TPS1100 Professional Series

Application programs Field Manual 1

English

Version 2.1

Leica Geosystems

The quick way to start with the TPS1100 Programs.

For additional details on single TPS1100 application program functions refer to the Applications Reference Manual on the CD.

To use the equipment in the permitted manner, please refer to the detailed safety instructions in the User Manual.

Index

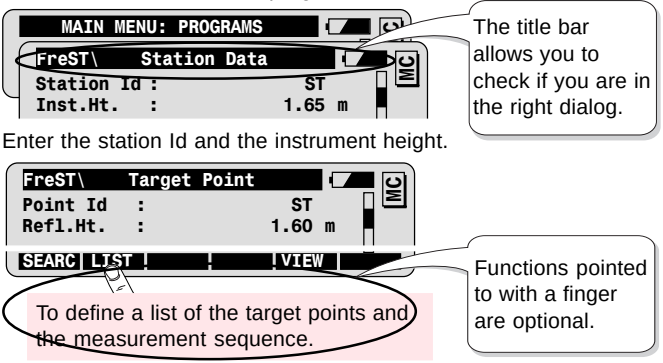
How to use this manual

This manual gives step by step instructions for the basic uses of the TPS1100 field programs and explains some advanced program features. It shall be used together with a TPS1100 instrument or the TPS1100 PC simulation.

The proposed sequence of operations will guide you from the start to the end of a program.

Example

Start Free Station from the program menu.



Symbols used in the sequence of operation

Press the fixed key PROG.

User input is necessary.

Press the function key F1 to activate the function ALL.

Repeat operation.

Other Symbols

Important information and tips.

Structure of the Field Manual

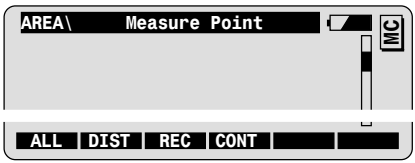
Each program is constructed with the same chapter structure. Each chapter answers questions:

1. Introduction	What does the program do? What are its typical uses?
2. Basic Procedure	How do I start the program? How do I use it?
3. Advanced Feature	Which special functions can I use to optimize my field work?
4. Configuration	How can I configure the program to my needs?
5. Program Flow	How can I navigate through the program? Where can I find a specific function?

General functions

This chapter explains common functions that are used in almost all programs (see also Quick Start).

Measurement options



ALL key

ALL F1

To measure a distance and record measurement data according to the active REC-mask.

DIST and REC combination

DIST F2

To measure and display a distance.

REC F3

To record displayed distance and angles according to the active REC-mask.

CONT

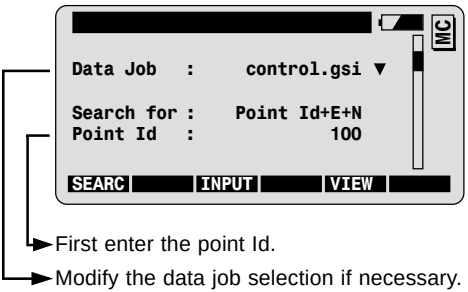
CONT F4

To accept displayed distance and angles, and continue to the next dialog without recording.

Search Point Dialog

This dialog allows you to:

- Import the coordinates of a point from a data job or,
- Enter the coordinates of a point manually.



Coordinates available in Data Job

SEARC F1 — To import coordinates from data job and go to the next step **without** showing the point coordinates

VIEW F2 — To import coordinates from data job and go to the next step **after** showing the point coordinates

Coordinates NOT available in Data Job

INPUT F3 — To enter coordinates manually.

MEAS F2 — To measure and record point coordinates. Not available in every program.

Orientation and Height Transfer

Introduction

This program can be used for the following purposes:

- To determine the orientation at the instrument station.
- To determine the station elevation.
- To determine simultaneously the orientation and the station elevation.

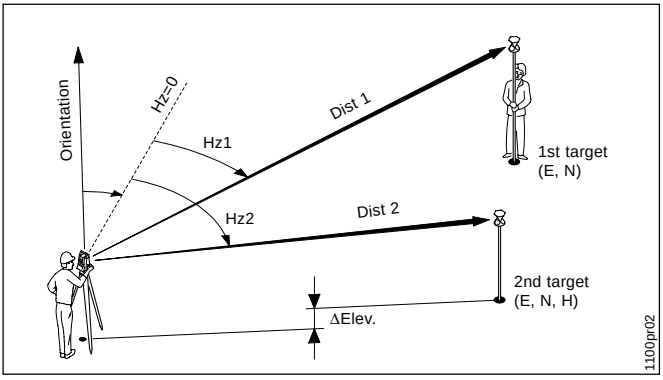
The orientation and the station elevation are calculated from measurements to as many as ten known points.

Orientation and Height Transfer is often used when more than one known point is available around the station. Measurements to additional known points allow a reliability control of the calculated orientation and station elevation.

Basic procedure

Before starting Orientation and Height Transfer the station must first be set using one of the following system functions or programs:

- Station Setup
- Resection, or
- Free Station.



1. Orientation only

Known:

Target points coordinates:

- *East, North*

Unknown:

- *Orientation*

Measure at least...

- *Directions to 1 target point*

2. Orientation and Height Transfer

Known:

Target points coordinates:

- *East, North, Elevation*

Unknown:

- *Orientation, Station Elevation*

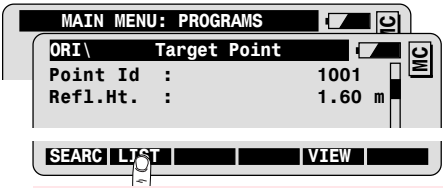
Measure at least...

- *Distance and directions to 1 target point*

Points with elevation only can be used for the determination of the station elevation.

Start Orientation from the program menu.

PROG

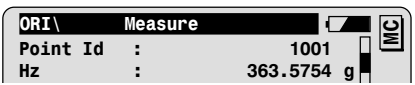


To define a list of the target points and the measurement sequence.

Enter Point Id and reflector height at the first target point.

SEARC F1

To search and import point coordinates from data job.



ALL F1

To measure and record first target point. See chapter *"Measurement options"*.

Repeat sequence "Target point entry and Measurement" for your next target points.

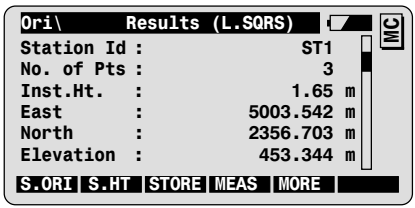
Motorized instruments will drive automatically to the target point.

CALC F6 To calculate the orientation and the station elevation.

Results

The results dialog displays:

- the current station coordinates.
- the oriented horizontal direction
- the a-posteriori standard deviations of the orientation and of the station elevation.



STORE F3 To record the Orientation and Height Transfer results.

S.ORI F1 + CONT F1 To set **orientation** only.

S.HT F2 + CONT F1 To set **station elevation** only.

S.ORI F1 + BOTH F2 To set both **orientation** and **station elevation**.

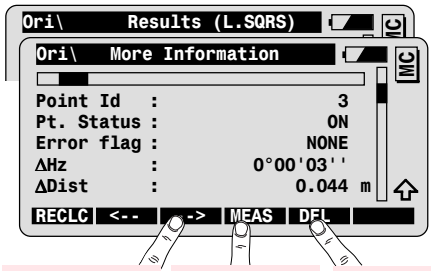
MEAS F4 To measure additional target points.
Returns to the Target Point dialog.

Advanced feature: Result analysis

Call the result analysis for individual measurements from the results dialog.

MORE F5

Error Flag	Possible values
NONE	Measurement OK
HZ	Horizontal angle error
DIST	Distance error
HT	Height difference error



Define the point status:

ON/OFF	Measurements used/not used in calculation.
Ignore Elev.	Elevation not used in calculation.

RECLC F1

To recalculate with the new settings.

ESC

To go back to the result dialogs without changes.

Configuration

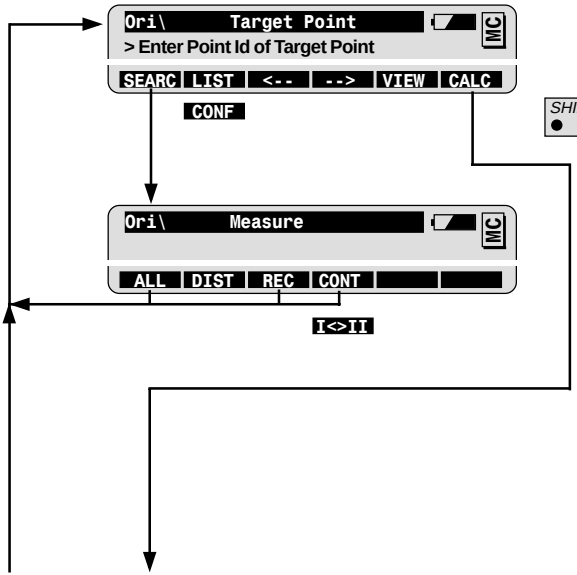
Call the configuration in the first application dialog.

SHIFT CONF F2

Hz Ori Acc	A priori standard deviation of the orientation.
Ht Acc TP	A priori standard deviation of the elevation of the target points.
Posn AccTP	A priori standard deviation of the position (East and North coordinates) of the target points.

