

GeoMax ZTS600



GE  **MAX**
Part of Hexagon Group

User Manual
Version 1.2

Introduction

Purchase

Congratulations on the purchase of a ZTS600 instrument.



This manual contains important safety directions as well as instructions for setting up and operating the product. Refer to "13 Safety Directions" for further information.



Read carefully through the User Manual before you switch on the product.

Product identification





The model and serial number of your product are indicated on the type plate. Enter the model and serial number in your manual and always refer to this information when you need to contact your agency or GeoMax authorised service workshop.

Model: _____

Serial No.: _____

Symbols

The symbols used in this manual have the following meanings:

Type	Description
 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.

Trademarks

- Windows is a registered trademark of Microsoft Corporation. All other trademarks are the property of their respective owners.

Validity of this manual

	Description
General	This manual applies to ZTS600 instruments.
Tele-scope	<ul style="list-style-type: none">• Measuring with IR mode: When measuring distances to a reflector with Electronic Distance Measurement (EDM) mode "IR", the telescope uses a wide visible red laser beam, which emerges coaxially from the telescope's objective.• Measuring with RL modes: Instruments that are equipped with a reflectorless EDM additionally offer the EDM mode "RL". When measuring distances with this EDM mode, the telescope uses a narrow visible red laser beam, which emerges coaxially from the telescope's objective.

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1 Description of the System

1.1 System Components

Main Components

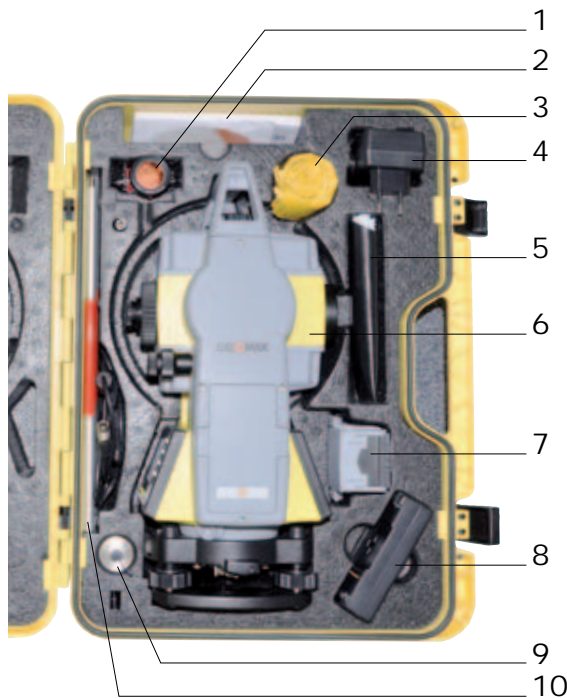


ZTS600 instrument with ZTS600 firmware

Component	Description
Instrument	An instrument for measuring, calculating and capturing data. Ideally suited for tasks from simple surveys to complex applications.
Office software	An office software consisting of a suite of standard programs for the exchanging and managing of data.
Data transfer	Data can be always transferred between the instrument and a computer via a data transfer cable.

1.2 Container Contents

Container contents



1. Mini prism ZPM100
 2. User Manual
 3. Protective cover
 4. Charger ZCH10x (part 1)
 5. Accessories (brush, cloth, tools)
 6. Total station
 7. Battery ZBA101
 8. Charger ZCH10x (part 2)
 9. Plumb bob
 10. Mini prism pole and data transfer cable
-

1.3 Instrument Components

Instrument components

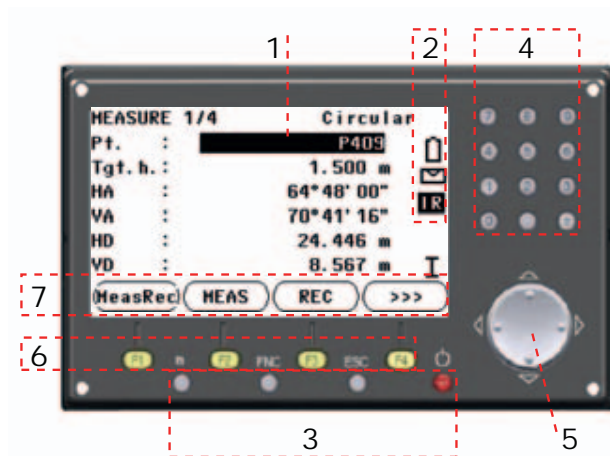


- 1. Detachable carrying handle with mounting screws
- 2. Optical sight
- 3. Focusing telescope image
- 4. Vertical drive
- 5. Circular level
- 6. Battery cover
- 7. Keyboard
- 8. Foot screw
- 9. Display
- 10. Horizontal drive
- 11. Serial interface RS232

