required point can be quickly located by moving the reflector in the direction of the required point, as displayed in the graphics.

Following Graphics settings are possible:

• OFF:
No graphics are displayed.

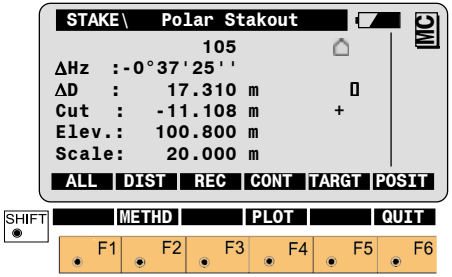
• From Station
The graphics are oriented from the instrument station to the point to be staked. This mode is recommended for guiding the rod person from the station.

• To Station
The graphics are oriented from the current reflector position to the station. This mode is adapted if working in the polar or orthogonal stakeout mode and in RCS mode.

• To North
The graphics are oriented to the North.
This mode is recommended for stakeout in RCS mode and in the grid coordinates mode.

• From North
The graphics are oriented to the South.
This mode is recommended for stakeout in RCS mode and in the grid coordinates mode.

Example: Polar Stakeout



These graphics appear after a distance measurement. No graphics of this type are available in the method “Setting out with help points”.

Symbols
Arrows may be used to guide the rod person to the point to be staked.

Select the display mode of symbols in the stakeout dialog:

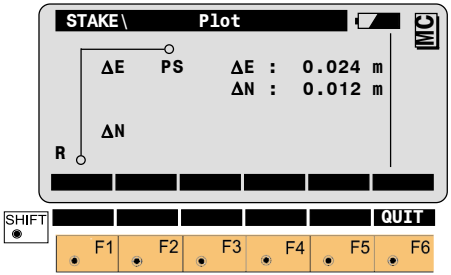
- **From Sta. (▼▲)**
Guidance of the rod person from the instrument station.

- **To Sta. (▲▼)**
Guidance at the rod, in relation to the instrument station
(e.g. if working in RCS mode).

- **NONE**
Symbols are not used.

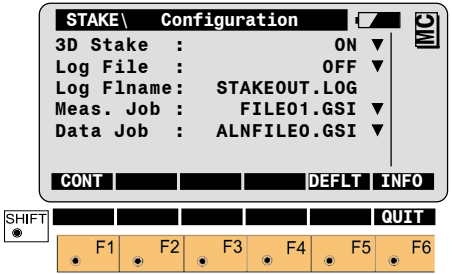
A plot is generated of the stakeout situation with display of the stakeout values, corresponding to the "STAKEOUT METHOD".

Note, below a typical plot is shown using the coordinate "STAKEOUT METHOD".



Depending on the configuration that is loaded onto your TPS1100 instrument, you may not see some or all of the options referred to below. See your Leica Geosystems dealer for more information about the configuration of your instrument.

SHIFT F2 Start the "Configuration Editor" from the "SEARCH POINT" dialog.



The "Configuration Editor" sets parameters for further program operations:

3D Stake

ON for 3-dimensional stakeout. Note the program will not perform 3D stakeout if no elevation is available for the point to be staked.

OFF for 2-dimensional stakeout. Note that there will be no difference in height displayed.

Log File

OFF no recording in a Log file

SHORT reduced recording in a Log file

LONG detailed recording in a Log file

Meas. Job

Selection of the measurement job for recording measurements.

Data Job

Selection of the data job containing the fix point coordinates (control data).

F1 Store the current configuration and proceed to the dialog "SEARCH POINT".

F5 Set the value to default. (3D stake = **ON**).

F6 Display software-version

SHIFT F6 Exit the program.

If "Log File" is set to "ON" the measurements and the results are stored in the ASCII-file specified within the "Configuration Editor". This file is created in the directory LOG on the memory card. Subsequently, you can read the memory card on your PC and obtain a hard copy of the Log-file.

Data will always be appended to the specified Log-file.

The Log-file contains the following information:

Header

The header line will contain the program used, information about the instrument, the name of the data file as well as date and time.

Record

SHORT recording of design coordinates, setout height and height difference in the log file.

```
Leica Geosystems  Program Stakeout V1.00
Instrument      :  TCA1103, Serial 102999
Meas. File      :  MYFILE.GSI
Program Start   :  24/04/1998 at 18:26

Station         :  1
                   E=100.000m   N=100.000m     H=40.000m        hi=1.560m
Point           :  3, Ht. Offset = 0.000m

Design          :  E=100.809m   N=103.346m     H=39.840m
                   sH=39.861m   dh= -0.021m     hr=1.700m
```

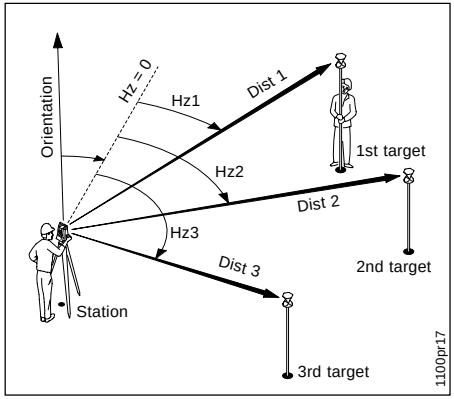
LONG recording of design coordinates, setout coordinates and differences of coordinates in the log file.

```
Leica Geosystems  Program Stakeout V1.00
Instrument      :  TCA1103, Serial 102999
Meas. File      :  MYFILE.GSI
Program Start   :  24/04/1998 at 18:28

Station         :  1
                   E=100.000m   N=100.000m     H=40.000m        hI=1.560m
Point           :  3, Ht. Offset = 0.000m
Design          :  E=100.809m   N=103.346m     H=39.840m
Staked          :  E=100.807m   N=103.344m     H=39.851m        hr=1.700m
Deltas          :  dE=0.002m      dN=0.002m     dH0-0.011m
```

Typical log file entries in the "STAKEOUT" program

Introduction

This manual describes the "FREE STATION" program of the TPS1100 Professional series.



This program can be used to deduce the three-dimensional coordinates for the instrument station and the horizontal orientation of the from measurements to a maximum of 10 target points.

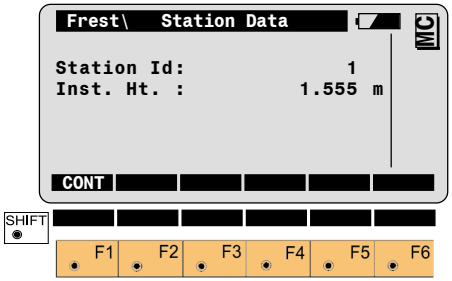
For simultaneous determination of the station elevation, height of instrument and height of reflector must already have been input and the elevation of the target points must be known.

You may use target points with elevation only.

The program allows measurement in single or dual-face mode.
Directions to target points can be determined, as can any combination of direction and distance. To compute the position coordinates, at least three elements (2 directions and 1 distance) are necessary.

Station Data

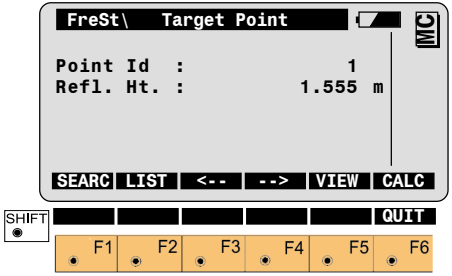
Enter station point number and height of the instrument.



F1 Proceed to define the target points.

SHIFT F2 Start the "CONFIGURATION"

Enter the target point number and height of the reflector.



F1 Search the coordinates of the target point from the coordinates of the point entered in the active data job and go to the measure mode.

F2 Define a list of target points and the measurement sequence. For further use: selection of points from the list is possible.

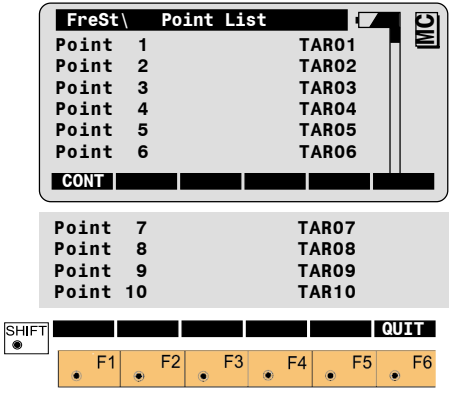
F3 Displays the previous point from the list of points you entered. Note that this key will not be available until there is at least one point in the list.

Displays the next point in the list of points you entered. Note that this key will not be available until there is at least one point in the list.

F5 Search and display the coordinates of the point found in the active data job.

F6 Run the calculation. Note, the key F6 will be assigned after sufficient measurements were taken to calculate a position.

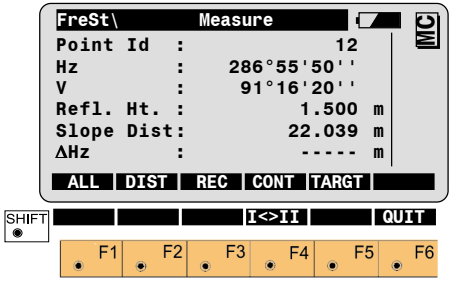
Enter a maximum of 10 points. The same point can be retrieved several times.
The same point number can be used several times without new input.



F1 Return to dialog "Target Point"

This dialog is similar to the TPS1100's basic "MEASURE MODE" dialog. Once a measurement is taken, the program will return to the dialog "Target Point" to acquire the next point for measuring.

If the station coordinates can be calculated successfully from the first few measurements, the ΔHz and ΔV values are displayed for further entered target points. Motorized theodolites will automatically drive the telescope to the target point.



F1 Simultaneously measure and record data in the active measurement job. Return to the dialog "TARGET POINT".

F2 Measure a distance.

F3 Record the measurement in the active measurement job. Return to the dialog "Target Point".

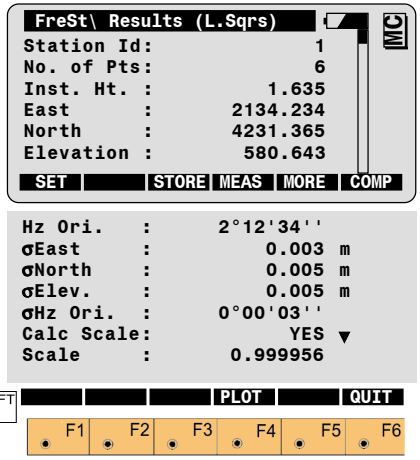
F4 Accept the measurement and return to the dialog "TARGET POINT".

F5 Enter target data. (see User Manual)

SHIFT F4 Change the theodolite face.

SHIFT F6 Exit the program.

Calculates the 3D station coordinates and orientation as well as the standard deviation of the results.



Station Id
Point number assigned to the station

No. of Pts
Number of points measured

Inst.Height
Instrument Height

East
Calculated Easting for the station

North
Calculated Northing for the station

Elevation
Calculated Elevation for the station

Hz. Ori
Oriented direction

σ East
Standard deviation of Easting

σ North
Standard deviation of Northing

σ Elev
Standard deviation of the Elevation

σ Hz. Ori
Standard deviation of the Orientation

Calc Scale
YES scale factor is calculated,
NO scale factor is not calculated
Note that this parameter is displayed only if sufficient measurement were taken.

Scale
The scale factor of the free station calculation.
Note that the scale is not shown if set to NO.

F1 Set orientation and station coordinates on the instrument.

F3 Record the following results in the active measurement job:

WI 11	Station Point Number
WI 25	Orientation correction
WI 84	Station Easting
WI 85	Station Northing
WI 86	Station Elevation
WI 87	Last reflector height used
WI 88	Instrument Height

F4 Measure more points. The program will recall the "TARGET POINT" dialog.

F5 Show the results of individual measurements on the screen (see dialog "More Information").

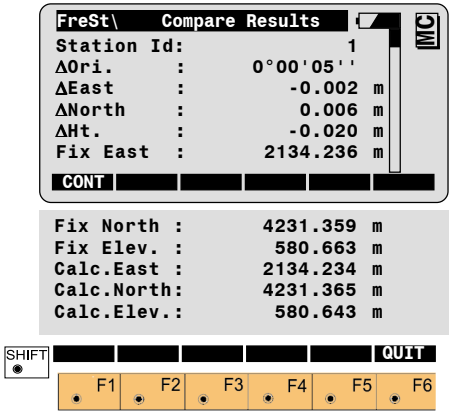
F6 Compare the Free Station results to the station coordinates and orientation currently set in the instrument.

SHIFT F2 Select between the "Robust" method and the Least Squares method.

SHIFT F4 Sketch of the station and the reference points used.

SHIFT F6 Exit the program.

The comparison function compares the station coordinates and the orientation calculated by the program to the station coordinates and the orientation currently set in the instrument.



ΔOri
Orientation difference between the calculated orientation and the orientation set in the instrument.

ΔEast
Difference between the calculated Easting of the station and the Easting set in the intrument. (Calc. East - Fix East)

ΔNorth
Difference between the calculated Northing of the station and the Northing set in the intrument. (Calc.North - Fix North)

ΔHt.
Difference between the calculated Elevation of the station and the Elevation set in the intrument. (Calc.Elev. - Fix Elev.)

Fix East
Easting coordinate of the station currently set in the intrument.

Fix North
Northing coordinate of the station currently set in the intrument.

Fix Elev.
Elevation of the station currently set in the intrument.

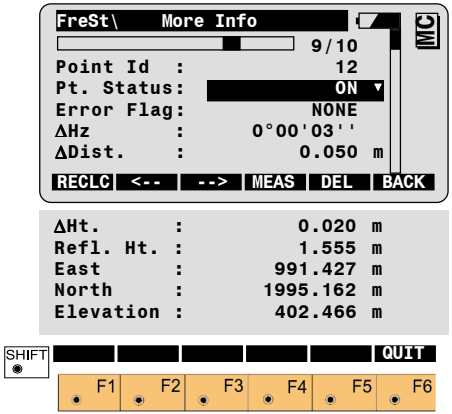
Calc. East
Easting coordinate of the station calculated with resection.

Calc.North
Northing coordinate of the station calculated with resection.

Calc.Elev.
Elevation of the station calculated with resection.

F1 Return to the results dialog.

Display the residuals of individual measurements. You can also disable points from the calculation of position or height as well as delete erroneous measured points.



9/10
Sequence number of the current point and total number of points in the measurement set. The scroll bar shows the sequential position of the measurements, graphically.

Point Id
The target point number.

Pt. Status
ON Measurements to target point used for calculation.
Ignore Elev.
Target point elevation disabled: measurements for elevation determination not used in calculation.
OFF Target point disabled: measurements to point NOT used for calculation.

Error Flag
Identified erroneous measurements. Possible values are:

NONE	measurement is OK
HZ	horizontal angle error
DIST	distance error
HT	height difference error

The flags may also be combined, i.e. DIST + HZ

Δ Hz.
Difference between calculated and measured Hz. angle

Δ Dist
Difference between calculated and measured distance

Δ Ht
Difference between calculated and measured height

Refl. Ht.
Reflector height used for that target point

East, North, Elevation
Target coordinates used.

F1 Recalculate the result.

F2 Scroll to the measurements of the previous point.

Plot

F3 Scroll to the measurements of the following point.

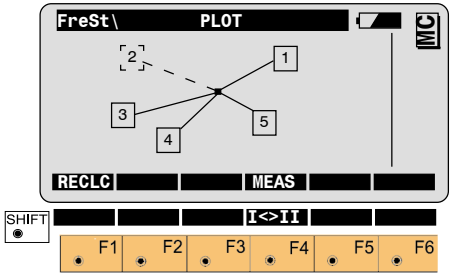
F4 Measure more point. Return to dialog "Target Point".

F5 Delete a point from the set of measurements . You can now measure a new point in its place.

F6 Return to the results dialog without changes.

SHIFT F6 Exit the program.

Generates a plot showing the measurement configuration. The station point is in the center and the top of the sketch shows the direction of Grid north. The sketch is true in angular but not true in distances. Points are numbered sequentially in the order in which they were measured. Points not used in the calculation are marked with a dotted line.



F1 Recalculate the solution and return to the dialog "RESULTS".

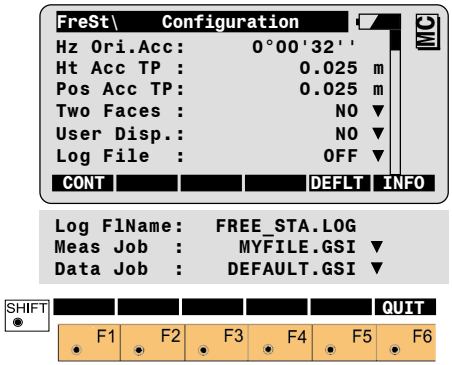
F4 Measure more points. The program will recall the "TARGET POINT" dialog.

0 ... 9 Toggle any point ON or OFF by pressing the numeric key corresponding to the sequence number of the point.

Note, that 0 represents point 10.

Depending on the configuration that is loaded onto your TPS1100 instrument, you may not see some or all of the options referred to below. See your Leica Geosystems dealer for more information about the configuration of your instrument.

Start the "Configuration Editor" from the "**STATION DATA**" dialog.



The "Configuration Editor" sets parameters for further program operations:

Hz Ori Acc
Limit for the standard deviation of the orientation. The orientation is regarded as "error free", if the computed standard deviation of the orientation is within twice the entered value.

Ht Acc TP
Height accuracy of the target points. The entered value, is used as an "a priori" accuracy in the calculation. The height is regarded as "error free", if the computed standard deviation is within twice the entered value.

Posn Acc TP
Position accuracy of the target points. The entered value, is used as an "a priori" accuracy in the calculation. The position is regarded as "error free", if the computed standard deviation is within twice the entered value.

Two Faces
YES for dual-face measurement,
NO for single-face.

User Disp

YES The same display mask as the one used in the system measurement dialog (MEAS) is used for measurements with "Free Station".

NO The "Free Station" default display applies.

Log File

ON, records measurements in a Log-File.The format is described on chapter Log File.

Log FlName

Enter the Log File Name

Meas. Job

Selection of the measurement job for recording measurements.

Data Job

Selection of the data job containing the fix point coordinates (control data).

F1 Store the current configuration and proceed to the dialog "STATION DATA".

F5 Set the values to default.

F6 Display software-version

SHIFT F6 Exit the program.

In the dual-face mode, the program will prompt for measurements in both faces. When both measurements are taken, the program will check the difference between the two. If the difference in angle is within **27' (0.5 gon)** and the difference of two measured distances is within **0.5 m (1.64 ft)**, the observations will be averaged. These tolerances are used to avoid errors in target identification. If exceeded an error message will be displayed.

If "Log File" is set to ON the measurements and the results are stored in the ASCII-file specified within the "Configuration Editor". This file is created in the directory LOG on the memory card. Subsequently, you can read the memory card on your PC and obtain a hard copy of the Log-file.

Data will always be appended to the specified Log-file.

The Log-file contains the following information:

Header
The header line will contain the program used, information about the instrument, the name of the data file as well as date and time.

Record
For each measurement, a record will be stored containing :
- Station coordinates and
- orientation correction,
- standard deviations for
  Easting,
  Northing,
  Height of station
  and orientation correction.

The residuals for
- horizontal angles,
- heights and
- measured distances
  are also listed.

```
Leica Geosystems  Program Free Station V 1.00
Instrument            :   TCA1103, Serial 102999
Meas. File            :   MYFILE.GSI
Program Start         :   20/04/1998 at 09:42
Using Least-Squares Solution

Station no.           :   200
                          E= -3.5461m    N= -0.7683m   ELV= -0.6518m   hi= 0.0000m

Ori.Corr.             :   0°00'20"
S.Dev. East           :   0.0003m
S.Dev. North          :   0.0003m
S.Dev. Elev.          :   0.0015m
S.Dev. Orient.        :   0"00'02"

4 point(s) measured   :

##  Point no.          d Hz          d Height      d Distance      Error Flag
1   109              0°01'21"        0.0012m       -0.0000m          NONE
2   110             -0°00'00"       -0.0045m       -0.0002m          NONE
3   112             -0°00'25"        0.0018m        0.0010m          NONE
4   113              0°00'48"        0.0014m       -0.0002m          NONE
```

Continued next page

```
Using Robust Solution

Station no.          :  200
                        E=  -3.5461m  N= -0.7683m     ELV= -0.6518m     hi= 0.0000m
Ori.Corr.            :  0°00'20"
S.Dev. East          :  0.0003m
S.Dev. North         :  0.0003m
S.Dev. Elev.         :  0.0015m
S.Dev. Orient.       :  0°00'02"

4 point(s) measured :

##  Point no.          d Hz          d Height      d Distance    Error Flag
1   109              0°01'21"        0.0012m       -0.0000m        NONE
2   110             -0°00'00"       -0.0045m       -0.0002m        NONE
3   112             -0°00'25"        0.0018m        0.0010m        NONE
4   113              0°00'48"        0.0014m       -0.0002m        NONE
```

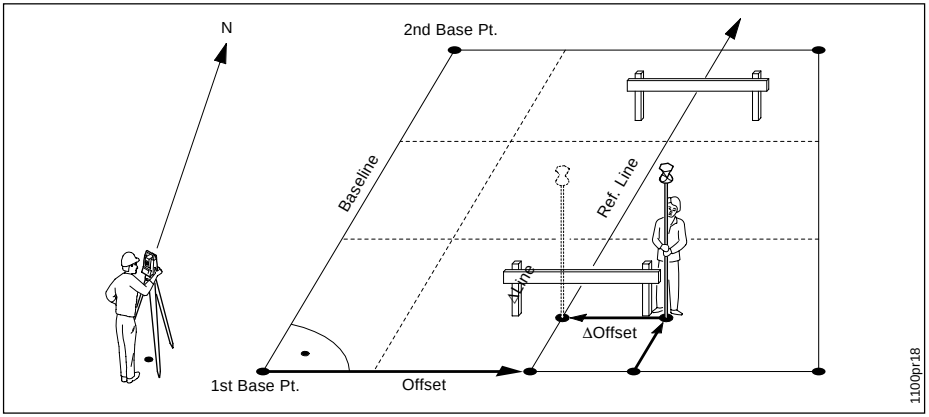
Typical log file entry in the "FREE STATION" program

Introduction

This manual describes the "Reference Line" program of the TPS1100 Professional series.

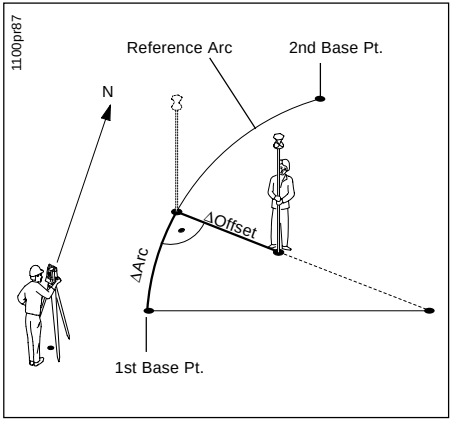
"REFERENCE LINE" is a specialized form of stakeout used for construction and building alignment. It permits positioning of a point referred to a line or an arc. Points for use in the program can be measured, entered manually, or read from the selected measurement job.
The program records individual measurements in the database. In addition, the program generates a log file containing all data for a given measurement session.

For three dimensional positioning, the program calculates height differences between the target point and a reference elevation.



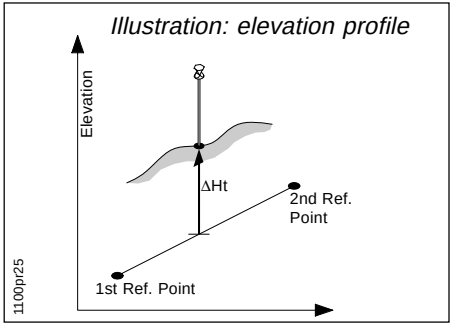
Depending on the configuration settings, the reference elevation for the reference line can be a constant elevation or an interpolated reference elevation. For reference arcs only constant elevations are possible.

Points with known offsets from the reference line or arc can be staked out with the function "Line and Offset".
The function is accessible from the "Define Reference Line/Arc" dialog.



For the configuration **Ref.Elev. = 1st Base Point**, the reference elevation for the calculation of ΔHeight values is the elevation of the 1st base point. The ref. elevation can be modified by specifying a height offset **(Ht.Offset)** in the “Define Reference Line” dialog. With **Edit Elev.** the height of each point can be changed separately (see Config. Dialog).

Illustration: elevation profile

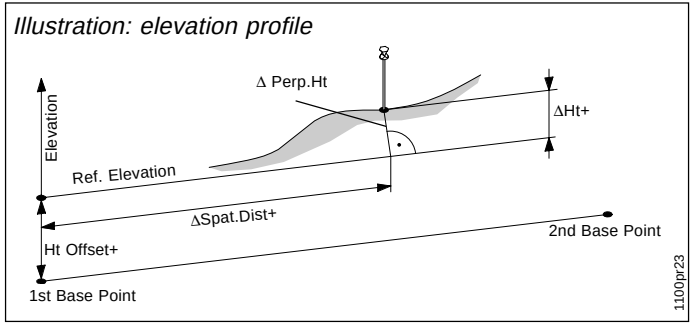


Ht Offset
Offset of the reference elevation in relation to the first base point.

Δ Ht
Height difference between the target point and the reference elevation.

For the configuration **Elev. Ref. = Baseline**, the reference elevation for the calculation of ΔHt values is the elevation of the baseline at the reflector position.
You can modify the reference elevation by specifiying a height offset **(Ht.Offset)** in the dialog for the definition of the reference line.

Illustration: elevation profile



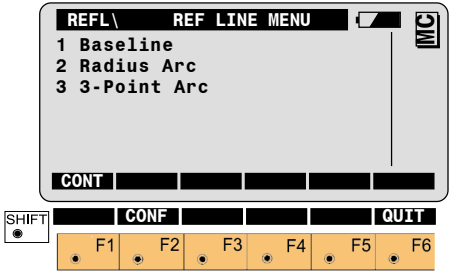
Ht Offset
Offset of the reference elevation in relation to baseline.

Δ Ht
Height difference along the vertical between the target point and the reference elevation.

Δ Perp.Dist
Height difference between the target point and the reference elevation, perpendicular to the reference elevation.

Δ Spat.Dist
Line Offset along the reference elevation.

The base method is selected in the Menu dialog.



Baseline
Line defined by two points.

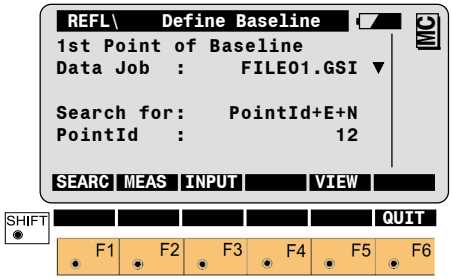
Radius Arc
Arc defined by two points and a radius.

3-Point Arc
Arc defined by three points.

Line of sight to the points is not necessary, since they can be imported from a data file.

Determine Base Points

This dialog defines the two points of the baseline. You can either manually enter, measure or search for the point in the database.



The dialogs to enter the Arc points are the same and will not be described here.

F1 Search the coordinates of the point entered in the active data job.

F2 Proceed to determine the base base point by a measurement.

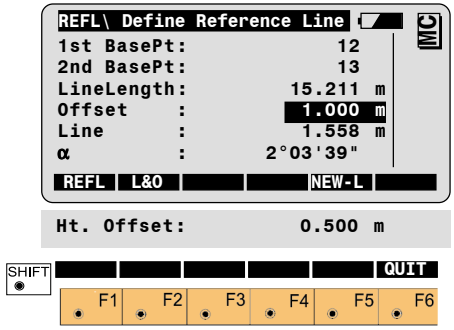
F3 Manually enter the first base point.

F5 Search and display the coordinates of the point found in the active data job.

SHIFT F6 Exit the program.

The reference line can be defined by entering a distance value, a line offset value and an angle value for the base line. Heights can be changed by a constant rate (eg, 1m) by entering a Ht offset value.
With Edit Elev. the height of each point can be set separately.

"Line and Angle" values cannot be set for reference arcs.



1st BasePoint
The first base point that defines the base line.

2nd BasePoint
The second base point that defines the base line.

LineLength
Entire length of Baseline.

Offset
Establishes the displacement parallel to the base line. For Arcs the offset is radial and applied to each point separately, arcs are not "shifted".

Line
Establishes the distance from the first reference point to the starting point of the new reference line.

Alpha
Establishes the angle between the base line and the new reference line.

Ht Offset
Displaces the base line parallel in height.

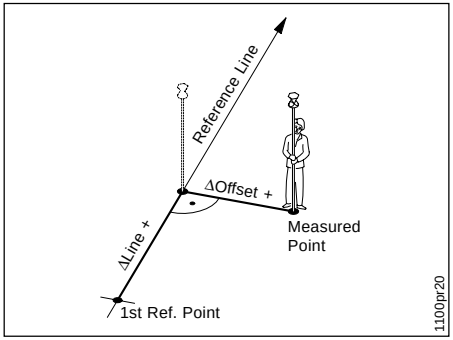
F1 Accept parameters as displayed and proceed to the "REF LINE RESULTS" dialog.

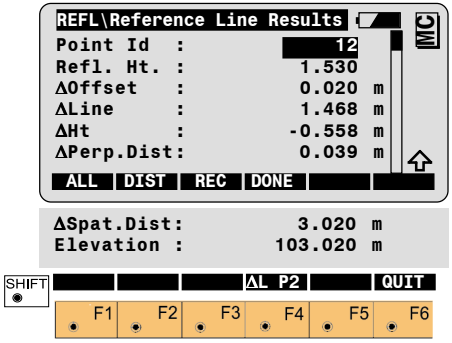
If instrument is in LOCK-mode with EDM-mode TRK/ RTRK, distance measurement is started.

F2 Go to "Line & Offset" and stakeout points with known offset values from reference.

F5 Return to Menu to define a new Base Line/Arc.

The “Reference Line Results” dialog displays the data of the measured point referring to the reference line, as shown below:





Point Id
The point number of the stakeout point.

Δ Offset
Perpendicular Offset:
Δ Offset+: To the right of the reference
Δ Offset-: To the left of the reference

Δ Line (or ΔArc)
Line offset from the first Ref. Point
Δ Line+: in the line direction
Δ Line-: in the opposite direction of the line.

ΔL from P2 (or ΔA from P2)
(only for configuration Line/α = OFF)
Line offset from the 2nd Ref. Point
ΔL P2+: in the direction of the line
ΔL P2-: in the opposite direction of the line (P2 -> P1).

Δ Ht
Edit Elev.= OFF: Height difference along the vertical between the target point and the reference elevation.
Edit Elev. = ON: Height difference between entered and measured elev.

Δ Perp.Dist
(only for configuration Ref.Elev. = Baseline. Not available for Arc)
Height difference between the target point and the reference elevation, perpendicular to the reference elevation.

Δ Spat.Dist
(only for configuration Ref.Elev. = Baseline. Not available for Arc)
Line Offset along the reference elevation.

Elevation:
Edit Elev. = OFF
Elevation of the measured point.

DesignElev.
Edit Elev. = ON
Elevation entered by user.

Simultaneously execute distance measurement and record the measurement.

Measure a distance.

Record the measurement in the measurement file.

Depending on the setting in the "Configuration" dialog a measurement block containing delta values is recorded:

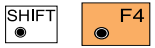
WI 11	Point Number of target
WI 35	Δ Offset
WI 37	Δ Ht
WI 39	Δ Line

or

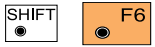
WI 11	Point Number of target
WI 35	Δ Offset
WI 37	Δ Perpendicular
WI 39	Δ Spatial distance

Depending on the settings in the "Configuration" dialog a log-file is also generated.

Return to "Define Reference Line" dialog.



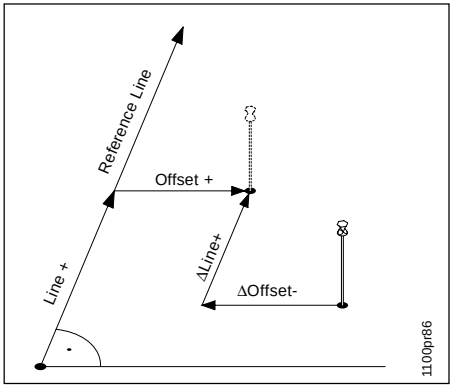
Display ΔLine from P2.

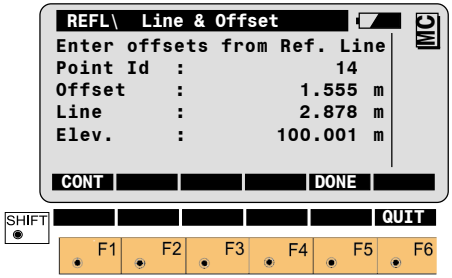


Exit the program.

Enter L&O values

Line and Offset is started from the "Define Reference Line/Arc" dialog. Points with known offset values from the reference can be staked out with this function.





Point Id
Point number of the point to be staked.

Offset
Perpendicular offset of the point to be staked.
Offset +: to the right of the reference
Offset - : to the left of the reference.

Line (or Arc)
Line offset from first point, along reference.
Line +: in the direction of the line.
Line - : in the opposite direction of the line.

DesignElev
Elevation of the point to be staked.

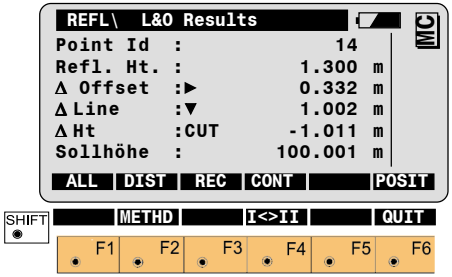
F1 Continue to "L&O Results" dialog.

If instrument is in LOCK-mode with EDM-mode TRK/RTRK, distance measurement is started.

F5 Return to "Define Reference Line" dialog.

SHIFT F6 Exit the program.

The results dialog displays the differences between entered and measured data. There are two methods to choose from: Orthogonal and Polar. *For more information refer to chapter "Method Dialog".*



Point Id
Point number of the point to be staked.

Refl. Ht.
Reflector height used at target.

Δ Offset
(orthogonal stakeout)
Difference in transversal displacement between actual and calculated point.

\+ : point is further to the right
\- : point is further to the left

Δ Line
(orthogonal stakeout)
Difference in longitudinal displacement between actual and calculated point along reference.
\+ : point is further along the reference
\- : point is closer to beginning of ref.

Δ Hz
(polar stakeout)
Difference in Hz between actual and calculated direction.

Δ Dist
(polar stakeout)
Difference in horizontal distance between actual and calculated values.

Δ Ht
Difference between design and measured elevation. Expressed both numerically and as CUT/FILL.

Elev.
Edit Elev. = OFF
Elevation of the measured point.

DesignElev.
Edit Elev. = ON
Elevation entered by user.

F1 Simultaneously execute distance measurement and record the measurement.

F2 Measure a distance.

F3 Record the measurement in the measurement job.

F4 Return to previous L&O dialog without recording data.

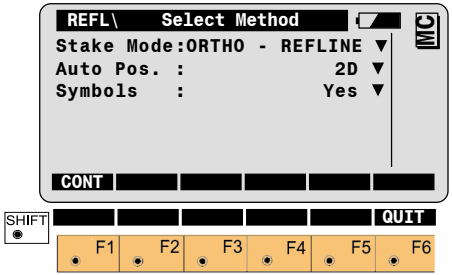
F6 (Re-)position the telescope on the target point. Note: this function is only available for motorized instruments.

SHIFT F2 Open "Method" dialog to change settings.

SHIFT F4 Change instrument face.

SHIFT F6 Exit the program.

SHIFT F2 Open "Method" dialog from "L&O Results" dialog.



Stake Mode
Select the stakeout mode.

ORTHOGONAL TO REFLINE
Differences between entered and measured Offset values are displayed after the first distance measurement.

ORTHOGONAL TO STATION
Displays orthogonal values based on the line defined by instrument station and reflector position.

POLAR STAKEOUT
Displays differences between calculated and measured direction and horizontal distance after first distance measurement.

Auto Pos.
Select positioning method.
(Motorized instruments only):

Off Automatic positioning off.

2D Positioning of the horizontal drive.

3D Positioning of the vertical and horizontal drive.

Symbols
Arrows can be used to guide the rod person to the point to be staked.
The available symbols depend on the selected method.

- **NO**
  Symbols are not used.

Ortho - RefLine

- **YES**
  Symbols guide the rod person along the reference.

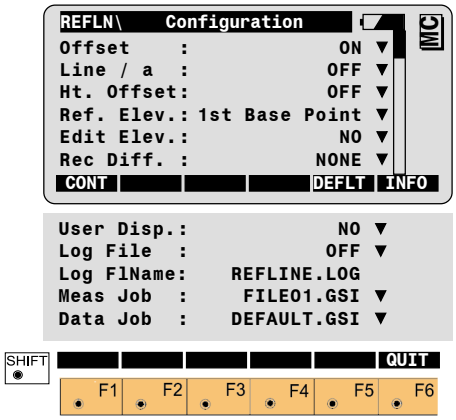
Ortho - Station/Polar Stakeout

- **TO STA. (↓↑)**
  Guidance at the rod, in relation to the instrument station.

- **FROM STA. (↑↓)**
  Recommended to guide rod person from instrument station.

Depending on the configuration that is loaded onto your TPS1100 instrument, you may not see some or all of the options referred to below. See your Leica Geosystems dealer for more information about the configuration of your instrument.

SHIFT F2 Start the "Configuration Editor" from the "**Reference Line Menu**" dialog.



The "Configuration Editor" lets you change and set the following parameters that determine program operation:

Offset
Set to **ON**, the program will allow the input of an offset from the reference line.

Line / α
Set to **ON**, the program will allow the input of a distance from the first base point to the starting point of the new reference line, and also an angle between the base line and the new reference line.

Ht Offset
Set to **ON**, the program will allow the input of a height offset.

Ref. Elev.
To define the reference elevation for the calculation of the height offset.

In order to change the setting for Ref. Elev., the parameter **Line/α** must be turned **OFF**.

Ref. Elev. = 1st Base Point
The reference elevation is the elevation of the first base point.

Ref. Elev. = Baseline
The reference elevation is the elevation of the baseline at the intersection point with the vertical through current reflector position.

Edit Elev.
Set to **YES**, point elevations can be edited directly in "Reference Line Results" and "L&O Results" dialogs. Δ Ht is the difference between entered and measured values and is updated automatically.

Rec Diff
Set to **NONE**, no additional measurement is recorded.
Set to **O** the program will record Δ Offset values only.
Set to **O**/ L, the program will record both Δ Offset and Δ Line values.
Set to **O/L/H**, the program will record Δ Offset, Δ Line and Δ Height of target values.

If the option "**Ref. Elev.**" is set to "**Baseline**" you can in addition calculate the values:
Set to **O/S** the program will record both Δ Offset and Δ Spatial distance values.
Set to **O/S/P**, the program will record Δ Offset, Δ Spatial distance and Δ Perp. Dist of the perpendicular line. (*Refer to figure in chapter Reference elevation*)

User Disp
Set to **YES**, the display defined in the MEAS application will be used.
If set to **NO**, the "REFERENCE LINE" default display applies.

Log File
Set to **ON**, the program will record measurement data in a log file in the format described on chapter Log File.

Log FlName
Enter the Log File Name.

Meas. Job
Selection of the measurement job for recording measurements.

Data Job
Selection of the data job containing the fix point coordinates (control data).

Store the current configuration and proceed with dialog "1st Point of Baseline".

Press to reset configuration parameters to their default values.

Displays date and version of the running application.