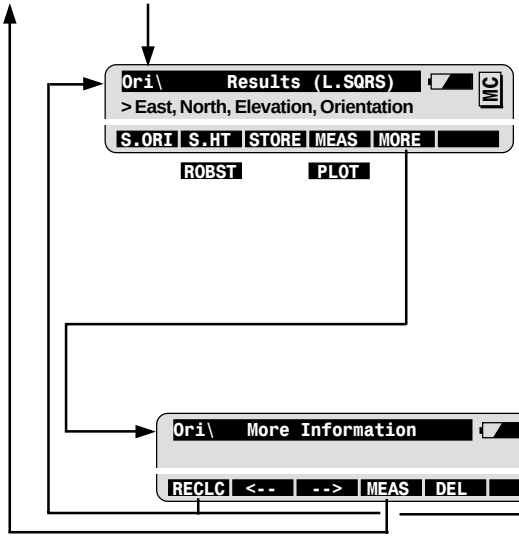
If the computed (a posteriori) standard deviations are within twice the values entered for the a priori standard deviations, the computed station coordinates and orientation will be accepted.

User Disp	Use the display mask defined by the user.
Two Faces	Single or two face measurement.
Log File	Creation of a logfile.
Log FIName	User definable name for the logfile.
Data Job	Selection of the job containing the fix point coordinates.
Meas. Job	Selection of the job for recording measurements.



SHIFT + CONF (F2) — Configuration can only be accessed in this first dialog.

CALC (F6) — available after 1 Point measured



STORE **F3** To set Orientation and/or Height and leave program

S.ORI **F1**
S.HT **F2**

Station Point Number	WI 11
Orientation correction	WI 25
Station coordinates	WI 84-86
Last used reflector Ht	WI 87
Instrument Height	WI 88

SHIFT **ROBST** **F2** Option for adjustment with Least Square or robust methods.

SHIFT **QUIT** **F6** To quit the Program at any time.

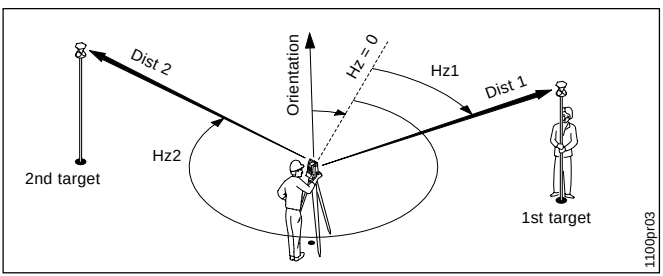
Introduction

Resection is used for station setup on an unknown point. The station coordinates and the Hz-circle orientation at the station are calculated from measurements to two known points.

In building and construction sites, resection can be used where the establishment of a permanent station is not practical, or where a marker is likely to be destroyed.

For Stake out, data collection or cadastral survey, resection allows you to choose the instrument location with the best view of the working area.

Basic procedure



Known:

1st and 2nd target points:

- *East, North*
- *Elevation (optional)*

Unknown:

Station coordinates:

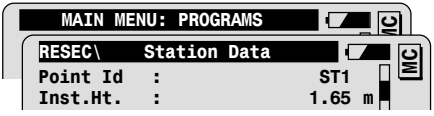
- *Stn. East, Stn. North*
- *Stn. Elev. (optional).*
  Orientation

Check the geometry of the target points in relation to the station point. Avoid very small or very large angles at the station.

Start resection

Start Resection from the program menu.

PROG

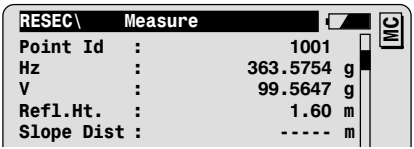


Enter the station Id and the instrument height.

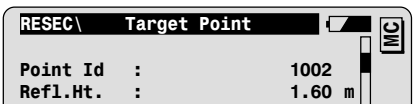
CONT
F1

Enter Point Id and reflector height at the first target point.

SEARC / F1 To search and import point coordinates form data job.

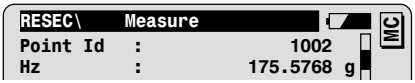


ALL / F1 To measure and record first target point. *(see chapter for "Measurement options")*

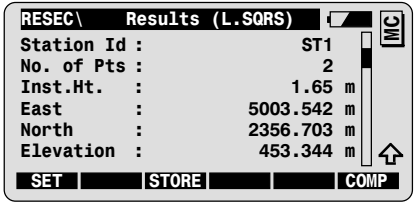


Enter Point Id and reflector height at the 2nd target point.

SEARC / F1 To search and import point coordinates from data.



ALL / **F1** To measure and record 2nd target point, and to display the resection results.



STORE / **F3** To record the resection results.

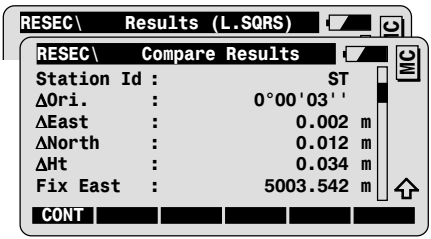
SET / **F1** To set station coordinates and orientation, and close the program.

Advanced Feature: Compare Results

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.

Call the comparison function from the results dialog.

COMP F5



The Delta values are the results of a substraction, e.g.

ΔEast = Calc.East - Fix East

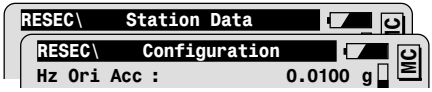
CONT F1

To return to the results dialog.

Configuration

Call the configuration in the first application dialog.

SHIFT CONF F2

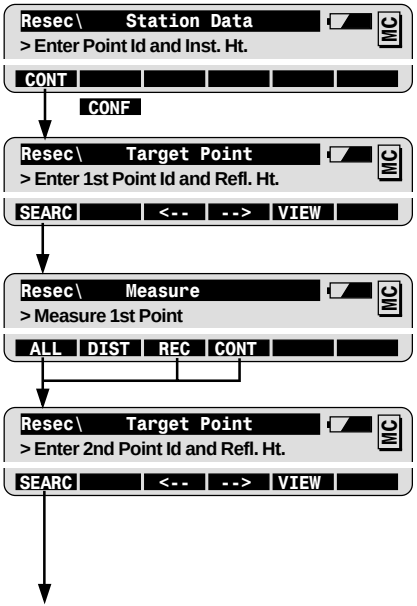


Hz Ori Acc	A priori standard deviation of the orientation.
Ht Acc TP	A priori standard deviation of the elevation of the target points.
Posn AccTP	A priori standard deviation of the position (East and North coordinates) of the target points.

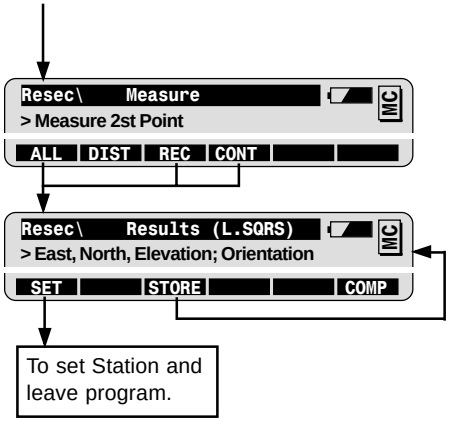
If the computed (a posteriori) standard deviations are within twice the values entered for the a priori standard deviations, the computed station coordinates and orientation will be accepted.

User Disp	Use the display mask defined by the user.
Two Faces	Single or two face measurement.
Log File	Creation of a logfile.
Log FlName	User definable name for the logfile.
Data Job	Selection of the job containing the fix point coordinates.
Meas. Job	Selection of the job for recording measurements.

Program Flow



Configuration can only be accessed in this first dialog.



STORE F3

Station Point Number WI 11
Orientation correction WI 25
Station coordinates WI 84-86
Last used reflector Ht WI 87
Instrument Height WI 88

SHIFT QUIT F6

To quit the Program at any time.

Tie Distance

Introduction

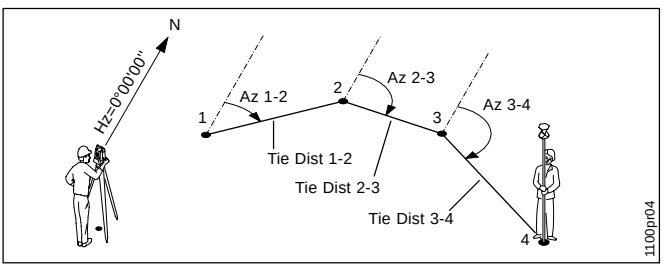
Tie Distance is used to calculate the distance and the azimuth of a segment defined by two points.

The polygon points can be directly measured, imported from coordinate data job, or entered manually.

Two modes are available for calculating tie distances: Polygon and Radial (see illustrations below).

Before starting Tie Distance:
The station must be set up and oriented.

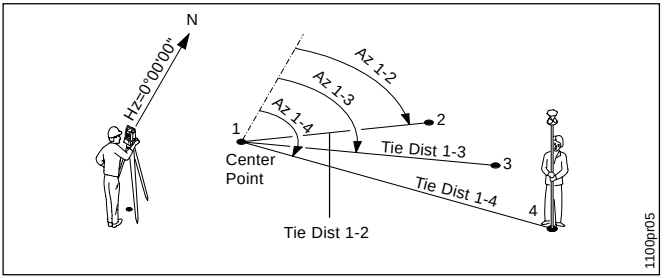
Polygon Mode



Known or Measured:
Polygon Points 1, 2, 3, 4

Unknown:
Tie Distance and Azimuth (Az.) between Pt.1 - Pt.2, Pt.2 - Pt.3 ...