2 User Interface






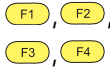

2.1 Keyboard

Keyboard



1. Focus
Actively measured field
2. Symbols
3. Fixed keys
Keys with firmly assigned functions.
4. Alphanumeric keys
5. Navigation key
Control of input bar in edit and input mode or control of focus bar.
6. Function keys
Are assigned the variable functions displayed at the bottom of the screen.
7. Softkey bar
Displays functions that can be called up with the function keys.

Keys











Key	Description
	Scrolls to next page when a screen consists of several pages.
	FNC key. Quick-access to measurement supporting functions.
	Navigation key. Controls the focus bar within the screen and the entry bar within a field.
	ENTER key. Confirms an entry and continues to the next field.
	ESC key. Quits a screen or edit mode without saving changes. Returns to next higher level.
	Function keys that are assigned the variable functions displayed at the bottom of the screen.
	Keypad for entry of text and numerical values.


2.2 Status Icons

Description

The icons provide status information related to basic instrument functions. Depending on the firmware version, different icons are displayed.

Icons

Icon	Description
	The battery symbol indicates the level of the remaining battery capacity, 75% full shown in the example.
	Compensator is on.
	Compensator is off.
	IR EDM mode for measuring to prisms and reflective targets.
	RL EDM mode for measuring to all targets.
	Offset is active.
	Keypad is set to numeric mode.
	Keypad is set to alphanumeric mode.
	Indicates that horizontal angle is set to left side angle measurement (anticlockwise).
	A double arrow indicates a field has a selectable list.

Icon	Description
▲, ▼, ◆	Up and down arrows indicate that several screens are available, which are accessed using  .
I	Indicates telescope position is face I.
II	Indicates telescope position is face II.

2.3 Softkeys

Description

Softkeys are selected using the relevant **F1** to **F4** function key. This chapter describes the functionality of the common softkeys used by the system. The more specialised softkeys are described where they appear in the application chapters.


Common softkey functions

Key	Description
-> ABC	To change the keypad operation to alphanumerical.
-> 012	To change the keypad operation to numerical.
MeasRec	To start distance and angle measurements and save the measured values.
MEAS	To start distance and angle measurements without saving the measured values.

Key	Description
EDM	To view and change EDM configuration. Refer to "4.3 EDM Configuration".
COORD	To open the manual coordinate entry screen.
EXIT	To exit the screen or application.
SEARCH	To search for an entered point.
RL/IR	To toggle between Prism and Non-Prism EDM modes.
LIST	To display the list of available points.
OK	If entry screen: Confirms measured or entered values and continues the process. If message screen: Confirms message and continues with selected action or returns to the previous screen to reselect an option.
BACK	To return to the last active screen.
REC	To save the displayed values.
RESET	To reset all editable fields to their default values.
VIEW	To display the coordinate and job details of the selected point.
>>>	To display the next softkey level.

2.4 Operating Principles

Turn instrument on/off

Use the On/Off key, , on the keyboard of the instrument.

Alphanumeric keypad

The alphanumeric keypad is used to enter characters directly into editable fields.

- **Numeric fields:** Can only contain numerical values. By pressing a key of the keypad the number will be displayed.
- **Alphanumeric fields:** Can contain numbers and letters. By pressing a key of the keypad the first character designated to that key will be displayed. By pressing several times you can toggle through the characters. For example: S->T->U->1->S....

Edit fields



ESC Deletes any change and restores the previous value.



Moves the cursor to the left.



Moves the cursor to the right.



Inserts a character at the cursor position.




Deletes the character at the cursor position.



In edit mode the position of the decimal place cannot be changed. The decimal place is skipped.

Special characters

Character	Description
*	Used as wildcards in search fields for point numbers or codes. Refer to "2.5 Pointsearch".
+/-	In the alphanumeric character set "+" and "-" are treated as normal alphanumeric characters with no mathematical function.  "+" / "-" only appear in front of an entry.