If "Log File" is set to ON the measurements and the results are stored in the ASCII-file specified within the "Configuration Editor". This file is created in the directory LOG on the memory card. Subsequently, you can read the memory card on your PC and obtain a hard copy of the Log-file.

Data will always be appended to the specified Log-file.

The Log-file contains the following information:

Header
The header line will contain the program used, information about the instrument, the name of the data file as well as dateand time.

Configuration
Each modification of baseline and reference line is stored.

Record
For each measurement, a record will be stored containing: Point No., as-staked Easting, Northing, and Elevation and their delta values.

```
Leica Geosystems  Program Reference Line V 1.00
Instrument      :  TCA1103, Serial 102999
Meas. File      :   MYFILE.GSI
Program Start   :  20/04/1998 at 09:42

Station no.     :  Stationpointnumber
                   E=1000.000m   N=2000.000m   H=400.000m    hi=1.1150m

1.BasePoint     :  Baselinepointnumber
                   E=1050.000m   N=2050.000m   H=410.000m

2.BasePoint     :  Baselinepointnumber
                   E=1060.000m   N=2060.000m   H=420.000m

Offset.         :  1.0000m

Point no.       :  1025
                   E=1005.961m   N=2048.409m   H=398.497      hr=1.115m

Deltas          :  dO=        4.3403m
                :  dL=        3.0907m
                :  dL-P2=    67.610m
                :  dH=       -1.5027m

Define Line and Offset
Offset          :  -1.000m
Line            :  70.711m
Elevation       :  401.000m

Line&Offset
Point No.       :  1026
Design          :  E=1100.000m   N=2100.000m   H=401.000
Staked          :  E=1100.051m   N=2099.989m   H=401.102      hr=1.115m
Differences     :  dE=0.051m     dN=0.011m     dH=0.102
```

Typical log file entries in the "REFERENCE LINE" program.

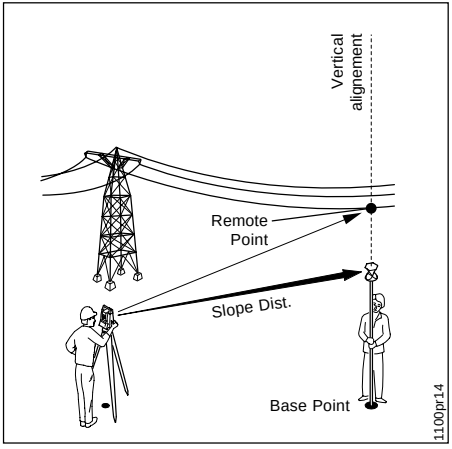
Remote Height

Introduction

This manual describes the "Remote Height" program of the TPS1100 Professional series.

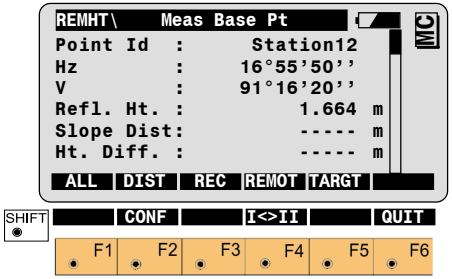
Remote Height is used to determine the elevation of inaccessible points, e.g. on cables or building facades. First, the distance to a base point situated vertically below (or above) the remote height point must be measured. Then you can aim to the remote height point.
The coordinates of the remote point are calculated from the distance measured to the base point and from the angles measured to the remote point.
To ensure correct results, the target and the reflector must be lined up vertically. In practice it is not generally possible to maintain an exactly-vertical line, and so you must decide what lateral deviation can be tolerated.

The horizontal distance to the inaccessible target must however coincide with the horizontal distance to the reflector.
When the instrument is aligned and the station coordinates have been set, the position coordinates of the remote height can be calculated and stored in the measurement job.



Measure Base Point

This dialog is used in accordance with the settings of the system function "Measure & Record" or according to the dialog shown below.



Point Id
The point number of the base point.

Hz
Horizontal direction from the remote point to the base point.

V
Vertical angle to the remote point.

Refl. Ht.
Reflector height used for the target point.

Slope Dist.
Slope distance from the instrument station to the base point.

Ht. Diff.
Height difference between the base point ground and the instrument ground.

Simultaneously measure and record in the active measurement job. Proceed with the "REMOTE POINT" dialog.

Measure a distance. Record the measurement in the active measurement job and proceed with the "REMOTE POINT" dialog.

Measure the distance. Accept the measurement without recording. Proceed with the "REMOTE POINT" dialog.

Enter the target data. (see User Manual)

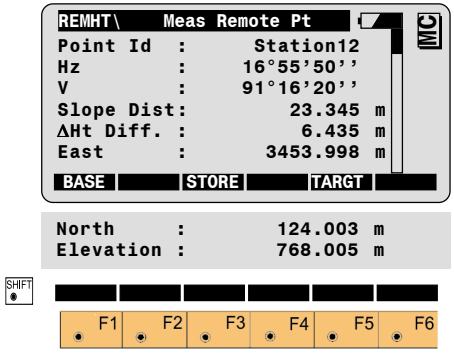
Proceed with "REMOTE POINT" dialog.

Start the "Configuration Editor".

Change the theodolite face.

Exit the program.

Once the base point has been measured, this dialog shows the position of the point - above or below the base point - aimed with the telescope. The data are immediately updated while turning the instrument.



Point Id
The point number of the remote point.

Hz
Horizontal direction from the instrument to the remote point.

V
Vertical angle to the remote point.

Slope Dist.
Slope distance from the instrument station to the remote point. (calculated)

Δ Ht. Diff.
Height difference between the remote point and the base point ground.

East
Calculated Easting for the remote point.

North
Calculated Northing for the remote point.

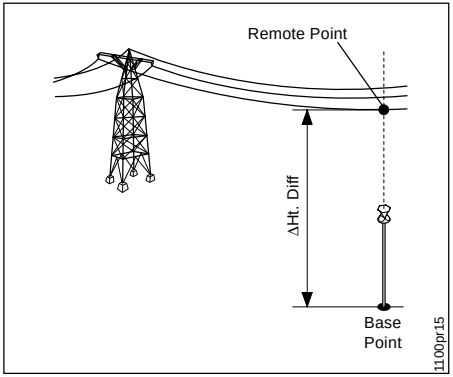
Elevation
Calculated Elevation for the remote point.

F1 Return to the "Measure Base Point" dialog.

F3 Record the measurement in the measurement job.

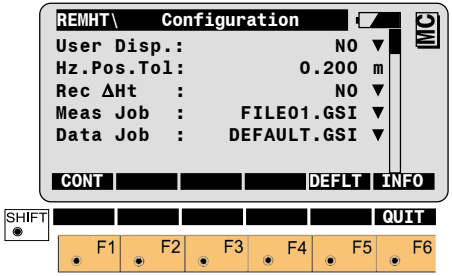
F5 Enter the target data. (see User Manual)

SHIFT F6 Exit the program.



Depending on the configuration that is loaded onto your TPS1100 instrument, you may not see some or all of the options referred to below. See your Leica Geosystems dealer for more information about the configuration of your instrument.

SHIFT F2 Start the "Configuration Editor" from the "Measure Remote point" dialog.



The "Configuration Editor" sets parameters for further program operations:

User Disp
Set to **YES**, the display defined in the "MEAS" application will be used.
If set to **NO**, the "REMOTE HEIGHT" default display applies.

Hz.Pos.Tol
Horizontal distance tolerance that valid point measurements cannot exceed.

Rec ΔHt
NO The Height difference **ΔHt.diff** between remote and base point is not recorded.
Rec in WI37
ΔHt.diff is stored as record WI37 in the measurement job.

Meas Job
Selection of the measurement job for recording measurements.

Data Job
Selection of the data job containing the fix point coordinates (control data).

F1 Accept the current configuration and proceed to the dialog "MEASURE BASE PT".

F5 Reset configuration parameters to their default values.

F6 Displays date and version of the running application.

Introduction

This manual describes the "Hidden Point" program of the TPS1100 Professional series.

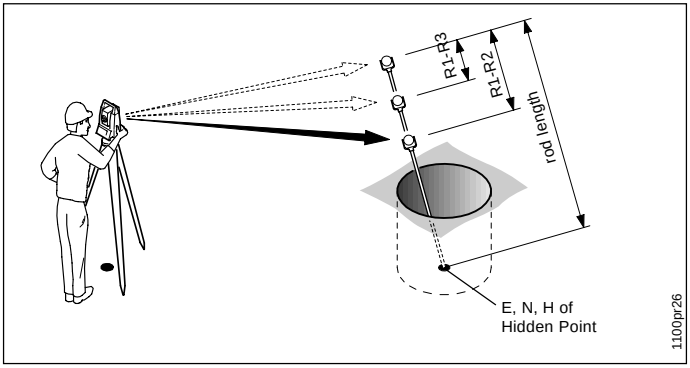
The program allows measurements to a point that is not directly visible, using a special hidden-point rod. The data for the hidden point are calculated from measurements to the prisms mounted on the rod with a known spacing and a known length of rod. The rod may be held at any angle, as long as it is stationary for all measurements.

"Measurements" are calculated as if the hidden point was observed directly. These "calculated measurements" can also be recorded.
The hidden-point rod can have either two or three reflectors. The rod you are using is defined in the "Configuration" of the program.

Here, you enter the length of the rod, spacing between reflectors, and the prism constant. *Refer to the following picture, which illustrates a hidden-point rod with three reflectors.*

If the hidden-point rod you are using has three reflectors, the program calculates coordinates for the hidden point from three measurement combinations:

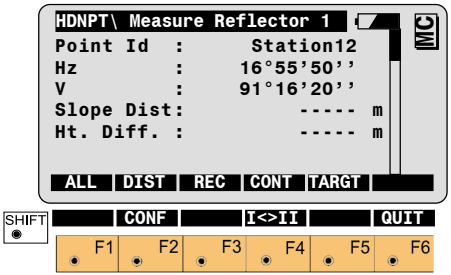
Reflector 1 + Reflector 2
Reflector 3 + Reflector 2
Reflector 1 + Reflector 3



The X, Y and Z coordinate values resulting from each of these measurement combinations are meaned to produce the XYZ coordinates of the hidden point.

In the case of motorized theodolites, you can configure the program so that it points the telescope at the third reflector automatically, after the first two reflectors have been measured.

The program will display the TPS 1100 "Measure & Record"dialog or the dialog shown below.
If the difference of the given and measured spacing between the prisms exceeds the "Meas. Tol. limit" a message is displayed.
You may accept the measurement or re-measure the prism.



F1 Simultaneously measure and record in the active file.
Proceed with the same dialog for the next prism. If the last point has already been measured, the program will proceed to the "RESULT" dialog.

F2 F3 Measure a distance. Record the measurement in the active file and proceed with the same dialog for the next prism. If the last prism has already been measured, the program will proceed to the "RESULT" dialog.

F2 F4 Measure the distance. Accept the measurement without recording. Proceed with the same dialog for the next prism. If the last prism has already been measured, the program will proceed to the "RESULT" dialog.

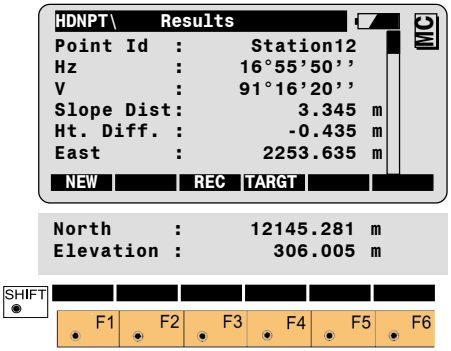
F5 Enter the target data. (see User Manual)

Note: When using the Hidden Point program, you must NOT change the target properties with the TARGT function, except to set the ppm for the measurements. The prisms on the hidden point rod MUST be defined in the CONFIGURATION of Hidden Point.

SHIFT F4 Change the theodolite face.

SHIFT F6 Press this key combination to quit the Hidden Point program at any time.

Once all reflectors have been measured, the program will display the results of the hidden-point calculation.
Using 3 reflectors the mean values of the “HIDDEN POINT“ are displayed.



Point Id
The Point number.

Hz
Horizontal direction to the hidden point.

V
Vertical angle to the hidden point.

Slope Dist.
Slope distance to the hidden point.

Ht. Diff
Height difference from instrument station to the hidden point.

East
Calculated Easting (E) for the hidden point.

North
Calculated Northing (N) for the hidden point.

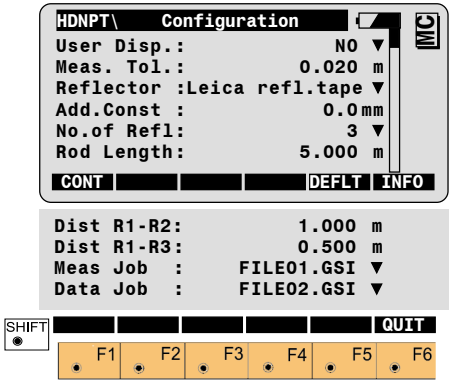
Elevation
Calculated Elevation for the hidden point.

F1 Take a new hidden-point measurement.

F3 Store the point calculation on the recording device.

F4 Enter target data. (see User Manual)

SHIFT F2 Start the "Configuration Editor" from the "MEASURE" dialog.



User Display

YES user defined display

NO the default display of the program "HIDDEN POINT".

Meas. Tol

Limit for the difference between the given and measured spacing of the reflectors. If the tolerance value is exceeded, the program will issue a warning.

In case of measurements with 3 prism the values is used as limit for the max. deviation of the 3 measurements.

Add. const.

Input of prism constant for the prisms of the rod. The prism constant set in the system is disregarded.

No. of Refl.

Number of the prisms on the rod you are using. Move the input cursor to this line, then toggle to either 2 or 3.

Auto pos.

When ON, the program will automatically point the telescope of a motorized theodolite at the third prism once the first two prisms have been measured. The exact pointing must be made manually.

Rod Length

Total length of hidden-point rod.

Dist. R1-R2

Spacing between the centers of reflector R1 and prism R2.

Dist. R1-R3

Spacing between the centers of prism R1 and prism R3. Enter only for rods with three prisms. Prism 3 must be situated between prism 1 and 2.

Refer to Figure on page 79, which illustrates a hidden point rod with three reflectors.

F1 Accept the current configuration and proceed to "MEASURE ROD"
Note that all parameters for the rod you are using must be defined before you can proceed. If any of the parameters have not been defined, the program will issue an error message to this effect. Press OK to clear the message, then make any necessary settings in the "CONFIGURATION".

F5 Set values to default. Default values are displayed.

F6 Displays date and version of the running application.

Example of Measurement data

Measurements to Point Ids 2 and 3 (the first two records) are the raw measurements. The measurement to Point Id 4 is the hidden point measurement - the measurement that could have been made if Point Id 4 was not behind an obstruction between it and the instrument station (with a Refl. Ht = 0.)

In this GSI8 example, the Recording Mask is the standard polar mask (Point Id, Horizontal Circle, Vertical Circle, Slope Distance and ppm / Offset. The actual data recorded will be determined by the Recording Mask in effect at the time the measurement and/or hidden point data are recorded.

```
110041+00000002 21.322+07018850 22.322+06455150 31..00+00003078
51..1.+0000+034
110042+00000003 21.322+10896450 22.322+06213050 31..00+00002910
```

Example: GSI8 Measurement data

Logfile

Hidden Point does not generate a logfile.

To Test / Prove the Hidden Point program
Setup and orient the instrument in an open area. Check the configuration to be sure the hidden point rod and prisms are properly defined. Position the tip of the hidden point rod on a mark that is directly visible from the instrument location.
Start the hidden point program and, making sure the hidden point rod does not move between measurements, measure the prisms on the hidden point rod.

Store the coordinates of the "hidden point" on the Memory Card. Start the Setting Out program, make sure the configuration allows for 3D positioning, then select the previously stored "hidden point" for setting out. Motorized instruments will drive directly to the point, which will then be behind the crosshairs of the telescope.

Manually turn non-motorized instruments until the ΔHz and ΔV both equal zero. The "hidden point" will be behind the crosshairs of the telescope.

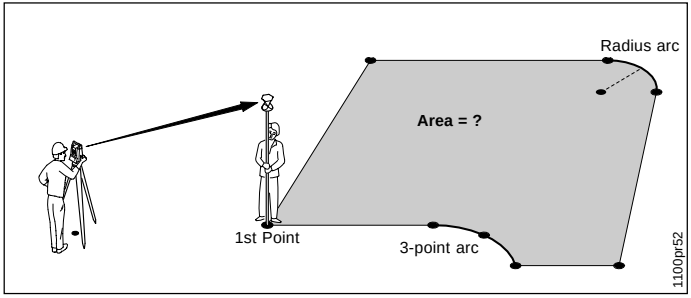
Uses for the Hidden Point program
The hidden point program may be used to obtain accurate three dimensional coordinates for a point that is currently blocked from direct measurement by an obstruction between the point and the instrument.

Typical uses are:
- Determination of flow line locations and elevations in manholes, without measuring from the rim of the manhole to the flow line and estimating corrections for non-verticality of the measuring tape and eccentricity from the measurement on the rim to the horizontal location of the flow line;
- Determination of recesses in building corners for detailed surveys, without estimating right angle offsets, with or without taping of the dimensions;
- Measurements behind overhangs, buttresses and columns for quantity determinations in underground construction or mining, without estimating right angle offsets, with or without taping of the dimensions;
- Measurements of industrial process piping or other equipment in close quarters;
- Detailed architectural surveys for remodeling or cultural preservation or restoration work;
- Any place where accurate measurements would require many more instrument setups in order to achieve line of sight from the instrument to the points being measured.

Introduction

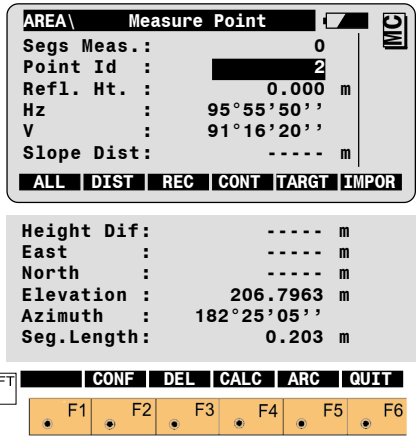
This manual describes the "Area" program of the TPS1100 Professional series.

An area can be defined by a series of straight lines and arcs. Arcs are defined by 3 radial points or 2 radial points and radius.



Measure Mode

Straight line



Segs Meas.
Counts the number of segments. With a new area the segment counter will be set to zero.

Seg. Len.
Length of the last straight line segment measured.

F1 Simultaneously measure and record data in the active measurement job.

F2 F3 Measure a distance and record data in the active measurement job.

F2 F4 Measure a distance without recording.

F5 Enter the target data. (*see User Manual*)

F6 Import target coordinates.

SHIFT F2 Start the "Configuration editor".

SHIFT F3 Deletes last completed segment. Resume at the start of a new segment.

SHIFT F4 Close the area polygon to the start point and calculates area and length of perimeter. The display of the results is shown in *chapter "Calculation".*

SHIFT F5 Select arc as the next segment.

SHIFT F6 Quit the Area program.

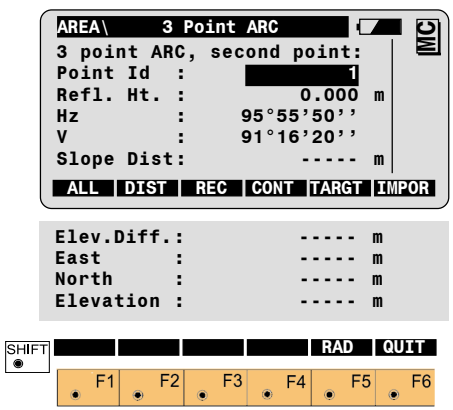
Arcs

During measurement, you can choose the ARC function to measure an arc defined by 3 radial points or 2 points and radius.
Select the wished ARC function after having measured the first point of arc.

Ensure the central angle of any arc is always smaller than 180° (200 gon).

- **Three Points**

Determine the second and third points of an arc sequentially. Completing the third point the program continues with Dialog "Measure point".



F1 Simultaneously measure and record data in the active measurement job.

F2 F3 Measure a distance and record data in the active measurement job.

F2 F4 Measure a distance without recording.

F5 Enter the target data.

F6 Import target coordinates.

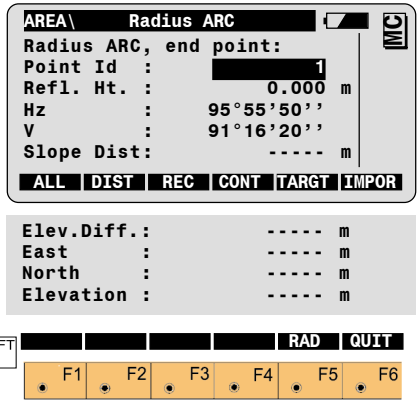
SHIFT F5 Select arc defined by 2 points and radius.

CODE Call up the CODE function.

SHIFT F6 Exit the program.

- **Radius Arc**

Determine the two points of an arc sequentially. After the end point the "Measure point" dialog prompts to input the radius.



F1 Simultaneously measure and record data of the end point of arc in the active measurement job.

F2 F3 Measure a distance and record data of the end point of arc in the active measurement job.

F2 F4 Measure a distance without recording.

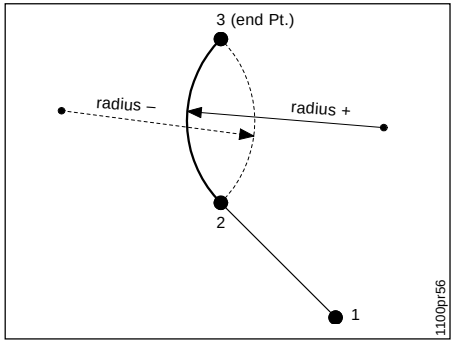
F5 Enter the target data. (see User Manual)

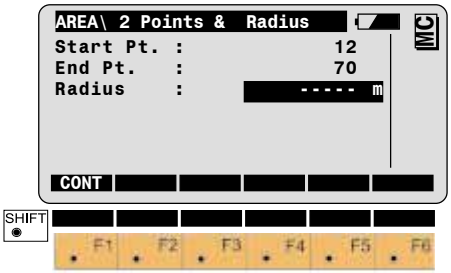
F6 Import target coordinates.

SHIFT F5 Press 3 Pt. to switch to the 3-Point Arc method.

SHIFT F6 Exit the program.

For arcs to the left enter the radius positive and for arcs to the right enter the radius negative.

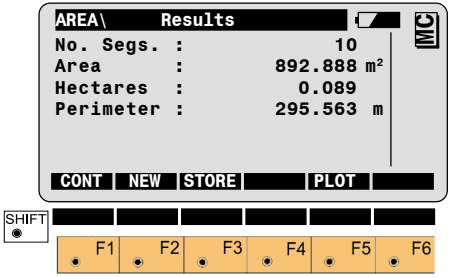




Radius
Enter the radius.

F1 Accept the input. Continue with dialog "MEASURE POINT".

Displays number of segments, computed area and length of perimeter.



No. Segs.
Number of segments used.

Area
Computed area in units of measure.

Hectares/Acres
Computed area in hectares or acres[1]. 1 acre = 43560 ft².

Perimeter
Length of perimeter of the current unit of measure.

[1] depending on the setting of the distance unit metre or feet.

F1 Continue with dialog "MEASURE POINT".

F2 Start a new area. Resets the segment counter to zero. Results of the last area computation will be erased.

F3 The following format will be used to record calculated area results:

WI 41: Code block identification (default = 36)
WI 42: Number of segments used.
WI 43: Area in the current measurement units, always with one decimal place.
WI 44: Length of perimeter in the current units of measure with one decimal place.

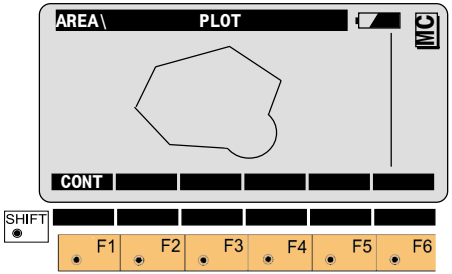
Code (default = 36)	no. of segments =4	area polygon 4500.3 m²	length polygon perimeter
▯ ▯▯ ▯			
WI 41	WI 42	WI 43	WI 44

F5 Generate a plot of the area.

SHIFT F6 Exit the program.

Plot

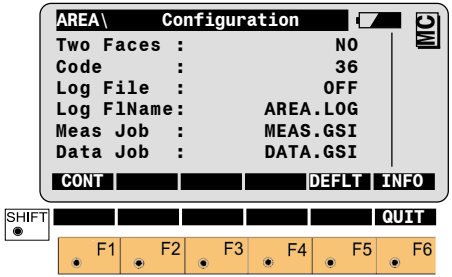
Shows a plot of the present area.



F1 Return to the dialog "RESULTS".

Depending on the configuration that is loaded onto your TPS1100 instrument, you may not see some or all of the options referred to below. See your Leica Geosystems dealer for more information about the configuration of your instrument.

SHIFT F2 Start the Configuration Editor from the "Measure Point" dialog.



The "Configuration Editor" sets parameters for further program operations:

Two Faces
YES for dual-face measurement,
NO for single-face.

Code
Enter the block identification code for recording the area results (max. eight alpha numeric characters)

Log File
Set to **ON**, the program will record measurement data in a log file in the format *described on the last page of this chapter.*

Log FlName
Enter the Log File Name.

Meas. Job
Selection of the measurement job for recording measurements.

Data Job
Selection of the data job containing the fix point coordinates (control data).

F1 Store the current configuration and proceed to the dialog "Measure Point".
Points can be added to the current area or a new area can be started.

F5 Set the values to default.

F6 Display date and version of the running application

SHIFT F6 Exit the program.

In the dual-face mode, the program will prompt for measurements in both faces. When both measurements are taken, the program will check the difference between the two. If the difference in angle is within **27' (0.5 gon)** and the difference of two measured distances is within **0.5 m (1.64 ft)**, the observations will be averaged. These tolerances are used to avoid errors in target identification. If exceeded an error message will be displayed.

If "Log File" is set to ON the measurements and the results are stored in the ASCII-file specified within the "Configuration Editor". This file is created in the directory LOG on the memory card. Subsequently, you can read the memory card on your PC and obtain a hard copy of the Log-file.

Data will always be appended to the specified Log-file.

The Log-file contains the following information:

Header
The header line will contain the program used, information about the instrument, the name of the data file as well as date and time.

Record
For each section of the area, start point and end point, horizontal distance and azimuth are stored.

For arcs with 2 points and radius the azimuth of arc, radius and length of arc are also stored.

For 3 point arcs the direction of arc, radius and length of arc are also stored.

```
Leica Geosystems  Program Area V 1.00
Instrument              : TCM1103, Serial  102999
Meas. file              : MYFILE.GSI
Program Start           : 20/04/1998 at 09:42

Segment Number          : 1
Start Point             : 1
End Point               : 2
H Distance              : 5.5555m
Azimuth                 : 140°11'17"

Segment Number          : 2
Start Point             : 2
End Point               : 4
Curve Right/Radius      : 4.9089m
ARC Length              : 2.326m

Segment Number          : 3
Start Point             : 4
Second Point            : 5
End Point               : 6
Curve Right/Radius      : 5.362m
ARC Length              : 2.254m

Number of Segments      : 3
Area                    : 9.8496m2
Hectares                : 0.0010
Perimeter               : 13.8396m
```

Typical log file entry in the "AREA" program

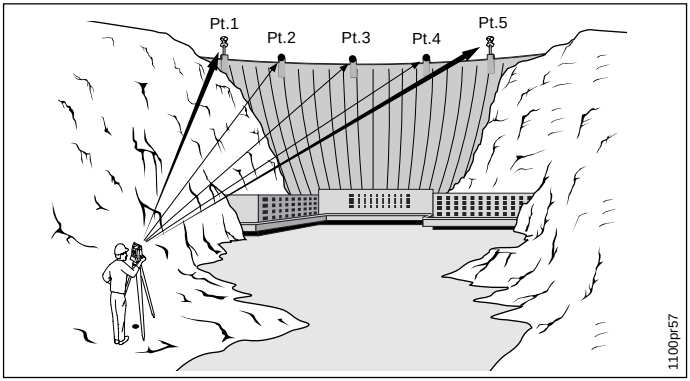
Introduction

This manual describes the "Sets of Angles" program for the TPS1100 Professional series instruments.

Sets of Angles is used to measure directions to targets for which coordinates are not necessarily known. Distance measurements are optional.

It provides field checking and analysis of measurements, while the instrument remains setup on the station.

The adequacy / accuracy of measurement data may be verified before leaving the observing station. With motorized instruments, rough pointing to each station is automatic, the operator need only refine the pointing before measuring. This eliminates observations to incorrect targets.



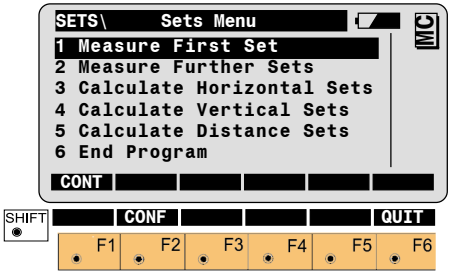
With Automatic Target Recognition, fine pointing and measurement can be automatic when the target is a reflector. The operator makes only the first observation to each station, then the rest of the measurements can be fully automated.
A minimum of two full sets must be observed, and all target points must be observed in Face I and Face II.
Sets of Angles has a "Learning Phase" during which it "learns" the positions and target Point Ids of the points you wish to measure.

"Learning" occurs automatically as you observe each target point in Face I. This information is then used to prompt you through the completion of your measurements at the station.

A maximum of 64 measurements per instrument station (in both faces) can be handled in one calculation. For instance, you may measure 16 sets to 4 target points, 8 sets to 8 target points, etc.

Sets menu

The target Point Ids and the sequence of measurement to the target points are stored in the program during the observation of the first half of the first set (in Face I.) This is the "Learning Phase." To complete the first set, and during the observation of the additional sets, you will be offered the target points in the sequence defined during the learning phase. If you are using a non-motorized instrument, the horizontal and vertical differences will be displayed, to guide you to the correct target point. Motorized instruments will automatically drive to the target point. TCA- and TCRA-instruments may make all measurements automatically, after the learning phase.

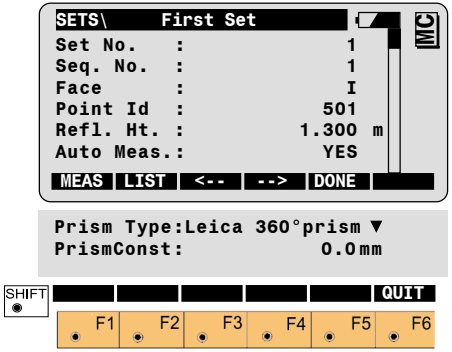


SHIFT F2 Start the "CONFIGURATION" Option, if available.

Measure Mode

- **Measure First Set**

This is the learning phase of the Sets of Angles program. Your inputs and measurements will be stored by the program to guide you through the balance of the measurement process.
You must measure to all desired target points in this set during the learning phase, and you may not add target points to the set after you leave the learning phase.



Set No.
Displays the number of the set currently being measured. Always "1" in the learning phase.

Seq. No.
Displays the sequential number of the point currently being measured.

Face
Displays the required instrument face for this measurement.

Point Id
Input the Point Id of the point currently being measured.

Refl. Ht.
(Optional, but necessary for the program to correctly calculate the elevation of the target point.) Input the Reflector Height of the point currently being measured.

Auto Meas.
Automatic Measurement option, available only with motorized instruments. Select **ON** or **OFF** as desired.

If **OFF**, motorized instruments must be manually pointed to this target point in further sets.

If **ON**, motorized instruments will automatically turn toward this target point in further sets.

If **ON** and the **target is a prism**, motorized instruments with ATR will automatically turn toward, fine point and measure to this target point.

Prism Type
(Optional, but necessary for the instrument to correctly measure the distance to the target point.) Select the type of prism at this target point.

PrismConst
Display only of the offset of the current Prism Type. Will be updated if the Prism Type is changed.

Press after all settings are correct and go to the Measurement Dialog.

(Optional) Press to create a list of up to ten target points. Subsequent measurements may then be made by selecting the target point from this list.

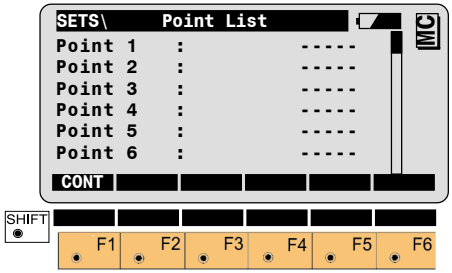
F3 (Not available until a list of target points has been defined.) Press to select the previous point on the list.

F4 (Not available until a list of target points has been defined.) Press to select the next point on the list.

F5 Press when all target points have been measured in Face I. You will see a warning that you are leaving the Learning Phase.
Press **YES** to continue. The program returns to the Sets Menu with the focus on 2 Measure Further Sets.
Press **NO** if you pressed DONE in error. The program returns to this dialog.

SHIFT F6 Press to Quit Sets of Angles. This option is available on nearly every dialog within Sets of Angles.

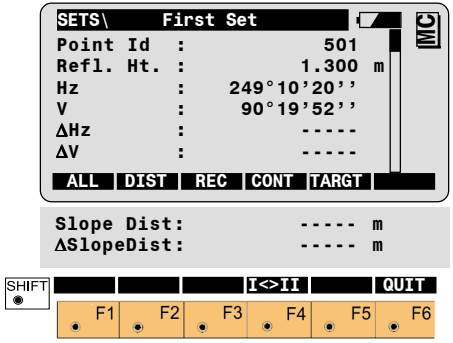
F2 Press to view Point list.



Point 1 - 10
Input up to ten Point Ids to enable selection from this list on the preceding dialog. You are not required to measure to every target point on this list.

F1 Press after all target Point Ids have been input.

Manually point the instrument at the target point. If the target is a prism and you are using a TCA- or TCRA-instrument with ATR turned on, you need point only "close" to the target. When you are "on target" select one of the measurement options:



Point Id
Displays the Point Id of the point currently being measured, as input on the previous dialog.

Refl. Ht.
Displays the Reflector Height of the point currently being measured, as input on the previous dialog.

Hz
Displays the current value of the Horizontal Circle.

V
Displays the current value of the Vertical Circle.

Δ Hz
Displays the difference between the current value of the Horizontal Circle and the first direction to the target point. Displays as dashes during the learning phase.

Δ V
Displays the difference between the current value of the Vertical Circle and the first direction to the target point. Displays as dashes during the learning phase.

Slope Dist
Displays the distance to the target point. Displays as dashes until a distance is measured manually.

Δ SlopeDist
Displays the difference between the current distance to the target point and the first distance to the target point. Displays as dashes during the learning phase.

Measure the distance to the target point, record the measurement results in the Meas Job and return to the previous dialog. Data will also be stored internally by Sets of Angles.

Measure the distance to the target point and remain at this dialog.

Record the measurement results in the Meas Job and return to the previous dialog. Data will also be stored internally by Sets of Angles.

Store the measurement results internally and return to the previous dialog. Data will not be stored in the Meas Job.

(May not be available) Check and/or set the reflector type, reflector height, ppms.

- **Measure Set**

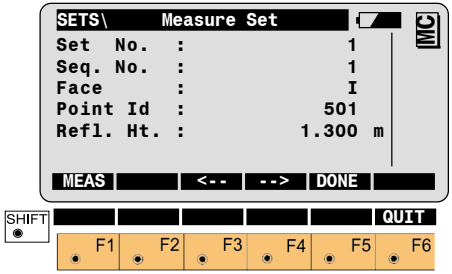
At the conclusion of the learning phase, select Measure Further Set. You will be prompted to make the measurements, in the sequence you selected in Configuration, to complete the first Set of measurements.

- Non-motorized instruments will display the Telescope Positioning dialog to help you find the target points in sequence.

- Motorized instruments will automatically turn to the target points in sequence. You must refine the pointing manually. After completing the first set, the program returns to the Sets Menu.

- With TCA- or TCRA-instruments and Auto. Meas. = **ON**, the first set will be completed automatically and the program returns to the Sets Menu.

You will use this dialog to measure all additional sets at this instrument station.



Set no.
Displays the number of the set currently being measured.

Seq. no.
Displays the sequential number of the point currently being measured.

Face
Displays the required instrument face for this measurement.

Point Id
Displays the Point Id of the point currently being measured.

Refl. Ht.
Displays the Reflector Height of the point currently being measured.

F1 Press to measure to the displayed target point in the displayed face.

F3 Press to measure to the previous target point in the displayed face. You may measure points out of sequence, but this may have undesirable effects in your post-processing software.

F4 Press to measure to the next target point in the displayed face. You may measure points out of sequence, but this may have undesirable effects in your post-processing software.

F5 Press when all target points have been measured in Face II or to abort measurement.

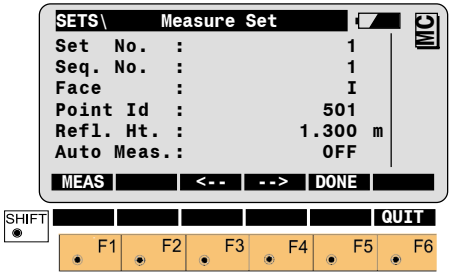
- **Measure Further Set**

After finishing the first set, select Measure Further Set again. You must repeat the above procedure to measure at least one more set. You may measure more than one additional set, up to the maximum number of pointings supported by Sets of Angles (64 Face I / Face II pointings to targets.)

If you have a motorized instrument, you will be able to specify the number of additional sets, and the instrument will turn to each target point in sequence until all the additional sets have been measured. TCA- and TCRA-instruments will automatically measure to all target points that have the Auto. Meas. parameter set to ON.

If you have a non-motorized instrument, you will select Measure Further Set after each set is completed, until all additional sets have been measured.

The Telescope Positioning dialog will help you find the target points in sequence.



Set no.
Displays the number of the set currently being measured.

Seq. no.
Displays the sequential number of the point currently being measured.

Point Id
Input the Point Id of the point currently being measured.

Refl. Ht.
(Optional, but necessary for the program to correctly calculate the elevation of the target point.) Input the Reflector Height of the point currently being measured.

Auto Meas.
Automatic Measurement option, available only with motorized instruments. Select ON or OFF as desired.

If **OFF**, motorized instruments must be manually pointed to this target point in further sets.

If **ON**, motorized instruments will automatically turn toward this target point in further sets.

If **ON** and the target is a prism, motorized instruments with ATR will automatically turn toward, fine point and measure to this target point.

Prism Type
(Optional, but necessary for the instrument to correctly measure the distance to the target point.) Select the type of prism at this target point.

PrismConst
Display only of the offset of the current Prism Type. Will be updated if the Prism Type is changed.

Press after all settings are correct and go to the Measurement Dialog.

(Optional) Press to create a list of up to ten target points. Subsequent measurements may then be made by selecting the target point from this list.

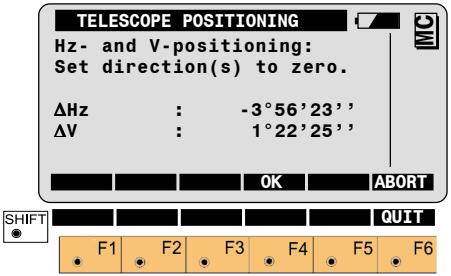
(Not available until a list of target points has been defined.) Press to select the previous point on the list.

(Not available until a list of target points has been defined.) Press to select the next point on the list.