Radial Mode

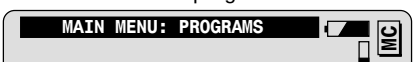


Known or Measured:
Central Point: 1
Radial Point: 2, 3, 4
Unknown:
Tie Distance and Azimuth (Az.) from the central point to the radial points 2, 3, 4.

Basic procedure

Start Tie Distance from the program menu.

PROG



First two points

The procedure for the first tie distance is the same for both the polygon and radial modes.

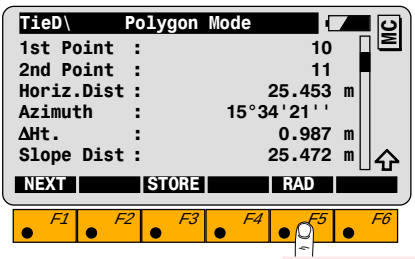
Enter point Id and reflector height of the first point.

ALL F1 To measure and record the first point. (see chapter for *"Measurement options"*)

Or **IMPOR** F6 To import point coordinates from a data file.

Repeat sequence for the second point. This completes the first tie distance and displays the corresponding results dialog.

Results in Polygon Mode

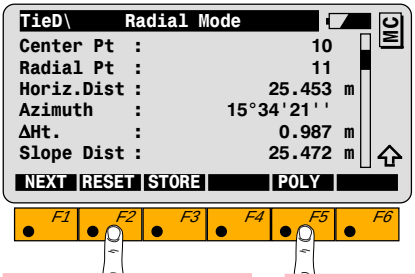


To switch between polygon and radial modes.

STORE F3 To record Tie Distance results.

NEXT F1 To measure or import the next polygon point.

Results in Radial Mode



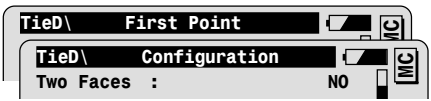
STORE F3 To record Tie Distance results.

NEXT F1 To measure or import the next polygon point.

Configuration

Call the configuration in the first application dialog.

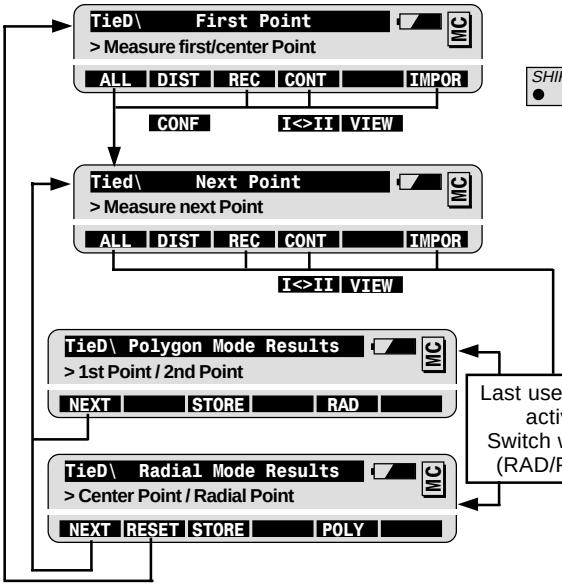
SHIFT ● CONF ● F2



User Disp	Use the display mask defined by the user.
Two Faces	Single or two face measurement.
Log File	Creation of a logfile.
Log FIName	User definable name for the logfile.
Meas. Job	Selection of the job for recording measurements.
Data Job	Selection of the job containing the fix point coordinates.

CONT ● F1 To quit the configuration.

Program Flow



SHIFT ● QUIT ● F6 — To quit the Program at any time.

SHIFT ● CONF ● F2 — Configuration can only be accessed in this first dialog.

RAD ● F5 — Change to Radial Mode

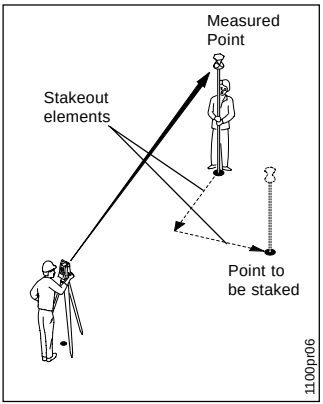
Last used Mode active. Switch with F5 (RAD/POLY)

POLY ● F5 — Change to Polygon Mode

STORE ● F3 — To store the results: WI11,25,35,37,39,79

Tie Distance

Introduction



Stakeout is used to place marks in the field at predetermined points.

Different stakeout modes are available: polar, orthogonal, auxiliary points, or grid coordinates. Depending on the active stakeout mode, the corresponding stakeout elements of the measured point are calculated in relation to the point to be staked.
Changing to a different stakeout mode is possible at anytime.

Coarse stakeout 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 points to be staked can be defined in two ways:

- The coordinates of the point are known. In this case, the points may be in data or entered manually within the stakeout program.
- The azimuth and horizontal distance to the point are known.

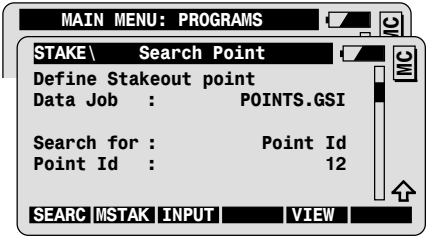
Basic procedure

Before starting Stakeout:
The station must be set up and oriented.

Stakeout point

PROG

Start Stakeout from the program menu.



Enter the point Id of the point to be staked.

SEARC F1

To search and import point from the data.
Continues to the next stakeout dialog.

Starts distance measurement if locked on and EDM-mode is TRK/ RTRK.

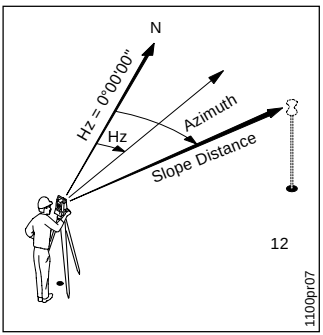
MSTAK F2

To enter a point given the azimuth and the distance:

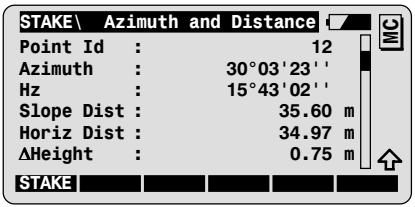
- Manually enter the **azimuth** and the **Horiz.Dist** from the station to the point to be staked.
- Confirming the entry with STAKE F1 continues to the next stakeout dialog.

Stakeout

Coarse Stakeout
Mode: Azimuth and Distance



The stakeout elements, azimuth and distance, are calculated from the instrument station to the point to be staked.



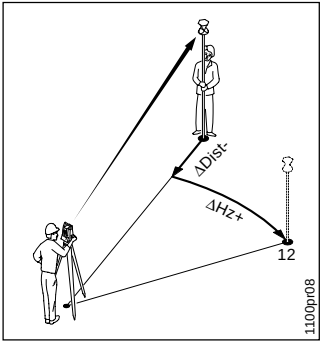
Turn the instrument until **Hz** and **Azimuth** values get closer.

ΔHeight is the height difference from the station to the point to be staked.

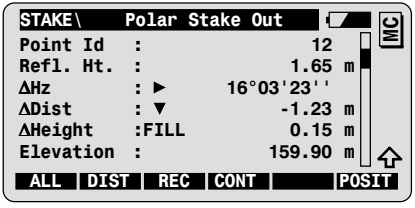
To continue to the main stakeout dialog.

Motorized instruments drive automatically to the direction of the point to be staked.

Main stakeout dialog
Mode: Polar Stakeout



The stakeout elements are calculated in relation to the baseline defined by the instrument station and the measured point.



DIST (F2) To measure a distance and calculate the stakeout elements **ΔHz**, **ΔDist**, and **ΔHeight**.

ΔHeight is the height difference between the measured point and the point to be staked. It is displayed in 3D stakeout mode only.

Repeat procedure unti thel required positioning accuracy is achieved.

ALL (F1) To measure and record the stakeout point.
Continues to the Search Point dialog for the entry of the next point to be staked.

Advanced Feature: Configuration of the stakeout method

SHIFT METHD FZ

Call the dialog for the configuration of the stakeout method from any stakeout dialog.

Coarse Mode	Selection of the coarse stakeout mode (see chapter *"Advanced Feature: Coarse mode")*.
Stake Mode	Selection of the main stakeout mode. (see chapter *"Advanced Feature:: Stakeout mode"*).
Auto Pos.	Selection of the mode for automatic positioning to the point to be staked (for motorized instruments only).
• OFF	No automatic positioning.
• 2D or 3D	2-dimensional or 3-dimensional positioning.
Ht Offset	Height offset addet to the design elevations of the points to be staked. CUT and FILL values refer to the elevations modified by the offset.
Graphics	Select the graphic mode to be displayed in the main stakeout dialog (see chapter *"Advanced Feature: Graphic mode"*).

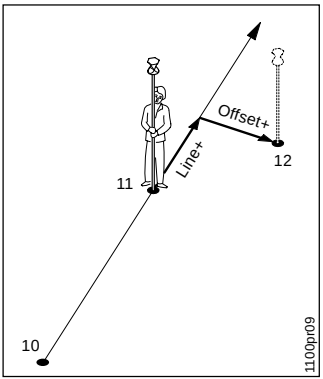
Symbols	Select the display mode of symbols in the stakeout dialog. The symbols may be used to guide the rod person to the point to be staked.
• From Sta. (▲▼)	Guidance of the rod person from the instrument station.
• To Sta. (▼▲)	Guidance at the rod, in relation to the instrument station (e.g. if working in RCS mode).