APPLICATIONS 1/3 ▼		
F1	Topography	(1)
F2	Point Projection	(2)
F3	Calculations	(3)
F4	Missing Line (MLM)	(4)

In this example selecting 2 on the keyboard would start the Point Projection application.

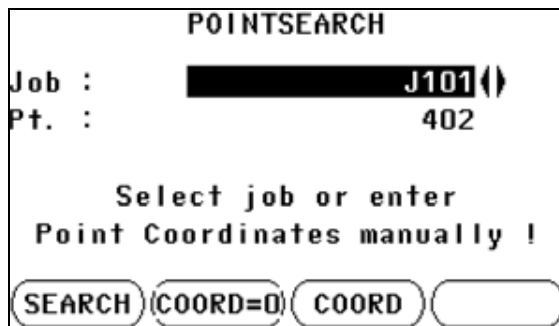
2.5 Pointsearch

Description

Pointsearch is a function used by applications to find measured or fixed points in the memory storage. It is possible to limit the point search to a particular job or to search the whole storage. The search procedure always finds fixed points before measured points that fulfill the same search criteria. If several points meet the search criteria, then the results are ordered according to the entry date. The instrument finds the most recent fixed point first.

Direct search

By entering an actual point number, for example 402, and pressing **SEARCH**, all points within the selected job and with the corresponding point number are found.



SEARCH

To search for matching points within the selected job.

COORD=0

To set all ENZ coordinates for the point ID to 0.

Wildcard search

The wildcard search is indicated by a "*". The asterisk is a place holder for any following sequence of characters. Wildcards should be used if the point number is not fully known, or to search for a batch of points.

Examples of point searches

- * All points are found.
 - A All points with exactly the point number "A" are found.
 - A* All points starting with "A" are found, for example, A9, A15, ABCD, A2A.
 - *1 All points containing only one "1" are found, for example, 1, A1, AB1.
 - A*1 All points starting with "A" and containing only one "1" are found, for example, A1, AB1, A51.
-

3 Operation

3.1 Instrument Setup

Description

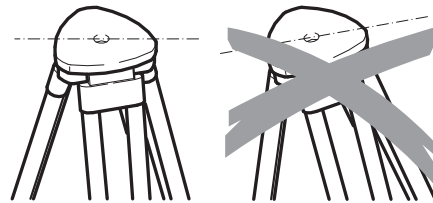
This topic describes an instrument setup over a marked ground point using the laser plummet. It is always possible to set up the instrument without the need for a marked ground point.



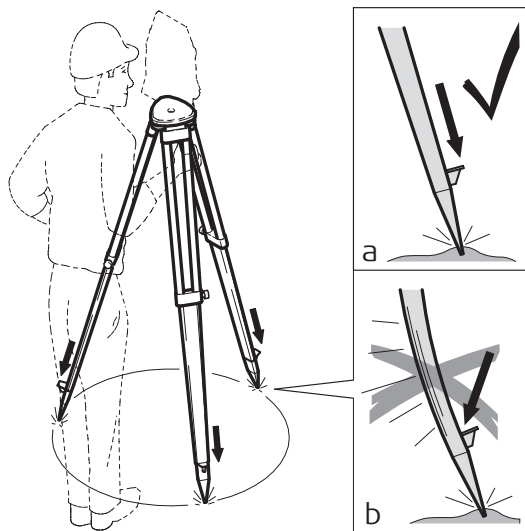
Important features

- It is always recommended to shield the instrument from direct sunlight and avoid uneven temperatures around the instrument.
- The laser plummet described in this topic is built into the vertical axis of the instrument. It projects a red spot onto the ground, making it appreciably easier to center the instrument.
- The laser plummet cannot be used in conjunction with a tribrach equipped with an optical plummet.

Tripod

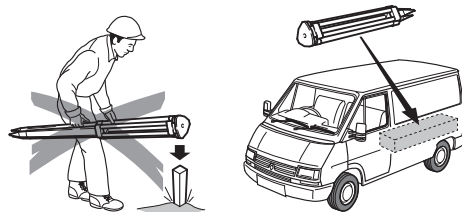


When setting up the tripod pay attention to ensuring a horizontal position of the tripod plate. Slight corrections of inclination can be made with the foot screws of the tribrach. Larger corrections must be done with the tripod legs.



Loosen the clamping screws on the tripod legs, pull out to the required length and tighten the clamps.