Press when all target points have been measured in Face II or to abort measurement.

- **Telescope Positioning (non motorized instruments only)**

To help you locate the target points easily when you are using a non-motorized instrument, and to reduce the possibilities for errors in target point identification, Sets of Angles displays the differences between the current orientation of the telescope and the "learned" direction to the target point specified on the previous dialog.



Δ Hz
Displays the difference between the current value of the Horizontal Circle and the first direction to the target point. Manually turn the instrument until the value is zero, then the instrument will be oriented toward the target point.

Δ V
Displays the difference between the current value of the Vertical Circle and the first direction to the target point. Manually turn the instrument until the value is zero, then the instrument will be oriented toward the target point.

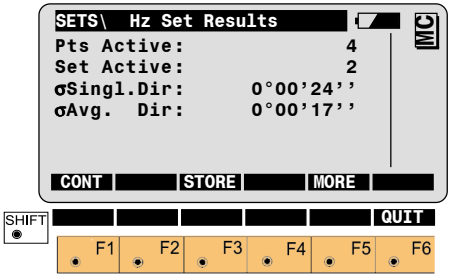
F4 Press when you are ready to measure to the target point. You will see the Measure Further sets measure dialog. This is not displayed until the telescope is within 0°27' (0.5 gon) of the target point.

F6 Press to abort and return to the previous dialog.

- **Calculate Horizontal and Vertical Sets**

The general display format is the same for horizontal directions, vertical directions and slope distances. The data displayed refer to the calculation function selected from the Sets Menu.
Standard deviations of a single direction in both faces (σSingl.Dir) and the standard deviation for an averaged direction from all sets (σAvg. Dir) are calculated.

Computations of standard deviations require that all targets and sets are observed in two faces. Exceptions may exist, in which case the standard deviation should be seen as an approximation to be used as a field control. The correct standard deviations a posteriori in this case can be calculated using the recorded data and a suitable computation method.



Pts. Active
Number of observed points used in the calculation.

Sets Active
Number of observed sets used in the calculation.

σSingl.Dir
Standard deviation of one observed horizontal or vertical direction, ok slope distance

σAvg. Dir
Standard deviation of an average direction ok slope distance from all sets.

F3 Results of sets of angles are recorded in the Meas Job. (*For details see dialog "FORMATS AND MORE INFORMATION"*)

F5 Show the results of individual measurements on the screen. (*For details see dialog "More Information"*).

F1 Returns to Set Menu.

SHIFT F6 Exit the program.

- **Example of Measure Job Data**

The following data are the result of running Sets of Angles to measure three sets to three target points (Point Ids 2, 3 and 5.) The horizontal, vertical and distance results were stored in the Meas. Job as well. The instrument was set to store data in GSI8 format using the long-time Leica Geosystems "standard" raw measurement data.

Record numbers 1 through 18 (110001 - 110018) are the raw measurement data. Records 19 through 39 (410019 - 410039) are the results data. The results data are explained below.

```
110001+00000002 21.322+20650070 22.322+06456000 31..08+00307660 51..1.+0000+000
110002+00000003 21.322+24530390 22.322+06215080 31..08+00290900 51..1.+0000+000
110003+00000005 21.322+29713310 22.322+07412400 31..08+00459730 51..1.+0000+000
110004+00000005 21.322+09713570 22.322+32587690 31..08+00459610 51..1.+0000+000
110005+00000003 21.322+04530500 22.322+33784700 31..08+00290800 51..1.+0000+000
110006+00000002 21.322+00650090 22.322+33543850 31..08+00307620 51..1.+0000+000
110007+00000002 21.322+20649620 22.322+06456000 31..08+00307670 51..1.+0000+000
110008+00000003 21.322+24529920 22.322+06215230 31..08+00290890 51..1.+0000+000
110009+00000005 21.322+29712870 22.322+07412590 31..08+00459740 51..1.+0000+000
110010+00000005 21.322+09713140 22.322+32587570 31..08+00459600 51..1.+0000+000
110011+00000003 21.322+04529930 22.322+33784680 31..08+00290830 51..1.+0000+000
110012+00000002 21.322+00649620 22.322+33543880 31..08+00307620 51..1.+0000+000
110013+00000002 21.322+20649680 22.322+06456170 31..08+00307660 51..1.+0000+000
110014+00000003 21.322+24529940 22.322+06215210 31..08+00290900 51..1.+0000+000
110015+00000005 21.322+29712900 22.322+07412560 31..08+00459740 51..1.+0000+000
110016+00000005 21.322+09713160 22.322+32587480 31..08+00459620 51..1.+0000+000
110017+00000003 21.322+04530200 22.322+33784770 31..08+00290800 51..1.+0000+000
110018+00000002 21.322+00649690 22.322+33543840 31..08+00307620 51..1.+0000+000
410019+HZ-RESLT 42....+00000003 43....+00000003 44....+00000038 45....+00000022
410020+HZ-MEAN0 42....+00000002 43....+00000000
410021+HZ-MEAN0 42....+00000003 43....+03880358
410022+HZ-MEAN0 42....+00000005 43....+09063360
410023+HZ-DIFF0 42....+00000002 43....+10000000 44....+20000000 45....+30000000
410024+HZ-DIFF0 42....+00000003 43....-10000034 44....+20000063 45....-30000029
410025+HZ-DIFF0 42....+00000005 43....+10000003 44....-20000020 45....+30000016
410026+V0-RESLT 42....+00000003 43....+00000003 44....+00000057 45....+00000033
410027+V0-MEAN0 42....+00000002 43....+06456103
410028+V0-MEAN0 42....+00000003 43....+06215224
410029+V0-MEAN0 42....+00000005 43....+07412466
410030+V0-DIFF0 42....+00000002 43....+10000022 44....+20000042 45....-30000064
410031+V0-DIFF0 42....+00000003 43....+10000029 44....-20000041 45....+30000011
410032+V0-DIFF0 42....+00000005 43....+10000102 44....-20000026 45....-30000076
410033+D0-RESLT 42....+00000003 43....+00000003 44....+00000004 45....+00000002
410034+D0-MEAN0 42....+00000002 43....+00307642
410035+D0-MEAN0 42....+00000003 43....+00290853
410036+D0-MEAN0 42....+00000005 43....+00459673
410037+D0-DIFF0 42....+00000002 43....+10000002 44....-20000003 45....+30000002
410038+D0-DIFF0 42....+00000003 43....+10000003 44....-20000007 45....+30000003
410039+D0-DIFF0 42....+00000005 43....+10000003 44....+20000003 45....-30000007
```

- **Formats and Data Recording**

The following formats are used to record results in the Meas Job.

Horizontal direction results:

WI 41 HZ-RESLT = Horizontal direction results
V0-RESLT = Vertical direction results
D0-RESLT = Slope distance results

WI 42 Number of target points observed

WI 43 Number of sets active in the computation

WI 44 Standard deviation of a single horizontal or vertical direction, or a slope distance

WI 45 Standard deviation of the mean horizontal or vertical direction, or slope distance

Horizontal Results	Number of target points =3	Number of sets =3	mR (standard deviation of a single direction) =3.8 cc	mM (standard deviation of the mean direction) =2.2 cc
410019+HZ-RESLT	42....+00000003	43....+00000003	44....+00000038	45....+00000022
WI 41	WI 42	WI 43	WI 44	WI 45

WI 41 HZ-MEAN0 = Mean horizontal direction
V0-MEAN0 = Mean vertical direction
D0-MEAN0 = Mean slope distance

WI 42 Target Point Id

WI 43 Mean value

Horizontal Mean	Target Point Id	Mean Horizontal Direction (First target point always =0)
410020+HZ-MEAN0	42....+00000002	43....+00000000
410021+HZ-MEAN0	42....+00000003	43....+03880358
410022+HZ-MEAN0	42....+00000005	43....+09063360
WI 41	WI 42	WI 43

WI 41 HZ-DIFF0 = Horizontal direction residual, per set
V0-DIFF0 = Vertical direction residual, per set
D0-DIFF0 = Slope distance residual, per set

WI 42 Target Point Id

WI 43 - 48 Residuals, per set

Residual (Mean Direction) per Set	Target Point Id	Set number and residual (Point Id 3, Set 1 = - 3.4 cc)	Set number and residual (Point Id 3, Set 2 = +6.3 cc)	Set number and residual (Point Id 3, Set 3 =- 2.9 cc)
410020+HZ-DIFF0	42....+00000002	43....+10000000	44....+20000000	45....+30000000
410020+HZ-DIFF0	42....+00000003	43....-10000034	44....+20000063	45....-30000029
410020+HZ-DIFF0	42....+00000005	43....+10000003	44....-20000020	45....+30000016
WI 41	WI 42	WI 43	WI 44	WI 45

Vertical direction results:

Vertical Results	Number of target points =3	Number of sets =3	mR (standard deviation of a single direction) = 5.7 cc	mM (standard deviation of the mean direction) = 3.3 cc
410019+V0-RESLT	42....+00000003	43....+00000003	44....+00000057	45....+00000033
WI 41	WI 42	WI 43	WI 44	WI 45

Vertical Mean	Target Point Id	Mean Vertical Direction
410020+V0-MEAN0	42....+00000002	43....+06456103
410020+V0-MEAN0	42....+00000003	43....+06215224
410020+V0-MEAN0	42....+00000005	43....+07412466
WI 41	WI 42	WI 43

Residual (Mean Direction) per Set	Target Point Id	Set number and residual (Point Id 3, Set 1= + 2.9 cc)	Set number and residual (Point Id 3, Set 2= - 4.1 cc)	Set number and residual (Point Id 3, Set 3= +1.1 cc)
410020+V0-DIFF0	42....+00000002	43....+10000022	44....+20000042	45....-30000064
410020+V0-DIFF0	42....+00000003	43....+10000029	44....- 20000041	45....+30000011
410020+V0-DIFF0	42....+00000005	43....+10000102	44....- 20000026	45....-30000076
WI 41	WI 42	WI 43	WI 44	WI 45

Slope distance results

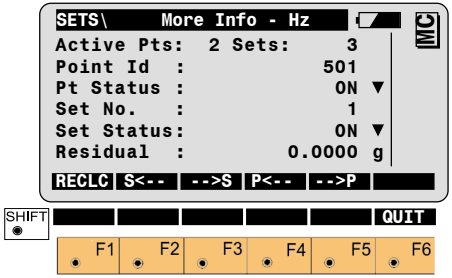
Distance Results	Number of target points =3	Number of sets =3	mR (standard deviation of a single direction) = 0.4 mm	mM (standard deviation of the mean direction) = 0.2 mm
410019+D0-RESLT	42....+00000003	43....+00000003	44....+00000004	45....+00000002
WI 41	WI 42	WI 43	WI 44	WI 45

Distance Mean	Target Point Id	Mean Distance
410020+D0-MEAN0	42....+00000002	43....+00307642
410020+D0-MEAN0	42....+00000003	43....+00290853
410020+D0-MEAN0	42....+00000005	43....+00459673
WI 41	WI 42	WI 43

Residual (Mean Distance) per Set	Target Point Id	Set number and residual (Point Id 3, Set 1= +0.3 mm)	Set number and residual (Point Id 3, Set 2= - 0.7 mm)	Set number and residual (Point Id 3, Set 3= +0.3 mm)
410020+D0-DIFF0	42....+00000002	43....+10000002	44....- 20000003	45....+30000002
410020+D0-DIFF0	42....+00000003	43....+10000003	44....- 20000007	45....+30000003
410020+D0-DIFF0	42....+00000005	43....+10000003	44....+20000003	45....-30000007
WI 41	WI 42	WI 43	WI 44	WI 45

- **More Information**

Further information is given relating to the differences of the measurements. Single points or full sets can be deactivated prior to calculation.



Active Pts
Number of points used in the calculation.

Sets
Number of sets used in the calculation.

Point no.
Target point.

Pnt. Status
Point used for computation (**ON/OFF**).

Set no.
Present displayed set.

Set Status
Point used for computation (**ON/OFF**).

Residual
Difference in horizontal direction, vertical direction or slope distance, using the direction of the active set and the averaged direction of all sets. For the vertical directions, the residual is used to compute the standard deviations.

F1 Re-calculate the results and return to the dialog showing the results.

F2 Display previous set.

F3 Display the next set.

F4 Display the previous point.

F5 Display the next point.

SHIFT F6 Exit the program.

A typical example of a Hz - measurement is shown in the following list:
The example shows a survey with 3 sets and 4 targets with directions in ° ' ".
The calculations are carried out according to the following table.

$$mR = \sqrt{\frac{\Sigma v^2}{(N-1)\,(s-1)}} = \sqrt{\frac{23''}{(4-1)\,(3-1)}} = \pm 2''$$

$$mM = \frac{mR}{\sqrt{s}} = \frac{2''}{\sqrt{3}} = \pm 1''$$

PtNr	Face I	Face II	Average face I+II (a)	Reduced average of set (b)	Average (d)	r= d - b	v= r+q	v²
1	0°00'20"	180°00'17"	0°00'19"	0°00'00"	0°00'00"	0	+1	1
2	24°43'34"	204°43'31"	24°43'33"	24°43'14"	24°43'10"	-4	-3	9
3	84°47'15"	264°47'11"	84°47'13"	84°46'54"	84°46'53"	-1	0	0
4	306°41'52"	126°41'42"	306°41'47"	306°41'28"	306°41'28"	0	+1	1
					q= -(Σ r)/N q =	-(5")/4 +1	Σ v=-1	
1	45°00'13"	225°00'16"	45°00'15"	0°00'00"		0	0	0
2	69°43'24"	249°43'23"	69°43'24"	24°43'09"		+1	+1	1
3	129°47'06"	249°47'08"	129°47'07"-9"	84°46'52"		+1	+1	1
4	351°41'45"	171°41'44"	351°41'45"	306°41'30"		-2	-2	4
					q= -(Σ r)/N q =	-(0)/4 0	Σ v=0	
1	90°00'19"	270°00'19"	90°00'19"	0°00'00"		0	-1	1
2	114°43'28"	294°43'26"	114°43'27"	24°43'08"		+2	+1	1
3	174°47'10"	354°47'15"	174°47'13"	84°46'54"		-1	-2	4
4	36°41'47"	216°41'45"	36°41'46"	306°41'27"		+1	0	0
					q= -(Σ r)/N q =	-(2)/4 -1	Σ v=-2	
							Σ v² =	23

A typical example of a V - measurement is shown in the following list:
The example shows a survey with 3 sets and 4 targets and directions in ° ' ".
The calculations are carried out according to the following table. The same method is used for slope distances.

$$mR = \sqrt{\frac{\Sigma v^2}{N*s-1}} = \sqrt{\frac{34''}{4*3-1}} = \pm 2''$$

$$mM = \frac{mR}{\sqrt{s}} = \frac{2''}{\sqrt{3}} = \pm 1''$$

Pt-Nr	Face I	Face II	Average face I+II (a)	Average (d)	v = d-a	v²
1	87°13'58"	272°46'24"	87°13'47"	87°13'46"	-1	1
2	88°42'12"	271°18'18"	88°41'57"	88°41'55"	-2	4
3	89°44'22"	270°16'00"	89°44'11"	89°44'11"	0	0
4	91°06'47"	268°53'38"	91°06'34"	91°06'33"	-1	1
1	87°14'01"	272°46'22"	87°14'49"		-3	9
2	88°42'09"	271°18'20"	88°41'54"		+1	1
3	89°44'27"	270°16'00"	89°44'13"		-2	4
4	91°06'47"	268°53'40"	91°06'33"		0	0
1	87°14'01"	272°46'34"	87°13'43"		+3	9
2	88°42'09"	271°18'20"	88°41'54"		+1	1
3	89°44'23"	270°16'04"	89°44'09"		+2	4
4	91°06'49"	268°53'42"	91°06'33"		0	0
					Σ V= -2	
					Σ v²=	**34**

Used formulae and designations

a = In both faces observed and averaged direction.
b = In both faces averaged and reduced direction of a set
d = Final averaged direction from all sets.
r = Difference between a final direction averaged from all sets and a single direction of a set.
q = Average of the differences (r).
v = Residuals.
s = Number of sets
N = Number of targets.

r = d - b
v = r + q for horizontal directions
v = d - a for vertical directions

Average of the differences for horizontal directions.

$$q = \frac{\Sigma r}{N}$$

Standard deviation of one horizontal direction observed in two faces.

$$mR = \sqrt{\frac{\Sigma v^2}{(N-1)\,(s-1)}}$$

Standard deviation of one vertical direction observed in two faces.

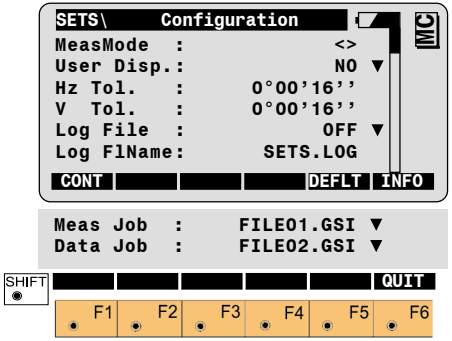
$$mR = \sqrt{\frac{\Sigma v^2}{N*s-1}}$$

Standard deviation of an averaged direction from all sets.

$$q = \frac{mR}{\sqrt{s}}$$

Configuration Editor

Start the "Configuration Editor" from the "SETS MENU" dialog.



The "Configuration Editor" sets parameters for further program operations:

Meas Method

> < All targets have to be observed for face II in **opposite** order to the observations in face I.

> > All targets have to be observed in face II using the **same** sequence as for the observations in face I.

◊ Each target has to be observed in face II immediately after its measurement for face I has been completed.

User Displ
Set to **YES**, the display defined in the "MEAS" application will be used.
NO uses the "SETS OF ANGLES" default display.

Hz Tol.
Input the tolerance for Hz-directions. This defines the limit for the difference between the actual direction and the direction observed within the first half set. A change in the horizontal circle orientation is always accounted for, after observing the first target within a new set. If the tolerance is exceeded, a warning is given.

V Tol.
Input the tolerance for vertical directions. This defines the limit for the difference in the vertical directions between the actual observations and the directions observed within the first half set. If the tolerance is exceeded, a warning is given.

Log File
ON, records measurements in a Log-File.
The format is described in *chapter "Log File" (see next page)*.

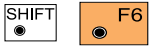
Log FlName
Enter the Log File Name.

Meas Job
Selection of the measurement job for recording measurements.

Data Job
Selection of the data job containing the fix point coordinates (control data).

Displays date and version.

Set default values. Default values are displayed in dialog "CONFIGURATION".



Exit the program

Store the current configuration and proceed to the dialog "SETS MENU".

If "LOG FILE" is set to ON the measurements and the results are stored in the ASCII-file specified within the "Configuration Editor". This file is created in the directory LOG on the memory card. Subsequently, you can read the memory card on your PC and obtain a hard copy of the Log-file.

Data will always be appended to the specified Log-file.

The Log-file contains the following information:

Header
The header line will contain the program used, information about the instrument, the name of the data file as well as date and time the program was started.

Data
The average horizontal and vertical angles of all sets, the standard deviation for one measurement and the standard deviation of an angle averaged from all sets, are stored in the Log-File.

The following data are the result of running Sets of Angles to measure three sets to three target points and computing the horizontal, vertical and distance results (the same data as in the Meas Job shown previously.)

```
Leica Geosystems  Program Sets of Angles V 1.00
Instrument    :
Meas. File    : FILE01.GSI
Program Start : 29/04/1998 at 11:04

Station       : 1
                E=          100.00000m     N=       100.00000m
                H=          400.00000m     hi=        0.00000m

Horizontal set results:
3 Sets measured with 3 points each.

Standard deviation of any measurement                :        0.00038g
Standard deviation of mean from all measurements     :        0.00022g
1.  Point Id : 2
                mean direction :                0.00000g
                Refl. Ht.      :                0.00000m
                Prism Type     :          Leica refl.tape
                Prism Constant :                0.03440m
2.  Point Id : 3
                mean direction :               38.80359g
                Refl. Ht.      :                0.00000m
                Prism Type     :          Leica refl.tape
                Prism Constant :                0.03440m
3.  Point Id : 5
                mean direction :               90.63361g
                Refl. Ht.      :                0.00000m
                Prism Type     :          Leica refl.tape
                Prism Constant :                0.03440m
```

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```
Results of single sets:

1.  Point Id : 2
              Set  1  :  Residual  :        0.00000g
                         average   :        0.00000g
              Set  2  :  Residual  :        0.00000g
                         average   :        0.00000g
              Set  3  :  Residual  :        0.00000g
                         average   :        0.00000g
2.  Point Id : 3
              Set  1  :  Residual  :       -0.00034g
                         average   :       38.80393g
              Set  2  :  Residual  :        0.00064g
                         average   :       38.80295g
              Set  3  :  Residual  :       -0.00029g
                         average   :       38.80388g
3.  Point Id : 5
              Set  1  :  Residual  :        0.00003g
                         average   :       90.63357g
              Set  2  :  Residual  :       -0.00020g
                         average   :       90.63381g
              Set  3  :  Residual  :        0.00017g
                         average   :       90.63344g

Vertical set results:
3 Sets measured with 3 points each.

Standard deviation of any measurement                :        0.00057g
Standard deviation of mean from all measurements     :        0.00033g
```

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```
1.  Point Id : 2
              mean direction  :          64.56104g
              Refl. Ht.       :           0.00000m
              Prism Type      :        Leica refl.tape
              Prism Constant  :           0.03440m
2.  Point Id : 3
              mean direction  :          62.15225g
              Refl. Ht.       :           0.00000m
              Prism Type      :        Leica refl.tape
              Prism Constant  :           0.03440m
3.  Point Id : 5
              mean direction  :          74.12466g
              Refl. Ht.       :           0.00000m
              Prism Type      :        Leica refl.tape
              Prism Constant  :           0.03440m

Results of single sets:

1.  Point Id : 2
              Set  1  :  Residual :           0.00022g
                         average  :          64.56081g
              Set  2  :  Residual :           0.00042g
                         average  :          64.56061g
              Set  3  :  Residual :          -0.00064g
                         average  :          64.56168g

2.  Point Id : 3
              Set  1  :  Residual :           0.00030g
                         average  :          62.15195g
```

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```
                Set  2  :  Residual  :        -0.00041g
                           average   :        62.15266g
                Set  3  :  Residual  :         0.00011g
                           average   :        62.15214g
3.  Point Id : 5
                Set  1  :  Residual  :         0.00103g
                           average   :        74.12364g
                Set  2  :  Residual  :        -0.00026g
                           average   :        74.12493g
                Set  3  :  Residual  :        -0.00076g
                           average   :        74.12543g

Distance set results:
3 Sets measured with 3 points each.

Standard deviation of any measurement                :      0.00004m
Standard deviation of mean from all measurements     :      0.00002m

1.  Point Id : 2
                mean distance  :              3.07642m
                Refl. Ht.      :              0.00000m
                Prism Type     :        Leica refl.tape
                Prism Constant :              0.03440m
2.  Point Id : 3
                mean distance  :              2.90853m
                Refl. Ht.      :              0.00000m
                Prism Type     :        Leica refl.tape
                Prism Constant :              0.03440m
3.  Point Id : 5
```

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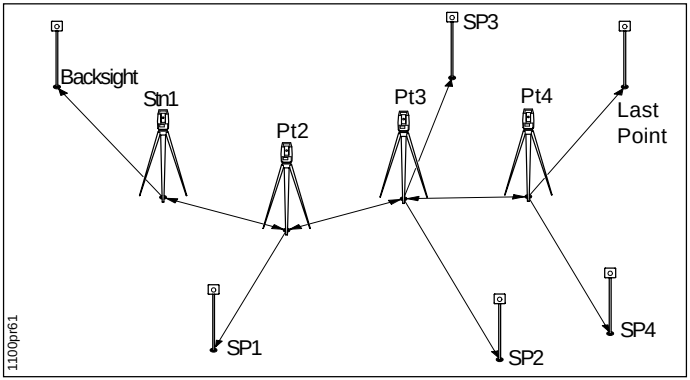
```
                mean distance :          4.59673m
                Refl. Ht.     :          0.00000m
                Prism Type    :      Leica refl.tape
                Prism Constant :         0.03440m

Results of single sets:

1.  Point Id : 2
                Set  1  :  Residual  :       0.00000m
                           average   :       3.07640m
                Set  2  :  Residual  :      -0.00003m
                           average   :       3.07645m
                Set  3  :  Residual  :       0.00000m
                           average   :       3.07640m
2.  Point Id : 3
                Set  1  :  Residual  :       0.00003m
                           average   :       2.90850m
                Set  2  :  Residual  :      -0.00007m
                           average   :       2.90860m
                Set  3  :  Residual  :       0.00003m
                           average   :       2.90850m
3.  Point Id : 5
                Set  1  :  Residual  :       0.00003m
                           average   :       4.59670m
                Set  2  :  Residual  :       0.00003m
                           average   :       4.59670m
                Set  3  :  Residual  :      -0.00007m
                           average   :       4.59680m
```

Introduction

This manual describes the "Traverse" program of the TPS1100 Professional Series instruments.

Using data about direction and distance, the program continuously computes the coordinates of the station (in the example shown above, the instrument "moves" from one station to the next, previously measured point) and aligns the horizontal circle.

For a point whose coordinates are known, the deviation from the coordinates determined by measurement can be computed and displayed.



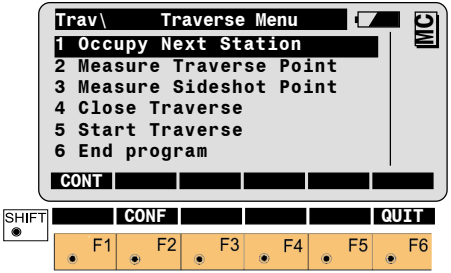
There is no adjustment of these differences in coordinates and direction. Subsequently, however, the measurements stored on the PCMCIA can be processed with the assistance of an appropriate software program.

Individual stations can be calculated as "sideshots" (SP). The coordinates and directions of these points are also determined in the course of this program.

If the program is terminated (e.g. to record a detail point), the values remain stored. The measurement procedure can be resumed after calling up the program again.

Traverse Menu

In this display, the individual functions of the program can be called. After a function has been performed, the user returns to this display.



Occupy Station

Select to occupy a station previously measured in this traverse.

Traverse Point

Select to measure to the next traverse station.

Sideshot Point

Select to measure to a sideshot point.

Close Traverse

Select to compute the misclosure data for the current traverse.

New Traverse

Select to discard any retained information and start a new traverse.

End Program

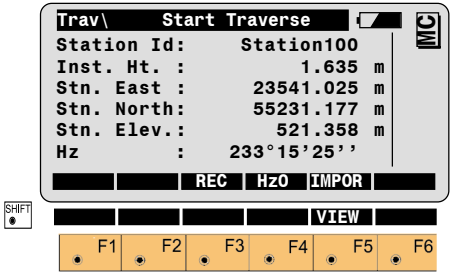
Select to end the traverse program. Data for the current traverse will be retained in memory for use if the program is restarted later.

F1 Press to accept the currently highlighted selection.

SHIFT F2 Start the "CONFIGURATION".

SHIFT F6 Press this key combination to quit the Traverse program at any time.

Any data of a previous traverse in the memory will be erased at the start of a new traverse. To avoid unintentional erasing, a confirmation must be made.
The first dialog requests the entry of the station point number, height of instrument, station coordinates and the setting of a specified Hz-angle.



Station Id

Input the Point Id of the first occupied station in the traverse.

Inst. Ht.
(Optional, but necessary to correctly compute elevations.) Input the height of the instrument tilting axis above the occupied station.

Stn.East
Input the Easting, or X ordinate, of the occupied station. The station coordinates may be imported using the IMPOR hotkey.

Stn.North
Input the Northing, or Y ordinate, of the occupied station.

Stn.Elev
(Optional, but necessary to compute elevations.) Input the Elevation, or Z ordinate, of the occupied station.

Hz
The current horizontal circle value.

F3 Records manually entered station data on the active recording device. The program proceeds to the "Measure Mode" dialog.

F4 Set horizontal-circle direction. For further information, please refer to chapter "Measure & Record" of "System" - user manual.

F5 Import station coordinates. For further information, please refer to chapter "Setup" of "System" - user manual.

SHIFT F5 Press this key combination to import and view the stored coordinates of a point.

- **Select method of orientation**

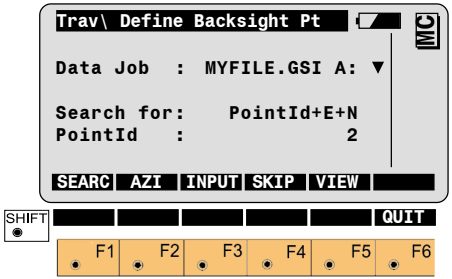
Three different methods orientation are available

1. Confirm the orientation already set in the system.[1] No measurements are performed (SYS).

2. Calculation of an azimuth from coordinates to one tie point. A following measurement to the tie point orients the Hz-circle (INPUT). *(See "Calculation Azimuth".*

3. Manual input of the azimuth to one tie point. A measurement to the tie point is required (AZI). *(See "Enter Backsight Azimuth")*

[1] If the orientation was previously determined with the "ORIENTATION" program, for example.



Data Job
Filename and location of the Job containing point coordinates to be recalled.

Search for
Describes what will be searched for in the Data Job.

Point Id
Input the Point Id to search for.

F1 Search coordinates in the Data Job. Continue with the "Measure Backsight Point" dialog.

F2 Select the "Measure Backsight Point" dialog and enter the azimuth.

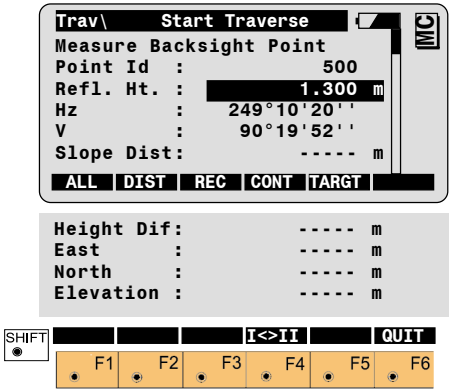
F3 Manual entry of coordinates for the tie point. The standard input dialog of the TPS 1100 is used. Continue with the "Measure Backsight Point" dialog.

F4 Confirms the present orientation. Continues with the dialog "TRAVERSE MENU".

F5 Search and view coordinates in the Data Job.

- **Calculate Azimuth**

This dialog corresponds to the TPS1100 Professional series "MEASURE" dialog.
On completion of a measurement, the program continues either with "MULTIPLE MEAS" or with the "TRAVERSE MENU" according to the settings in the configuration.



F1 Simultaneously measure and record data in the Meas Job.

F2 F3 Measure a distance[1] and record data in the Meas Job.

F2 F4 Measure a distance without recording in the Meas Job.

F4 Proceed to the dialog "TRAVERSE MENU".

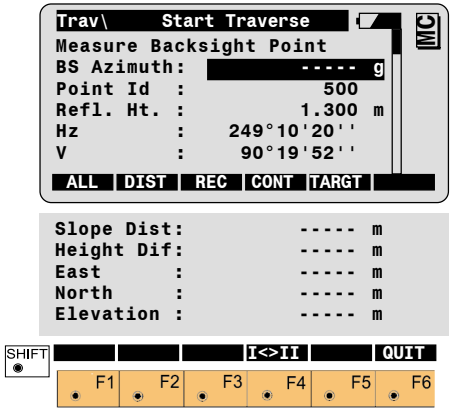
F5 Enter target data. (see User Manual)

SHIFT F4 Change the theodolite face.

[1] Distance measurement is optional.

- **Enter Backsight Azimuth**

This dialog corresponds to the TPS 1100 Professional series "MEASURE" dialog with the additional entry of the backsight azimuth.
On completion of the first measurement, the program continues either with "MULTIPLE MEAS" or with the "TRAVERSE MENU" according to the settings in the configuration.



BS Azimuth
Enter the backsight azimuth for the orientation.

F1 Simultaneously measure and record data in the Meas Job.

F2 F3 Measure a distance[1] and record data in the Meas Job.

F2 F4 Measure a distance without recording in the Meas Job.

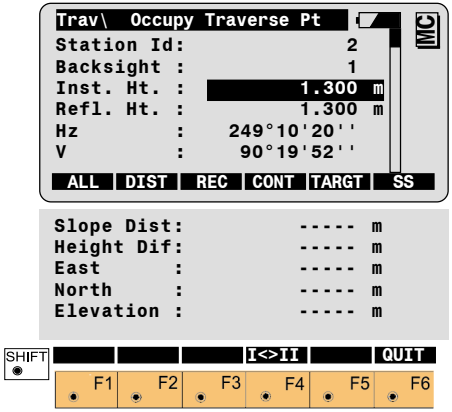
F5 Enter target data. (see User Manual)

SHIFT F4 Change the theodolite face.

[1] Distance measurement is optional.

The instrument is set up on previously measured traverse point. A measurement (distance measurement is optional) is made to the last traverse point.

This dialog corresponds to the TPS1100 Professional series "MEASURE" dialog. After the function has been performed, the station coordinates and orientation are set in the instrument.



Station Id
Station identifier

Backsight
Backsight identifier

F1 Simultaneously measure and record data in the Meas Job.

F2 F3 Measure a distance[1] and record data in the Meas Job.

F2 F4 Measure a distance without recording in the Meas Job.

F4 Proceed to the dialog "TRAVERSE MENU".

F5 Enter target data. (see User Manual)

F6 Toggles to select the last measured sideshot, or the last measured traverse point, as the new station.[2]

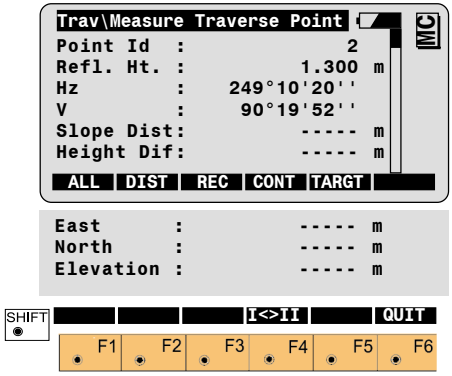
SHIFT F4 Change the theodolite face.

[1] Distance measurement is optional.

[2] Only active if a sideshot point was measured.

Only one Traverse Point may be measured to (distance required) from any given Occupy Station. As many Sideshot Points as desired may be measured (distance required).

This corresponds to the TPS1100 Professional series "MEASURE" dialog. After the measurement, the program continues either with "MULTIPLE MEAS" or with the "TRAVERSE MENU" according to the settings in the configuration.



F1 Simultaneously measure and record data in the Meas Job.

F2 F3 Measure a distance and record data in the Meas Job.

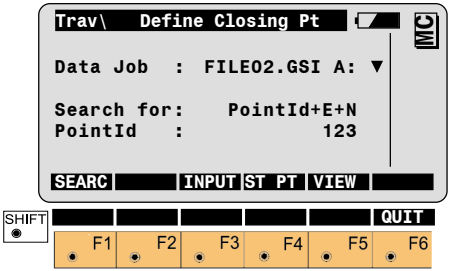
F2 F4 Measure a distance without recording in the Meas Job.

F4 Proceed to the dialog "TRAVERSE MENU".

F5 Enter target data. (see User Manual)

SHIFT F4 Change the theodolite face.

The program requires a closing point for comparison with the last traverse point measured. The default point number is the starting point of the traverse.

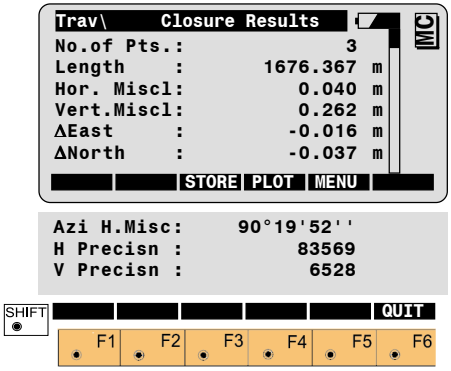


F1 Seach coordinates in the Data Job.

F3 Enter coordinates using the standard input dialog.

F4 Confirms the coordinates of the starting point.

F5 Search and view coordinates in the database.



No. of Pts.
Number of traverse points

Length
Length of traverse

Hor. Miscl.
Horizontal misclosure

Vert.Miscl.
Vertical misclosure

Δ East
Misclosure in easting (X)

Δ North
Misclosure in northing (Y)

Azi H.Misc
Azimuth of horizontal misclosure

H Precisn
Position precision

$$= \frac{\text{traverse length}}{\text{horizontal misclosure}}$$

V Precisn
Vertical precision

$$= \frac{\text{traverse length}}{\text{vertical misclosure}}$$

F3 The results of the traverse are recorded in the Meas Job.

F4 Plot of the traverse.

F5 Continue with the "Traverse Menu".

Examples

Codeblocks with results of the traverse closure:

WI 41: Code 38
WI 42: Number of traverse points.
WI 43: Length of traverse (sum of legs).
WI 44: Azimuth of misclosure

```
   410010+00000038  42....+0000005  43....+01013515
```

WI 41 Code 39
WI 42 Horizontal Misclosure
WI 43: Misclosure easting
WI 44: Misclosure northing
WI 45: Misclosure in height

```
410011+00000039 42...+0000123 43...+00000045 44...+00000114
45...+00000087
```

WI 41 Code 40
WI 42 Position precision (traverse length / Horizontal misclosure)
WI 43: Vertical precision (height difference / Horizontal misclosure)

```
410012+00000040   42....+0008239   43....+00011650
```

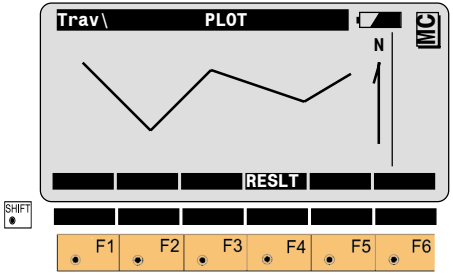
Measurement block with the traverse Station Coordinates of station points

WI 11: Point number
WI 25: ΔHz (correction of orientation)
WI 84: E_0 easting coordinate
WI 85: N_0 northing coordinate
WI 86: Height
WI 88: Instrument height

```
110015+00123456   25.143+14611200   84..40+00001215
85..40-00003153   86..40+00403285    88..10+00001555
```

Plot

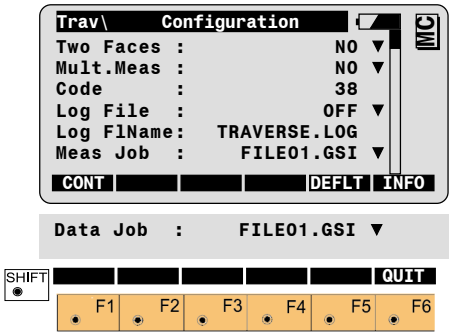
Generates a plot of the traverse.



F1 Return to the dialog "CLOSURE RESULTS".

Configuration Editor

Start the "Configuration Editor" from the "traverse menu" dialog.



The "Configuration Editor" sets parameters for further program operations:

Two Faces
YES for dual-face measurement
NO for single-face.

Mult.Meas
YES to allow multiple measurements,
NO for single measurement.

Code
Input the code number used when recording results in the Meas Job (max. 8 characters).

Log File
Set to ON, the program will record measurement data in the Log File according to the format described on *chapter Log File.*

Log FlName
Enter the Log File Name.

F1 Accept the displayed parameters and return to the "TRAVERSE MENU".

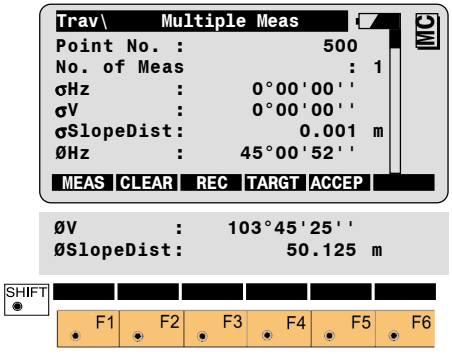
F5 Set all values to default. Default values are shown in dialog.

F6 Display the Traverse Information dialog.

Dual-face Measurement

In the dual-face mode, the program will prompt for measurements in both faces. When both measurements are taken, the program will check the difference between the two. If the difference in angle is within **27' (0.5 gon)** and the difference of two measured distances is within **0.5 m (1.64 ft)**, the observations will be averaged. These tolerances are used to avoid errors in target identification. If exceeded an error message will be displayed.

The measurement to a point can be repeated as often as desired to achieve a higher accuracy or reliability. The mean value of the measurements and the respective standard deviation is displayed.



Point no.
The target point number.

No. of Meas
Counter of the measurements.

σ Hz
Standard deviation of the horizontal direction for a single measurement.

σ V
Standard deviation of the vertical angle for a single measurement.

σ Slope Dist
Standard deviation of the slope distance for a single measurement.

Ø Hz
Mean value of the Hz-measurements.

Ø V
Mean value of the V-measurements.

ØSlope Dist
Mean value of the slope distances.

F1 Further measurements.

F2 Delete all measurements of the current point and start again.

F3 Record the mean value of the measurements on the active recording device. Return to the "TRAVERSE MENU" dialog.

F4 Enter target data. (see User Manual)

F5 Accept the mean values and return to the "TRAVERSE MENU".

If "LOG FILE" is set to ON, the measurements and the results are stored in the LOG FILE specified within the "Configuration Editor". This file is created in the directory LOG on the memory card. Subsequently, you can read the memory card on your PC and obtain a hard copy of the Log-file.

Data will always be appended to the specified Log-file.

The Log-file contains the following information:

Header
The header line will contain the name of this program, information about the instrument, the name of the data file and date and time.

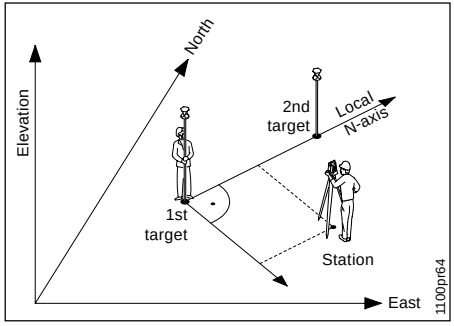
Record
Computed coordinates of traverse points are continously stored. The option Close traverse in the "TRAVERSE MENU" displays and stores at any time the coordinate - differences of traverse points of which the coordinates are known.