Advanced Feature: Coarse Mode

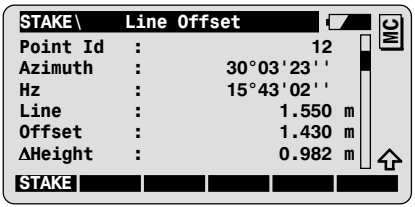
Coarse Mode = None

The coarse mode is switched off. After the entry of the point to be staked in the Search Point dialog, the main stakout dialog will be accessed directly.

Coarse Mode = Line Offset



The stakeout elements are calculated in relation to the baseline defined by the two last points staked out.



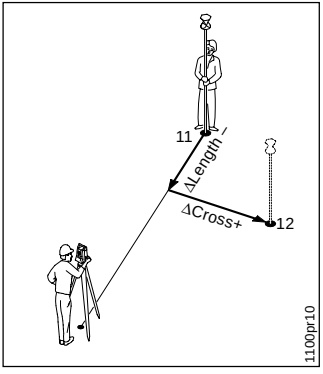
Line and **Offset** values are displayed after two points have been staked out.

ΔHeight is the height difference from the last point staked.

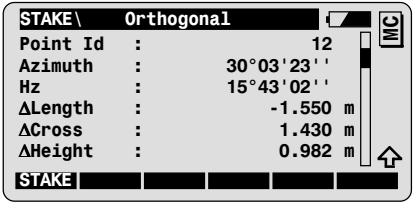
STAKE F1 To continue to the main stakeout dialog.

Motorized instruments drive automatically to the direction of the point to be staked.

Coarse Mode = Orthogonal



The stakeout elements are calculated in relation to the baseline defined by the instrument station and the last point staked out.



ΔLength and **ΔCross** values are displayed after the first point have been staked out.

ΔHeight is the height difference from the last point staked.

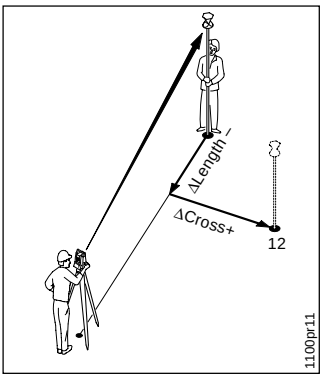
STAKE F1

To continue to the main stakeout dialog.

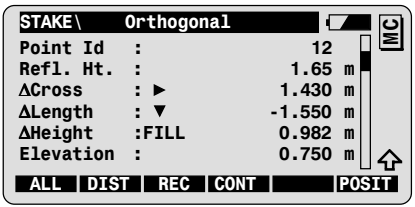
Motorized instruments drive automatically to the direction of the point to be staked.

Advanced Feature: Main stakeout mode

Stake Mode = Orthogonal Stake



The stakeout elements are calculated in relation to the baseline defined by the instrument station and the measured point.



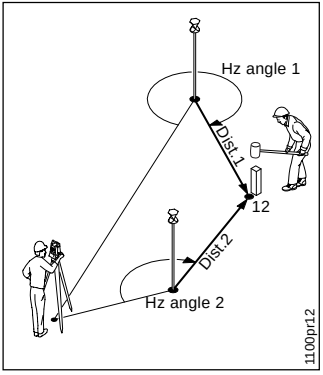
DIST F1 To measure a distance and calculate the stakeout elements **ΔCross** and **ΔLength**.

ΔHeight is the height difference between the measured point and the point to be staked. It is displayed in 3D stakeout mode only.

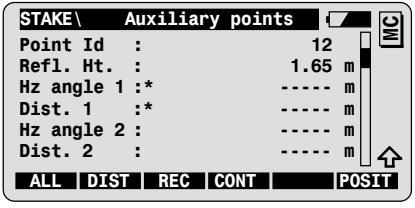
Repeat procedure until required positioning accuracy is achieved.

ALL F1 To measure and record stakeout point.
Continues to the Search Point dialog for the entry of to the next point to be staked.

Stake Mode = Auxiliary Point



In this mode, the stakeout elements for points that can not be sighted directly are caculated from measurements to two auxiliary points.



The auxiliary point to be measured is marked with an asterisk (*).

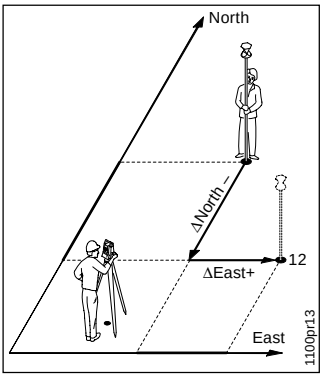
DIST (F2) To measure a distance to the first auxiliary point and calculate the stakeout elements **Hz angle 1** and **Dist. 1**. The asterisks switches to the second auxiliary point to be measured.

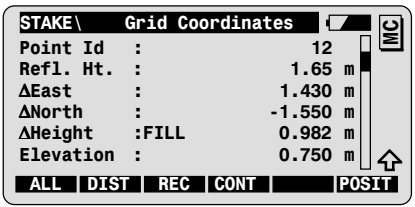
DIST (F2) To measure a distance to the second auxiliary point and calculate the stakeout elements **Hz angle 2** and **Dist. 2**.

CONT (F4) To stake out the next point. Continues to the dialog for the entry of the stakeout point.

Stake Mode = Grid Coordinates

The displacements along the grid coordinates axes are calculated from the measured point to the point to be staked.





DIST (F2) To measure a distance and calculate the stakeout elements **ΔEast**, **ΔNorth** and **ΔHeight**.

ΔHeight is the height difference between the measured point and the point to be staked. It is displayed in 3D stakeout mode only.

Repeat the procedure until the required positioning accuracy is achieved.

ALL (F1) To measure and record the stakeout point.
Continues to the Search Point dialog for the entry of to the next point to be staked.

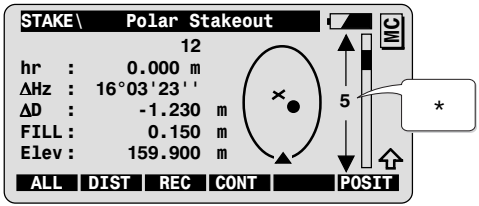
Advanced Feature: Graphic mode

The following modes are available for displaying stakeout graphics in the stakeout dialog:

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 recommended for stakeout 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.

Graphic mode= from Station
Stake mode = Polar Stake

Illustration of the stakeout dialog in the polar stake mode after having measured a distance.



Symbols:

- ▲ Instrument station
- × Reflector position
- ● Point to be staked

* The scale gives an indication of the distance between the reflector position and the point to be staked.

The graphics is updated dynamically when turning the instrument towards the point to be staked.

Configuration

SHIFT + CONF F2

Call the configuration in the first application dialog:

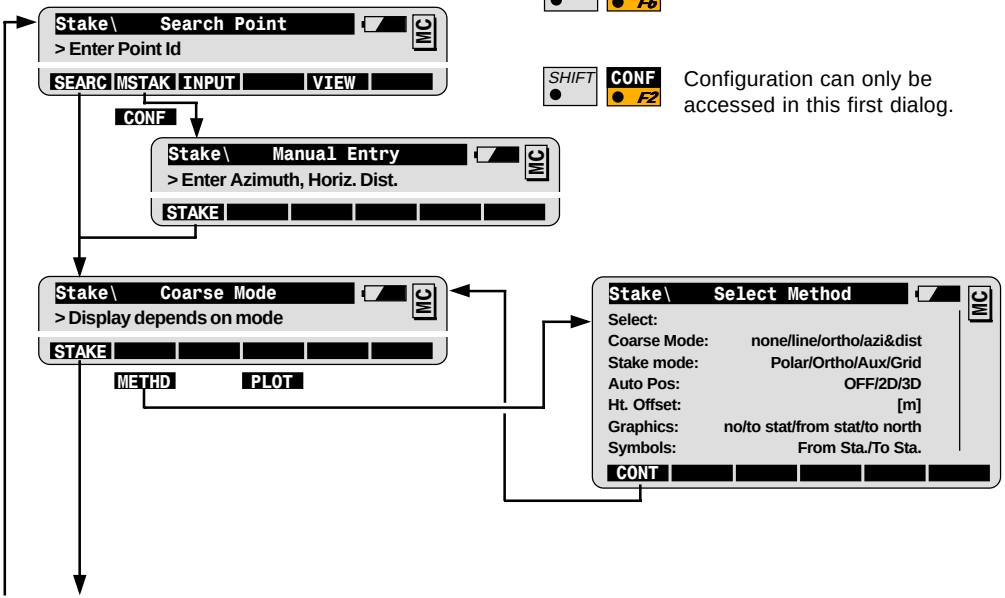
3D Stake	3-dimensional stakeout ☞ The height elements are displayed only if an elevation is available for the point to be staked.
Log File	Creation of a logfile.
Log FIName	User definable name for the logfile.
Data Job	Selection of the job containing the fix point coordinates.
Meas. Job	Selection of the job for recording measurements.