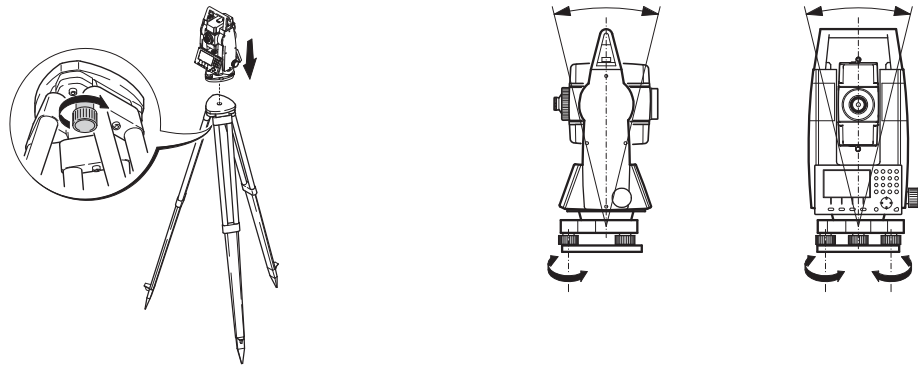
- a In order to guarantee a firm foothold sufficiently press the tripod legs into the ground.
- b When pressing the legs into the ground note that the force must be applied along the legs.



Careful handling of tripod.

- Check all screws and bolts for correct fit.
- During transport always use the cover supplied.
- Use the tripod only for surveying tasks.

Setup step-by-step



1. Extend the tripod legs to allow for a comfortable working posture. Position the tripod over the marked ground point, centring it as best as possible.
2. Fasten the tribrach and instrument onto the tripod.
3. Turn on the instrument, press **FNC** from within any application and select **Electr.Level/Laserpl.**
4. Move the tripod legs and use the tribrach footscrews to center the plummet over the ground point.
5. Adjust the tripod legs to level the circular level.
6. By using the electronic level, turn the tribrach footscrews to precisely level the instrument. Refer to "Level up with the electronic level step-by-step".
7. Center the instrument precisely over the ground point by shifting the tribrach on the tripod plate.
8. Repeat steps 6. and 7. until the required accuracy is achieved.

Level up with the electronic level step-by-step

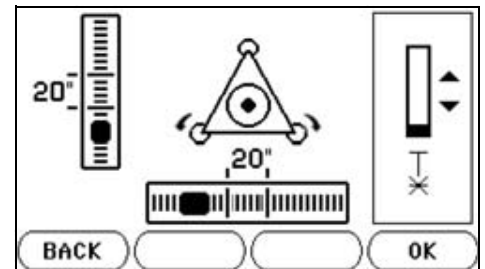
The electronic level can be used to precisely level up the instrument using the footscrews of the tribrach.

1. Turn the instrument until it is parallel to two footscrews.
2. Center the circular level approximately by turning the footscrews of the tribrach.
3. Turn on the instrument, press **FNC** from within any application and select **Electr.Level/Laserpl.**



The bubble of the electronic level and the arrows for the rotating direction of the footscrews only appear if the instrument tilt is inside a certain levelling range.

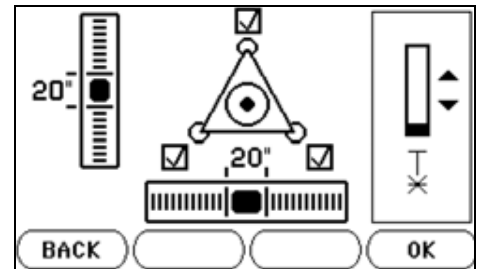
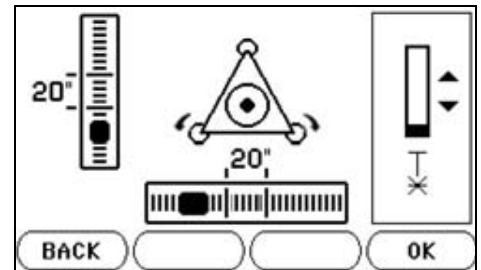
4. Center the electronic level of the first axis by turning the two footscrews. Arrows show the direction of rotation required. When the electronic level is centered the arrows are replaced by checkmarks.



- Center the electronic level for the second axis by turning the last foot-screw. An arrow shows the direction of rotation required. When the electronic level is centered the arrow is replaced by a checkmark.