```
Leica Geosystems  Program Traverse V 1.00
Instrument        :   TCA1103, Serial 102999
Meas. File        :   MYFILE.GSI
Program Start     :   20/04/1998 at 10:25

Backsight         :   500
Station           :   Pt.1
                      E= -0.679m     N= 9.545m      H= 400.062m    hi= 1.530m

Station           :   Pt.2
                      E=-13.462m     N=10.528m      H= 400.170m    hi= 1.650m

Station           :   Pt.3
                      E=26.513m      N=16.821m      H= 401.260m    hi= 1.610m

Last Trav.Pt.     :   501
                      E= -77.949m    N= 25.037m     H= 399.923m

Closing Pt.       :   501
                      E= -78.016m    N= 24.996m     H= 400.181m

No. of Pts.       :   4
Length            :   82.788m
Hor. miscl.       :   0.047m
Vert. miscl.      :   0.268m
DEasting          :   -0.017m
DNorthing         :   -0.031m
Azi H.miscl       :   226°51'25"
H Precision       :   2036
V Precision       :   2356
```

Typical log file entry in the "TRAVERSE"

Introduction

This manual describes the "Local Resection" program of the TPS1100 Professional Series.



Two points are measured from any instrument station. The first point measured forms the centre of a local coordinate system (N=0; E=0; H=0). The second point measured determines the direction of the positive N - axis.

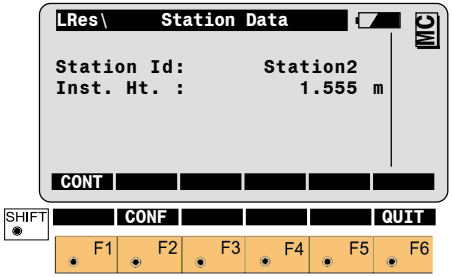
The program can be used to deduce the three-dimensional local coordinates for the instrument station and the orientation of the horizontal circle from measurements to 2 target points. To compute the position coordinates, at least 4 elements (2 distances and 2 directions) are necessary.

For simultaneous determination of the local station elevation, height of instrumentand height of reflector must already have been input.

The program allows measurement in single or dual-face mode.

Station Data

Enter station point number and height of the instrument.

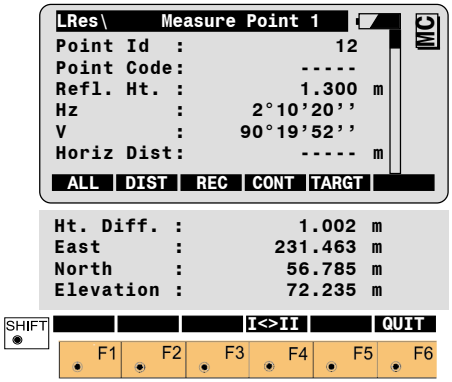


F1 Proceed to the dialog "MEASURE POINT 1".

SHIFT F2 Start the "CONFIGURATION"

SHIFT F6 Quit program.

This dialog is similar to the TPS1100's basic "MEASURE MODE" dialog. Once the measurement to the first and to the second point is taken, the program will proceed to the dialog "RESULTS".



F1 Simultaneously measure and record data in the active measurement job.

F2 Measure a distance.

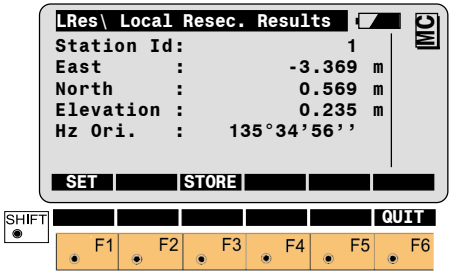
F3 Record the measurement in the active measurement job.

F4 Accept the measurement.

F5 Enter target data. (see User Manual)

SHIFT F4 Change the theodolite face.

In this dialog the calculated station coordinates are shown with orientation.



Station Id
Station point number

East
Calculated E (local) for the station

North
Calculated N (local) for the station

Elevation
Calculated Elevation (local) for the station

Hz. Ori
Angular correction needed to orient the instrument

F1 Set orientation and station coordinates on the instrument. Note that this key will end the program.

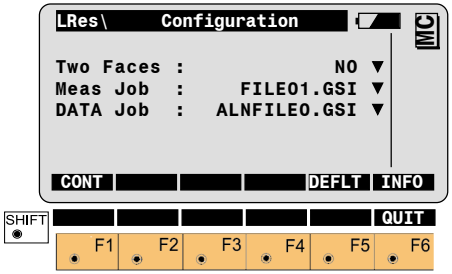
F3 Record the following results in the measurement job:

WI 11	Station Point Number
WI 25	Orientation correction
WI 84	Station Easting
WI 85	Station Northing
WI 86	Station Elevation
WI 87	Last reflector height used
WI 88	Instrument Height

SHIFT F6 Exit the program.

Depending on the configuration that is loaded onto your TPS1100 instrument, you may not see some or all of the options referred to below. See your Leica Geosystems dealer for more information about the configuration of your instrument.

SHIFT F2 Start the "Configuration Editor" from the "STATION DATA" dialog.



The "Configuration Editor" sets parameters for further program operations:

Two Faces
YES for dual-face measurement,
NO for single-face.

Meas. Job
Selection of the measurement job for recording measurements.

Data Job
Selection of the data job containing the fix point coordinates (control data).

Store the current configuration and proceed to the dialog "STATION DATA".

Set the value to the default.

Displays date and version of the running application.

In the dual-face mode, the program will prompt for measurements in both faces. When both measurements are taken, the program will check the difference between the two. If the difference in angle is within **27' (0.5 gon)** and the difference of two measured distances is within **0.5 m (1.64 ft)**, the observations will be averaged. These tolerances are used to avoid errors in target identification. If exceeded an error message will be displayed.

Introduction

This manual describes the "COGO" program of the TPS1100 Professional Series.
The following provides a general overview of the individual COGO functions.

The "**Inverse**" routine computes the direction and distance between two points.

The "**Traverse**" routine computes a new coordinate point given a direction and distance from a known point (Polar stakeout).

The "**Intersections**" routine computes:
- Bearing-Bearing intersections,
- Bearing-Distance intersections,
- Distance-Distance intersections or
- Intersection by Points

The function "**Offsets**" consists of the following subfunctions:
- "Distance point straight line"
  Calculates the difference in length/ abscissa and the lateral deviation/ ordinate with reference to a basis line emanating from a known point.
- "Orthogonal point calculation"
  A new point can be calculated which emanates from a basis line using the difference in length/ abscissa and the lateral deviation/ ordinate.

The "**Point Arc**" routine computes a radius point given any three points.

The point coordinates can either:
- be determined by measurement,
- entered manually using a keyboard or
- read from the memory card.

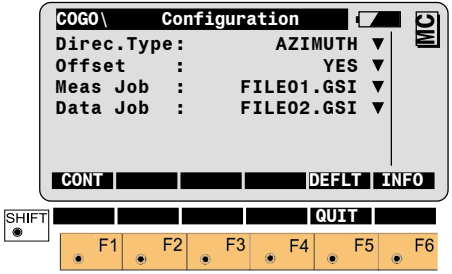
Data, both measured and read from the memory card, can be mixed. This means, however, that station coordinates and orientation have to be correctly set.

Directions and distances can be entered manually, called up or freshly determined. The values can then be amended by means of multiplication, division, addition and subtraction.

The program "Stakeout" can be called up directly from the individual result dialog boxes (if available) in order to set out the points immediately.
The program "Stakeout" assumes that the instrument is set and oriented to a known point.

Depending on the configuration that is loaded onto your TPS1100 instrument, you may not see some or all of the options referred to below. See your Leica Geosystems dealer for more information about the configuration of your instrument.

Start the "Configurations Editor" from the "**COGO MENU**" dialog.



The "Configuration Editor" sets parameters for further program operations:

Direc. Type Bearing
Azimuth

Offset
YES entering a parallel displacement is possible
NO entering a parallel displacement is not possible

Meas Job
Selection of the measurement job for recording measurements.

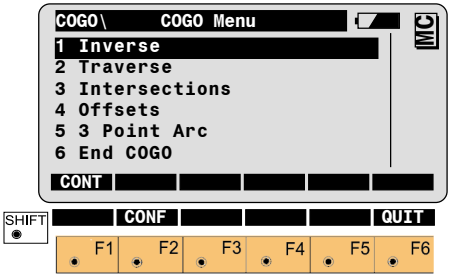
Data Job
Selection of the data job containing the fix point coordinates (control data).

F1 Accept displayed values and proceed to the dialog "COGO MENU".

F5 Set all values to default. The values are shown in the dialog above.

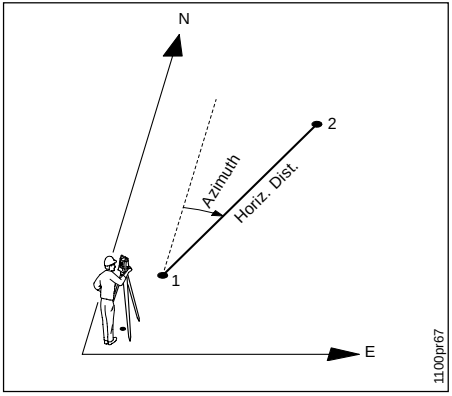
F6 Displays date and version.

SHIFT F6 Exit the program.



SHIFT F2 Call up the "Configuration-Editor".

Computes distance and direction between two points.

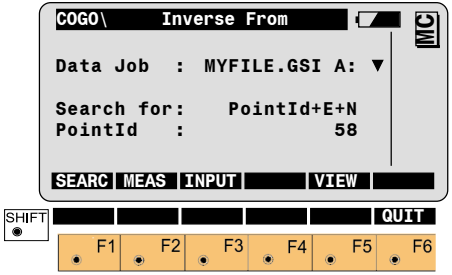


Search
- Direction (magnetic bearing or azimuth)
- Horizontal distance

Given
- point 1 (E, N)
- point 2 (E, N)

Station coordinates and orientation need to have been set correctly before the coordinates of point 1 (and/or 2) can be determined by measurement.

1 Call up the function Inverse in the "**COGO MENU**" dialog.



F1 Search for the coordinates of the first (second) point in the datajob.

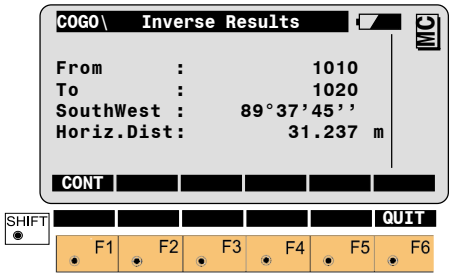
F2 Measuring the first (second) point of the straight line.

F3 Manual entering of the first (second) point of the straight line.

F5 Search and display the coordinates of the point found in the active data job.

SHIFT F6 Exit the program.

The following dialog box shows the result of the polar calculation from both the given points:



From
Display of point number of the first point

To
Display of point number of the second point

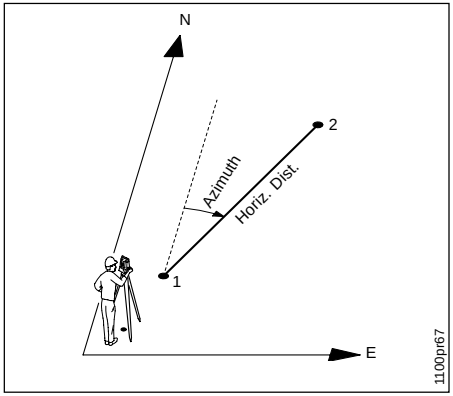
SouthWest
Display of magnetic bearing.
If "**Azimuth**" is selected in the configuration during "**Direc. Type**:", then the azimuth will be displayed between both the points.

Horiz.Dist.
Display of horizontal distance between the points

F1 Return to "COGO Menu".

SHIFT F6 Exit the program.

Computes a new point given a direction and distance from a known point.

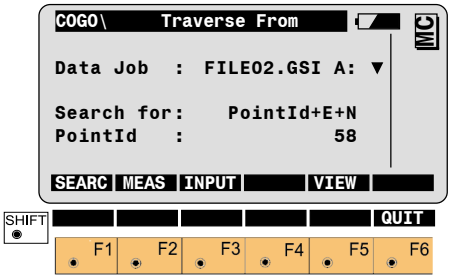


Search
- coordinates of point 2 (E, N)

Given
- point 1 (E, N),
- Direction (magnetic bearing or azimuth),
- Horizontal distance.

Station coordinates and orientation need to have been set correctly before the coordinates of point 1 can be determined by measurement.

2 Call up the function "Traverse" from the "**COGO MENU**".



F1 Search for coordinates of the first point in the data job.
Continue to *„Defining direction by magnetic bearing“ or „Defining direction by azimuth“*.

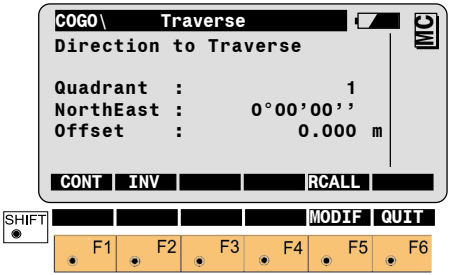
F2 Measuring the first point.

F3 Manual entering of the first point.

F5 Search and display the coordinates of the point found in the active data job.

SHIFT F6 Exit the program.

If "**Bearing**" is selected in the configuration for "**Direc. Type:**", then the following dialog box appears:



Quadrant

Enter quadrant:
1 = NorthEast
2 = SouthEast
3 = SouthWest
4 = NorthWest

Northeast
Enter magnetic bearing

Offset
Enter parallel displacement.
Only active if "**YES**" is entered in the configuration during "**Offset**:"
Left = negative parallel offset
Right = positive parallel offset

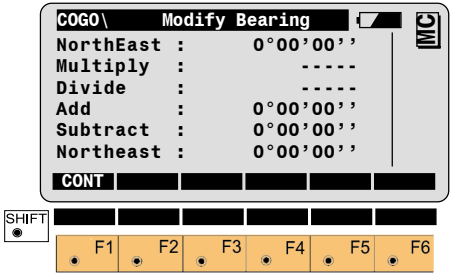
F1 Accept displayed values and proceed with dialog "Distance to Traverse".

F2 Determining the direction by means of the function "Polar calculation"(*refer to chapter "Inverse"*).

F5 INPUT Enter quadrant, magnetic bearing
RCALL Call up of a direction which has been previously stored using the function "**Polar calculation**".

SHIFT F5 Changing the direction see under existing dialog box "MODIFY BEARING"

SHIFT F6 Exit the program.



NorthEast
Display of entered magnetic bearings

Multiply
Entering multiplication factor

Divide
Entering division factor

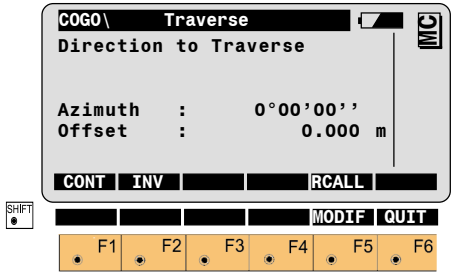
Add
Entering angle for a correction to the right

Subtract
Entering angle for a correction to the left

NorthEast
Display of corrected magnetic bearings

F1 Accept displayed values and proceed with *dialog "Distance to Traverse"*.

If "**Azimuth**" is selected in the configuration for "**Direc. Type:**", then the following dialog box appears:



Azimuth
Entering Azimuth

Offset
Entering parallel displacement.
Only active if "**YES**" is entered in the configuration during "**Offset:**"
Left = negative parallel offset
Right = positive parallel offset

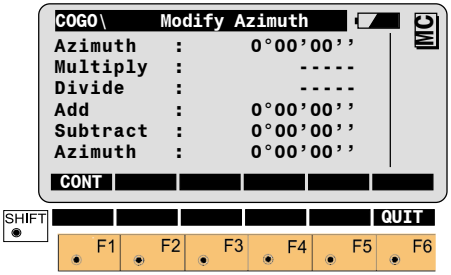
F1 Accept displayed values and proceed with *dialog "Distance to Traverse"*.

F2 Determining the direction by means of the function "**Polar calculation**" *(refer to chapter "INVERSE").*

F5 INPUT Entering Azimuth
RCALL Call up of a direction which has been previously stored using the function "**Polar calculation**".

SHIFT F5 Changing the direction *(refer to dialog "Modify Azimuth ")*

SHIFT F6 Exit the program.



Azimuth
Display of corrected Azimuth

F1 Accept displayed values and proceed to *dialog "Distance to Traverse"* .

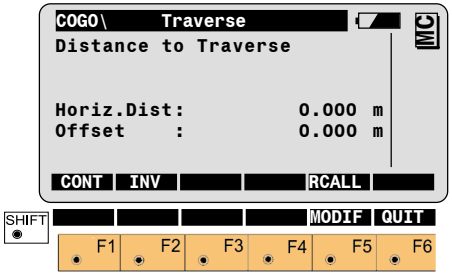
Azimuth
Display of entered Azimuth

Multiply
Entering multiplication factor

Divide
Entering division factor

Add
Entering angle for a correction to the right

Subtract
Entering angle for a correction to the left



Horiz.Dist
Entering horizontal distance

Offset
Entering parallel displacement.
Only active if "**YES**" is entered in the configuration during "**Offset:**"
Left = negative parallel offset
Right = positive parallel offset

F1 Accept displayed values and proceed to *dialog "Traverse results".*

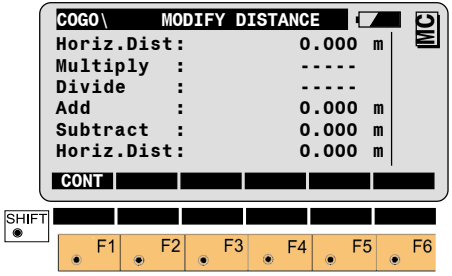
F2 Determining the distance by means of the function "**Polar calculation**" *(refer to chapter "Inverse").*

F5 INPUT Entering horizontal distance

RCALL Call up of a distance which has been previously stored using the function "Polar calculation".

SHIFT F5 Changing the distance *(refer to dialog "Modify Distance").*

SHIFT F6 Exit the program.



Horiz.Dist.
Display of entered horizontal distance

Multiply
Entering multiplication factor

Divide
Entering division factor

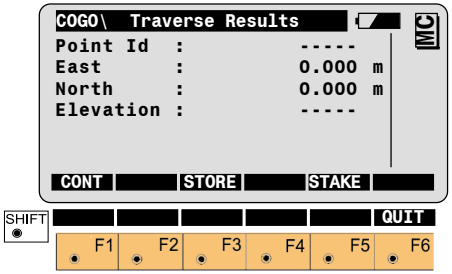
Add
Entering distance for a positive correction

Subtract
Entering distance for a negative correction

Horiz.Dist.
Display of corrected horizontal distance

Accept displayed values and proceed to *dialog "TRAVERSE RESULTS".*

The following dialog box shows the result of the traverse:



Point Id
Entering point number of the point to be accepted

East
Display of east coordinate

North
Display of north coordinate

Elevation
Entering height (optional)

F1 Return to "**COGO MENU**".

F3 The following results have been stored in the active measurement data file:

WI 11	Station Point Number
WI 81	Easting coordinate
WI 82	Northing coordinate
WI 83	Elevation (optional)

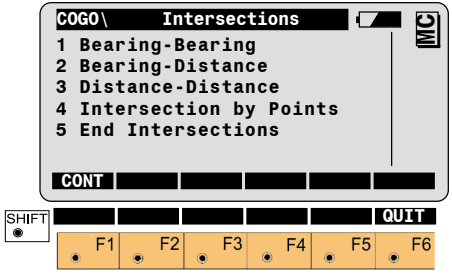
If "Point Id" has not been entered, the function is not available.

F5 Call up the program "Stakeout".
The program "Stakeout" assumes that the instrument is set and oriented to a known point.
If "Point Id" has not been entered, the function is not available.

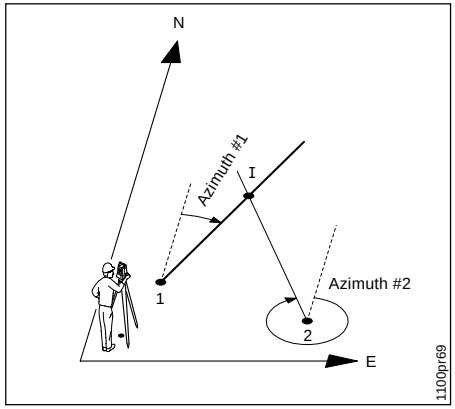
SHIFT F6 Exit the program.

Intersections

3 Call up the function"Intersections" from the "**COGO MENU**".



Bearing-Bearing Intersection

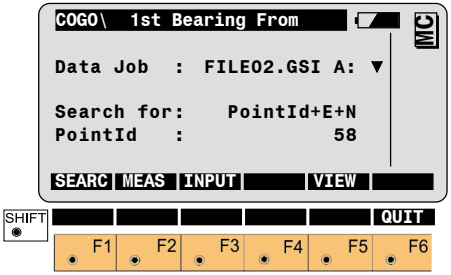


Search
- Coordinates of intersection (E, N)

Given
- point 1 (E, N), direction (magnetic bearing or azimuth)
- point 2 (E, N), direction (magnetic bearing or azimuth)

Station coordinates and orientation need to have been set correctly before the coordinates of point 1 (and/or 2) can be determined by measurement.

1 Call up the function "Bearing-Bearing" from the menu "Intersections".



F1 Search for the coordinates of the first (second) point in the datajob.

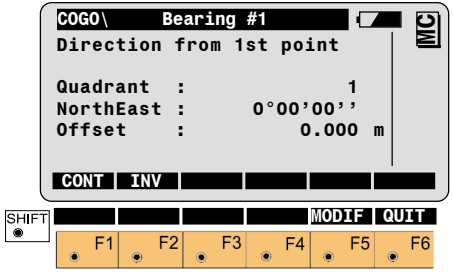
F2 Measuring the first (second) point of the straight line.

F3 Manual entering of the first (second) point of the straight line.

F5 Search and display the coordinates of the point found in the active data job.

SHIFT F6 Exit the program.

If "**Bearing**" is selected in the configuration for "**Direc. Type:**", then the following dialog box appears:



Quadrant
Enter quadrant (First or second straight lines)
1 = Northeast
2 = Southeast
3 = Southwest
4 = Northwest

NorthEast
Enter magnetic bearing (First or second straight lines)
If "**Azimuth**" is selected in the configuration during "**Direc.Type:**", then the azimuth of the first straight line (or the second straight line) can be entered.

Offset
Entering parallel displacement.
Only active if "**YES**" is entered in the configuration during "**Offset**:"
Left = negative parallel offset
Right = positive parallel offset

F1 Accept displayed values.

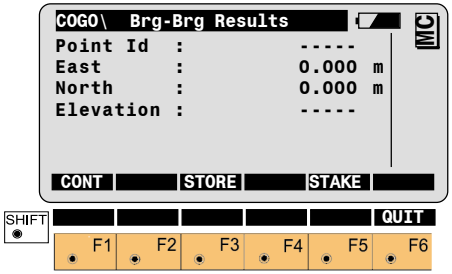
F2 Determining the direction by means of the function "**Polar calculation**" *(refer to chapter "Inverse").*

F5 INPUT
Enter bearing, mangnetic bearing resp. azimuth (if "**Azimuth**" is selected in the configuration during "**Direc. Type:**"
RCALL
Call up of a direction which has been previously stored using the function "**Polar calculation**".

SHIFT F5 Changing the direction *(as dialog box "Modify Bearing", "Modify Azimuth")*

SHIFT F6 Exit the program.

The following dialog box shows the result of the bearing-bearing intersection:



Point Id
Entering point number of the bearing-bearing

East
Display of east coordinate

North
Display of north coordinate

Elevation
Entering height (optional)

F1 Return to "INTERSECTIONS".

F3 The following results have been stored in the active measurement data file:

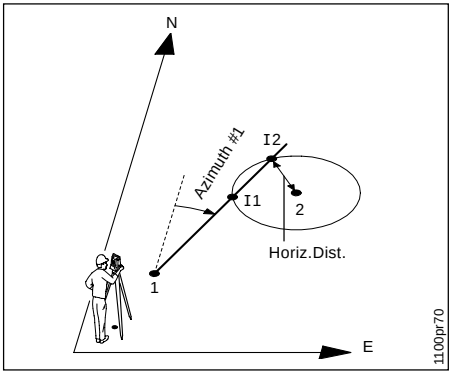
WI 11 Station Point Number
WI 81 Easting coordinate
WI 82 Northing coordinate
WI 83 Elevation (optional)

If "Point Id" has not been entered, the function is not available.

F5 Call up the program "Stakeout".

The program "Stakeout" assumes that the instrument is set and oriented to a known point.
If "Point Id" has not been entered, the function is not available.

SHIFT F6 Exit the program.



Search

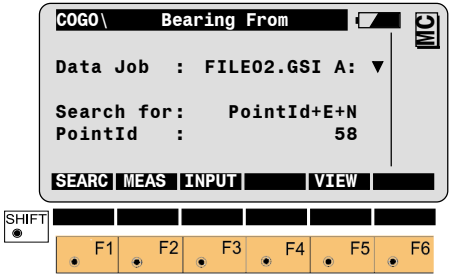
- Bearing-bearing coordinates S1 and S2 (E, N)

Given

- point 1 (E, N), direction (magnetic bearing or azimuth)
- point 2 (E, N), radius

Station coordinates and orientation need to have been set correctly before the coordinates of point 1 (and/or 2) can be determined by measurement.

2 Call up the function "Bearing-Distance" from the menu "**INTERSECTIONS**".



F1 Search for the coordinates of the first point (or circle centre point) in the datajob.

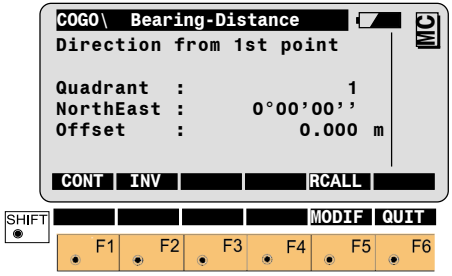
F2 Measuring the first point (or circle centre point).

F3 Manual entering of the first point (or circle centre point).

F5 Search and display the coordinates of the point found in the active data job.

SHIFT F6 Exit the program.

If "**Bearing**" is selected in the configuration for "**Direc. Type:**", then the following dialog box appears:



Quadrant
Enter quadrant:
1 = Northeast
2 = Southeast
3 = Southwest
4 = Northwest

NorthEast
Enter magnetic bearing
If "**Azimuth**" is selected in the configuration during "**Direc. Type:**", then the azimuth of the straight line can be entered.

Offset
Entering parallel displacement.
Only active if "**YES**" is entered in the configuration during "**Offset**:"
Left = negative parallel offset
Right = positive parallel offset

F1 Accept displayed values.

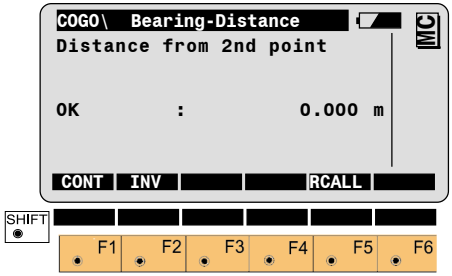
F2 Determining the direction by means of the function "**Polar calculation**" *(refer to chapter "Inverse").*

F5 INPUT Enter bearing, mangnetic bearing resp. azimuth (if "**Azimuth**" is selected in the configuration for "**Direc. Type:**"
RCALL Call up of a direction which has been previously stored using the function "**Polar calculation**".

SHIFT F5 Changing the direction *(as dialog box "Modify Bearing", resp. "Modify Azimuth")*

SHIFT F6 Exit the program.

Enter distance from second point:



Horiz.Dist.
Entering radius

F1 Accept displayed values.

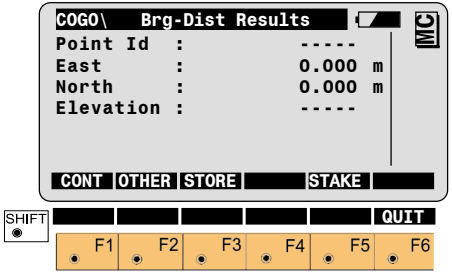
F2 Determining the radius by means of the function "**Polar calculation**" *(refer to chapter "Inverse")*.

F5 INPUT Entering radius
RCALL Call up of a radius which has been previously stored using the function "**Polar calculation**".

SHIFT F5 Changing the direction (as dialog box "Modify Distance").

SHIFT F6 Exit the program.

The following dialog box shows the result of the bearing-distance intersection:



Point Id
Entering point number of the bearing-bearing

East
Display of east coordinate

North
Display of north coordinate

Elevation
Entering height (optional)

F1 Return to "**Intersections**".

F2 Changing between both solutions.

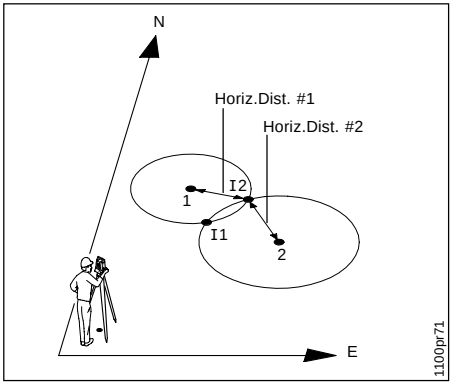
F3 The following results have been stored in the active measurement data file:

WI 11 Station Point Number
WI 81 Easting coordinate
WI 82 Northing coordinate
WI 83 Elevation (optional)

If "Point Id" has not been entered, the function is not available.

F5 Call up the program "Stakeout".
The program "Stakeout" assumes that the instrument is set and oriented to a known point.
If "Point Id" has not been entered, the function is not available.

SHIFT F6 Exit the program.

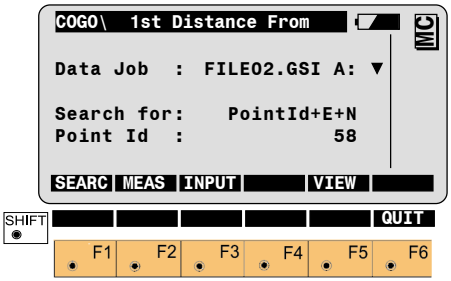


Search
- Bearing-bearing coordinates S1 and S2 (E, N)

Given
- point 1 (E, N), radius 1
- point 2 (E, N), radius 2

Station coordinates and orientation need to have been set correctly before the coordinates of point 1 and/or 2 can be determined by measurement.

3 Call up the function "Distance-Distance" from the menu "**Intersections**".



F1 Search for the coordinates of the first circle centre point (second circle centre point) in the datajob.

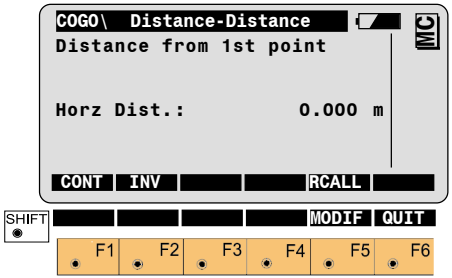
F2 Measuring the first circle centre point (2nd circle centre point).

F3 Manual entering of the first circle centre point (2nd circle centre point).

F5 Search and display the coordinates of the point found in the active data job.

SHIFT F6 Exit the program.

Enter distance from points:



Horiz.Dist.
Entering distance from first point (2nd point)

F1 Accept displayed values.

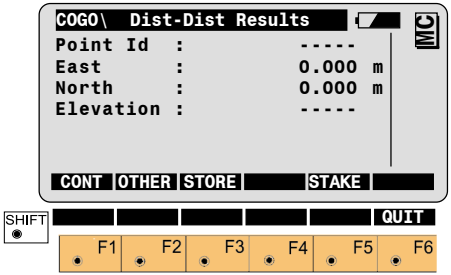
F2 Determining the radius by means of the function "**Polar calculation**" *(refer to chapter "Inverse").*

F5 INPUT Entering radius
RCALL Call up of a radius which has been previously stored using the function "**Polar calculation**".

SHIFT F5 Changing the direction *(as dialog box "Modify Distance").*

SHIFT F6 Exit the program.

The following dialog box shows the result of the distance/distance intersection:



Point Id
Entering point number of the bearing-bearing

East
Display of east coordinate

North
Display of north coordinate

Elevation
Entering height (optional)

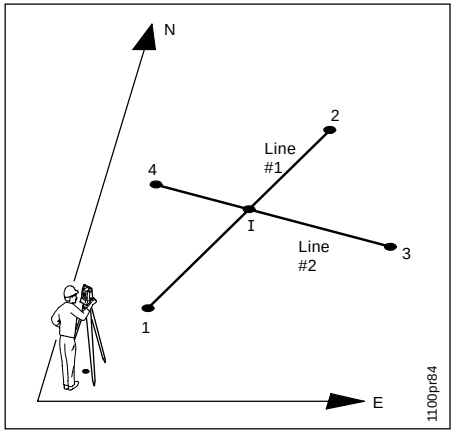
F1 Return to "**Intersections**".

F2 Changing between both solutions

F3 The following results have been stored in the active measurement data file:
WI 11 Station Point Number
WI 81 Easting coordinate
WI 82 Northing coordinate
WI 83 Elevation (optional)
If "Point Id" has not been entered, the function is not available.

F5 Call up the program "Stakeout".
The program "Stakeout" assumes that the instrument is set and oriented to a known point.
If "Point Id" has not been entered, the function is not available.

SHIFT F6 Exit the program.

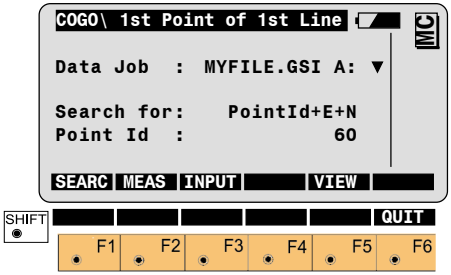


Search
- Coordinates of intersection (E, N)

Given
- Point 1 (E,N), point 2 (E,N)
- Point 3 (E,N), point 4 (E,N)

Station coordinates and orientation need to have been set correctly before the coordinates of any point can be determined by measurement.

4 Call up the function "Intersection by Points" from the menu "**Intersections**".



F1 Search for the coordinates of the 1st point of the first line (and 2nd point, as well as points defining second line) in the active data job.

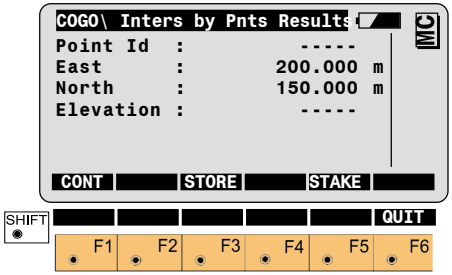
F2 Determine the point by measurement.

F3 Manually enter the point coordinates.

F5 Search for and display the coordinates of the point in the active data job.

SHIFT F6 Exit the program.

The following dialog shows the results of an Intersection by Points:



Point Id
Enter point id of the intersection point.

East
Displays east coordinate

North
Displays north coordinate

Elev.
Enter point elevation (optional).

F1 Return to "Intersections" dialog.

F3 Store the following results in the active measurement data file:

WI	11	Station point number
WI	81	Easting coordinate
WI	82	Northing coordinate
WI	83	Elevation (optional)

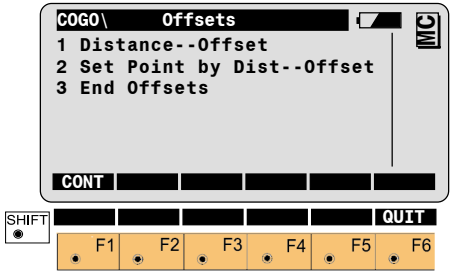
If "Point Id" has not been entered the function is not executable.

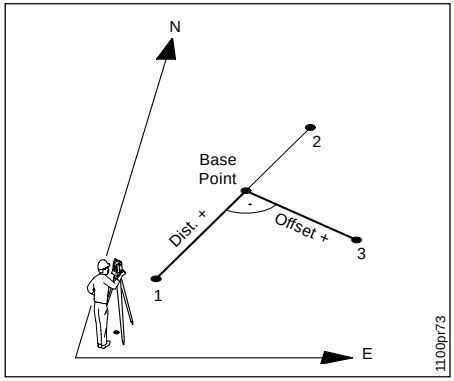
F5 Call up the program "Stakeout".
"Stakeout" assumes that the instrument is set and oriented to a known point.
If "Point Id" has not been entered the function is not executable.

SHIFT F6 Exit the program.

Offsets

4 Call up the function "Offsets" in the "**COGO MENU**"





Station coordinates and orientation need to have been set correctly before the coordinates of point 1 resp. 2 and/or point 3 can be determined by measurement.

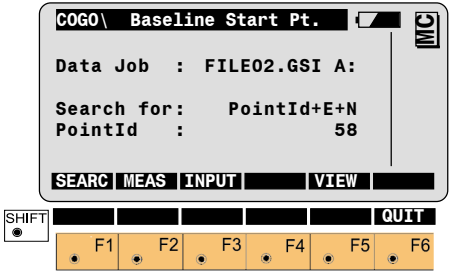
Explanation of the polarity rule of Horiz. Dist. and Offset. During entering, the polarity is based on the straight line 1 -> 2.

Search
- Difference in length/abscissa (Horiz.Dist)
- Lateral deviation/ordinate (Offset)
- Base point coordinates (E, N)

Given
- Baseline Start Point 1 (E, N),
- Baseline End Point 2 (E, N),
- lateral point 3 (E, N)

+ Offset	Parallel displacement to the right
– Offset	Parallel displacement to the left
+ Horiz.Dist.	Displacement from basis point 1 in the direction of basis point 2
– Horiz.Dist.	Displacement from basis point 1 in the opposite direction to basis point 2

1 Call up the function "Distance-Offset" from the menu "**Offsets**".



F1 Search for the coordinates of baseline start point resp. the baseline end point (or the lateral point) in the data job.

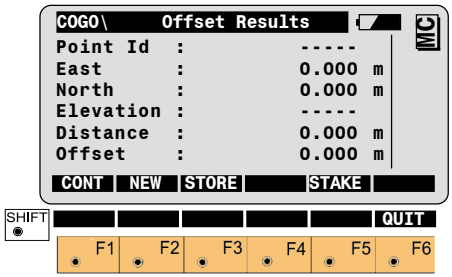
F2 Measuring the baseline start point resp. the baseline end point (or the lateral point).

F3 Manual entering of the baseline start point resp. the baseline end point (or the lateral point).

F5 Search and display the coordinates of the point found in the active data job.

SHIFT F6 Exit the program.

The following dialog box shows the results:



Point Id
Entering point number of the base point

East
Display of east coordinate

North
Display of north coordinate

Elevation
Entering height (optional)

Distance
Display difference in length/abscissa (Horiz. Dist.)

Offset
Display lateral deviation/ordinate (Offset)

F1 Return to the menu "**Offsets**".

F2 Entering the new lateral point with reference to the already existing basis line.

F3 The following results have been stored in the active measurement data file:

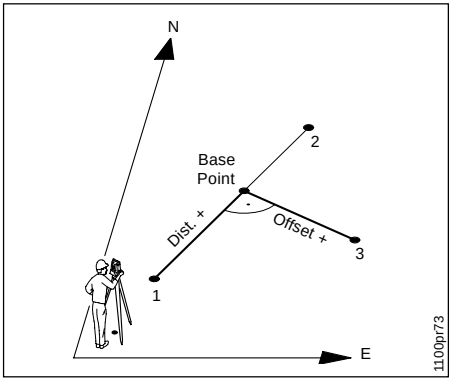
WI 11	Station Point Number
WI 81	Easting coordinate
WI 82	Northing coordinate
WI 83	Elevation (optional)

If "Point Id" has not been entered, the function is not available.

F5 Call up the program "Stakeout".

The program "Stakeout" assumes that the instrument is set and oriented to a known point.
If "Point Id" has not been entered, the function is not available.

SHIFT F6 Exit the program.



Search

- Lateral point 3 coordinates (E, N)

Given

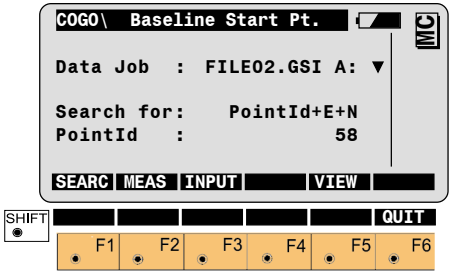
- Baseline Start Point 1 (E, N),
- Baseline End Point 2 (E, N),
- Difference in length/abscissa (Horiz. Dist.)
- Lateral deviation/ordinate (Offset)

Station coordinates and orientation need to have been set correctly before the coordinates of point 1 resp. point 2 can be determined by measurement.

Explanation of the polarity rule of Horiz. Dist. and Offset
During entering, the polarity is based on the straight line 1 -> 2.

+ Offset	Parallel displacement to the right
– Offset	Parallel displacement to the left
+ Horiz. Dist.	Displacement from basis point 1 in the direction of basis point 2
– Horiz. Dist.	Displacement from basis point 1 in the opposite direction to basis point 2

2 Call up the function "Set Point by Dist-Offset" in the menu "**Offsets**".



F1 Search for the coordinates of baseline start point (or the baseline end point) in the data job.

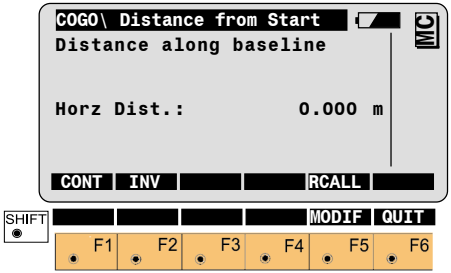
F2 Measuring the baseline start point (or the baseline end point).

F3 Manual entering of the baseline start point (or the baseline end point).

F5 Search and display the coordinates of the point found in the active data job.

SHIFT F6 Exit the program.

Enter distance analog baseline (Horiz. Dist.):



Horz.Dist.
Enter distance along baseline (Horiz. Dist.)

F1 Accept displayed values

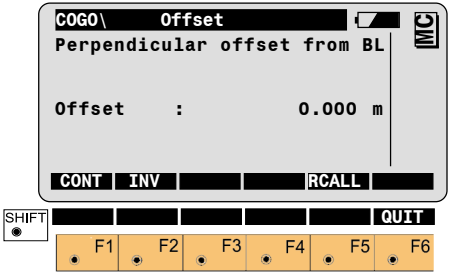
F2 Determining the distance along baseline (Horiz. Dist.) by means of the function "**Polar calculation**" *(refer to chapter "Inverse").*

F5 INPUT Entering distance along baseline
RCALL Call up of a distance along baseline which has been previously stored using the function "**Polar calculation**".

SHIFT F5 Changing the direction *(as dialog box "Modify Distance").*

SHIFT F6 Exit the program.

Enter lateral deviation/distance (Offset):



Horz.Dist.
Enter lateral deviation/distance (Offset)

F1 Accept displayed values.

F2 Determining the lateral deviation/distance (Offset) by means of the function "**Polar calculation**" *(refer to chapter "Inverse").*

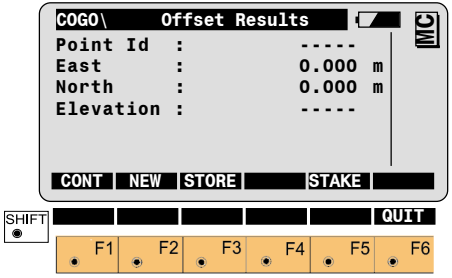
F5 INPUT Entering lateral deviation/distance

RCALL Call up of a lateral deviation/distance which has been previously stored using the function "**Polar calculation**".

SHIFT F5 Changing the direction *(as dialog box "Modify Distance").*

SHIFT F6 Exit the program.

The following dialog box shows the results of the orthogonal point calculation:



Point Id
Entering point number of the lateral point

East
Display of east coordinate

North
Display of north coordinate

Elevation
Entering height (optional)

F1 Return to the menu "Offsets".

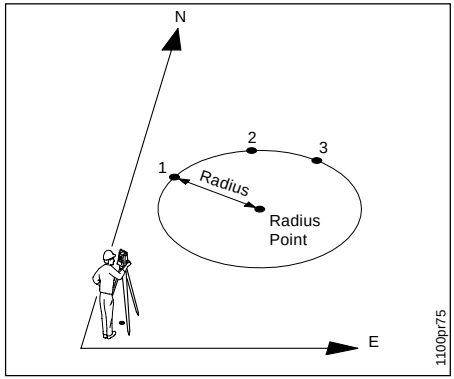
F3 The following results have been stored in the active measurement data file:

WI 11 Station Point Number
WI 81 Easting coordinate
WI 82 Northing coordinate
WI 83 Elevation (optional)

If "Point Id" has not been entered, the function is not available.

F5 Call up the program "Stakeout".
The program "Stakeout" assumes that the instrument is set and oriented to a known point.
If "Point Id" has not been entered, the function is not available.

SHIFT F6 Exit the program.

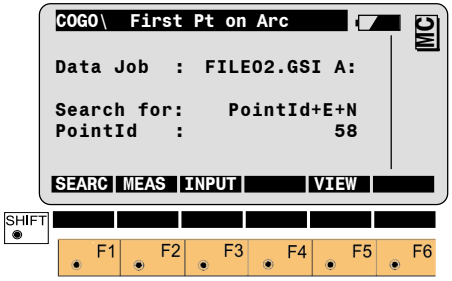


Search
- Circle centre coordinates (E, N),
- Radius

Given
- Arc point 1 (E, N),
- Arc point 2 (E, N),
- Arc point 3 (E, N)

Station coordinates and orientation need to have been set correctly before the coordinates of point 1, 2 and/or point 3 can be determined by measurement.

5 Call up the function "Three Point Arc" from the "**COGO MENU**"



F1 Search for the coordinates of the first resp. the second resp. the third arc point in the data job.

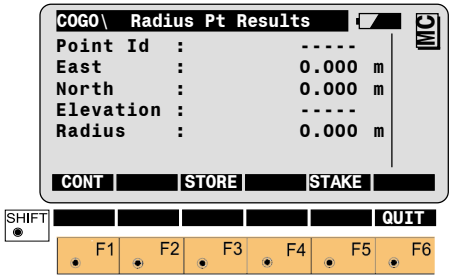
F2 Measuring the first resp. the second resp. the third arc point.

F3 Manual entering of the first resp. the second resp. the third arc point.

F5 Search and display the coordinates of the point found in the active data job.

SHIFT F6 Exit the program

The following dialog box shows the results of the calculation:



Point Id
Entering point number of the circle centre

East
Display of east coordinate

North
Display of north coordinate

Elevation
Entering height (optional)

Radius
Display of radius arc

F1 Return to the "**COGO MENU**".

F3 The following results have been stored in the active measurement data file:

WI 11	Station Point Number
WI 81	Easting coordinate
WI 82	Northing coordinate
WI 83	Elevation (optional)

If "Point Id" has not been entered, the function is not available.

F5 Call up the program "Stakeout".
The program "Stakeout" assumes that the instrument is set and oriented to a known point.
If "Point Id" has not been entered, the function is not available.

SHIFT F6 Exit the program.

Introduction

This manual describes the program "ROAD+ FILE EDITOR" of theLeica Geosystems TPS1100 Professional series.
This program is used to view and edit existing project files for the program "**Road+**" or to create new project files.

Road+ File Editor automatically applies the required file name prefixes and extensions for Road+ project files.
You may create a new Coordinate Data File, or add data to an existing one with Road+ File Editor.

1. Horizontal Alignment File
File Name: ALN?????.GSI

2. Vertical Alignment File
File Name: PRF?????.GSI

3. Template File
File Name: CRS?????.GSI

4. Station Equation File
File Name: EQN?????.GSI

5. Cross-section Assignment File
File Name: STA?????.GSI

6. Coordinate Data File
File Name: ????????.GSI

You may replace the question marks (?) in the above example file names with any DOS-permitted file name character.

Road+ File Editor may be used to create project data files for Road+, or to edit project data files that have been created by some other program like the Windows application RoadEd, available from Leica Geosystems.
The file editing options available in Road+ File Editor vary according to the type of file being edited:

You may not delete records from a Coordinate Data File, nor may you insert new records between existing records. Only the Point Id may be changed in existing records. You may add Code blocks, Point Coordinate and/or Station Coordinate Data records at only the end of the file.

You may delete, insert and/or edit all Road+ horizontal alignment element types with Road+ File Editor. Road+ horizontal alignment element types are:

- Tangents;
- Circular Curves;
- Clothoid transitions (Tangent to circular curve, circular curve to tangent and between circular curves), and;
- End of Positioning

You must use the following sign convention to describe the direction of curvature for non-tangent horizontal alignment elements:

- For right hand curves (the center of curvature is to the right of the horizontal alignment) the radius and transition parameters are positive values.
- For left hand curves (the center of curvature is to the left of the horizontal alignment) the radius and transition parameters are negative values.

You may delete, insert and/or edit all Road+ vertical alignment element types with Road+ File Editor. Road+ vertical alignment element types are:

- Tangents;
- Circular Curves;
- Parabolas, and;
- End of Positioning