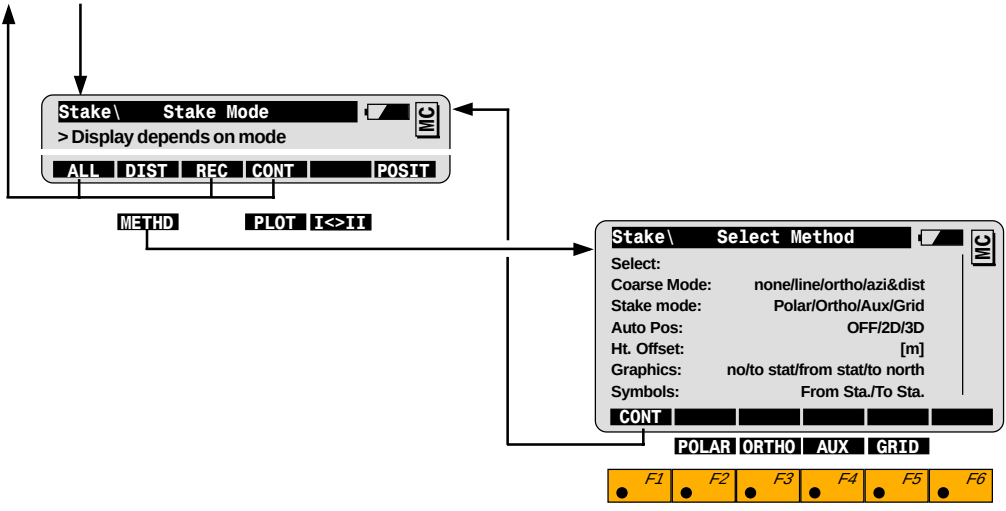
CONT F1 To exit the configuration dialog.

Program Flow

SHIFT ● QUIT ● F6 — To quit the Program at any time.

SHIFT ● CONF ● F2 — Configuration can only be accessed in this first dialog.





SHIFT + QUIT (F6) To quit the Program at any time.

Remote Height

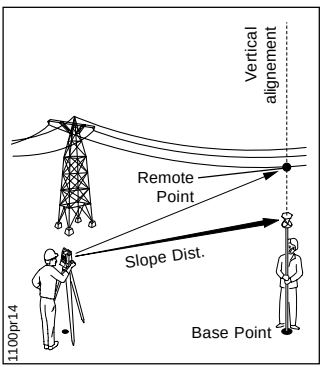
Introduction

Remote Height is used to determine the elevation of inaccessible points, e.g. on cables or building facades.

Basic Procedure

First, the distance to a base point situated vertically below (or above) the remote height point must be measured. Then 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.



Before starting Remote Height:
The station must be set up and oriented.

Known:

- *Distance to the base point*
- *Hz and V to the remote point*

Unknown:

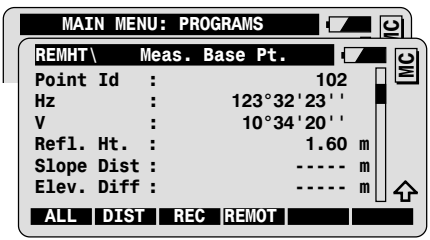
- *Coordinates of remote point: Elevation, East, North*

In practice, it is not possible to maintain an exact vertical alignement of base point and remote point. Depending on the needed accuracy, you can set the maximal displacement of the remote point to be tolerated (see chapter *"Configuration"*).

Measure Base Point

Start Remote Height from the program menu.

PROG



Enter point Id and reflector height at the base point.

ALL

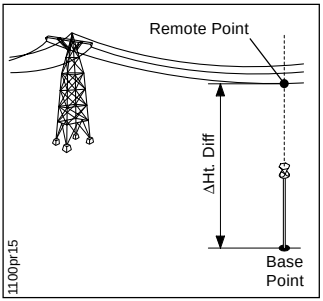
Fz

To measure and record the base point. (See chapter *"Measurement options"*).

Continues to the next dialog for remote point measurements.

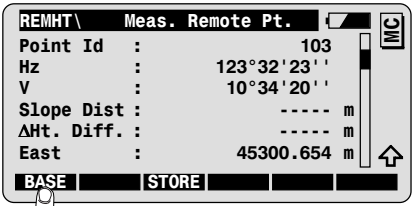
Remote Height

Measure Remote Point



ΔHt.Diff:
Height Difference between base and remote point.

Dialog for remote point measurement.



To define a new base point.

Enter the point Id of the remote point and aim to the remote point.

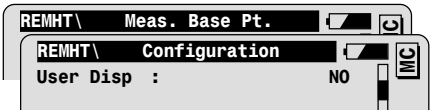
The angles and the coordinates of the remote point are updated dynamically.

STORE F3 To record the measurements to the remote point. Note that coordinates are recorded only if defined in the active REC-mask.

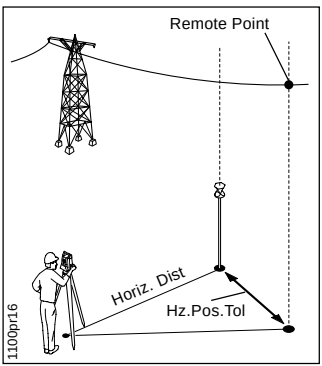
SHIFT **QUIT** F6 To quit the program.

Configuration

Call the configuration in the first application dialog:

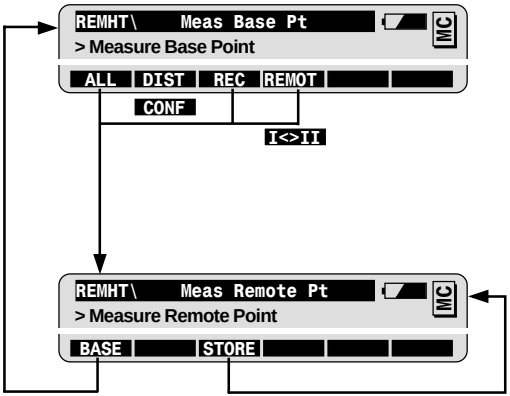


Hz.Pos.Tol:



User Disp	Use the display mask defined by user.
Hz.Pos.Tol	Tolerance for vertical alignement: enter the maximal horizontal distance to be tolerated between base point position and remote point position. ☞ A warning is displayed if the tolerance is exceeded.
Rec ΔHt= REC in WI37	To store the ΔHeight Difference between base point and remote point as record WI37.
Meas. Job	Selection of the job for recording measurements.
Data Job	Selection of the job containing the fix point coordinates.

Program Flow



SHIFT ● CONF ● F2 — Configuration can only be accessed in this first dialog.

STORE ● F3 — To record measurements to the remote point.
Depending on CONF-settings: Record additional measurement block with ΔHt Diff (WI 37)

SHIFT ● QUIT ● F6 — To quit the Program at any time.

Free Station

Introduction

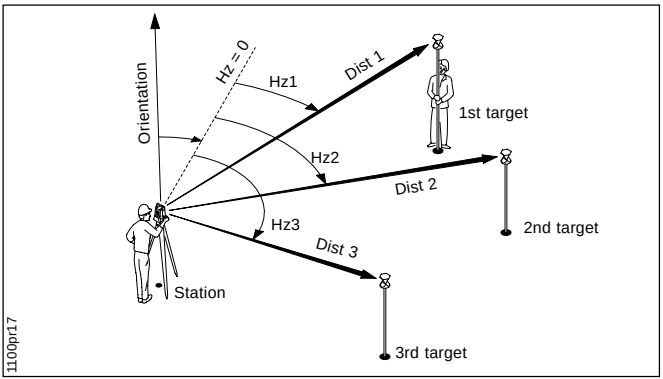
Free station is used for a station setup on an unknown point.
The station coordinates and the Hz-circle orientation at the station are calculated from measurements for up to ten known points.

A combination of directions and distances or of directions only may be measured to the target points.
If bad target points are found in the Free Station results, they can be suppressed or remeasured. The Free Station can be immediately recalculated.

Free Station is mostly used when more than two known points are available around the station. Measurements to additional known points allow a reliability control of the calculated station coordinates and orientation.

In building and construction sites, Free Station can be used where the establishment of a permanent station is not practical, or where a marker is likely to be destroyed.

For Stake out, data collection or cadastral survey, Free Station allows you to choose the instrument location with the best view of the working area.



Known:
Target point coordinates:
- *East, North*
- *Elevation (optional)*

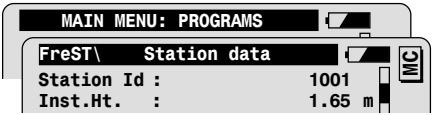
Unknown:
Station coordinates:
- *Stn. East, Stn. North*
- *Stn. Elev. (optional).*
  Orientation

Measure at least...
Distance and directions to 2 target points
or directions only to 3 target points

Points with elevation only can be used in Free Station.

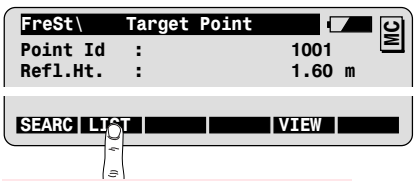
Start Free Station from the program menu.

PROG



Enter the station Id and the instrument height.

CONT F1

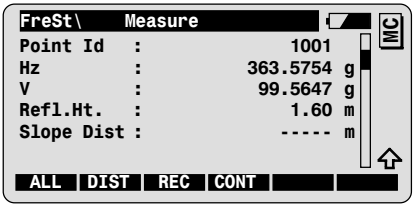


To define a list of the target points and the measurement sequence.

Enter Point Id and reflector height at the first target point.

SEARC F1

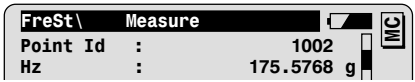
To search and import point coordinates from data job.



ALL (F1) To measures and record first target point.
See chapter *"Measurement options"*.

Enter Point Id and reflector height at the 2nd target point.

SEARC (F1) To search and import point coordinates from data job.



ALL / **F1** — To measure and record 2nd target point.