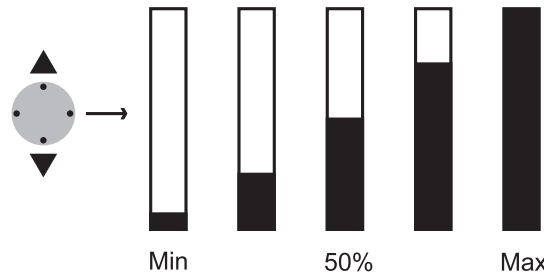
When the electronic level is centered and three checkmarks are shown, the instrument has been perfectly levelled up.



- Accept with **OK**.

Change the intensity of the laser plummet

External influences and the surface conditions may require the adjustment of the intensity of the laser plummet.



In the **Electr.Level/Laserpl** screen, adjust the intensity of the laser plummet using the navigation key. The laser can be adjusted in 25% steps as required.

Position over pipes or holes

Under some circumstances the laser dot is not visible, for example over pipes. In this case, using a transparent plate enables the laser dot to be seen and then easily aligned to the center of the pipe.

3.2 Working with the Battery



Charging / first-time use

- The battery must be charged prior to using it for the first time because it is delivered with an energy content as low as possible.
- For new batteries or batteries that have been stored for a long time (> three months), it is effectual to make 2 - 5 charge/discharge cycles.
- The permissible temperature range for charging is between 0°C to +35°C/+32°F to +95°F. For optimal charging we recommend charging the

batteries at a low ambient temperature of +10°C to +20°C/+50°F to +68°F if possible.

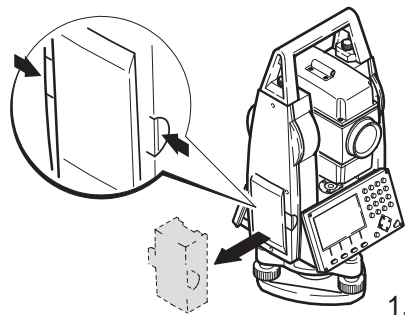
- It is normal for the battery to become warm during charging. Using the chargers recommended by GeoMax, it is not possible to charge the battery if the temperature is too high.

Operation / discharging

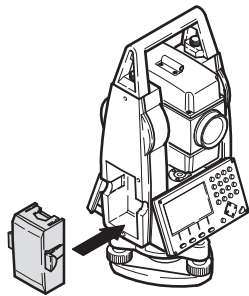
- The batteries can be operated from -20°C to +50°C/-4°F to +122°F.
- Low operating temperatures reduce the capacity that can be drawn; very high operating temperatures reduce the service life of the battery.

Change the battery step-by-step

1. Remove battery holder.



2. Insert battery holder into instrument.



2.



- Insert battery correctly (note pole markings on the inside of the battery holder). Check and insert battery holder true to side into the housing.
- For the type of battery refer to "14 Technical Data".

3.3 Data Storage

Description

An internal memory is included in all instruments. The firmware stores all data in jobs in a database in the internal memory. Data can then be transferred to a computer or other device for post processing via a cable connected to the serial interface RS232 port.

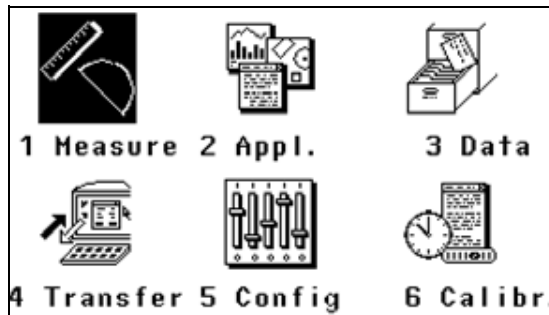
Refer to "10 Data Management" for further information on data management and data transfer.

3.4 Main Menu

Description

The **MAIN MENU** is the starting place for accessing all functionality of the instrument. It is usually displayed immediately after the **Electr.Level/Laserpl** screen, after switching on the instrument.

MAIN MENU



Description of the MAIN MENU functions

Function	Description
Measure	Measure program to begin measuring immediately. Refer to "3.5 Measure Application".
Appl.	To select and start applications. Refer to "9 Applications".