You must use the following sign convention to describe the direction of curvature for non-tangent vertical alignment elements:

- For "sag" or "dip" curves (the center of curvature is above the vertical alignment) the radius and parabola parameters are positive values.

- For "crest" curves (the center of curvature is below the vertical alignment) the radius and parabola parameters are negative values.

You may insert new Cross Sections and delete and/or edit existing Cross Sections with Road+ File Editor. Cross Sections are defined by a series of straight line (tangent) elements. The elements are defined by the horizontal offsets and vertical height differences, from the location of the horizontal and vertical alignments, of the end points of the elements.

You must use the following sign convention to describe the horizontal offsets and vertical height differences of the end points of the elements:

- If the point is to the left of the horizontal alignment, the horizontal offset is negative.

- If the point is to the right of the horizontal alignment, the horizontal offset is positive.

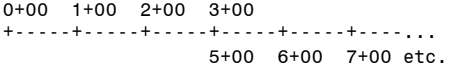
- If the point is below the vertical alignment, the vertical height difference is negative.

- If the point is above the vertical alignment, the vertical height difference is positive.

You may insert new Station Equations and delete and/or edit existing Station Equations with Road+ File Editor.

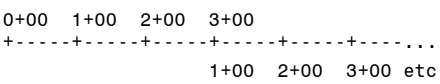
Station Equations are identified by a number, the Ahead Station and the Back Station. "Gap" and "Overlap" station equations are supported by Road+ and Road+ File Editor.

Gap Equations



In this Gap Equation example, the Ahead Station is 5+00 and the Back Station is 3+00.

Overlap Equations



In this Overlap Equation example, the Ahead Station is 1+00 and the Back Station is 3+00.

You may insert new Cross Section Assignments and delete and/or edit existing Cross Section Assignments with Road+ File Editor.
Cross Section Assignments define which Cross Section controls the shape of the project at which station. You may assign a Cross Section to any portion of an alignment by entering the starting and ending stations for which the Cross Section controls the shape of the project. Abrupt and tapered transitions between Cross Sections are possible.

Abrupt Transitions

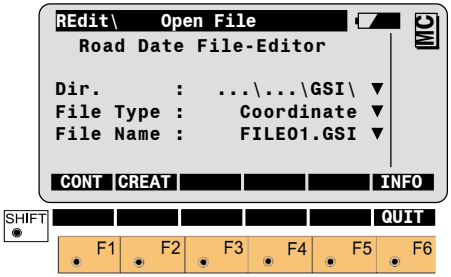
Specify the ending station of the first Cross Section. Then, specify the beginning station of the second Cross Section the smallest possible station increment ahead (typically 0.001 ft. or m.)

Tapered Transitions
Specify the ending station of the first Cross Section equal to the station at the beginning of the transition. Then, specify the beginning station of the second Cross Section equal to the station at the end of the transition. The transition may change the width and/or the shape (i.e. superelevation) of the project.

The Cross Sections at both ends of the transition must contain exactly the same number of elements.

Open file

Start program "**FILE EDITOR**" from the "**MAIN MENU: PROGRAMS**" dialog.



Path:
The PC Card in your TPS1100 Professional Series Instrument is the A:\ drive. Select any existing directory on the card to create new Road+ files, or select any existing directory containing existing files that you wish to edit.

File Type:
Select the type of file you wish to create or edit with Road+ File Editor.

Coordinate
Refer to the chapter "Coordinate Data files", page 168, in this manual for further details.

Horiz. Align
Refer to the chapter "Horizontal Alignment Files", page 173, in this manual for further details.

Vert. Align
Refer to the chapter "Vertical Alignment Files", page 178, in this manual for further details.

Cross Section
Refer to the chapter "Cross Sections Files", page 184, in this manual for further details.

Sta. Eqn.

Refer to the chapter "Station Equations Files", page 186, in this manual for further details.

CRS Assignmnt

Refer to the chapter "Cross Section Assignment Files", page 188, in this manual for further details.

File Name:
After selecting the type of file you wish to work with, you must select an existing file to edit, or press "CREAT" to create a new file of the type you have selected.

F1 Press to view and/or edit the existing file you have selected. The first record of the file will be displayed.

When you see a message that Road+ File Editor failed to read an existing file, and that file was created manually or with third party software, it usually means there is a problem with the GSI formatting of the file.

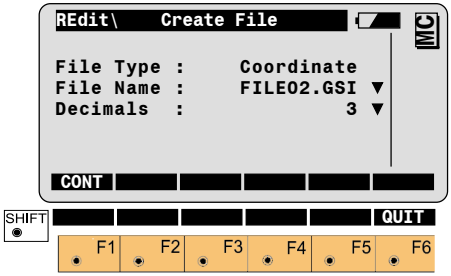
F2 Press to create a new file of the type you have selected. You will specify the name of the file on the next dialog.

F6 Press to see the date and Version number of your Road+ File Editor.

SHIFT F6 Press to Quit Road+ File Editor. This option is available on nearly every dialog within Road+ File Editor.

New Coordinate File

You will see this dialog if you selected File Type "Coordinate" and pressed "CREAT" on the previous dialog. You must specify a name for the new file. You may specify any DOS-legal file name. Road+ File Editor will apply the necessary extension for you automatically.



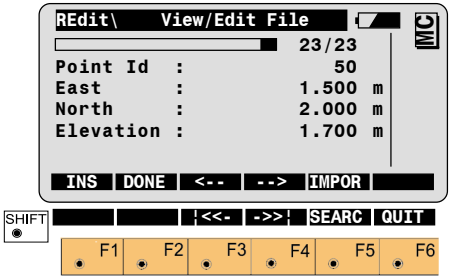
File Type
Displays the type of file that is being created.

File Name
Input any DOS-legal file name.

Decimals
Select the number of decimal places to be used in this file.

F1 Press to create the new file and continue to the Insert Record dialog. (*Go to Dialog "Insert Record".*)

You will see this dialog if you selected "Insert Point Coordinates" on the previous dialog. The scrollbar at the top of this dialog graphically shows your position in the current file. The numbers to the right of the scrollbar show the number of the current record / the total number of records in the current file.



Point Id
You may edit the Point Identifier offered here, or press Enter to accept it and move to the next input field. This is the only field that may be edited in existing records.

East
The Easting or X ordinate of the point you wish to create. You may edit this value only when creating a new point.

North
The Northing or Y ordinate of the point you wish to crate. You may edit this value only when creating a new point.

Elev
The Elevation or Z ordinate of the point you wish to create. You may edit this value only when creating a new point.

F1 Press this key when you have completed the edits of the current record and are ready to insert a new record. New records will always be inserted at the end of a Coordinate Data File.

F2 Press this key when you have completed all edits in the current file.

F3 Press this key to display the record before the currently displayed record in this file. This key label will not be displayed if the current record is the first record in the file.

F4 Press this key to display the record after the currently displayed record in this file. This key label will not be displayed if the current record is the last record in the file.

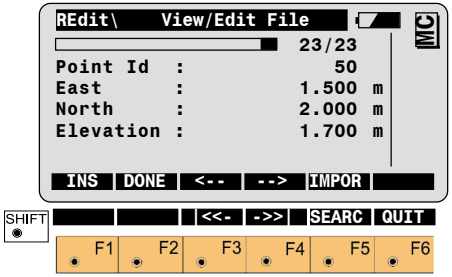
F5 Press this key to import the coordinates of a point in this or another file. This key label will not be displayed if the current record is a Code record.

SHIFT F3 Press this key combination to display the first record in this file.

SHIFT F4 Press this key combination to display the last record in this file.

SHIFT F5 Press this key combination to search for a particular record in this file. (*Go to Dialog "Search"*)

You will see this dialog if you selected "Insert Station Coordinates" on the previous dialog. The scrollbar at the top of this dialog graphically shows your position in the current file. The numbers to the right of the scrollbar show the number of the current record / the total number of records in the current file.



Point Id
You may edit the Point Identifier offered here, or press Enter to accept it and move to the next input field. This is the only field that may be edited in existing records.

East
The Easting or X ordinate of the station you wish to create. You may edit this value only when creating a new station.

North
The Northing or Y ordinate of the station you wish to crate. You may edit this value only when creating a new station.

Elev
The Elevation or Z ordinate of the station you wish to create. You may edit this value only when creating a new station.

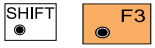
Press this key when you have completed the edits of the current record and are ready to insert a new record. New records will always be inserted at the end of a Coordinate Data File.

Press this key when you have completed all edits in the current file.

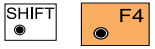
Press this key to display the record before the currently displayed record in this file. This key label will not be displayed if the current record is the first record in the file.

Press this key to display the record after the currently displayed record in this file. This key label will not be displayed if the current record is the last record in the file.

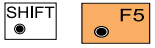
Press this key to import the coordinates of a point in this or another file. This key label will not be displayed if the current record is a Code record.



Press this key combination to display the first record in this file.

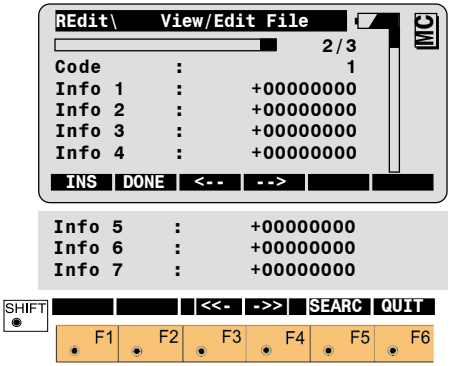


Press this key combination to display the last record in this file.



Press this key combination to search for a particular record in this file. (*Go to Dialog "Search"*)

You will see this dialog if you selected "Insert Code Block" on the previous dialog.



Code
Input the Code you wish to enter.

Info1 - 7
Input the Info words you wish to enter.

F1 Press this key when you have completed the edits of the current record and are ready to insert a new record. New records will always be inserted at the end of a Coordinate Data File.

F2 Press this key when you have completed all edits in the current file.

F3 Press this key to display the record before the currently displayed record in this file. This key label will not be displayed if the current record is the first record in the file.

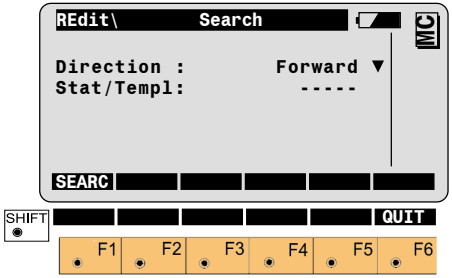
F4 Press this key to display the record after the currently displayed record in this file. This key label will not be displayed if the current record is the last record in the file.

SHIFT F3 Press this key combination to display the first record in this file.

SHIFT F4 Press this key combination to display the last record in this file.

SHIFT F5 Press this key combination to search for a particular record in this file. (*Go to Dialog "Search"*)

You will see this dialog if you selected "SEARC" on the previous dialog.



Direction
Select the direction you wish to search from the current record. Forward searches toward the end of the file, Backward searches toward the beginning of the file.

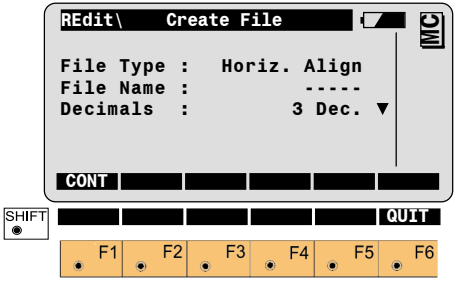
Stat/Templ
Input the Point Id or Code for which you wish to search.

F1 Press this key to search for the first occurrence of the input Point Id or Code.

If the specified Point Id or Code is found, you will see the record containing it.
If the specified Point Id or Code is not found, you will see a message. After the message, you will see the current record again.

New Horizontal Alignment File

You will see this dialog if you selected File Type "Horiz. Align" and pressed "CREAT" on the previous dialog.



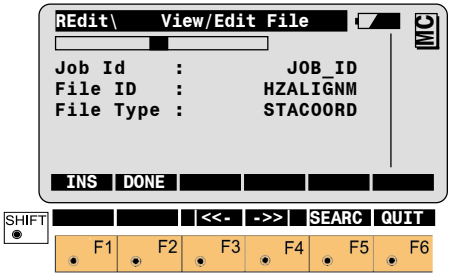
File Type
Displays the type of file that is being created.

File Name
Input any 5 character DOS-legal file name.

Decimals
Select the number of decimal places to be used in this file.

F1 Press to create the new file and continue to the Header Record dialog. (Go to Dialog "View / Edit Header Record".)

You will see this dialog if you created a new or selected an existing Horizontal Alignment File.



Job Id
You may edit the Job Identifier offered here, or accept the default offered. The Job Id is used by Road+ to determine which project data files are likely to be associated together.

File Id
The File Id of a Horizontal Alignment File is "HZALIGNM" and may not be changed.

File Type
The File Type of a Horizontal Alignment File is "STACOORD" and may not be changed.

F1 Press this key when you are ready to insert a new horizontal alignment element into the file. New records will always be inserted after the currently displayed record in a Horizontal Alignment File.

F2 Press this key when you have completed all edits in the current file.

F3 Press this key to display the record before the currently displayed record in this file. This key label will not be displayed if the current record is the first record in the file.

F4 Press this key to display the record after the currently displayed record in this file. This key label will not be displayed if the current record is the last record in the file.

F5 Press this key to import the coordinates of a point in another file.

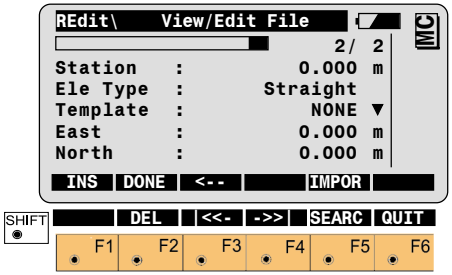
SHIFT F2 Press this key combination to delete the currently displayed record in this file. This is not available if the Header Record is displayed.

SHIFT F3 Press this key combination to display the first record in this file.

SHIFT F4 Press this key combination to display the last record in this file.

SHIFT F5 Press this key combination to search for a particular record in this file. (*Go to Dialog "Search"*)

You will see this dialog if you selected "Insert Tangent" on the Insert Record dialog in a Horizontal Alignment File.



Station
Input the Station or Chainage at the beginning of the element.

Ele Type
Straight

Template
Input the name of the Cross Section you wish to associate with this Horizontal Alignment element. This may be "NONE" if you are using a Cross Section Assignment File as a part of this Road+ project, or if this Road+ project does not include Cross Sections.

East
The Easting or X ordinate at the beginning of the element.

North
The Northing or Y ordinate at the beginning of the element.

F1 Press this key when you have completed the edits of the current record and are ready to insert a new record. New records will always be inserted after the currently displayed record in a Horizontal Alignment File.

F2 Press this key when you have completed all edits in the current file.

F3 Press this key to display the record before the currently displayed record in this file. This key label will not be displayed if the current record is the first record in the file.

F4 Press this key to display the record after the currently displayed record in this file. This key label will not be displayed if the current record is the last record in the file.

F5 Press this key to import the coordinates of a point in another file.

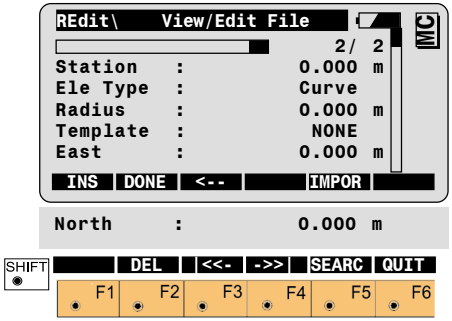
SHIFT F2 Press this key combination to delete the currently displayed record in this file. This is not available if the Header Record is displayed.

SHIFT F3 Press this key combination to display the first record in this file.

SHIFT F4 Press this key combination to display the last record in this file.

SHIFT F5 Press this key combination to search for a particular record in this file. (*Go to Dialog "Search"*)

You will see this dialog if you selected "Insert Circular Curve" on the Insert Record dialog in a Horizontal Alignment File.



Station
Input the Station or Chainage at the beginning of the element.

Ele Type
Curve

Radius
Input the Radius of the Circular Curve.

Template
Input the name of the Cross Section you wish to associate with this Horizontal Alignment element.

East
The Easting or X ordinate at the beginning of the element.

North
The Northing or Y ordinate at the beginning of the element.

F1 Press this key when you have completed the edits of the current record and are ready to insert a new record. New records will always be inserted after the currently displayed record in a Horizontal Alignment File.

F2 Press this key when you have completed all edits in the current file.

F3 Press this key to display the record before the currently displayed record in this file. This key label will not be displayed if the current record is the first record in the file.

F4 Press this key to display the record after the currently displayed record in this file. This key label will not be displayed if the current record is the last record in the file.

F5 Press this key to import the coordinates of a point in another file.

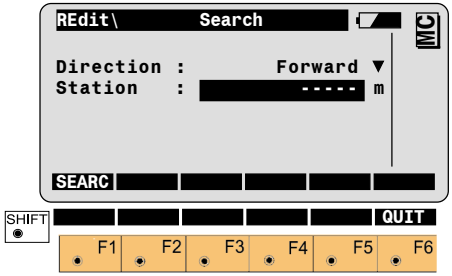
SHIFT F2 Press this key combination to delete the currently displayed record in this file. This is not available if the Header Record is displayed.

SHIFT F3 Press this key combination to display the first record in this file.

SHIFT F4 Press this key combination to display the last record in this file.

SHIFT F5 Press this key combination to search for a particular record in this file. (*Go to Dialog "Search"*)

You will see this dialog if you selected "SEARC" on the previous dialog.



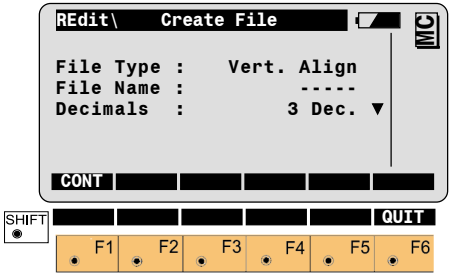
Direction
Select the direction you wish to search from the current record.

Station
Input the Station for which you wish to search.

F1 Press this key to search for the input Station.

New Vertical Alignment File

You will see this dialog if you selected File Type "Vert. Align" and pressed "CREAT" on the previous dialog.



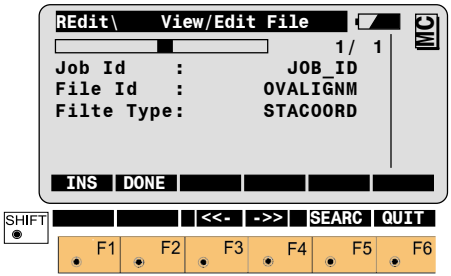
File Type
Displays the type of file that is being created.

File Name
Input any 5 character DOS-legal file name.

Decimals
Select the number of decimal places to be used in this file.

F1 Press to create the new file and continue to the Header Record dialog. (*Go to Dialog "View / Edit Header Record"*.)

You will see this dialog if you created a new or selected an existing Vertical Alignment File.



Job Id
You may edit the Job Identifier offered here, or accept the default offered.

File Id
The File Id of a Vertical Alignment File is "VALIGNM" and may not be changed.

File Type
The File Type of a Vertical Alignment File is "STACOORD" and may not be changed.

F1 Press this key when you are ready to insert a new vertical alignment element into the file. New records will always be inserted after the currently displayed record in a Vertical Alignment File.

F2 Press this key when you have completed all edits in the current file.

F3 Press this key to display the record before the currently displayed record in this file. This key label will not be displayed if the current record is the first record in the file.

F4 Press this key to display the record after the currently displayed record in this file. This key label will not be displayed if the current record is the last record in the file.

F5 Press this key to import the elevation of a point in another file.

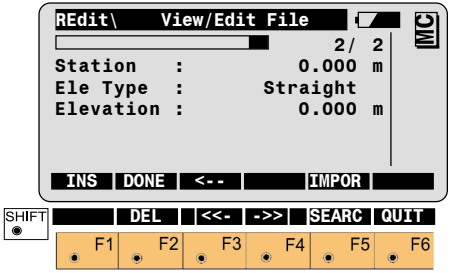
SHIFT F2 Press this key combination to delete the currently displayed record in this file. This is not available if the Header Record is displayed.

SHIFT F3 Press this key combination to display the first record in this file.

SHIFT F4 Press this key combination to display the last record in this file.

SHIFT F5 Press this key combination to search for a particular record in this file. (*Go to Dialog "Search"*)

You will see this dialog if you selected "Insert Tangent" on the Insert Record dialog in a Vertical Alignment File. A Tangent is a straight element in an alignment.



Station
Input the Station or Chainage at the beginning of the element.

Ele Type
Straight

Elevation
The Elevation or Z ordinate at the beginning of the element.

F1 Press this key when you have completed the edits of the current record and are ready to insert a new record. New records will always be inserted after the currently displayed record in a Vertical Alignment File.

F2 Press this key when you have completed all edits in the current file.

F3 Press this key to display the record before the currently displayed record in this file. This key label will not be displayed if the current record is the first record in the file.

F4 Press this key to display the record after the currently displayed record in this file. This key label will not be displayed if the current record is the last record in the file.

F5 Press this key to import the elevation of a point in another file.

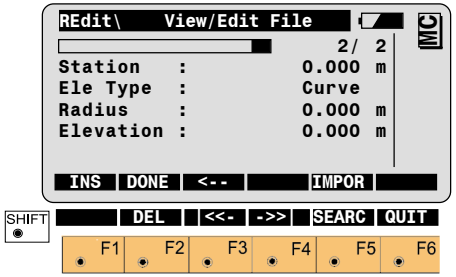
SHIFT F2 Press this key combination to delete the currently displayed record in this file. This is not available if the Header Record is displayed.

SHIFT F3 Press this key combination to display the first record in this file.

SHIFT F4 Press this key combination to display the last record in this file.

SHIFT F5 Press this key combination to search for a particular record in this file. (*Go to Dialog "Search"*)

You will see this dialog if you selected "Insert Circular Curve" on the Insert Record dialog in a Vertical Alignment File. A Circular Curve is a curve of constant radius in the alignment.



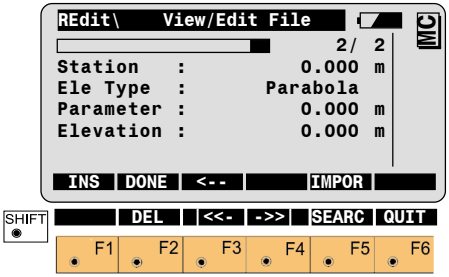
Station
Input the Station or Chainage at the beginning of the element.

Ele Type
Curve

Radius
Input the Radius of the Circular Curve.

Elevation
The Elevation or Z ordinate at the beginning of the element.

You will see this dialog if you selected "Insert Parabola" on the Insert Record dialog in a Vertical Alignment File.



Station
Input the Station or Chainage at the beginning of the element.

Ele Type
Parabola

Parameter

Input the Parameter of the Parabola ("p").

For "sag" or "dip" curves (the center of curvature is above the vertical alignment) the Parameter is a positive value.

For "crest" curves (the center of curvature is below the vertical alignment) the Parameter is a negative value.

The "p" parameter is the reciprocal of the rate of change of slope in the vertical curve:

$$p = L / (G_{OUT} - G_{IN})$$

or

$$p = (Y_I - Y_S)^2 / 2(X_I - X_S)$$

Where

G_{OUT} = the slope of the vertical alignment at the end of the vertical curve, as a decimal fraction (not percent);

G_{IN} = the slope of the vertical alignment at the beginning of the vertical curve as a decimal fraction (not percent), and;

L = the horizontal distance from the beginning to the end of the vertical curve.

and:

Y_I = The elevation above datum of any point on the vertical curve;

Y_S = The elevation above datum at the low or high point of the vertical curve;

X_I = The station or chainage of any point on the vertical curve;

X_S = The station or chainage at the low or high point of the vertical curve;

The general equation for a parabola is:

$$Y = aX^2 + bX + c$$

When the parabola describes a vertical curve in an alignment:

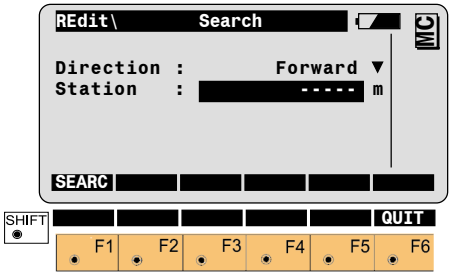
Y = The elevation above datum of a point on the vertical curve;
X = The horizontal distance from the beginning of the vertical curve;
a = One half of the rate of change of slope in the vertical curve;
b = The slope of the vertical alignment, as a decimal fraction (not percent), at the beginning of the vertical curve, and;
c = The elevation above datum at the beginning of the vertical curve.

Therefore, the "p" parameter may also be expressed as:

$$p = \tfrac{1}{2}a$$

Elevation
The Elevation or Z ordinate at the beginning of the element.

You will see this dialog if you selected "SEARC" on the previous dialog.



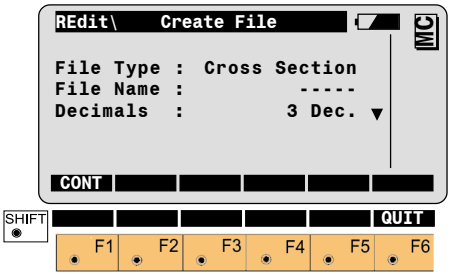
Direction
Select the direction you wish to search from the current record.

Station
Input the Station for which you wish to search.

F1 Press this key to search for the input Station.

New Cross Section File

You will see this dialog if you selected File Type "Cross Section" and pressed "CREAT" on the previous dialog.



File Type
Displays the type of file that is being created.

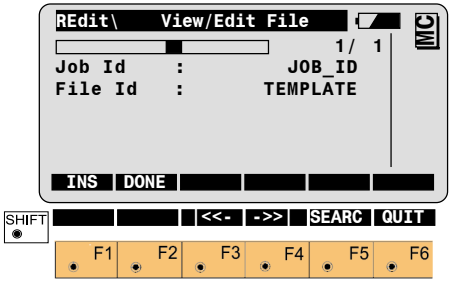
File Name
Input any 5 character DOS-legal file name.

Decimals
Select the number of decimal places to be used in this file.

F1 Press to create the new file and continue to the Header Record dialog. (*Go to Dialog "View / Edit Header Record".*)

Header Record

You will see this dialog if you created a new or selected an existing Cross Section File.

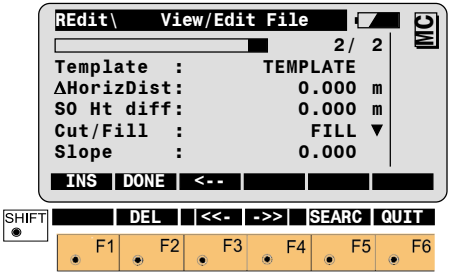


Job Id
You may edit the Job Identifier offered here, or accept the default offered. The Job Id is used by Road+ to determine which project data files are likely to be associated together.

File Id
The File Id of a Cross Section File is "TEMPLATE" and may not be changed.

You will see this dialog if you selected "INS" on the Header Record dialog in a Cross Section File.

The points defining a Cross Section must be entered in sequence from the farthest left to the farthest right on the Cross Section. The points defining a Cross Section should be entered consecutively to minimize file access during the operation of Road+.



Template
Input the name of the template, if you are going to create a new one or change the name of an existing one. Otherwise, this field displays the name of the Template you are currently editing.

ΔHorizDist
Input the horizontal distance from the Horizontal Alignment to the point you wish to create or edit.
For points to the right of the Horizontal Alignment, ΔHorizDist is a positive number. For points to the left of the Horizontal Alignment, ΔHorizDist is a negative number.

SO Ht diff
Input the vertical distance from the Vertical Alignment to the point you wish to create or edit.

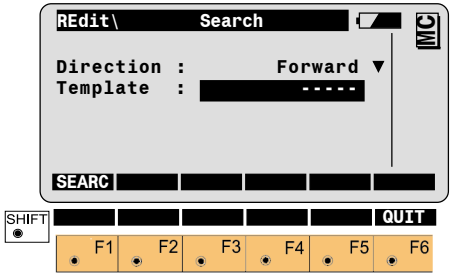
For points above the Vertical Alignment, SO Ht diff is a positive number. For points below the Vertical Alignment, SO Ht diff is a negative number.

Cut/Fill
(Optional) Select a description for the current Cross Section.

- **Cut** means the hinge point is below the existing surface of the ground.
- **Fill** means the hinge point is above the existing surface of the ground.
- **Standard** means the hinge point is not specifically identified as being above or below the existing surface of the ground (the "Cut/Fill" and "Slope" information are omitted from the file.)

Slope (Optional)
The ratio of the Δ Horizontal Distance to the Δ Vertical Distance from the Hinge Point to the existing ground. The slope must be assigned only to the first and last points (hinge points) in a Cross Section. All points falling between the hinge points must have a slope of zero.
If the design surface is rising toward the right, the slope is a positive value. If the design surface is falling toward the right, the slope is a negative value.

You will see this dialog if you selected "SEARC" on the previous dialog.



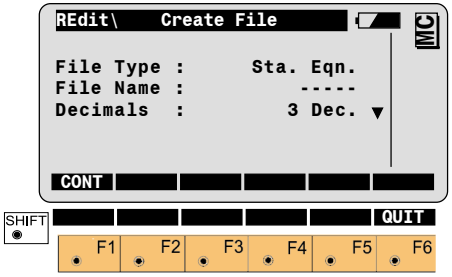
Direction
Select the direction you wish to search from the current record.

Template
Input the Cross Section name or number for which you wish to search.

F1 Press this key to search for the input Cross Section name or number.

New Station Equation File

You will see this dialog if you selected File Type "Station Equation" and pressed "CREAT" on the previous dialog.

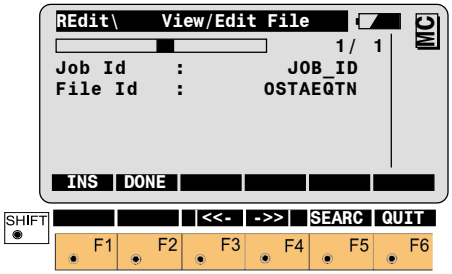


File Type
Displays the type of file that is being created.

File Name
Input any 5 character DOS-legal file name.

Decimals
Select the number of decimal places to be used in this file.

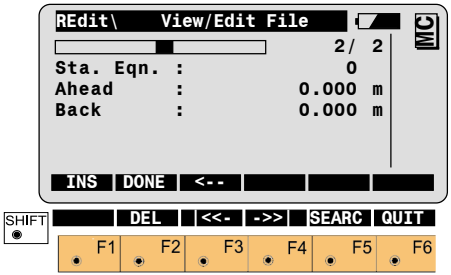
You will see this dialog if you created a new or selected an existing Station Equation File.



Job Id
You may edit the Job Identifier offered here, or accept the default offered. The Job Id is used by Road+ to determine which project data files are likely to be associated together.

File Id
The File Id of a Station Equation File is "STAEQTN" and may not be changed.

You will see this dialog if you selected "INS" on the Header Record dialog in a Station Equation File.

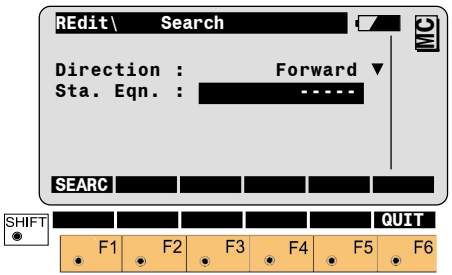


Sta. Eqn.
The number, starting from 1, of the equation in the Horizontal Alignment.

Ahead
The value from which the Stationing continues forward along the Horizontal Alignment.

Back
The value from which the Stationing decreases backward along the Horizontal Alignment.

You will see this dialog if you selected "SEARC" on the previous dialog.

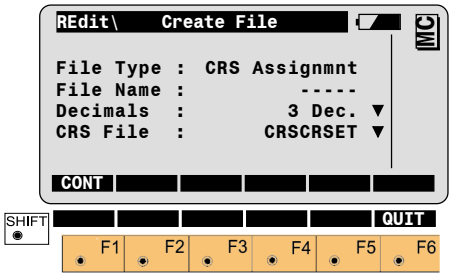


Direction
Select the direction you wish to search from the current record.

Sta. Eqn.
Input the Station Equation number for which you wish to search.

New Cross-section Assignment File

You will see this dialog if you selected File Type "CRS Assignmnt" and pressed "CREAT" on the previous dialog.



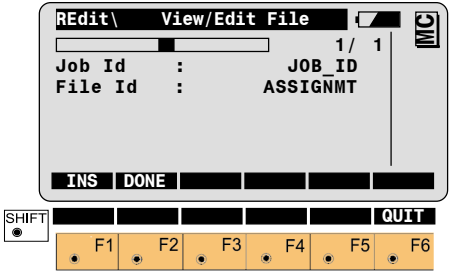
File Type
Displays the type of file that is being created.

File Name
Input any 5 character DOS-legal file name.

Decimals
Select the number of decimal places to be used in this file.

CRS File
Select the Cross Section File with which this Cross-section Assignment File is associated. (The Cross Sections assigned by this file must be defined in the associated Cross Section File.)

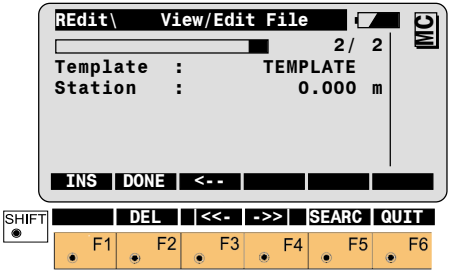
You will see this dialog if you created a new or selected an existing Station Equation File.



Job Id
You may edit the Job Identifier offered here, or accept the default offered.

File Id
The File Id of a Cross-section Assignment File is "ASSIGNMT" and may not be changed.

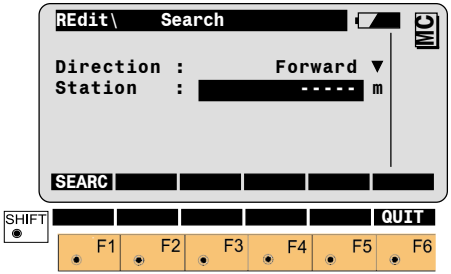
You will see this dialog if you selected "INS" on the Header Record dialog in a Cross-section Assignment File.



Template
The name (or number) of the Cross Section to be assigned.

Station
The Station at which the assignment begins.

You will see this dialog if you selected "SEARC" on the previous dialog.



Direction
Select the direction you wish to search from the current record.

Station
Input the Station for which you wish to search.

Introduction

This manual describes the "ROAD+" program of the TPS1100 Professional Series.

The program uses the station and offset method to control contsruction staking of roads and other types of curvilinear projects. The program supports station equations, cross section assignment by station, cross section definition, cross section interpolation, automatic superelevation and widening, and slope staking/catch points.

Alignment Definition

An alignment consists of three basic components which are horizontal alignment, vertical alignment and cross-section template. Of these, a horizontal alignment is mandatory to use "ROAD+". All other alignment elements are optional.

"ROAD+" reads the elements of each of these components from data files that are in GSI file format. In addition, a file can be created for entering cross-section stations for specific locations such as points needed for the staking of superelevation points. If station equations are needed, "ROAD+" will read a file created for station equations and apply the appropriate corrections.

Data Files

Each of the data files "ROAD+" reads contain the necessary information specific to the component being defined. The files have unique identifiers and must be in the GSI file format:

Horizontal Alignment File..... ALN?????.GSI
Vertical Alignment File.....PRF?????.GSI
Template File ..... CRS?????.GSI
Cross-section Assignment File..... STA?????.GSI
Station Equation File..... EQN?????.GSI

The three letter prefix, ALN, PRF, CRS, STA and EQN identify the type of file and must be used when creating the data files. The ? can be any valid DOS character. The file extension GSI defines the file as a GSI file and must be used.

1. Permitted elements in the Hz-alignment

Straight defined by station (chainage) and coordinates of starting point

Curve defined by station (chainage) and coordinates of starting point and
Radius of curve (– = left-hand curve; + = right-hand curve)

Spiral between a Straight and a Curve, defined by station (chainage) and coordinates of starting point; and Parameter A[1] of spiral (negative parameter = spiral into or from left-hand curve)

Curve In Clothoid transition between a Curve of larger radius and a Curve of smaller radius, defined by station (chaingage) and coordinates of starting point; and
Radius of larger curve; and
Radius of smaller curve

Curve out Clothoid transition between a Curve of smaller radius and a Curve of larger radius, defined by station (chaingage) and coordinates of starting point; and
Radius of smaller curve; and
Radius of larger curve

End of project (EOP) station (chainage) and coordinates of end-point

[1] $\mathbf{A = \sqrt{L \times R}}$, where L=length of spiral, R=radius of curve

2. Permitted elements in V-alignments

Straight defined by station (chainage) and height of starting point

Curve defined by station (chainage) and height of starting point and radius of curve
(– = crest; + = dip)

Parabola defined by station (chainage) and height of starting point, and parameters of parabola[2] (– = crest; + = dip)

End of project (EOP) station (chainage) and height of end-point of gradient

[2] Parabola parameter formulae:

$p=(S-S_0)^2 / 2(H-H_0)$

Where:

- S = any station (chainage) on the parabola
- S_0 = station (chainage) of the high/low point of the parabola
- H = height at any station S (above), and
- H_0 = height of the high/low point of the parabola

OR

$p = L / (G_{OUT} - G_{IN})$