Repeat sequence for the next target points.
Note: from the third point on, motorized instruments will drive automatically to the target.

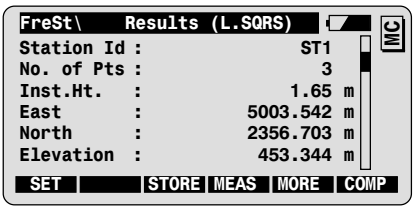
CALC / **F6** — To calculate the station coordinates and the orientation.

You may calculate after having measured at least:
- Distance and angles to 2 target points or
- Angles to 3 target points

Free Station results

The results dialog displays:

- the station coordinates
- the oriented direction (Hz. Ori)
- the a-posteriori standard deviations of the station coordinates and orientation
- the local scale factor



STORE F3 To record the free station results.

SET F1 To set station coordinates and orientation, and close the program.

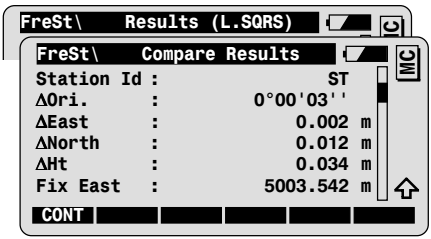
MEAS F4 To measure additional target points. Returns to the Target Point dialog.

Advanced Feature: Compare Results

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.

Call the comparison function from the results dialog.

COMP F5



The Delta values are the results of a substraction, e.g.

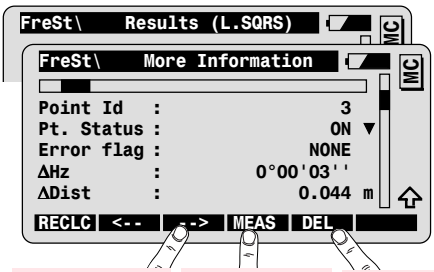
ΔEast = Calc.East - Fix East

CONT F1 To return to the results dialog.

Advanced Features: Result analysis

MORE F5

Call the result analysis for individual measurements from the results dialog.



Error Flag	Possible values
NONE	Measurement OK
HZ	Horizontal angle error
DIST	Distance error
HT	Height difference error

Define the point status:

ON/OFF	Measurements used/not used in calculation.
Ignore Elev.	Elevation not used in calculation.

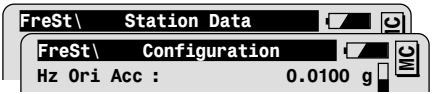
RECLC F1 To recalculate with the new settings.

ESC To go back to the result dialogs without changes.

Configuration

SHIFT ● CONF ● F2

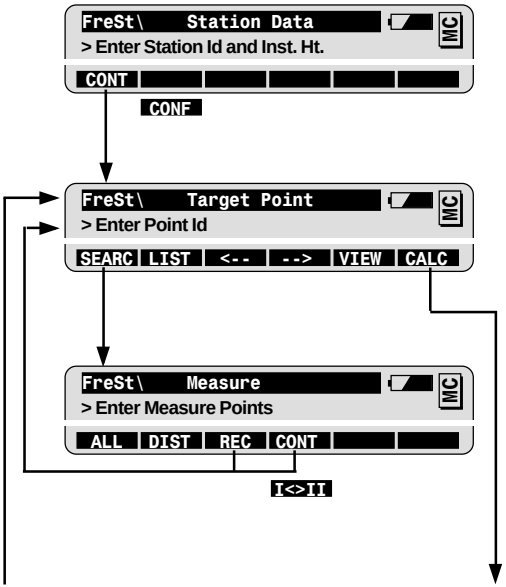
Call the configuration in the first application dialog.



Hz Ori Acc	A priori standard deviation of the orientation.
Ht Acc TP	A priori standard deviation of the elevation of the target points.
Posn AccTP	A priori standard deviation of the position (East and North coordinates) of the target points.

If the computed (a posteriori) standard deviations are within twice the values entered for the a priori standard deviations, the computed station coordinates and orientation will be accepted.

User Disp	Use the display mask defined by the user.
Two Faces	Single or two face measurement.
Log File	Creation of a logfile.
Log FIName	User definable name for the logfile.
Data Job	Selection of the job containing the fix point coordinates.
Meas. Job	Selection of the job for recording measurements.

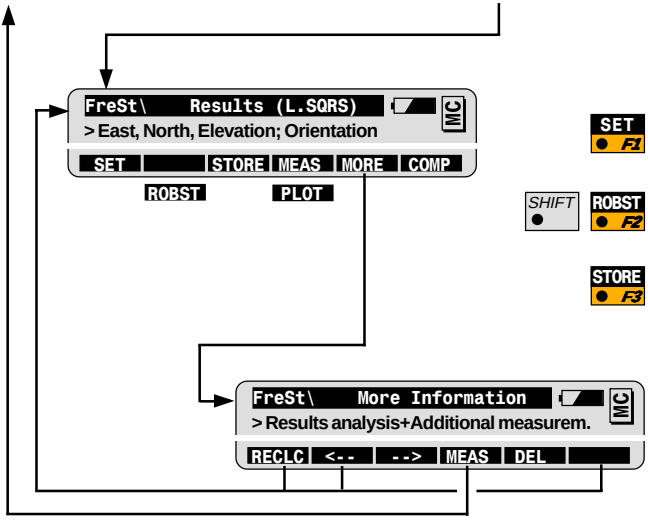


SHIFT CONF F2

Configuration can only be accessed in this first dialog.

CALC F6

To start calculations. Available after 3 Points have been measured.



SET F1 — To set the Station and leave the program.

SHIFT **ROBST** F2 — Option for adjustment with Least Square or robust methods.

STORE F3

Station Point Number	WI 11
Orientation correction	WI 25
Station coordinates	WI 84-86
Last used reflector Ht	WI 87
Instrument Height	WI 88

SHIFT **QUIT** F6 — To quit the Program at any time.

Reference Line

Introduction

This program is used to set out points along a reference line or reference arc, with various offsets to the left and right. Radial offsets can be applied to the arc and the reference line can be shifted with parallel offsets or even rotated anytime to match predefined setting out instructions.

The orthogonal setting out elements of the target points are calculated in relation to the defined reference line/arc.

In Building and Construction, Reference Line is the specialized program to set out building foundations (batter staking).

It may also be used for simple alignment types such as water and sewer line layout as well as roadlines and bridges.

It is very convenient for orthogonal set out thanks to various offset possibilities and because point coordinates do not need to be precalculated. Only the coordinates of the start and end points of the reference line/arc are needed.

Points with known offset values from the defined line or arc can easily be set out with the function Line & Offset.

Basic procedure

Before starting Reference Line:

The station must be set up and oriented.

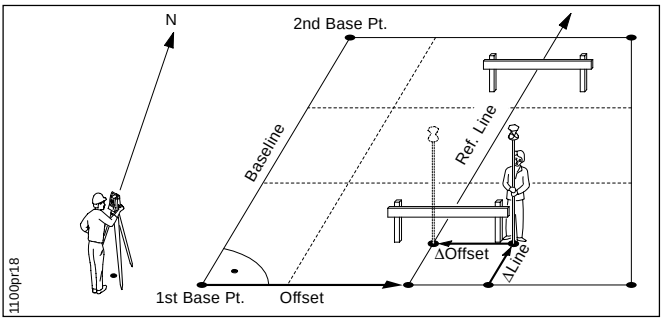
A Baseline or -arc is defined in the first step. There are three methods to define a base: Line, Radius Arc, and 3-Point Arc.

Start any of the methods from the Reference Line Menu.

Line of sight to the baseline points is not needed. They can be imported from a data file.

1 Baseline

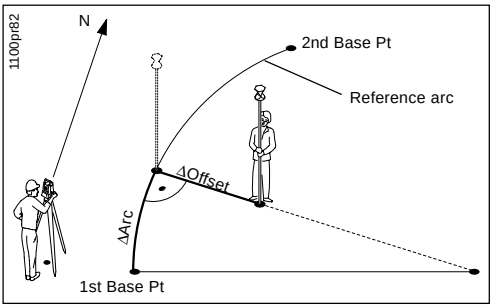
In the picture, the reference line is defined by a parallel offset to the right of the baseline.



Known:
- 1st BasePt
- 2nd BasePt
Parallel ***Offset*** *between Reference line and Baseline.*

Unknown:
ΔOffset, ΔLine:
Position of point to set out on the reference line.

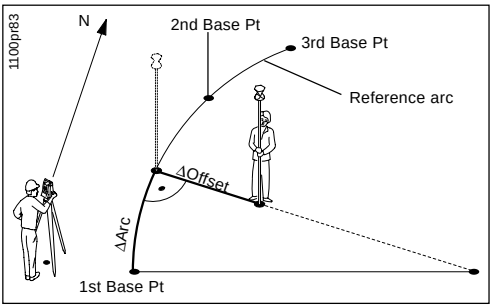
2 Radius Arc



Known:
- 1st Base Pt
- 2nd Base Pt
- Radius
Offset

Unknown:
ΔOffset, ΔArc:
position of point to set out on reference arc.

3 3-Point Arc

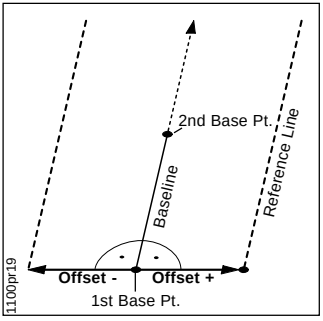


Known:
- 1st Base Pt
- 2nd Base Pt
- 3rd Base Pt
Offset

Unknown:
ΔOffset, ΔArc:
position of point to set out on reference arc.