Where:

- G_{OUT} = the slope of the vertical alignment at the end of the vertical curve, expressed as a decimal fraction (not percent);
- G_{IN} = the slope of the vertical alignment at the beginning of the vertical curve, expressed as a decimal fraction (not percent), and;
- L = the horizontal distance from the beginning to the end of the vertical curve.

OR

p = 1 / 2a,
in the general equation
$Y = aX^2 + bX + c$ for a parabola as used to describe a vertical curve in an alignment.

Where:

- Y = The height of a point on the vertical curve;
- X = The horizontal distance of the point from the beginning of the vertical curve;
- a = One half of the rate of change of slope in the vertical curve;
- b = The slope of the vertical alignment at the beginning of the vertical curve, and;
- c = The height above datum at the beginning of the vertical curve.

3. Permitted elements in cross sections

If both cuts and fills exist in your project, you must define cut and fill cross sections for your project.

Offset from horizontal alignment

Height difference from vertical alignment[3]

[3] A vertical alignment is required in order to use cross sections in ROAD+.

4. Permitted elements in cross section assignments

Name The name or number of the cross section

Station The station (chainage) at which the cross section is to be applied

5. Permitted elements in station equations

Station equation sequence number

Back Station The last station (chainage) leading up to the equation

Ahead Station The first station (chainage) continuing away from the equation

There are two methods that can be used to create the necessary Road+ input data files.

- The Windows application, RoadEd; and
- The TPS1100 Professional Series instrument program, Road+ File Editor.

If the program called "Road+ FILE EDITOR" is loaded into the theodolite, all necessary data can be entered through the keyboard of your TPS1100 Professional Series instrument.

To enter the data on the computer, a Windows application called "RoadEd" can be used. If you create the files using "RoadEd", the files must be copied to the PCMCIA card.

"ROAD+" allows measurements in one telescope position only. A typical "ROAD+" session includes the following steps:

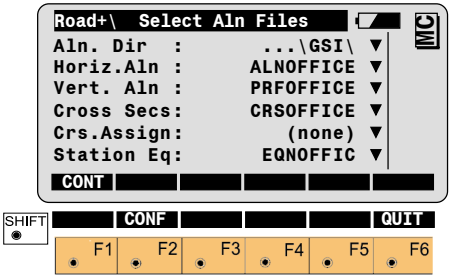
1. Enter setup information for the instrument and orient.
2. Start the ROAD+ program and configure.
3. Select the alignment files
4. Select a station
5. Pick a point on the cross-section to stakeout, enter an offset, choose method.
6. Stake the point and record the data.
7. Choose another point on the cross-section and stake it out.
8. When all selected points on the cross section have been staked, enter a new station and repeat steps 5-7.

In the sections that follow, operation of the program will be covered in more detail. This will assist you to become proficient with the "ROAD+" program for normal everyday operations, such as staking a project with stations and offsets, and slope staking.

Before starting the program, enter the setup information for the location of the theodolite and orient the instrument to the reference point.

From the "MAIN MENU: PROGRAMS" display, move the highlighted cursor to the "ROAD+" program and press  on the keyboard of the instrument. This will bring up the "Select Aln Files" dialog.

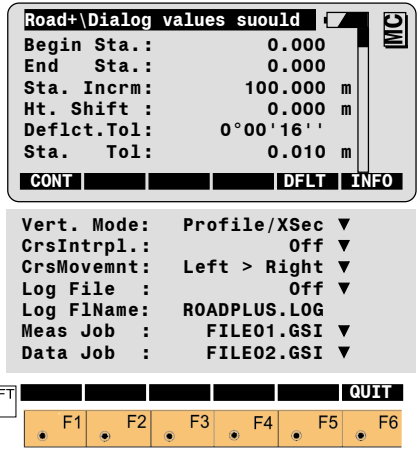
The display illustration examples contain text and values for example purposes only. The actual values you will see on the display of your instrument will be different.



SHIFT F2 Call up the "Configuration-Editor".

Before selecting the alignment files to use, you should enter the configuration parameters for the job.

SHIFT F2 Start the "Configuration-Editor" from the "Select Aln Files" dialog.



Begin Sta.
Enter the beginning station (chainage) for your work area

End Sta.
Enter the ending station (chainage) for your work area

Sta. Incrm
Enter the station (chainage) interval to be used

Ht. Shift
Enter a vertical shift value if needed. The value entered will be applied to the whole alignment.

Deflct. Tol.
Enter an angle tolerance for deflection angles. Make this a small value but not 0.

Sta. Tol.
Enter a value for stationing (chainage) tolerance.

Vert. Mode
The normal mode is Profile/XSec. However, if you have installed the TPS1100 Application DTM Stake, you will see an additional option here. Profile/XSec uses a vertical alignment and cross sections to define the project in the vertical direction. DTM uses a digital terrain model to define the project in the vertical direction.

Crs Intrpl
The cross section interpolation can be switched ON or OFF. More details are described in chapter "Cross section definition".

CrsMovemnt
This function controls the movement along the cross section.
There are three choices:
- LEFT to RIGHT,
- RIGHT to LEFT and
- NONE.

The direction chosen is for display purposes only. The rodperson can go in any direction desired along the cross section.

Log file
When the log file is set to ON, staked out data can be stored in a file for printing at a later date.

Log FlName
Enter a file name for the log file. The default file name can be used. LogFlName appears only if "Log File = ON" is selected in the "Configuration".

Meas Job
Selection of the measurement job for recording measurements.

Data Job
Selection of the data job containing the fix point coordinates (control data).

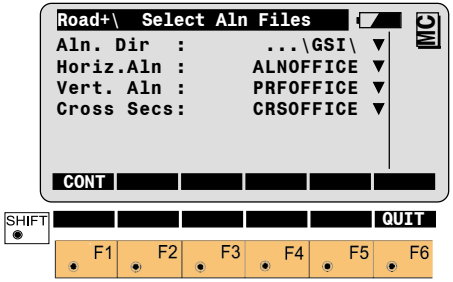
F1 Accepts and stores parameters displayed. Continues to display "SELECT ALN FILES"

F5 Sets standard values. The values are displayed in dialog on page 195.

F6 Displays date and version of the program.

To proceed further, you must select a horizontal alignment file. The other files are optional and are dependent on what you are staking. For instance, if you are only staking the centerline of the road, then it would not be necessary to have a vertical alignment, template, cross section assignment or station equation file. If your project requires these other files then you will need to select them here.

All alignment files must be stored in the same directory on the memory card.



Horizontal Alignment File

The Horizontal Alignment file defines the plan view shape of the project centerline.

 Select the horizontal alignment file. A dialog box appears with a list of all ALN?????.GSI files available. Move the cursor to the file needed and press  .
The "Select Aln File" display will return and the cursor will be highlighting the Vertical Alignment file.

Vertical Alignment File

The Vertical Alignment file defines the height of the project centerline.

 Select the vertical alignment file. A dialog box appears with a list of all PRF?????.GSI files available. Move the cursor to the file needed and press  .
The "Select Aln File" display will return and the cursor will be highlighting the Cross Section file.

Cross Section/template File

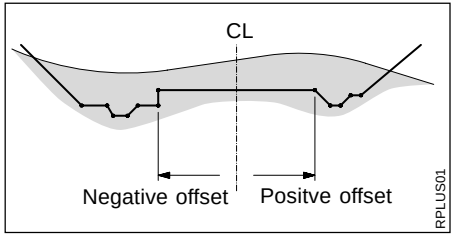
The Cross Section file defines the cross-sectional shape of the project.

 Select the cross section file. A dialog box appears with a list of all CRS?????.GSI files available. Move the cursor to the file needed and press  .
The "Select Aln File" display will return and the cursor will be highlighting the Cross Section Assignment file.

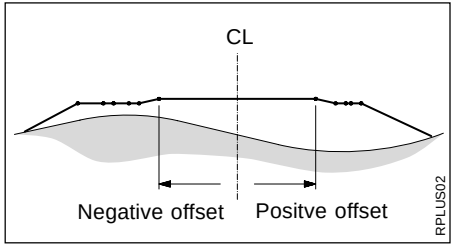
Cross Section Definition

When defining the cross section, both a cut and fill template can be created similar to the following diagrams.

Cross section - Cut



Cross section - Fill



CL = Centerline

The cross section assignment file contains the following elements:

- Cross Section name
- Controlling Chainage

Road+ treats the data in the Cross Section Assignment File in two different ways, according to the setting of the CRS Intrpl switch in the configuration routine.
When CRS Intrpl is set to OFF, a cross section assigned in this file will remain in effect until another cross section is defined. The transition between the two cross sections will be abrupt, at the station where the next cross section assignment takes effect. When the file is created you will designate the name of the template to use and the chainage to begin using the template. The next template name entered also contains a starting chainage. A third template can be assigned to begin at another chainage and so forth.

For example, the file might contain the following information:

XSEC1, 0
XSEC2, 100
XSEC3, 300
XSEC1, 550

Road+ would use template XSEC1 beginning at station (chainage) 0+00 and ending at station (chainage) 1+00, XSEC2 beginning at station (chainage) 1+00 and ending at station (chainage) 3+00, XSEC3 from station (chainage), 3+00 to station (chainage) 5+50, and use XSEC1 again, beginning at station (chainage) 5+50.

When CRS Intrpl is set to ON, this same data would be treated differently, assuming all three cross section templates have the same number of points in them.

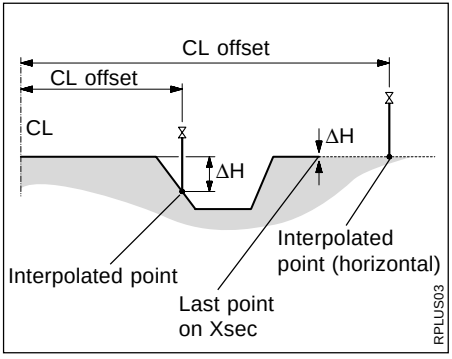
Road+ would start with XSEC1 at station (chainage) 0+00, and transition linearly to XSEC2 at station 1+00. Then it would transition linearly to XSEC3 at station (chainage) 3+00, and finally transition linearly back to XSEC1 at station (chainage) 5+50. If the project continues past station (chainage) 5+50, XSEC1 will be applied.

Select the cross section assignment file. A dialog box appears with a list of all STA?????.GSI files available. Move the cursor to the file needed and press .

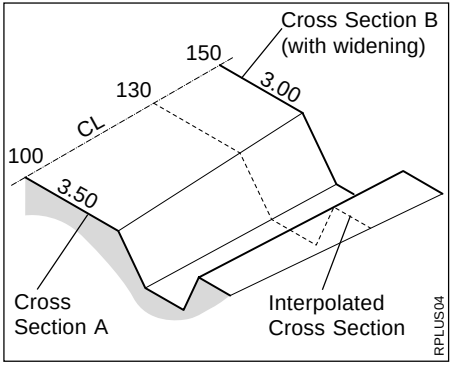
- **Cross Section Interpolation**

Cross sections can be interpolated both along the cross section (i.e. between defined points), and between cross sections themselves. The interpolation between cross sections makes superelevation and widening possible. The following diagrams illustrate these concepts.

Interpolation along a cross section:



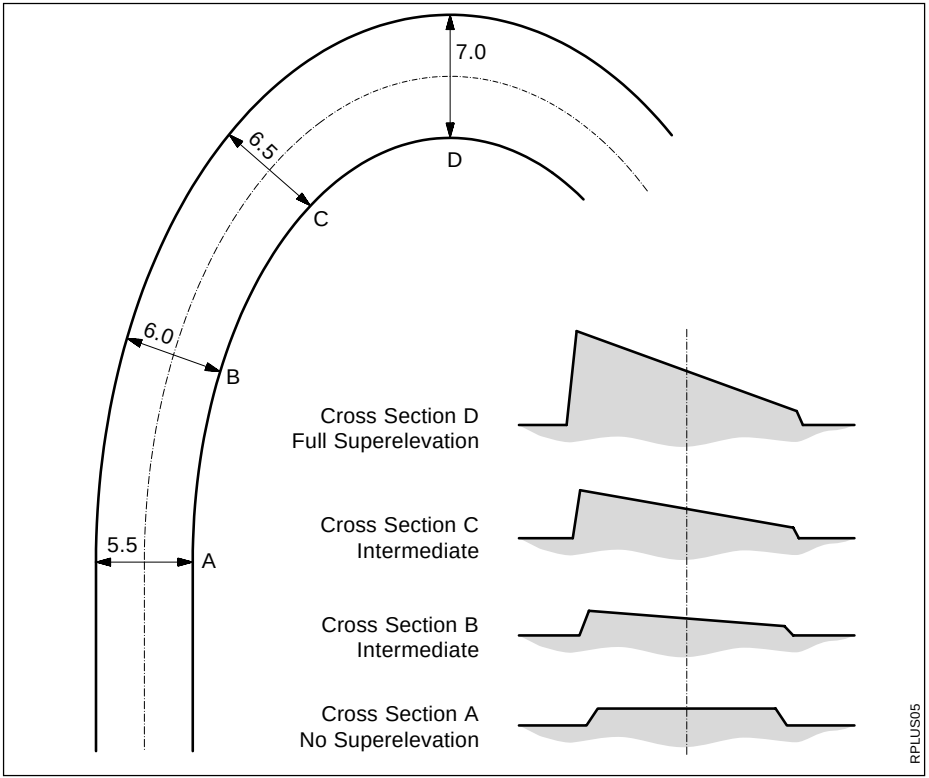
Interpolation between cross sections:



- **Superelevation/Widening**

Superelevation is controlled by the cross sections. Cross sections must be placed at the appropriate chainage for the beginning of superelevation, full superelevation and back to no superelevation. The STA?????.GSI file contains these special locations for cross sections as well as cross section locations for widening. The diagram that follows illustrates the concept for superelevation.

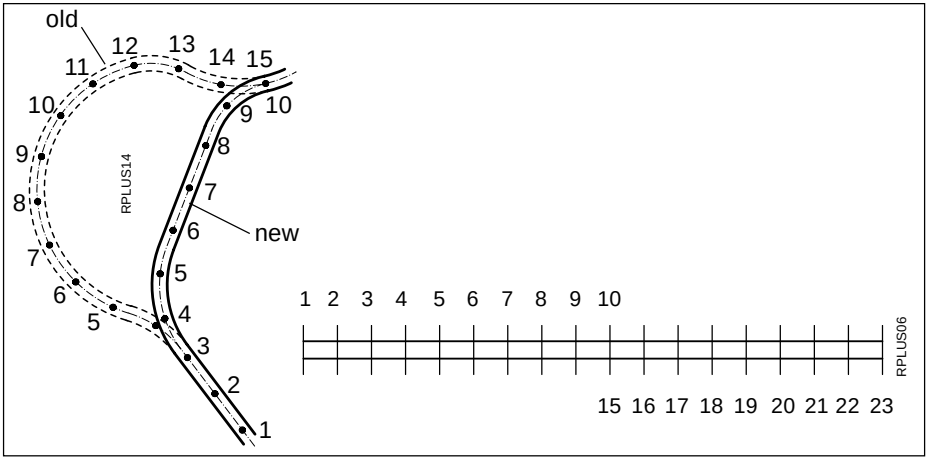
Superelevation governed by cross sections:



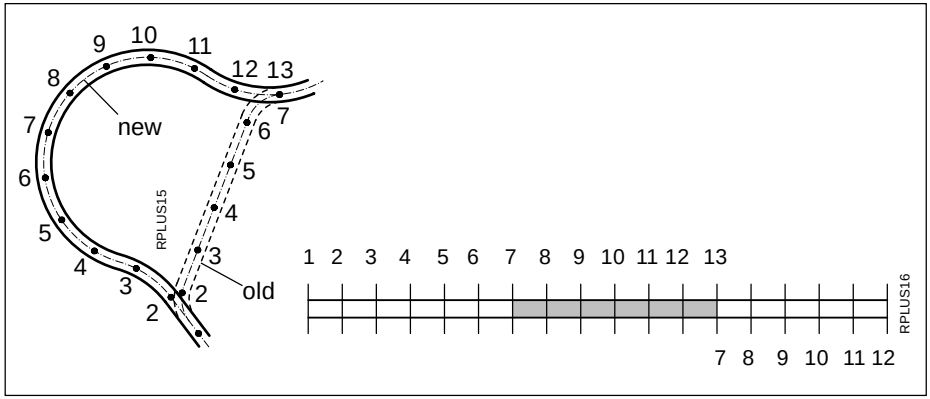
Station equations are used to adjust the alignment stationing. The most common reason for doing so is the insertion or removal of curves during the design process. Inserting or removing a curve would require re-calculating the stationing of an entire alignment. Using station equations eliminates this.

Station equations can create either a gap or overlap as shown in the following diagrams.

Gap Station Equation
Station Back 10+000 = Station Ahead 15+000



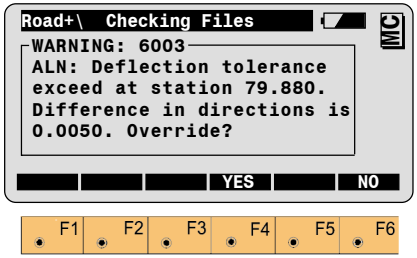
Overlap Station Equation
Station Back 13+000 = Station Ahead 7+000



Select the station equation file. A dialog box appears with a list of all EQN?????.GSI files available. Move the cursor to the file needed and press .

F1 When all files have been selected. Continues to display "Station & OFFSET". Prior to the "Station & OFFSET" display appearing, you will see a brief message about checking for errors in the selected files.

During the file checking process, each file is inspected for possible errors in the data format such as missing or incorrect word index. If errors are found, an error message is displayed indicating the type of error. During the inspection process, if any errors are found that would cause erroneous data to be computed and displayed, the file checking routine will be aborted. If this occurs, the file(s) containing the problem must be fixed before continuing. In addition to checking for file errors, geometrical components are checked. This includes tangent directions of adjacent elements and chord lengths of elements. Any deviations which exceed permitted tolerances are displayed such as in the following example.



F6 Selecting the "NO" option to override will bring up another display that says "Continue checking alignment ?". If you choose "NO" the display will return to the "SELECT ALN FILES" menu. If you choose "YES" the program will continue to check the files. If no other errors are found the program will go to the opening "Station & Offset" display.

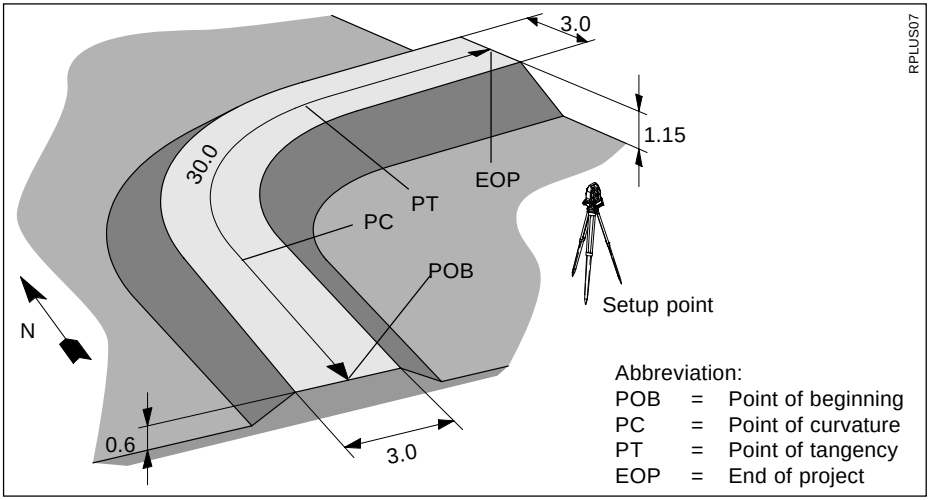
F4 Selecting the "YES" option to override will cause the program to override the error and continue to check other files for possible errors. If no other errors are found the program will go to the "Station & Offset" opening display.

Preparing for the example

The most common method for staking out roads, pavement, curb & gutter etc. is to use a horizontal offset from the actual point. For instance, a four foot offset from finished back of curb (BC) is commonly used to provide cut/fill stakes for a street and curb lines.

In this section of the manual, a sample project will be used to demonstrate the procedures to follow for staking a portion of the job. The project consists of a 3 m wide paved bicycle path with a curve. The project will be staked on a 0.6 m offset from the edge of pavement. The POB and PC will be staked for both sides.

This project also uses a simple template. The project is designed to illustrate the application of the "ROAD+" Program . It is not intended to provide a demonstration of road design procedures.



Our bike path is about 30 m in length as illustrated here. The riding surface is 3 m wide, lying 1.5 m on each side of the centerline. From the edge of the riding surface, fill slopes extend downward at a slope of 2:1.

The vertical alignment (or profile) for the project is a simple 2% uphill slope. An assumed elevation of 30.50 is placed on the original ground at the Setup Point, and the road starts at elevation 31.1. This allows you to practice with all of the components of the "ROADPLUS" program. For the field work, we recommend a flat, open area about 25 m on a side.

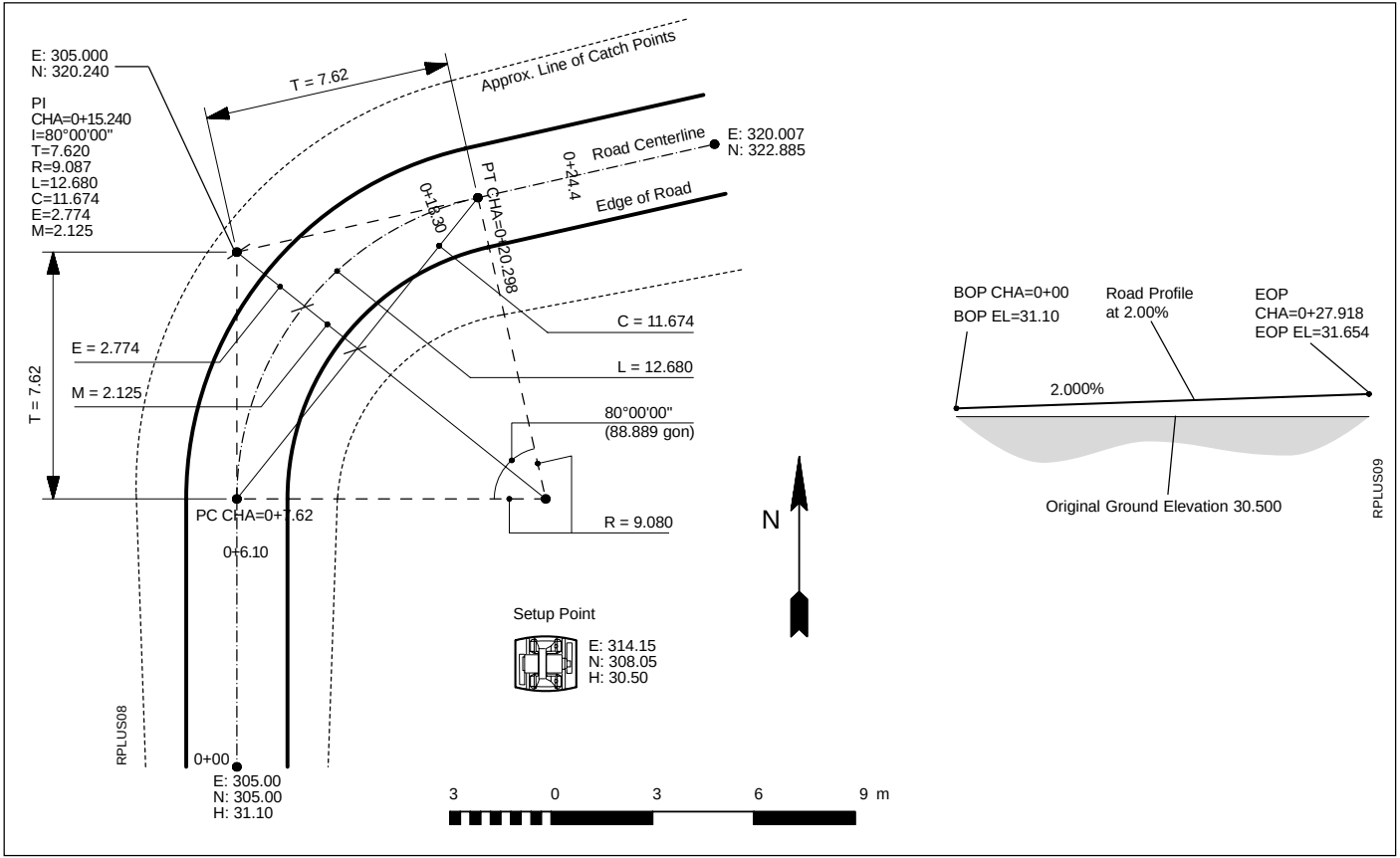
The following pages contain illustrations and listings of all the data needed to run the example.

There are 3 easy steps to the example:

1. Use the "RoadEd" program on your PC, or Road+ File Editor on your TPS1100 Professional Series Instrument, to enter the design information for the Horizontal Alignment, Vertical Alignment, and Templates.
   A special naming convention identifies the type of file that each alignment and template are stored in. The first three letters in the file name tell "ROADPLUS" what is in the file and how to view it. The GSI extension is also required.

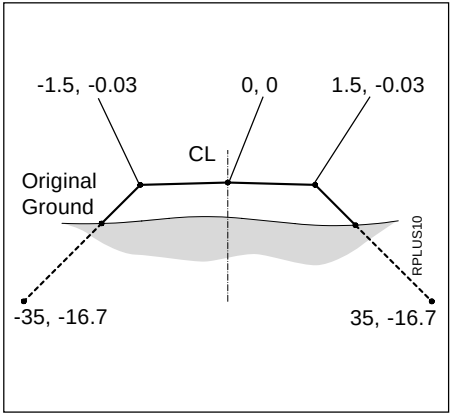
Horizontal Alignment:	ALN?????.GSI
Vertical Alignment:	PRF?????.GSI
Templates:	CRS?????.GSI

In "RoadEd", enter the following example project data. Let's call the project "EXAMPLE" and configure the units to m, 3 decimal places. Let's name the files "ALN_EX1.GSI", "PRF_EX1.GSI", and "CRS_EX1.GSI".


E: 305.000
N: 320.240
PI
CHA=0+15.240
I=80°00'00"
T=7.620
R=9.087
L=12.680
C=11.674
E=2.774
M=2.125
T = 7.62
Approx. Line of Catch Points
Road Centerline
E: 320.007
N: 322.885
Edge of Road
0+24.4
0+18.30
PT CHA=0+20.298
C = 11.674
L = 12.680
80°00'00"
(88.889 gon)
R = 9.080
E = 2.774
M = 2.125
T = 7.62
PC CHA=0+7.62
0+6.10
0+00
E: 305.00
N: 305.00
H: 31.10
RPLUS08
Setup Point
E: 314.15
N: 308.05
H: 30.50
N
3 0 3 6 9 m
BOP CHA=0+00
BOP EL=31.10
Road Profile
at 2.00%
EOP
CHA=0+27.918
EOP EL=31.654
2.000%
Original Ground Elevation 30.500
RPLUS09

Horizontal Alignment: ALN_EX1.GSI					
Station	**Element**	**Rad/Par**	**Template**	**E**	**N**
0.000	Straight	0.000	Tutor	305.000	305.000
7.620	Curve	9.080	Tutor	305.000	312.620
20.298	Straight	0.000	Tutor	312.502	321.562
27.918	EOP	0.000	Tutor	320.007	322.885

Vertical Alignment : PRF_EX1.GSI				
	Chainage	**Element**	**Rad/Par**	**H**
1	0	Straight	0	31.100
2	27.918	EOP	0	31.654



Template: CRS_EX1.GSI

The horizontal alignment file specifies a template for each chainage. Our horizontal alignment file specifies only one template, "Tutor". You can, however, specify different templates for any chainage as you may require. We will define two templates, "Tutor" and "TypCut", in our template file.

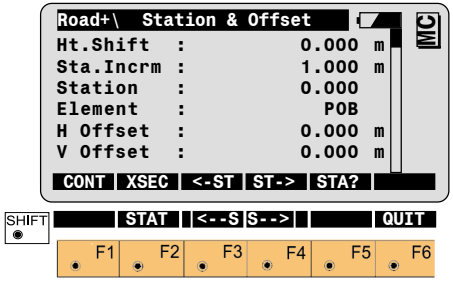
While running "ROADPLUS", you can switch templates at any time. ("TypCut" will not be used to stake out this example)

	Template	**Offset**	**Ht. Diff.**
1	Tutor	-35.000	-16.700
2	Tutor	-1.500	-0.030
3	Tutor	0.000	0.000
4	Tutor	1.500	-0.030
5	Tutor	35.000	-16.700
6	TypCut	-35.000	+16.630
7	TypCut	-1.500	-0.030
8	TypCut	0.000	0.000
9	TypCut	1.500	-0.030
10	TypCut	35.000	+16.630

2. **Copy the alignment and template files to your PCMCIA card.** Copy the files into the GSI subdirectory on your PCMCIA card. If the GSI subdirectory doesn't already exist on the PCMCIA card, you will need to create it. Place the PCMCIA card in your instrument.

3. **Set up the instrument in your work area and stakeout the example roadway.** Set the instrument coordinates to the values shown for point 1 (*see figure page 206*). Orient the instrument towards a convenient "North", and set Hz_o to zero (*see figure page 206*). Start "ROAD+" and continue reading this manual.

When the "Chainage & Offset" display first appears, only the lower portion beginning with "Station" will be visible. To view the entire display, use the green up/down arrow keys on the keyboard to scroll up to the top.



Ht. Shift
Vertical shift applied to the whole alignment. Set this to zero in this example.

Sta. Incrm.
The station (chainage) increment set in the configuration is displayed. If desired, a new value can be entered.

Station
Enter the station (chainage) to be staked.

Element
This displays the element for the chosen station (chainage) such as POB, PC, CURVE etc.

H. Offset
Horizontal offset to apply to the current chainage. Set this to -0.6 to stake the left side and 0.6 to stake the right side of the bikeway in this example.

V Offset
Additional vertical offset to apply to the current chainage.

F1 Press to stakeout the centerline point at the specified station (chainage). Depending on your program configuration, you may see the coordinates of this centerline point, or you may go directly to the STAKEOUT program.

F5 Allows you to take a measurement and determine the station (chainage) and offset of that measurement. You may then use the station (chainage) of that measurement to stake out a cross section point, if you desire.

F6 Press to change between cut and fill templates. "FillS" is shown when a cut template is active, "CutS" when a fill template is active.

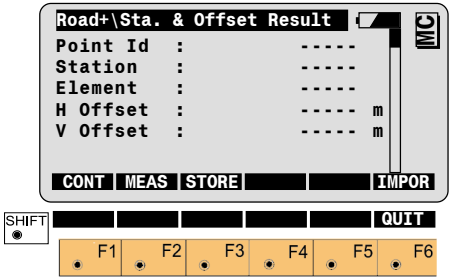
SHIFT F2 Allows you to view the active station equations, if you specified a station equation file when you started Road+.

SHIFT F3 Allows you to "jump" directly to the Begin Station (Chainage) specified in the configuration.

SHIFT F4 Allows you to "jump" directly to the End Station (Chainage) specified in the configuration.

SHIFT F5 Allows you to place a note in the Log File, if one is activated in the configuration.

From this dialog, you may make a measurement and Road+ will calculate the station (chainage) and offset at the prism, or you may import a point and calculate the station (chainage) and offset of that point.



F1 to set the measured point into the Station & Offset dialog. (Not available until after a measurement has been made, or a point imported.)

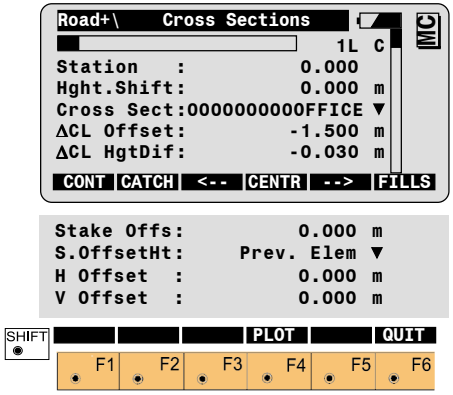
F2 to make a measurement. The normal measurement dialog is displayed. Press F4 when you are ready to calculate the station (chainage) and offset of a measured point. You will return to this dialog and see the Station, Element and Horizontal and Vertical offsets to the measured point.

F3 to store the results of this measurement. (Not available until after a measurement has been made.

F6 to import a point from a file, and use it to compute the station (chainage) and offset.

The first step in the procedure is to select a point on the cross section to be staked and enter the offset.

F2 Access the cross section options.



1L
Indicates the location of the cross section point in relation to the centerline. In this example, the "1L" means the first point of the template left of centerline.

C
Indicates that a cut template is active. An F would indicate that a fill template is active.

Chainage
Displays the current chainage.

Hght. Shift
Displays the vertical shift, if any, applied to the whole alignment.

Template
Displays the template name being used.

ΔCL Offset
Displays the horizontal distance of the template point from centerline (– for left)

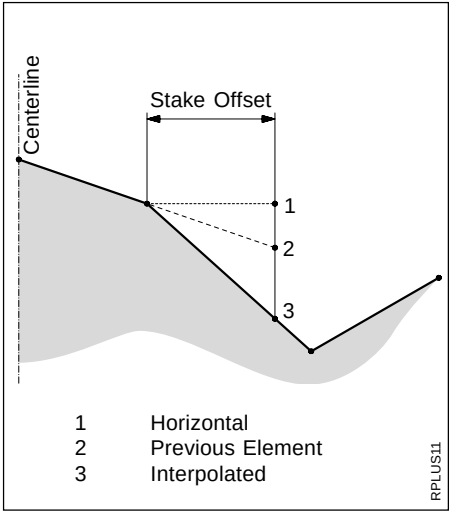
ΔCL Hgt Diff
Displays the difference in elevation of the template point between the centerline and the point to be staked.

Stake Offs.
This is the offset value that will be used for setting the offset stake. If the point is left of centerline, the value entered must be a negative number.

S. Offset Ht.
This display indicates the method used in computing the elevation of the point to be staked. The three methods are "Previous Element", "Interpolated" and "Horizontal".

Offset
Horizontal offset to apply to current chainage.

Ht. Offset
Additonal vertical offset to apply to current chainage.



F2 Activates the slope staking options

F3 Move along the current cross section from right to left.

F4 Sets the cross section point to the centerline

F5 Move across the current cross section from left to right

SHIFT F4 Displays a plot of the template.

The first point we want to stake for the bike path is the left edge of pavement. This point is 1.5 m left of centerline so the "ΔCL Offset" value should be set to a -1.5 m.

F3 Change the location to -1.5 m. The "ΔCL Ht. Diff" value will automatically change to the correct vertical difference based upon the design of the template.

The stake offset value needs to be set to a -0.600 m. The negative value is used because the point to stake is left of centerline.

To accept the value press ↵ .

The final step in the process is to select the method to use for computing the elevation of the offset point to be staked. The "ROAD+" program provides three methods to choose from:

Horizontal
The elevation is computed horizontally to the catch point.

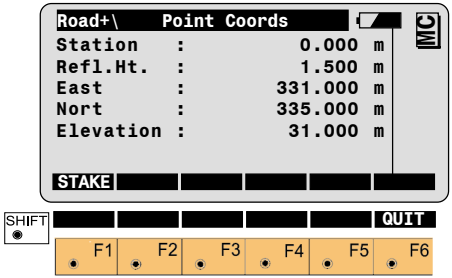
Previous Element
The elevation is computed on an extension of the grade of the previous element.

Interpolated
The elevation is interpolated to intersect the design slope of the cross section.

The most common method used is the "Horizontal" method.
To select this method, move the cursor to "S. Offset Ht" and press ↵ to display the three options.
Move the cursor to "Horizontal" and press ↵ .
This setting will remain as the current method until a different method is chosen. Therefore it is not necessary to go through the procedure every time.

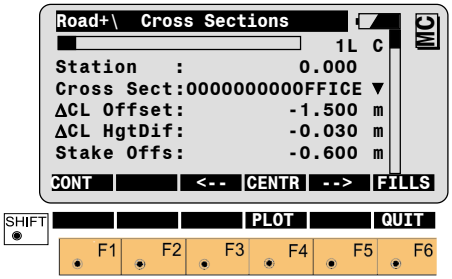
F1 Accepts and stores parameters set. Continues to display "Point Coords".

The "POINT COORDS" dialog displays the current chainage location of the offset point to be staked. The display also shows the value for the prism pole (Refl. Height) and the Easting and Northing coordinates of the offset point and the finished grade elevation of the actual point (not the offset location).



F1 Activates the stakeout program. (*See STAKEOUT*) Record the staked out point, or "CONT" in STAKEOUT to return to ROAD+.

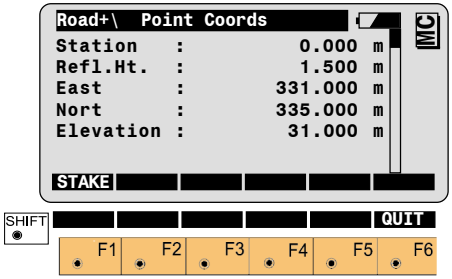
- **Stakeout Next point on Cross Section**



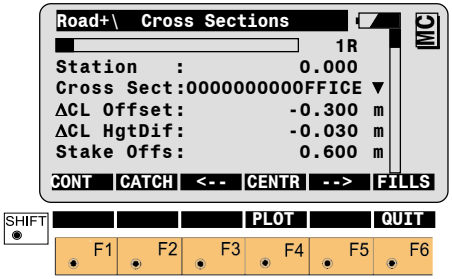
To set the offset stake for the right side of our example project:

F5 Set the "ΔCL Offset" value to positive 1.500 m.
Note when you do this the position changes from "1L" to "1R". Scroll down and highlight "Stake Offs.". Change the offset value to positive 0.600 m.

F1 Returns to the "POINT COORDS" display.

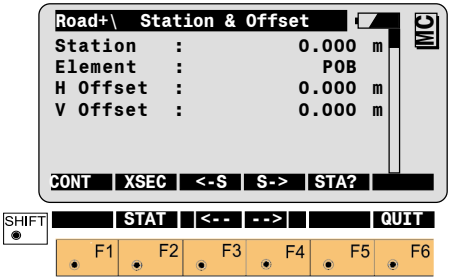


F1 Stakeout the 0.600 m offset stake for the right side of the bike path. (*See STAKEOUT*) Record the staked out point, or "CONT" in STAKEOUT to return to ROAD+.



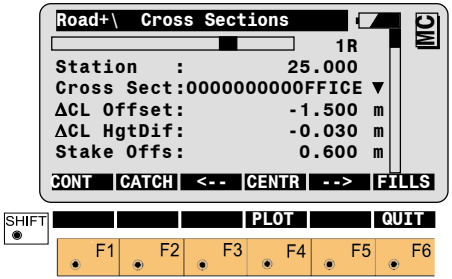
For this example, the last point staked was the 0.600 m offset point for the right side. When the "Cross Sections" display appears, the "ΔCL Offset" changes to the next point on the cross section. The next point to stake is the 0.600 m offset for the right side at the next station.

ESC Exits from the "Cross Sections" display and returns to the "Station & Offset".



F4 Moves to the next station (chainage) (you also may enter a new station (chainage)). The Station & Offset display will change to reflect the new station location.

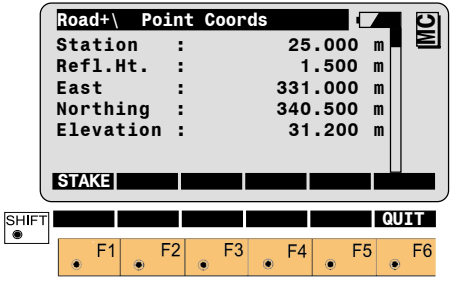
F2 Brings up the "Cross Sections" display.



In our example the last point staked was on the right side. Rather than have the rod person cross back over to the left side, it makes sense to stay on the right side and stake that position and then cross over to the left side.
To stake the catch point on the right side:

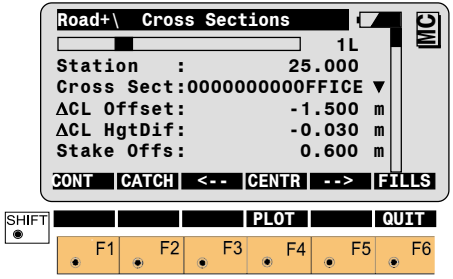
F5 Set the "ΔCL Offset" from centerline value to positive 1.500 m. The offset value should be positive 0.600 m, but should not require a change because that was the last offset value used for the previous right side point.

F1 Access the "Point Coords" display.



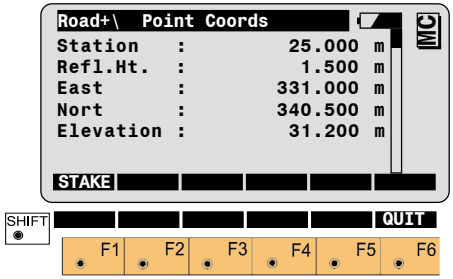
To stake the offset point on the right side for chainage 25+00:

F1 Activates the stakeout program.
Record the staked out point, or "CONT" in STAKEOUT to return to ROAD+.



F3 Change the "ΔCL Offset" from centerline to negative 1.5 m. Change the "Stake Offs." value to negative 0.600 m.

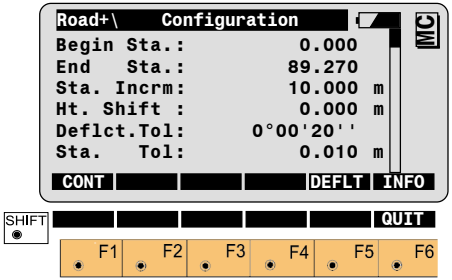
F1 Access the "Point Coords" display.



F1 Access the stakeout program. (*See STAKEOUT*)
Record the staked out point, or "CONT" in STAKEOUT to return to ROAD+.

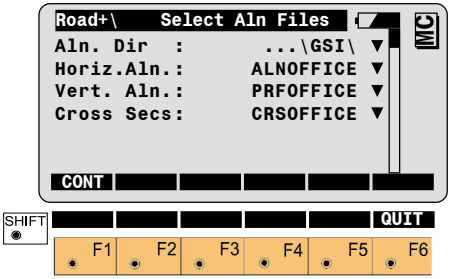
Start "ROAD+" from the program menu.

SHIFT F2 Start the "Configuration-Editor" from the "Select Aln Files" dialog.



Enter the beginning and ending station (chainage), the station (chainage) increment and so forth. Make all entries.

F1 Returns to the "Select Aln Files" display.

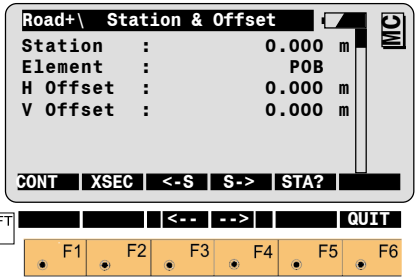


F6 Select the alignment files.

Place the cursor on each file type, press ↵ and pick the file from the displayed list. Select the files.

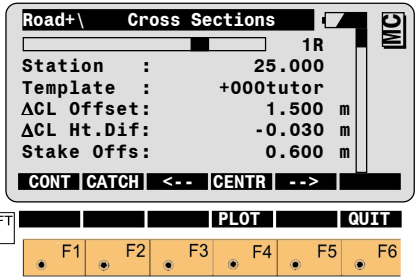
F1 To accept the specified files and check them for errors.

A Horizontal Alignment File must be selected.



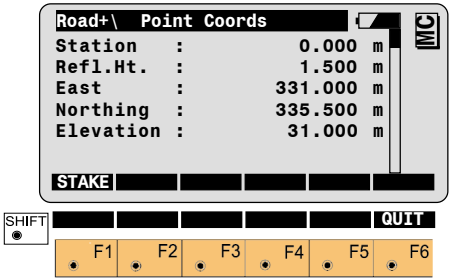
F2 To select the template point to stake (back of curb, edge of pavement etc.):

The "Cross Sections" options display appears.

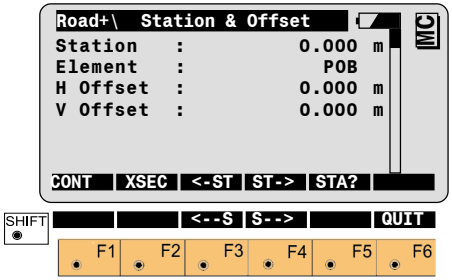


F3 or F5 Set the "ΔCL Offset" value. This value is the distance from centerline of the point you want to stake.
Move the cursor to "Template" and pick the cross section template to use, then set the "Stake Offs." (stake offset value). If the point is left of the centerline, enter the offset value as a negative value.

F1 Continues with display "Point Coords".



F1 The stakeout program will start with the polar stakeout method being used. (*See STAKEOUT*)
Record the staked out point, or "CONT" in STAKEOUT to return to ROAD+.

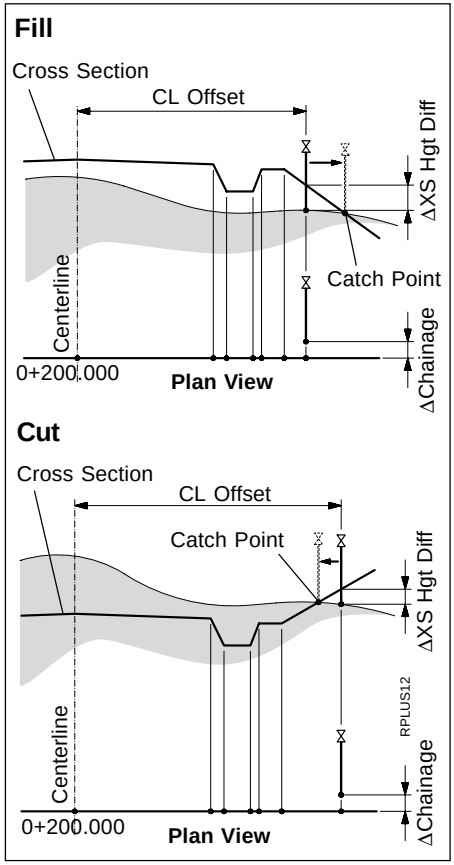


F3 or F4 Select a new station (chainage) (you also may enter a station (chainage).

F2 Select the point to stake out and the offset.
Repeat the procedure outlined in sections *"Set offset value and select point to stakeout"* through *"Select new chainage"*. Continue in this manner until all points have been staked.

Slope staking involves determining a point where the cross section template meets the ground surface. This Catch Point of zero cut/fill (Catch Point) is found primarily by trial and error and a lot of computing. The following diagram illustrates the concepts of slope staking.

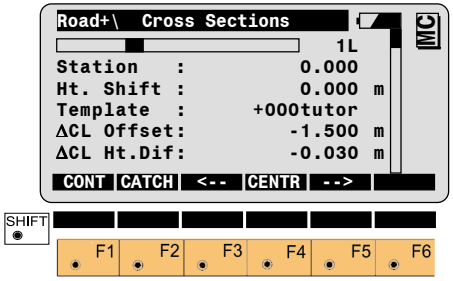
The slope staking routine is accessed from the "Cross Sections" display.



Set the "H + V Offsets" to zero.

F2 Start the "CROSS SECTIONS" display from the "CHAINAGE & OFFSET" display.

Set the "Ht. Shift" to zero.

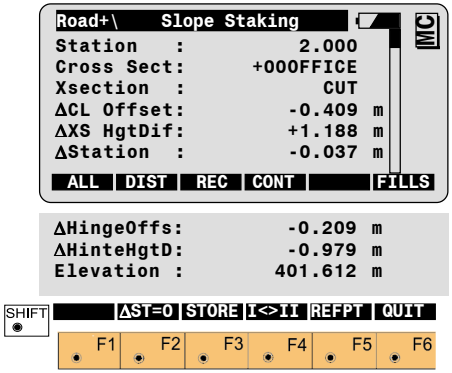


F3 or F5 Select the left- or right-most cross section point.

Before proceeding, move the cursor to the "Template" option.

Choose the template to use for slope staking. If the displayed template is the correct one, then it will not be necessary to change it.

F2 Start the slope stake program.



The "STORE" and "REFPT" options are not available until after a distance is measured.

F2 Measure to the current position of the prism pole. When the value of "ΔXS Hgt Diff" and "ΔStation" are zero, or close to it, the prism pole is at the catch point.

In the sample display shown, the value for "ΔXS Hgt Diff" is 1.188m. The value is positive, meaning the measurement was taken at a point that is above the cut slope. Assuming the cut slope is 1:1, the rodperson will want to move approximately 1 meter away from the centerline before making the next measurement.

The value of the ΔStation is -0.037m. The value is negative, meaning the measurement was taken at a point whose station is slightly lower than the indended 2.000. The rodperson will want to move slightly up station before making the next measurement.

In addition, the horizontal distance from centerline is displayed which is -0.409 m for this example.

After moving to a new location, measure a distance to the prism and view the results. When the "ΔXS Hgt Diff" and "ΔStation" are at or near zero the catch point has been located both vertically and horizontally for the chosen chainage.

F3 Record the staked out position.
The "SLOPE STAKING" display returns and another catch point can be staked.

F4 Exit the slope staking program.

- **SLOPE STAKING Menu Function Key Summary**

F1 Measures the distance to the target, and automatically records the data as defined by the currently set recording mask.

F2 Measures the distance only, and updates the display.

F3 Records the information for the current measurements.

SHIFT F2 Sets the station to the value of the last measurement.

The "ΔSt=0" function is not available until a distance is measured.

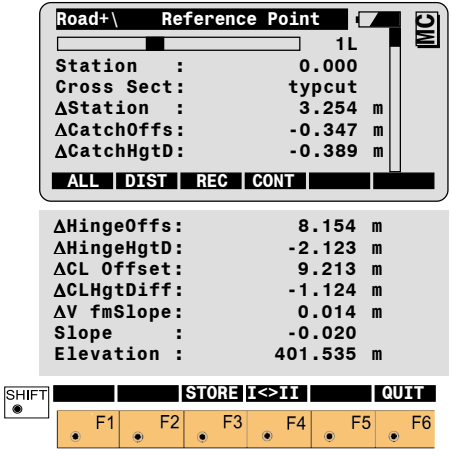
SHIFT F3 Stores the data to the log file.

The STORE function is not available until a distance is measured.

SHIFT F4 Switches between face one and face two for measurements.

SHIFT F5 After a measurement is made to the prism pole the "REFPT" option will be available. See section "Reference Point" for a detailed discussion of this option.

SHIFT F5 Displays additional information about how the location of the prism pole relates to components of the cross-section. Do this after a measurement at the catch point has been made.



1L
Indicates the location of the cross section point in relation to the centerline. In this example, the "1L" means the first point of the template left of centerline.

Station
Displays the currently specified station (chainage).

Cross Sect
Displays the currently specified template name.

ΔStation
Displays difference between the station (chainage) of the last measurement to the rod and the currently specified station (chainage). Move the rod toward the beginning of the project if this value is positive, move the rod away from the beginning of the project if this value is negative.

ΔCatch Offs
The horizontal offset from the catch point to the last measurement.

ΔCatch HgtD
The vertical offset from the catch point the last measurement.

ΔHinge Offs
The horizontal offset from the hinge to the last measurement.

ΔHinge HgtD
The vertical offset from the hinge to the last measurement.

ΔCL Offset
The horizontal offset from the centerline to the last measurement.

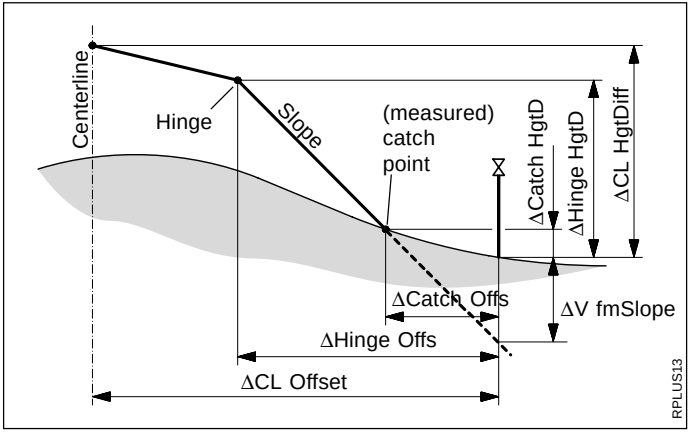
ΔCL HgtDiff
The vertical offset from the centerline to the last measurement.

ΔV fmSlope
Vertical distance from Cut- or Fill-slope at the specified station.

Slope
Slope ratio of Cut- or Fill slope.

Elevation
Elevation at measurement.

The following illustration represents the various components of the REFPT option.



The following describes the format and contents of the data stored for alignments and cross-sections in the Road+ program. All files are in GSI format and all files for a project must be located in the same directory of the memory card.

The following geometric elements are supported:

Element	Definition	Declaration in the alignment file
Tangent	Station, Beginning (X,Y)	"STRAIGHT"
Circular curve	Station, Beginning of arc (X,Y), Radius,	"000CURVE"
Spiral in	Station, Beginning of curve (X,Y), A-Parameter (A= $\sqrt{LxR}$)	"00SPIRIN"
Spiral out	Station, Beginning of curve (X,Y), A-Parameter (A= $\sqrt{LxR}$)	"0SPIROUT"
Curve in	Station, Beginning of curve (X,Y), Radius 1, Radius 2	"0CURVEIN"
Curve out	Station, Beginning of curve (X,Y), Radius 1, Radius 2	"CURVEOUT"
End of Project	Station, Coordinates (X,Y)	"00000EOP"

Header of the Horizontal Alignment File:

```
41....+000JOBID 42....+HZALIGNM 43......+STACOORD
```

WI 41 Job-Identification. Max. 8 ASCII-characters, may be defined by user.
WI 42 Identification of Horizontal Alignment file. May not be changed by user.
WI 43 Identification of principal point type file. May not be changed by user.

The data block for a principal point in the file is structured as follows :

```
11....+KILOMETR 71....+0NEXTGEO 72....+0NEXTRAD
73....+0TEMPLNR 81..10+00000000 82..10+00000000
```

WI 11 Station (chainage) of the point.
WI 71 Type of the following geometric element.
WI 72 Radius of the next horizontal geometric element, Radius 1 for a compound curve, or the A-Parameter for spirals.
WI 73 Number of a cross-section (Template) assigned to the next geometric element.
WI 74 Radius 2 for compound curves.
WI 81 E-Coordinate of the point.
WI 82 N-Coordinate of the point.

Comments:

- The header consists of a single block at the start of a data file.
- Tangents and the EOP contain “00000NON” in WI72
- Data units and decimal places in WI’s 11, 72 and 74 are defined by WI81 and WI82.
- If the radius point for a curve (circular or spiral) is to the left of the alignment (looking in the direction of increasing stations) the radius is negative.
- If the radius point for a curve (circular or spiral) is to the right of the alignment (looking in the direction of increasing stations) the radius is positive.
- A cross section (Template) may be assigned to more than one location.

- An alignment file must contain at least two elements. The last element must be "EOP".
- There is no limitation on the size of the Hz-alignment file. If a file is created/edited using the program "ROAD+FILE EDITOR" on the TPS1100, there is a limitation of 200 data blocks.

Example of a Horizontal Alignment:

```
41....+0EXAMPLE 42....+HZALIGNM 43....+STACOORD
11....+00000000 71....+STRAIGHT 72....+00000NON
73....+QP000125 81..10+06000000 82..10+02000000
11....+00198832 71....+00SPIRIN 72....-00122474
73....+QP000123 81..10+06068005 82..10+02186841
11....+00348832 71....+000CURVE 72....-00100000
73....+QP000123 81..10+06150344 82..10+02307751
11....+00450725 71....+0SPIROUT 72....-00100000
73....+QP000123 81..10+06247816 82..10+02304071
11....+00550725 71....+STRAIGHT 72....+00000NON
73....+QP000125 81..10+06310759 82..10+02227794
11....+00714138 71....+00SPIRIN 72....+00054772
73....+QP000124 81..10+06392465 82..10+02086275
11....+00789138 71....+000CURVE 72....+00040000
73....+QP000124 81..10+06445859 82..10+02037807
11....+00824376 71....+0SPIROUT 72....+00044721
73....+QP000124 81..10+06478120 82..10+02048886
11....+00874376 71....+STRAIGHT 72....+00000NON
73....+QP000125 81..10+06496445 82..10+02094478
11....+01127904 71....+00000EOP 72....+00000NON
73....+QP000125 81..10+06540469 82..10+02344154
```

The principal points method allows joining elements without the use of intermediate tangents.
The following combinations, for example, may be defined:

- **Double spiral: spiral out followed by spiral in**
- **Multiple circular curves**
- **S curves with and without intermediate tangents**

Geometric elements supported:

Element	Definition	Declaration in the alignment file
Tangent	Station, H	"STRAIGHT"
Circular curve	Station, Radius, H	"000CURVE"
Parabola	Station, Parabola parameter, H (see page 192 for Parameter Formulare)	"0PARABOL"
End of Project	Station, H	"00000EOP"

Vertical Alignment File Header:

```
41....+000JOBID 42....+0VALIGNM 43......+STACOORD
```

WI 41 Job-Identification. Max. 8 ASCII-characters, may be defined by user.
WI 42 Identification of Vertical Alignment file. May not be changed by user.
WI 43 Identification of principal point type file. May not be changed by user.

Example for a data block for a vertical alignment point:

```
11...+KILOMETR 71...+ONEXTGEO 72...+ONEXTRAD 83..10+00000000
```

WI 11	Station (chainage) of a vertical alignment point
WI 71	Type of the following geometric element
WI 72	Radius of the following geometric element or parabola parameter
WI 83	Elevation of the point

Comments:

- The header consists of a single block.
- Tangents and the EOP contain “00000NON” in WI72
- Data units and decimal places in WI’s 11 and 72 are defined by WI83.
- Tangent and arc lengths are calculated from the stationing.
- The stationing is projected onto a horizontal plane.
- If the curve radius point lies above the centerline, the radius is positive.
- If the curve radius lies beneath the centerline, the radius is negative.
- An alignment file must contain at least two elements.

Example of a vertical alignment file:

```
41....+0example 42....+0VALIGNM 43....+STACOORD
11....+00000000 71....+STRAIGHT 72....+00000NON 83..10+00400000
11....+00300000 71....+0PARABOL 72....-01142932 83..10+00422500
11....+00500000 71....+STRAIGHT 72....+00000NON 83..10+00420000
11....+00550000 71....+0PARABOL 72....+02091126 83..10+00415000
11....+00850000 71....+STRAIGHT 72....+00000NON 83..10+00406522
11....+01127904 71....+00000EOP 72....+00000NON 83..10+00418605
```

Geometric elements supported:

Element	Definition
Height differences	Height difference from the centerline
Distance	Horizontal distance from the centerline
Cross section type	Differentiate between CUT and FILL cross sections
Slope	Slope ratio

Header of the Cross Section File:

```
41....+00JOB_ID 42....+TEMPLATE
```

WI 41 Job identification. Max. 8 ASCII characters, user definable.
WI 42 Template file identification. May not be changed by user.

A data block for a cross section is structured as follows:

```
11....+0PROF_NR 35..10+DISTANCE 36..10+000HDIFF
71....+0000FILL 72....+00002000
```

WI 11 The cross section number.
WI 35 Horizontal distance from the centerline.
WI 36 Height difference from the centerline.
WI 71 Cross section type.
WI 72 Slope ratio.

Comments:

- All data blocks having the same cross section number (WI11) belong together.
- All data blocks belonging to a cross section must be consecutive in the file to minimize file access.
- The data blocks for a cross section must be sorted from left to right across the section.
- Data units defined by WI 35+36.
- Cross-sections do not have to be sorted by number.
- A negative distance (WI35) indicates a point to the left of the centerline.
- A positive distance (WI35) indicates a point to the right of the centerline.
- A negative height difference (WI36) indicates a point below the centerline.
- A positive height difference indicates a point above the centerline.
- A cross-section may contain up to 48 points.
- A template file must contain at least one cross-section.
- The entries for cross section type and slope are optional.
- The non-zero slope entry must be attached only to the last point on each side of the cross section.

Example:

```
41....+0EXAMPLE 42....+TEMPLATE
11....+QP000123 35..10-00013000 36..10-00003000
11....+QP000123 35..10-00010000 36..10-00005000
11....+QP000123 35..10-00004000 36..10-00000100
11....+QP000123 35..10+00004000 36..10+00000100
11....+QP000123 35..10+00010000 36..10-00006000
11....+QP000123 35..10+00013000 36..10-00003500
11....+QP000124 35..10-00012000 36..10-00002000
11....+QP000124 35..10-00011000 36..10-00004000
11....+QP000124 35..10-00004000 36..10+00000100
11....+QP000124 35..10+00004000 36..10-00000100
11....+QP000124 35..10+00011000 36..10-00005000
11....+QP000124 35..10+00012000 36..10-00002500
11....+QP000125 35..10-00012000 36..10-00002000
11....+QP000125 35..10-00011000 36..10-00002500
11....+QP000125 35..10-00004000 36..10-00000070
11....+QP000125 35..10+00004000 36..10-00000070
11....+QP000125 35..10+00011000 36..10-00002500
11....+QP000125 35..10+00012000 36..10-00002000
11....+TEMPLATE 35..41-00002000 36..11+00000000 71....+0000FILL
72....+00002000
11....+TEMPLATE 35..41-00000500 36..11+00000000 71....+0000FILL
72....+00000000
11....+TEMPLATE 35..41+00000000 36..11+00000000 71....+0000FILL
72....+00000000
11....+TEMPLATE 35..41+00001000 36..11+00000000 71....+0000FILL
72....+00000000
11....+TEMPLATE 35..41+00002000 36..11+00000000 71....+0000FILL
72....+00002000
```

Elements supported:

Element	Definition
Cross Section number	The number or identifier of the cross section
Chainage	The chainage from which the cross section is applied

Header of the Cross Section Assignment File:

```
410001+000ASKER 42..10+ASSIGNMT 43....+CRSASKER
```

WI41 Job identification. Max. 8 ASCII characters, user definable.
WI42 Cross section assignment file identification. May not be changed by user. Data units are defined by characters 6+7 of WI42.
WI43 Name of the corresponding cross section file.

A data block for a cross section assignment is structured as follows:

```
110002+0000NORM 71....+00382000
```

WI 11 The cross section number or identifier
WI 71 Beginning chainage for that cross section

Comments:

- A cross section assignment file must have a corresponding cross section file.
- A cross section remains valid until a new cross section is assigned.
- A given cross section may be assigned more than once.
- The units for station (chainage) are defined in WI 42 in the file header.

Example:

```
410001+000asker 42..10+ASSIGNMT 43....+CRSASKER
110002+0000NORM 71....+00382000
110003+0000NORM 71....+00552000
110004+00000568 71....+00568000
110005+000568.1 71....+00568100
110006+000585.1 71....+00585100
110007+000585.2 71....+00585200
110008+0000NORM 71....+00611000
110009+0000NORM 71....+00775000
110010+00000811 71....+00811000
110011+000826.9 71....+00826900
110012+00000827 71....+00827000
110013+00000827 71....+00844000
110014+000826.9 71....+00844100
110015+00000860 71....+00860000
```

Elements supported:

Element	Definition
Station equation number	The number or identifier of the station equation
Chainage ahead	The chainage to be applied going forward along the alignment from the equation.
Chainage back	The chainage to be applied going backward along the alignment from the equation.

Comments:
Data units are defined by characters 6+7 in WI42+43

Header of Station Equation File:

```
41....+00JOB_ID 42....+0STAEQTN
```

WI41 Job identification. Max. 8 ASCII characters, user definable.
WI42 Station Equation file identification. May not be changed by user.

A data block for a station equation is structured as follows:

```
41....+00000001 42..10+00100000 43..10+00200000
```

WI 41 The station equation number.
WI 42 Chainage ahead.
WI 43 Chainage back.

Example:

```
41....+00JOB_ID 42....+0STAEQTN
41....+00000001 42..10+00100000 43..10+00200000
41....+00000002 42..10+00566000 43..10+00600000
```


If "Log File" is set to "ON" the measurements and the results are stored in the ASCII-file specified within the "Configuration Editor". This file is created in the directory LOG on the memory card. Subsequently, you can read the memory card on your PC and obtain a hard copy of the Log-file.

Data will always be appended to the specified Log-file.

The Log-file contains the following information:

Header includes:

- the program used,
- information about the instrument,
- the file to store the measurement data,
- the date and the time.

Configuration

the name of the input files for:
- the Hz-alignment,
- the V-alignment and
- the cross section.

Measurement

- Instrument station with coordinates and instrument height.
- Stakeout point with heigth offset,
- offset[1] and height displacement[2] relative to centre line,
- comparison values from planning, and associated differences.

[1] This value results from
- the displacement of the zero point of the profile

and
- the displacement taken from the transverse profile.

[2] This value results from
- the displacement of the zero point of the profile

and
- the displacement taken from the transverse profile
- the height displacement in the configuration.

Example of a log file for the program "Road+":

```
Leica Geosystems  VIP RoadPlus V 0.90
Instrument        :    TPS1100, Serial 400001,
Meas. File        :    FILE01.GSI
Program Start     :    02/07/1998 at 10:37

Horizontal Aln    :    ALNSPORT.GSI
Vertical Aln      :    PRFSPORT.GSI
Cross Sections    :    CRSSPORT.GSI

Station no.       :    1
                       E= 0.000m      N= 0.000m    ELV= 0.000m       hi= 1.6000m

Point No.         :    55
Chainage          :    150.000, Offset=  0.000m,              Hght Offset= 0.000m
Design            :    E= -79.269m,      N=   19.917m,        ELV= 400.501m
Staked            :    E= -1.057m,       N=  2.578m,          ELV=   0.107m
Deltas            :    dE= -78.211m,     dN=  17.339m,        dELV= 400.394m

Point No.         :    5
Chainage          :    100.000, Offset=   0.000m,             Hght Offset= 0.000m
Design            :    E= -46.305m,      N=   26.708m,        ELV=    400.409m
Staked            :    E=  -0.000m,      N=   2.774m,         ELV=     0.051m
Deltas            :    dE= -46.305m,     dN= 23.934m,         dELV=   400.358m