Reference Line

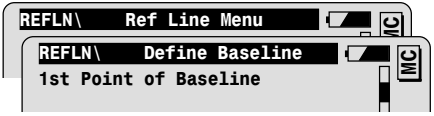
Define Reference Line



→	*direction of the baseline*
Offset +	*to the right of the baseline*
Offset -	*to the left of the baseline*

For Arc the radial offset is applied to each point.

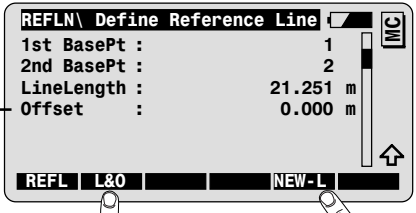
1 Start Baseline from the Ref Line Menu



Enter the first point of the baseline.

SEARC F1 To search and import point from data job.

Repeat sequence for second point of baseline.
And define the reference line parameters:

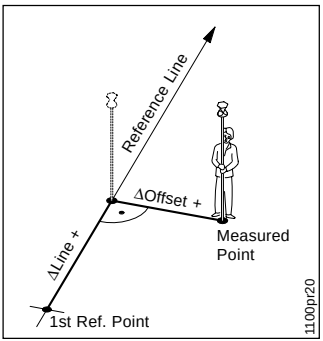


To set out points with known offsets.

To define new baseline.

Offset = 0	Reference line = Baseline
Offset ≠ 0	Reference line parallel to Baseline

Setting Out elements



ΔOffset	*Perpendicular offset*
ΔOffset+	*To the right of the reference line.*
ΔLine	*Line offset from the 1st Ref. Point.*
ΔLine+	*In the line direction.*

REFL F1

```
REFLN\     Ref Line Results        MC
Point Id   :                3
ΔOffset    :            1.230 m
ΔLine      :            2.463 m
ΔHt        :            0.235 m
Elevation  :          100.500 m

 ALL | DIST | REC | DONE
```

Enter Point Id to be set out.

DIST F2 To measure a distance and trigger the calculation of the setting out elements: ΔOffset, ΔLine and ΔHt.

ΔHt:	Height Offset in relation to the reference Elevation (Elevation of the 1 st Base Point).
Elevation:	Elevation of the measured point.

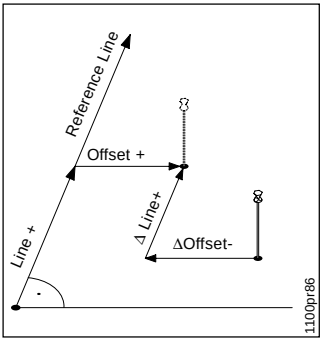
SHIFT + **ΔL P2** F4 To display ΔLine from the second point.

ALL F1 To measure and record setting out point. Point Id is incremented.

DONE F4 To return to Define Reference Line dialog.

SHIFT + **QUIT** F6 To quit the Reference Line program.

Linie and Offset



L&O F2

```
REFLN\ Define Reference Line
REFLN\     Line & Offset
Enter Offsets from Ref. Line
Point Id   :          110
Offset     :       10.555 m
Line       :       23.454 m
DesignElev :      100.500 m
```

Enter Point Id of point to be staked, as well as perpendicular offset and distance along line. Entering an elev. is optional.

CONT F1

```
REFLN\     L&O Results
Point Id   :          110
Refl. Ht.  :        1.300 m
Δ Offset   :◄      -0.542 m
ΔLine      :▲       1.222 m
ΔHt        :FIL     0.500 m
Elev.      :      100.000 m
           DIST
```

DIST F2 To measure a distance and calculate the stakeout elements **Δ Offset** and **Δ Line**.

Δ HT is the height difference between the measured and the design elevation.

Repeat procedure until required positioning accuracy is achieved.

ALL F1 To measure and record point. Continues to the first L&O dialog to enter offsets for next point.

CONT F4 Returns to first L&O dialog to enter offsets without recording data.

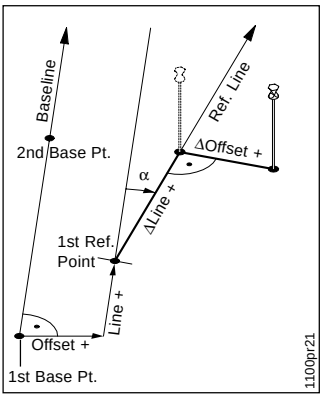
Advanced Feature: Configuration of the L&O method

SHIFT METHD F6 Call up the dialog for the configuration of the L&O method from the set out dialog.

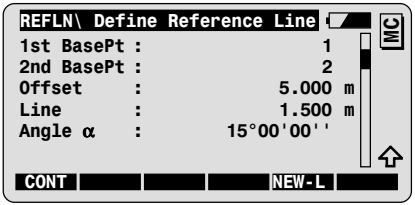
Stake Mode	Selection of the stakeout mode:
Ortho-Reference	Stakeout elements are calculated in relation to the reference line/arc.
Ortho-Station	Stakeout elements are calculated in relation to the line defined by station and reflector.
Polar	Stakeout elements are calculated in relation to the station and the measured point.
Auto Pos.	Mode for automatic positioning to the point:
OFF	No automatic positioning
2D or 3D	2-dimensional or 3-dimensional positioning
Symbols	Symbols can be used to guide the rod person to the point to be staked.
Orthogonal	ON: positive in direction of reference.
Polar	- From Station (↑↓): Guides rod from station - To Station (↓↑): Guides from the rod in relation to the instrument station (if working in RCS mode)

Advanced Feature: Rotated Ref. Line

Configuration:
Line / α = ON



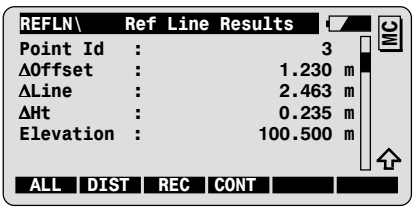
Dialog for the definition of a rotated Reference line:



Enter the **Line** offset to define the starting point of the reference line (1st Ref. Point).

Enter the rotation **angle α**.

CONT F1

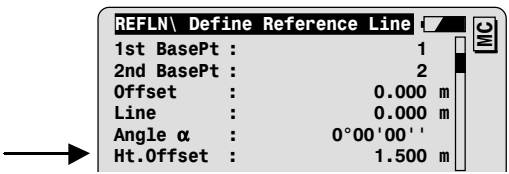


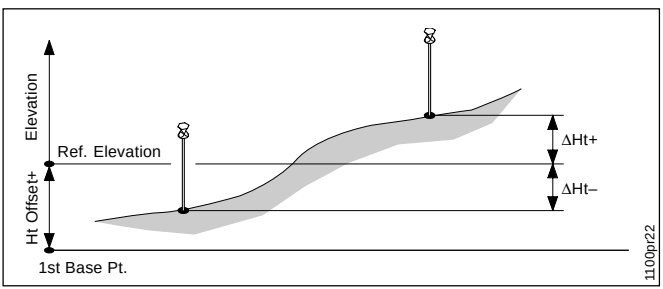
DIST F2

To measure a distance and trigger the calculation of the setting out elements in relation to the new reference line and it's starting point.

Advanced Feature: Constant reference elevation

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.
You can modify the reference elevation by specifiying a height offset (**Ht.Offset**) in the dialog for the definition of the reference line.





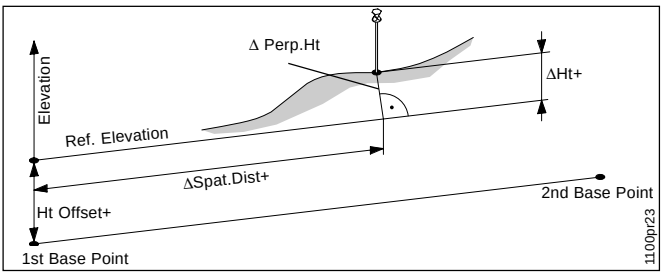
Configuration:
Ref. Elev. = 1st Base Point
Ht. Offset = ON

Setting out element:
ΔHt along the vertical, in relation to the Reference elevation

Advanced: Height Offset

Interpolated reference elevation

For the configuration **Ref.Elev. = 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.

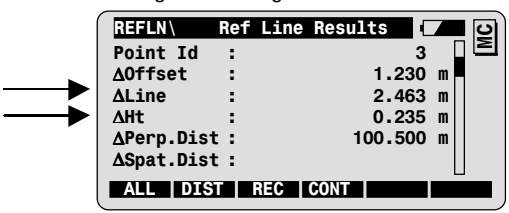


Configuration:
Ref. Elev. = Reference Line
Ht. Offset = ON

Setting out elements:

ΔHt	*Along vertical*
ΔPerp.Dist	*Perpendicular to the Ref. line*
ΔSpat.Dist	*Line offset along the Ref. line*

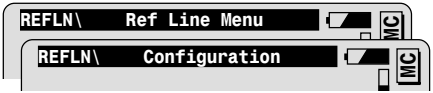
Results dialog with setting out elements:



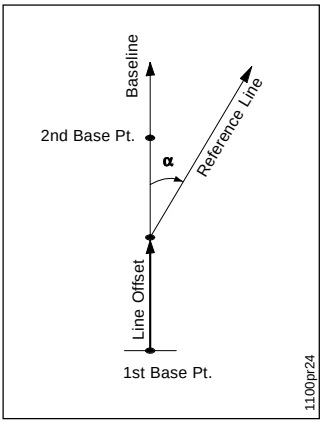
Configuration

SHIFT CONF F2

Call the configuration in the first application dialog.