Point No.         :    5
Chainage          :    100.785, Offset=      0.000m,          Hght Offset= 0.000m
Design            :    E= -46.688m,      N=  27.392m,         ELV=  400.365m
Staked            :    E= -0.000m,       N=  2.774m,          ELV=   0.051m
Deltas            :    dE= -46.688m,     dN= 24.619m,         dELV= 400.314m
```

Introduction

This manual describes the "AUTO RECORD" program of the TPS1100 instruments.

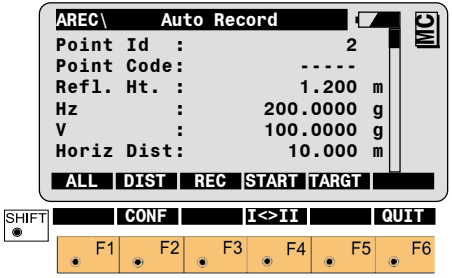
The program automates the recording of field measurement data and is designed especially for TPS1100 instruments with ATR. The program does not require the use of a 360° prism, but the 360° prism does facilitate the field work by avoiding the need to keep the prism oriented toward the TPS1100 instrument. Once the program configuration has been set in accordance with the requirements of the particular survey being performed, and tracking mode measurements started, positions will be automatically measured and recorded with no further operator input.

Feature coding may be added to the recorded data as necessary, while the program continues to operate. It is not necessary to exit the program in order to input and record feature coding information.

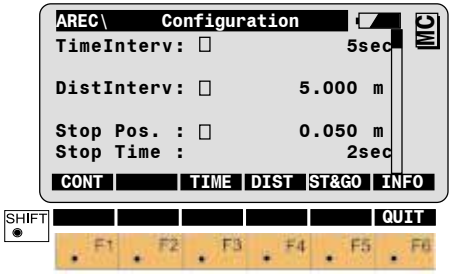
Automatic recording may be triggered by the current distance from the last recorded position, the time elapsed since the last recorded position, the prism remaining stationary for a specified length of time, or any combination of the above factors. When a combination of factors is specified, a position is recorded as soon as any one of the factors is satisfied. At any time, a position may be recorded manually by pressing a single button. Whenever a position is recorded, manually or automatically, all currently active factors are "reset" and begin counting anew for the next automatically recorded position.

Configuration Options

Before using the Auto Record program the first time, you must select the mode or modes and define the interval or intervals you wish to use to control the automatic recording process.
When you start the program, the AREC\ MEASUREMENT dialog will be displayed.



SHIFT F2 To access the AREC\ CONFIGURATION dialog.



Three automatic recording modes are available:

- Time Interval,
- Distance Interval and
- Stable Position.

The intervals are applied relative to the last recorded position, whether triggered manually or automatically. In all cases, the measurement data will be recorded using the REC Mask you have specified.

TimeInterv
When this mode is ON and the TCA-/TCRA-instrument is following a prism in the tracking measurement mode, measurement data will be recorded automatically whenever the time since the last recorded measurement data exceeds the time interval shown here, i.e. every 5 seconds.

DistInterv
When this mode is ON and the TCA-/TCRA-instrument is following a prism in the tracking measurement mode, measurement data will be recorded automatically whenever the three dimensional slope distance from the last recorded measurement data exceeds the distance shown here, i.e. 5 meters.

Stable Pos, StableTime
When this mode is ON and the TCA-/TCRA-instrument is following a prism in the tracking measurement mode, measurement data will be recorded automatically whenever the prism remains within a circle of the radius for the length of time shown here, i.e. the position remains constant within 5 centimeters for 2 seconds.

F1 Continue to the AREC\ MEASUREMENT dialog after selecting and/or setting the automatic recording mode(s) as necessary.

F3 Toggle the Time Interval mode ON or OFF. When this mode is OFF, the small square next to TimeInterv: will be empty and the time interval definition will be a series of dashes. When this mode is ON, there will be a small X in the square, and the last active time interval will be shown.

F4 Toggle the Distance Interval mode ON or OFF. When this mode is OFF, the small square next to DistInterv: will be empty and the distance interval definition will be a series of dashes. When this mode is ON, there will be a small X in the square, and the last active distance interval will be shown.

F5 Toggle the Stable Position mode ON or OFF. When this mode is OFF, the small square next to Stable Pos: will be empty, and both the stable position and stable time definitions will be a series of dashes. When this mode is ON, there will be a small X in the square, and the last active stable position and stable time definitions will be shown.

F6 Display the Auto Record Information screen.

SHIFT F6 Quit the Auto Record program without recording any more data.

You may have any combination of automatic recording modes active at the same time, or all of them if you find it advantageous. When more than one mode is active simultaneously, the first mode that is satisfied causes the position of the prism to be recorded and then resets all of the active modes.

For example:

- Suppose you have both the Distance Interval and Stable Position modes ON, the TCA-/ TCRA-instrument is following a prism in the tracking measurement mode, and the last recorded measurement data was at X = 10, Y = 10.

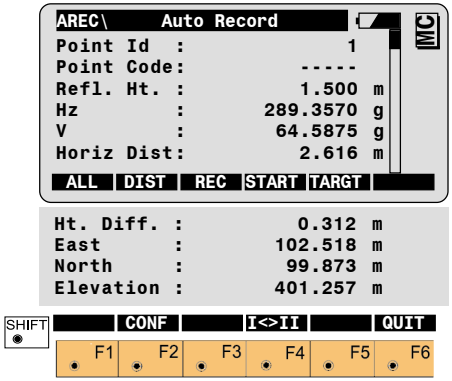
As long as the prism is moving continuously but never gets more than 5 meters from XY = 10, no more data will be recorded. If you stop and center the prism over a point of interest, say at X = 12, Y = 12, for 2 seconds, that measurement data will be automatically recorded and will reset the distance interval as well. Then, as long as the prism is moving continuously but never gets more than 5 meters from XY = 12, no more measurement data will be automatically recorded.

- If you move directly North from XY = 12, more measurement data will be automatically recorded as you move past X = 12, Y = 17. The exact measurement data to be recorded will depend upon how rapidly you are moving and how close to the 5 meter limit the preceding measured position was.

- If you continue moving directly North from X = 12, Y = 17 and press REC to trigger a manual position recording as you pass X = 12, Y = 20, that will reset the distance interval as well. Then, as long as the prism is moving continuously but never gets more than 5 meters from X = 12, Y = 20, no more measurement data will be automatically recorded.

This combination of Distance Interval and Stable Position modes is ideal for automating a topographic survey of an irregularly detailed site. In relatively open areas, measurement data will be automatically recorded as the prism is "scanned" across the surface, based on the specified distance interval. In areas with more detail, measurement data will be automatically recorded whenever the prism is centered over a point of interest for the indicated amount of time.

When the program starts, it will display the AREC\ MEASUREMENT dialog.



Point Id
The point identifier assigned to the next recorded position.

Point Code
The Point Code assigned to the next recorded position. The Point Code may or may not be recorded, depending on the REC Mask you have specified.

Refl. Ht.
The current height of the prism above the end of the plumb pole, or above the ground if the prism is mounted on a vehicle or other objects.

Hz
The current reading of the horizontal circle. This will correspond with the grid azimuth of the line of sight only if the instrument has been oriented before starting the Auto Record program.

V
The current reading of the vertical circle.

Horiz.Dist
The last unrecorded slope distance reduced to a horizontal distance at the elevation of the instrument.

Ht. Diff.
The ground to ground height difference from the instrument station to the prism at the last measured slope distance.

East
The Easting or X coordinate at the last measured slope distance to the prism.

North
The Northing or Y coordinate at the last measured slope distance to the prism.

Elevation
The ground elevation at the last measured slope distance to the prism.

F1 Manually trigger the measurement of a single distance and record the measurement data in the active Measure Job. The distance-related results will not be displayed. The data will be recorded using the REC Mask you have specified.

F2 Manually trigger the measurement of a single distance. The distance-related results will be displayed and may be viewed by scrolling the display.

F3 Manually record the currently displayed data, with or without any distance-related data, in the active Measure Job. May be pressed at any time during the automatic data recording process to record the current position of the prism in the active Measure Job. The data will be recorded using the REC Mask you have specified.

F4 Start the automatic data recording process. ATR will be turned on, if it is not already on, and the EDM will start measuring in the rapid tracking mode. Whenever an automatic recording mode is satisfied, a position will be automatically recorded in the active Measure Job. The data will be recorded using the REC Mask you have specified.

F5 If this function is available on this dialog in your current instrument configuration, use it to set the prism offset and ppms to match the conditions that exist when you are measuring.

SHIFT F2 Access the Auto Record Configuration dialog to select and/or change the automatic recording mode and interval in use.

SHIFT F4 Change the instrument face from I to II (Motorized instruments only.)

SHIFT F6 Quit Auto Record without recording any more data.

CODE Call up the CODE function to create and record a Code Block in the active Measure Job.

The Auto Record program works with the TPS1100 series TCA instruments to automate the collection of large quantities of measurement data for topographic surveys. It can be used to great advantage on larger, open sites when the prism is mounted on a vehicle, and the vehicle is then driven on a suitable weaving pattern to cover the area of the site. Measurement data will be recorded along the path of the vehicle, on virtually any useful spacing. Auto Record can also be used to speed the process of collecting data for detailed topographic surveys, as-built surveys and any other type of survey where large numbers of features must be located.

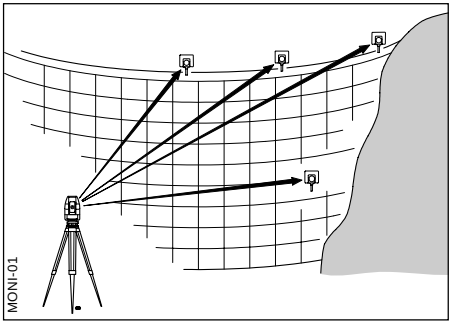
Auto Record does not interfere with the use of Coding to identify the measurements being recorded.

Remote Control Surveying (RCS) also works well with Auto Record, making it especially easy to perform detailed topographic surveys with a one man survey crew.

Auto Record does not generate a logfile.

Introduction

This manual describes the "Monitoring" program for the TPS1100 Professional series instruments.
The program is used for repeated automatic measurements. It measures angles and distances to predefined points.
The location of the points can be "learned" by measuring to them in the "Learning Points" dialog or point information can be taken from a *.GSI file stored on the PCMCIA card.



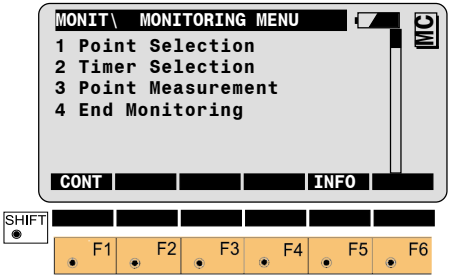
Max. 50 points and as many repetitions as desired, at any time intervals.

With the timer function the program can trigger automatic measurements at any predefined interval.

The measurements can be:
- repeated as often as is necessary,
- at any time
- performed in both faces.

The point number, the horizontal and vertical angles and the slope distance for the individual measurements are stored on the memory card.

Points to be measured must be permanently equipped with Leica Geosystems prisms.
The instrument must be firmly mounted on a tripod or pillar.
Measurements are limited only by the storage capacity of the PCMCIA memory card.



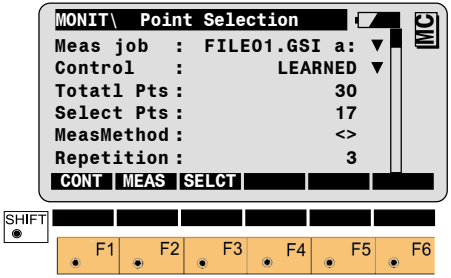
1 Selection of points to be measured.

2 Set timer requirements.

3 Start point measurement.

4 Exit the "Monitoring" program.

The points and the measurement method to be used can be selected in this menu.



Meas job:
Select the measurement job to record measured data to.

Control:
The points to be used during the measurement can be "learned" or taken from a previously stored data file by selecting either 'Learned' or a '*.GSI' file.

Total Pts:
Total number of learned or recorded points.

Select Pts:
Number of points selected for measurements.

MeasMethod:
There are 4 measurement methods to choose from.

<> Measures all repetitions in face I followed immediately by all repetitions in face II at each point. Instrument stays in closest face, i.e. if last face at point A is face II then first face at point B is face II.

[A I	A II	B II	B I	C I	...]
[1,2,3	1,2,3	1,2,3	1,2,3	1,2,3	...]

>< Measures loops of all points in face I followed by all points in face II in the inverse sequence of points. Number of loops equals the number of repetitions.

```
[1: I      II      2: I      II      3: I      ...]
[  A B C  C B A     A B C  C B A     A B C  ...]
```

>> Measures a set of all points in face I followed by all points in face II in the same point order. Number of sets equals number of repetitions.

```
[1: I      II      2: I      II      3: I      ...]
[  A B C  A B C     A B C  A B C     A B C  ...]
```

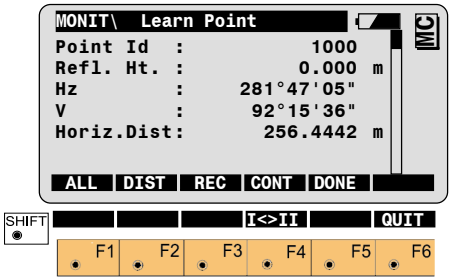
> Measures all repetitions to each point before moving to next point. Only in face I.

```
[A I     B I     C I     ...]
[1,2,3   1,2,3   1,2,3   ...]
```

F1 Go to Main menu after all points have been activated and MeasMethod selected.

F2 Calls the Measurement menu for first time point measurement *(See measurement menu).*

F3 Calls the Point Selection (*See Selecting the Points to be Measured).*



If the measurement file already contains points, then when this function is called you will be asked whether the points are to be overwritten.

For the instrument to learn a point the prism must be targeted manually. Triggering the distance measurement then initiates a distance measurement and a precise determination of the angle.

F1 Simultaneously measure and record data in the active measurement job.
Measured point becomes selectable.

F2 Measure a distance.

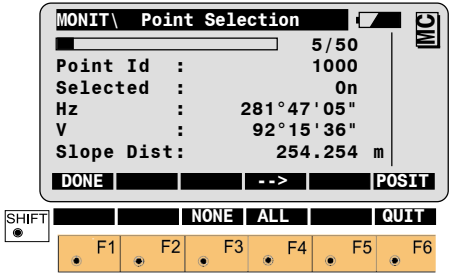
F3 Record the measurement in the active measurement job.
Measured point becomes selectable.

F4 Accept the measurement.
Measured point becomes selectable.

F5 Quit the function after all points have been measured; return to the "Point Selection" menu.

Selecting the points to be measured

Select the points required for the automatic measurement here.
Identical point numbers can be used for different points.



Selected:
On/Off activates and deactivates current point.

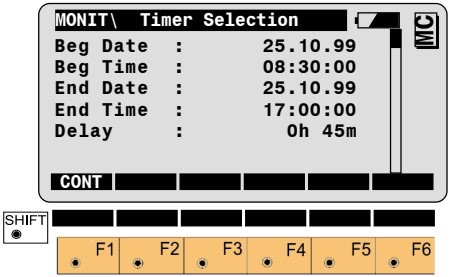
F1 Ends Point Selection and returns to previous dialog.

F4 Display the next point in the file.

F6 Positions telescope to displayed target.

SHIFT F3 Deactivate all points.

SHIFT F4 Activate all points.

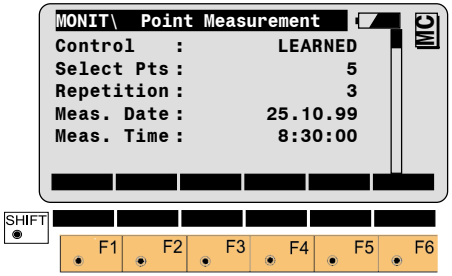


Beg/End Date/Time:
Enter beginning date and time as well as end date and time. End time must be later than beginning time and current time for measurements to start.

Delay:
A delay of up to 99 hours and 59 minutes can be set. Delay is from beginning to beginning, i.e. if a complete measurement with all repetitions takes 30 minutes and delay is set to 45 min, there will be a 15 min. pause after the end of the measurements before the instrument starts to measure again. If Delay is shorter than measurement time, instrument measures continuously.

F1 Go back to Main Menu after completing all settings.

Dialog shows date and time of next measurement.



If a point can not be measured, the TCA or TCRA starts its internal search routine and, if unsuccessful, goes on to the next point to be measured.

ESC Abort the automatic measurement.

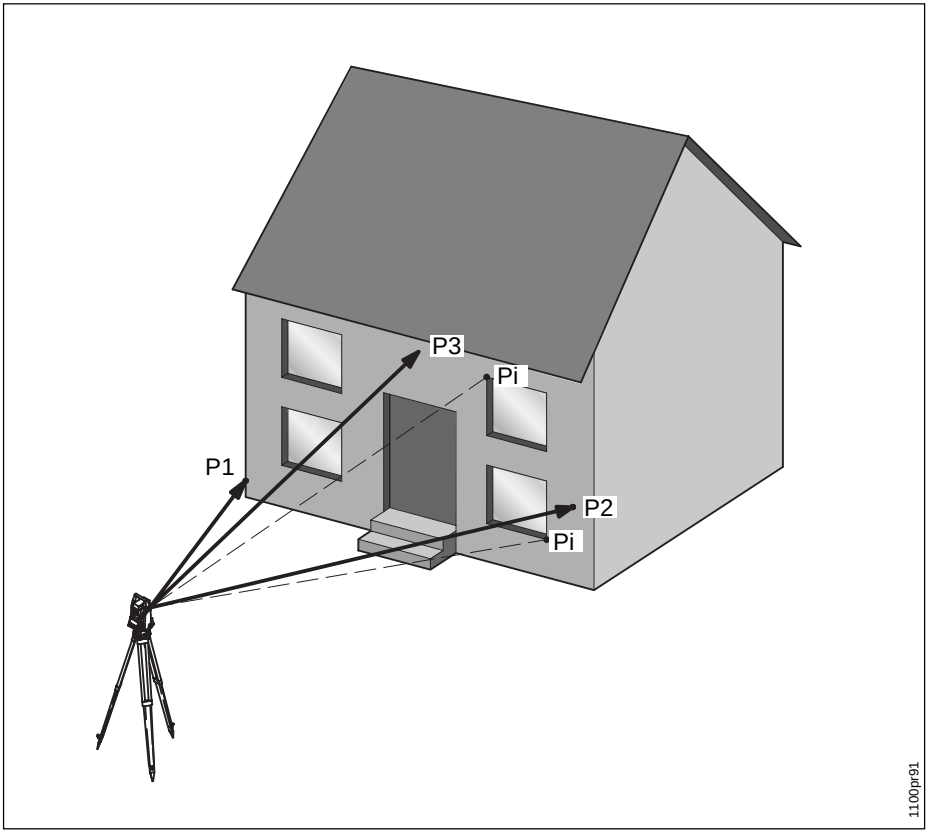
Introduction

This manual describes the program "Reference Plane" for TPS1100 Professional series instruments.

Reference Plane first defines a reference plane and then calculates coordinates of points on the plane from Hz- and V- angles. If distances are measured, the perpendicular deviation of the point from the plane is also calculated.

The plane can be defined in the instrument coordinate system or in a "local" plane coordinate system.

Two points can be used to define a vertical plane or 3-10 points can define a tilted plane. With 4 or more points, a least squares adjustment is calculated resulting in an adjusted plane.

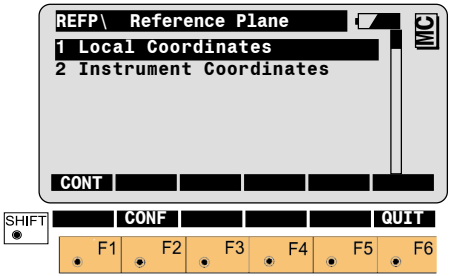


The max. allowed deviation of these points from the plane can be set in the Configuration dialog.

Once the plane has been defined it can be shifted by an entered offset. Alternatively it can be shifted through a measured point.

Plane information as well as measured points can be recorded in a Logfile.

The coordinate system is selected in the beginning.



Local Coordinates
After measuring the points to define the plane the user can enter local coordinates for the first point. This sets the local coordinate system. All points are calculated in it.

Instrument Coordinates
All points are calculated and recorded in the instrument coordinate system.

For Instrument Coordiantes station must be setup and oriented.

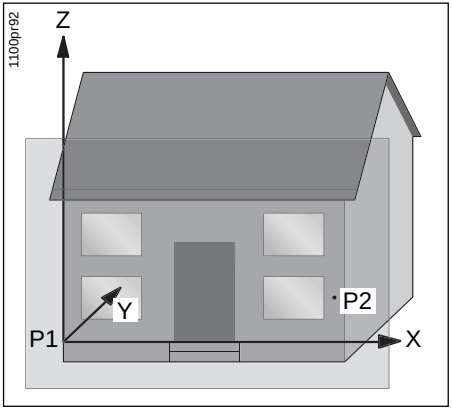
Vertical Plane

A vertical plane is defined by 2 points.

The X-axis of the plane starts in the first measured point and points to the right (seen from the instrument station). It is horizontal.

The Z-axis is parallel to the instrument zenith.

The Y-axis is perpendicular to the plane. Offsets are applied in the direction of the Y-axis.

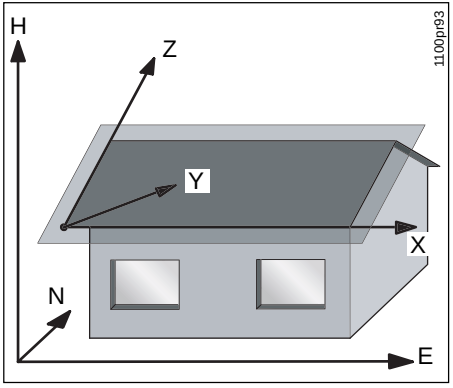


For **horizontal planes** the positive Z-axis points in the direction of the instrument's zenith. X- and Y-axes are horizontal.

Tilted Plane

For "local" planes defined by 3 or more points the Z-axis is defined by the steepest grade of the plane.

The Y-axis is the normal vector of the plane (+Y is away from the instrument) and the X-axis is perpendicular to Z and Y and consequently horizontal. Offsets are applied in the direction of the Y-axis.

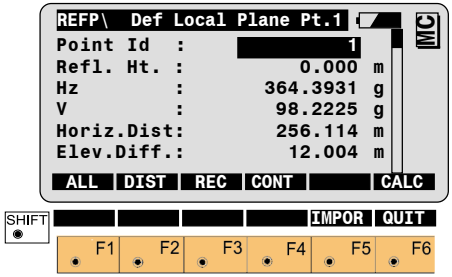


Define Points

Coordinates of the origin are entered by the user after plane definition.

The "origin" is defined as the projection of the first measured point onto the calculated (adjusted) plane.

This dialog defines the points that determine the plane. Up to 10 points can be used. They can be measured or imported from a file.



F1 Simultaneously measure and record data in the Meas job. Continue to next point.

F2 Measure a distance.

F3 Record the measurement in the measurement job.

F4 Continue to next point without recording data in measurement job.

F6 Calculate the plane parameters. Note: this key is only available after two points have been measured/input.

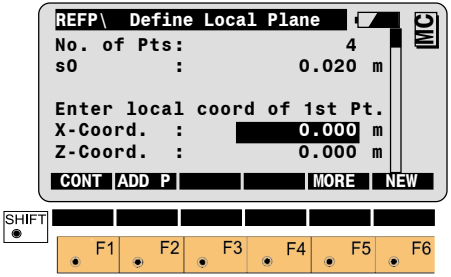
SHIFT F5 Import point coordinates.

SHIFT F6 Exit program.

Two points define a vertical plane. Use more points to define a tilted plane.

The program checks if the plane is defined in space (minimum distances between points) but does not check for optimal point distribution.

Calculates the plane parameters as well as standard deviation of the adjusted plane (for more than 3 points). Coordinate entry for origin of local system.



No. of Pts.
Number of points used for plane calculation.

s0
Standard deviation of the plane.

X-Coord
Enter local X-coord of origin. The origin is defined as the projection of the first measured point onto the calculated plane (see graphics).

Z-Coord
Enter local Z-coord. of origin. The origin is defined as the projection of the first measured point onto the calculated plane (see graphics).

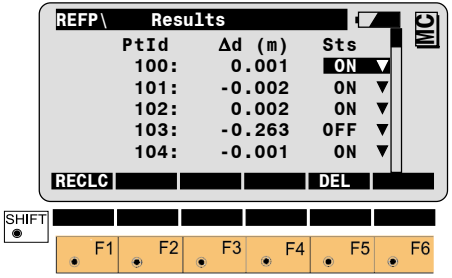
F1 Set origin and continue to offset dialog.

F2 Measure additional points to define plane.

F5 Show the results of each definition point. (See "Results" dialog)

F6 Define new plane.

Displays the perpendicular deviation of each defining point from the plane (only if 4 or more points are used).



Pt.Id
Displays Pt.Id of defining points.

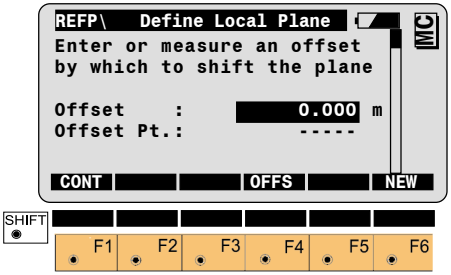
Δd (m)
Deviation of point from plane.

Sts
Point status can be ON/OFF. If point is off, it is not included in the calculation.

F1 Recalculate the plane.

F5 Delete point.

Once the plane has been defined, it can be shifted by an offset. The offset value can be entered manually or a point can be measured to shift the plane through.



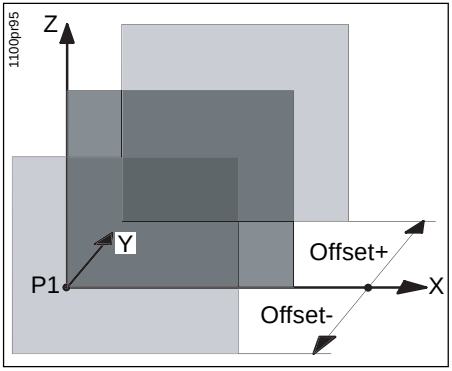
Offset
Enter value by which to offset the plane. If point was measured, calculated offset is displayed.
Offsets are applied in the direction of the Y-axis.

Offset Pt.
Displays PtId of measured point.

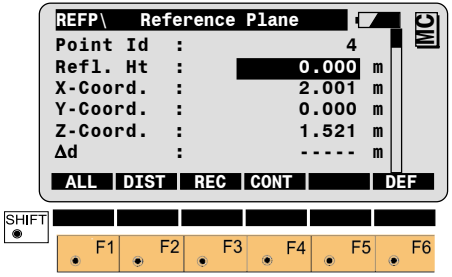
F1 Set offset and measure points on the plane.

F4 Measure point to offset plane through.

F6 Define new plane.



The local coordinate system measurement dialog displays the coordinates of points on the plane in the defined local coordinate system.



X-Coord.
X-coordinate in local system. Changes with telescope movement.

Y-Coord./Δd
Y-coordinate in local system. This is always identical to Δd - the distance to the plane and is 0.000 unless a distance was measured.

Z-Coord.
Z-coordinate in local system. Changes with telescope movement.

F1 Measure and record data in active Meas job and logfile if configured.

F2 Measure a distance.

F3 Record data in active measure job and Logfile if configured. Increment Point Id.

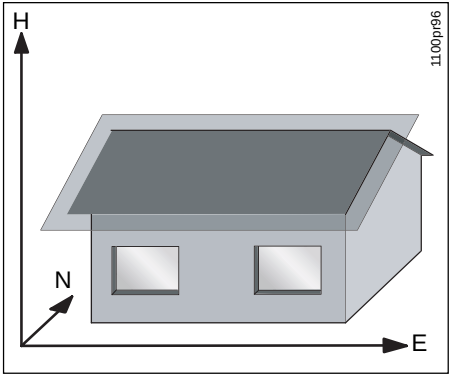
F4 Clear distance and increment PtId without recording data.

F6 Return to Define Offset dialog.

GSI file always stores instrument system information. For local system information turn Logfile ON (see chapter "Configuration").

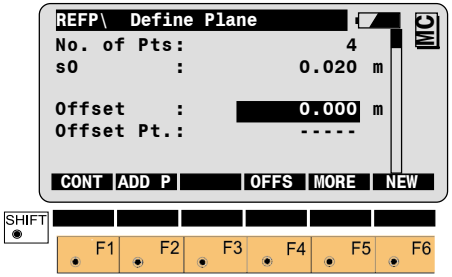
Instrument system

The "Define Point" dialogs for instrument systems are the same as for local systems. The plane coordinate system is not defined by the user. Points on the plane have instrument coordinates.



Define Instrument Plane

The “Define Plane” dialog combines standard deviation and offset.



No. of Pts
Number of points used for calculation.

s0
Standard deviation of the plane.

Offset
Enter value or measure point to offset the plane. Offsets are applied in the direction of the normal vector.

Offset Pt.
Displays PtId of measured point.

F1 Accept settings and measure points on the plane.

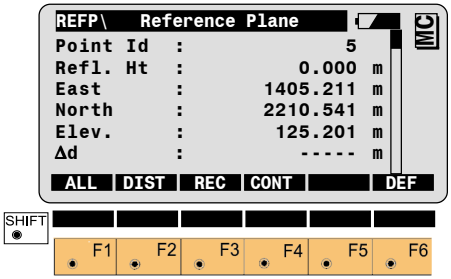
F2 Measure additional points to define plane.

F4 Measure point to offset plane through.

F5 Show the results of each definition point (see "Results" dialog).

F6 Define new plane.

The coordinates shown for the points are in the instrument coordinate system. Keys are the same as for "Local".



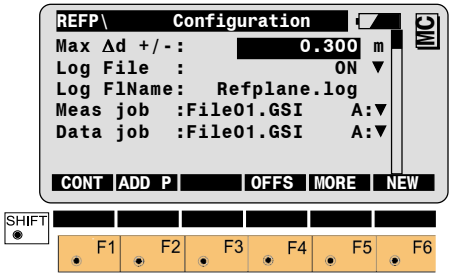
East
East coordinate of point. Changes with telescope movement.

North
North coordinate of point. Changes with telescope movement.

Elev.
Elevation of point. Changes with telescope movement.

Δd
Distance from point to plane. "-----" unless a distance was measured.

Start the "Configuration Editor" from the "Main Menu".



Max Δd
Maximum allowed perpendicular deviation of plane definition point from calculated plane.

Log File
Set to ON, the program records measurement data to a log file.

Should be **ON** for local systems, since GSI file only contains instrument coordinates. Log file saves local system coordinates.

Log FlName
Enter the Logfile name.

Meas job
Sets the measurement job to record data to.

Data job
Sets the data job containing fixpoint coordinates.

F1 Store the configuration and return to “Main Menu”.

F5 Set the values to default.

F6 Display date and version no. of running application.

If Logfile is set to ON the measurements and the results are stored in the ASCII-file specified within the "Configuration". This file is created in the directory LOG on the memory card. Subsequently, you can read out the memory card and obtain a hard copy of the Logfile.

If ON, data is always added to the specified Log-file.

The Logfile contains the following information:

Header
The header line contains the program used, information about the instrument, the name of the data file as well as date and time.

Configuration
Each modification of the reference plane is stored.

Record

For each measurement a record is stored containing:

- Points defining the plane in local or instrument coordinates, depending on settings.
- Plane parameters (standard deviation, no. of points used, offset)
- Coordinates of points measured on plane.

TPS1100 Prog. Reference Plane V 2.00
Instrument : TCRA1102plus, Serial 618268
Meas.File : MYFILE01.GSI
Progam Start : 12/11/2000 at 15:15

Define Local Plane

	Point Id	X-Coord (m)	Y-Coord (m)	Z-Coord (m)	Dd (m)	Status
Station coord	2	1.936	-3.142	1.936		
	100	-0.000	0.001	-0.000	0.001	ON
	101	3.458	-0.002	3.458	-0.002	ON
	102	3.310	0.002	3.310	0.002	ON
	103	2.222	-0.263	2.222	-0.263	OFF
	104	0.644	-0.001	0.644	-0.001	ON

No. of Pts : 4
s0 (m) : 0.000
Offset (m) : 0.000
Offset Pt. : -----

Points Measured

	Point Id	X-Coord (m)	Y-Coord (m)	Z-Coord (m)	Dd (m)
	201	0.727	0.000	0.404	-----
	202	1.835	-0.004	1.095	-0.004
	203	-0.028	-0.065	2.089	-0.065
	204	2.175	-0.290	0.170	-0.290
	205	2.519	0.000	0.908	-----

Typical logfile entries in the "Reference Plane" program.

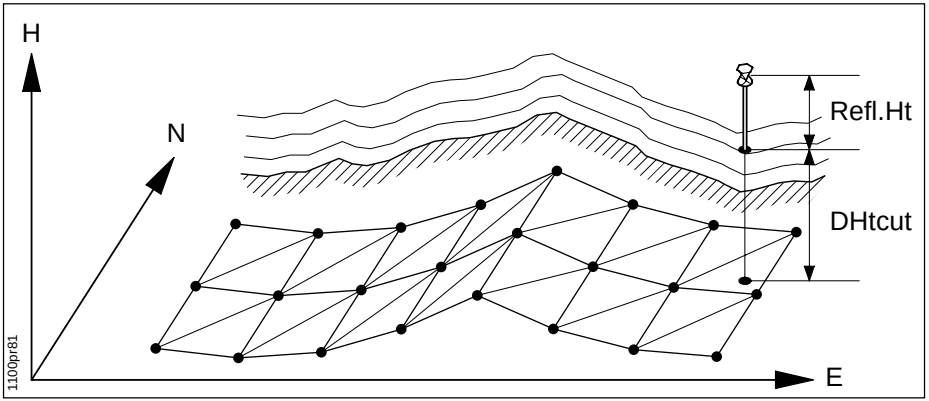
Introduction

This manual describes the "DTM-Stakeout" program for the TPS1100 Professional series instruments. The program is used to compare measured elevations to a stored Digital Terrain Model. After measurement the CUT or FILL value between existing ground and the DTM is displayed.

"DTM Stakeout" can be used to stake out points where the DTM represents the surface to be staked.

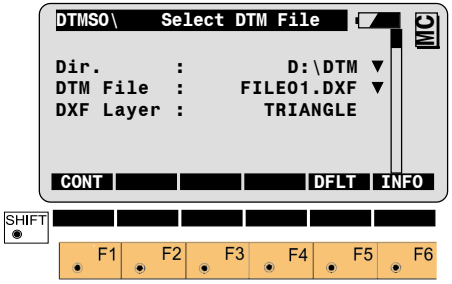
It can also be used to compare existing ground to the DTM, e.g. for quality control purposes where the DTM represents the final project surface.

"DTM Stakeout" requires the instrument station to be setup and oriented. The instrument must also be configured in the same units as those used in the DTM.



Select DTM File

The first dialog allows selection of the DTM file to be used. The file can be in AutoCad DXF format or in Leica GSI format (see chapter *Data Formats*).



Dir.
Select the directory where the DTM file is stored.

DTM File
Choose the DTM file to be used.

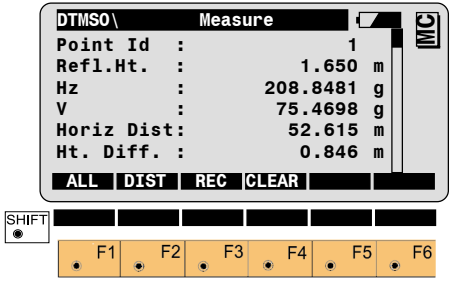
DXF Layer
If using a DFX file, enter the layer name for the DTM file.

F1 Continue to Measurement dialog. DTM-Stakeout will automatically check the validity of the file.

F5 Re-set the Layer name to TRIANGLE.

F6 Display the DTM-Stakeout information dialog.

This dialog corresponds to the TPS1100 Professional series "Measure" dialog with the additional entry of the Ht. Difference.



Ht. Diff.
Displays the difference in elevation between the DTM and the measured point.

+ (FILL): if measured point is lower than DTM.
- (CUT): measured point is higher than DTM.

F1 To measure and record the CUT/FILL values and the coordinates of the target piont.

F2 Measure a distance and calculate the CUT/FILL values.

F3 Record the measurement in the measurement job.

F4 To clear the displayed values.

SHIFT F6 Exit the program.

Data for DTM-Stakeout may be prepared in one of two formats. These are AutoCAD DXF or the standard Leica GSI format. The files must be stored on the PC-card.

Files may be named with any valid DOS name and either a *.dxf or *.gsi extension.

- **AutoCAD DXF - Format**

DTM triangles are imported as 3DFACE entities from a DXF file. Properties, Layers, etc. may be in the DXF file but are ignored by the DTM-Stakeout application. The completion of the polygon by repeating the first or last point is required by AutoCAD but not by the application. The format is as follows:

0	Start of record.
3DFACE	Record is a 3D face entity.
TRIANGLE	3D face type.
10	X coordinate, first point.
723573.984000	X value.
20	Y coordinate, first point.
7663192.178000	Y value.
30	Z coordinate, first point.
23.383000	Z value.
11	X coordinate, second point.
723576.998000	X value.
21	Y coordinate, second point.
7663191.120000	Y value.
31	Z coordinate, second point.
23.029000	Z value.
12	X coordinate, third point.
723572.684000	X value.
22	Y cordinate, third point.
7663189.966000	Y value.
32	Z coordinate, third point.
24629.000	Z value.
13	X coordinate, third point.
723572.684000	X value.
23	Y cordinate, third point.
7663189.966000	Y value.
33	Z coordinate, third point.
24629.000	Z value.
0	End of record.

- **LISCAD generated DXF File**

An AutoCAD DXF file containing 3DFACE may be generated by users of Leica's LISCAD in the following manner:

1) In Terrain Modeling/Display/ Features…Select the Model tab – Turn on only the triangles.
2) In Terrain Modeling/Display/ Groups… - Turn off all Groups but DEFAULT.
3) In CAD Output/Settings/CAD System – Choose AutoCAD DXF.
4) In CAD Output/Settings/Codes… - Deselect all the options on all the tabs.
5) In CAD Output/Settings/Models…- Set Labels to none, Contours to none, and activate the Triangles check box.
6) In CAD Output/Output! – Select the Options button – In the General tab turn off all option check boxes except Model and use Default for All, in the AutoCAD tab deselect all check boxes except 3Dimensional. Then click OK.
7) Click OK and create the DXF file that contains only the 3DFACE's.

The required format of a GSI file containing DTM triangles is described below.

Header of the DTM file

The header is the first line in the GSI file. There must be one header line per file in the follwing form:

```
41....+000JOBID 42....+DTMNTWRK 43....+DTMCOORD 44....+00001000 45....+00001000
```

WI41	Job identification, maximum 8 characters, may be defined by user.
WI42	Identification of DTM file, may not be changed by user. This entry must be +DTMNTWRK.
WI43	Identification of principal point type, may not be changed by user. This entry must be +DTMCOORD.
WI44	Optional easting offset. May be defined by user.
WI45	Optional northing offset. May be defined by user.

☞ If used, easting and northing offsets are added to the coordinates of the triangle vertices. These values have no digits to the right of the decimal place.

For example if units are set to (m), "44….+00001000" means that 1000m will be added each Easting coordinate.

The data block records for the triangle vertices are contained within the GSI file in sets of three. There is one block for each vertex of each triangle.

Data block for triangle vertex

```
11....+00000907 71....+TRI00001 81..10+21000000 82..10+50996000 83..10+00100000
```

WI11	Point identification, ignored by the application.
WI71	Triangle number, indicates triangle the coordinates belong to.
WI81	Easting of the triangle vertex.
WI82	Northing of the triangle vertex.
WI83	Elevation of the triangle vertex.

☞ The program cannot calculate the model from coordinate lists. The coordinates must be sorted by triangles. That is, three coordinate blocks with the same triangle number must be found together in the file. The vertices do not have to be sorted in any other way.

Example GSI file

The following is a portion of a DTM file in the Leica GSI format. The header and coordinates for the first four and last two triangle vertices are shown. The file contains 44 triangles.

```
41....+000JOBID 42....+DTMNTWRK 43....+DTMCOORD 44....+00001000 45....+00001000
11....+00000907 71....+TRI00001 81..10+21000000 82..10+50996000 83..10+00100000
11....+00000013 71....+TRI00001 81..10+21000000 82..10+50992500 83..10+00100000
11....+00000014 71....+TRI00001 81..10+20998059 82..10+50992756 83..10+00100000
11....+00000013 71....+TRI00002 81..10+21000000 82..10+50992500 83..10+00100000
11....+00000907 71....+TRI00002 81..10+21000000 82..10+50996000 83..10+00100000
11....+00000012 71....+TRI00002 81..10+21001941 82..10+50992756 83..10+00099500
11....+00000014 71....+TRI00003 81..10+20998059 82..10+50992756 83..10+00100000
11....+00000013 71....+TRI00003 81..10+21000000 82..10+50992500 83..10+00100000
11....+00000002 71....+TRI00003 81..10+21002859 82..10+50987867 83..10+00100374
11....+00000907 71....+TRI00004 81..10+21000000 82..10+50996000 83..10+00100000
11....+00000014 71....+TRI00004 81..10+20998059 82..10+50992756 83..10+00100000
11....+00000015 71....+TRI00004 81..10+20996250 82..10+50993505 83..10+00099600
…
11....+00000908 71....+TRI00043 81..10+20996000 82..10+51000000 83..10+00099800
11....+00000019 71....+TRI00043 81..10+20992500 82..10+51000000 83..10+00100000
11....+00000904 71....+TRI00043 81..10+20993912 82..10+51007934 83..10+00100000
11....+00000003 71....+TRI00044 81..10+21003750 82..10+51006495 83..10+00099700
11....+00000904 71....+TRI00044 81..10+20993912 82..10+51007934 83..10+00100000
11....+00000901 71....+TRI00044 81..10+21007934 82..10+51006088 83..10+00100000
```

DTM-Stakeout does not generate a logfile.

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