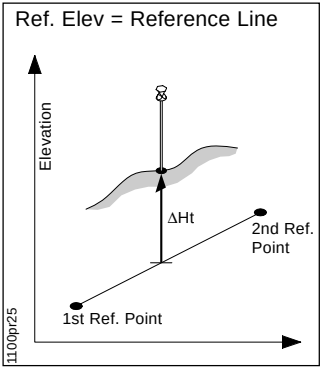


Line / α :



Parameters for the definition of the Reference line:

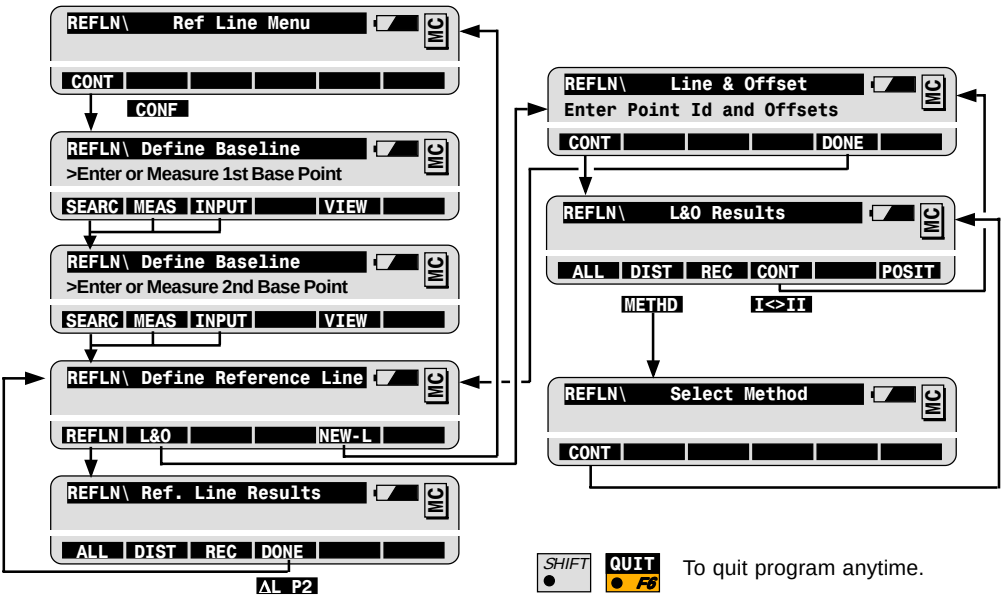
Offset	To define a parallel offset of the Reference Line in relation to the Baseline.
Line /α	To define a line offset for the starting point of the Reference Line and an angle between Reference Line and Baseline.
Ht Offset	To define a height offset of the Reference Line in relation to the reference elevation.
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.	
= ON	Edit or add elevation in the Ref Line and L&O Results dialogs. New elevation is stored.
= OFF	Elevation cannot be changed or added in Results.
Rec Diff	To record setting out elements in a measurement block.
= NONE	Record measurement block according to REC-Mask.
= O, O/L, O/L/H or O/S, O/S/P	Record additional values: O = ΔOffset, L = ΔLine/ΔArc, H = ΔHeight S = ΔSpat.Dist, P = ΔPerp.Dist (available only if Ref. Elev. = Baseline)
User Disp	To display the user-defined display mask in measurement mode.
Logfile	To create a logfile.
Log FlName	User definable name for the logfile.
Meas. Job	Selection of the job for recording measurements.
Data Job	Selection of the job containing the fix point coordinates.

CONT F1 To exit the configuration dialog.

Program Flow



Hidden Point

Introduction

The program allows measurements to a point that is not directly visible using a special hidden-point rod.

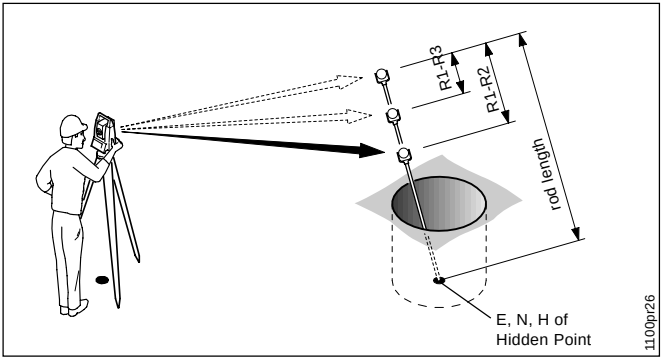
The data for the hidden point are calculated from measurements to the reflectors mounted on the rod with a known spacing and a known rod length. The rod may be held at any angle as long as it is stationary for all measurements.

“Measurements” are calculated as if the hidden point was observed directly. These “calculated measurements” can also be recorded.

Typical uses are:
Measurement of inverts, building corner details of measurement of points behind overhangs.

Basic procedure

Before starting Hidden Point:
The station must be set up and oriented.

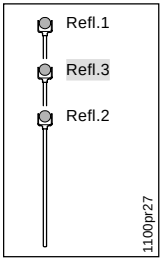


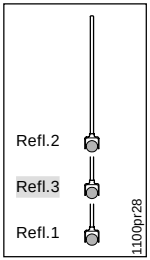
Known:
Hidden Point Rod Parameters
- *Rod Length*
- *Spacing between center of reflectors*

Unknown:
Coordinates of Hidden Point

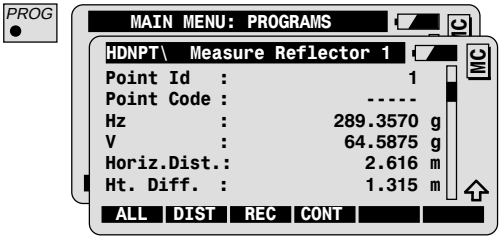
Set rod parameters in CONFIGURATION.

Measurement sequence:





Start Hidden Point from the program menu.



Enter Point Id at first reflector.

Hold rod stationary at any angle with tip on the hidden point. Measure the reflectors in the illustrated sequence.

ALL F1

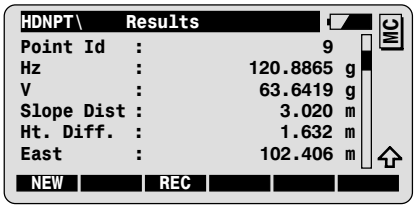
To measure and record in the active Measure Job. See chapter *"Measurement options"*.

Repeat for second and optional third reflectors.

Motorized instruments may automatically drive to the third reflector.

Results

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.



Enter Point Id of hidden point.

To record hidden point data.

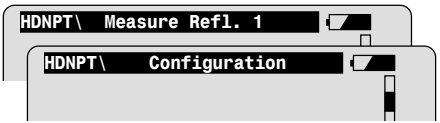
To measure to a new hidden point.

To quit the Hidden Point program.

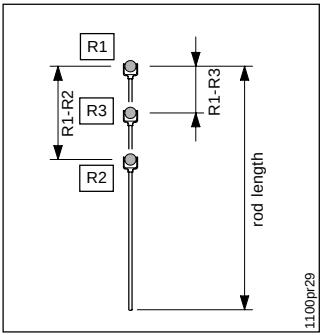
Configuration

Call the configuration in the first application dialog.

SHIFT CONF F2



User Disp	Use the display mask defined by the user.
Meas. Tol.	Limit for the difference between the given and measured spacing of the reflectors.
Reflector	Selection of the hidden point rod reflector.
Add.Const.	Display of the reflector constant. ☞ This value depends on the selected reflector.
No.of Refl.	Number of reflectors on the hidden point rod.
Auto Pos.	Automatically point to optional third reflector (motorized instruments only)

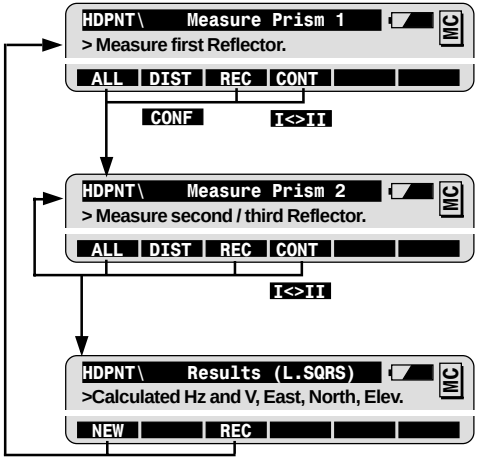


Rod Length	Distance from center of end prism to tip of the hidden point rod.
Dist R1-R2	Spacing between the centers of prisms R1 and R2.
Dist R1-R3	Spacing between the centers of prisms R1 and R3.
Meas. Job	Selection of the job for recording measurements.
Data Job	Selection of the job containing the fix point coordinates.

CONT F1

When configuration is completed.

You must configure the hidden-point rod the first time you use the program. For continued use, it is only necessary to use CONFIGURATION when you want to change one of the settings.



SHIFT CONF F2 — Configuration can only be accessed in this first dialog.

SHIFT QUIT F6 — To quit the Program at any time.

Leica Geosystems AG, Heerbrugg, Switzerland has been certified as being equipped with a quality system which meets the International Standards of Quality Management and Quality Systems (ISO standard 9001) and Environmental Management Systems (ISO standard 14001).

Total Quality Management - Our commitment to total customer satisfaction

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Original text

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