Function	Description
Data	To manage jobs, data, codelists, and system memory. Refer to "10 Data Management".
Transfer	To export data. Refer to "10.2 Data Transfer".
Config	To change EDM configurations, communication parameters and general instrument settings. Refer to "4 Configuration".
Calibr.	To access check and adjust calibrations. Refer to "5 Calibration".

3.5 Measure Application

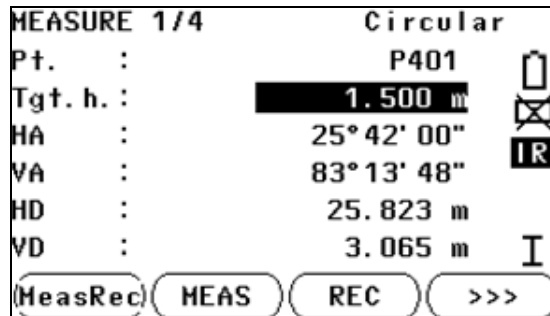
Description

After switching on and setting up correctly, the instrument is immediately ready for measuring.

Access

Select **Measure** from the **MAIN MENU**.

MEASURE



>>> **STN.**

To enter station data and set the station.

>>> **SetHA**

To set the horizontal orientation.

The procedure for **Measure** is identical to the procedure for the application **Topography**. Therefore this procedure is only described once within the application chapter. Refer to "9.2 Topography".

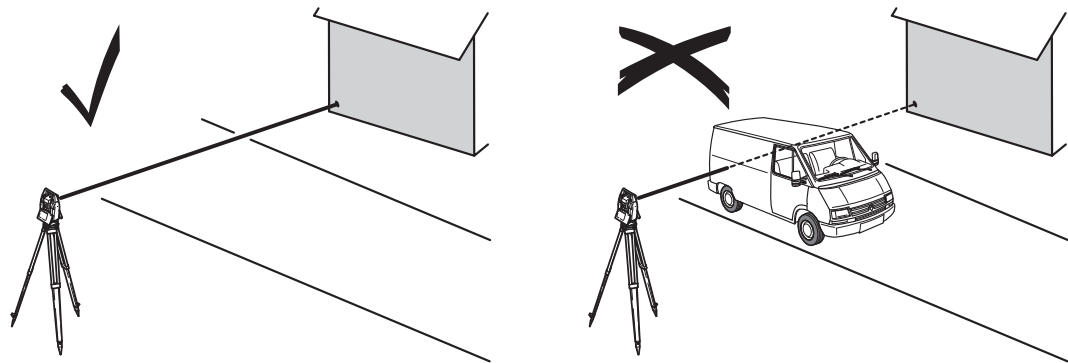
3.6 Distance Measurements - Guidelines for Correct Results

Description

A laser distancer (EDM) is incorporated into the instrument. The distance can be determined by using a visible red laser beam which emerges coaxially from the telescope objective. There are two EDM modes:

- Prism measurements (IR)
- Non-Prism measurements (RL)

RL measure- ments



- When a distance measurement is triggered, the EDM measures to the object which is in the beam path at that moment. If a temporary obstruction, for example a passing vehicle, heavy rain, fog or snow is between the instrument and the point to be measured, the EDM may measure to the obstruction.
- Be sure that the laser beam is not reflected by anything close to the line of sight, for example highly reflective objects.
- Avoid interrupting the measuring beam while taking Non-Prism measurements or measurements using reflective foils.
- Do not measure with two instruments to the same target simultaneously.

IR measure- ments

- Accurate measurements to prisms should be made in Prism-standard mode.

- Measurements to strongly reflecting targets such as traffic lights in Prism mode without a prism should be avoided. The measured distances may be wrong or inaccurate.
 - When a distance measurement is triggered, the EDM measures to the object which is in the beam path at that moment. If for example people, cars, animals, or swaying branches cross the laser beam while a measurement is being taken, a fraction of the laser beam is reflected from these objects and may lead to incorrect distance values.
 - Measurements to prisms are only critical if an object crosses the measuring beam at a distance of 0 to 30 m and the distance to be measured is more than 300 m.
 - In practice, because the measuring time is very short, the user can always find a way of avoiding unwanted objects from interfering in the beam path.
-

Red laser to prism

- RL-Prism mode enables distance measurements of over 3.5 km to standard prisms using the visible red laser beam.
-


Red laser to reflector tape

- The visible red laser beam can also be used to measure to reflective foils. To guarantee the accuracy the red laser beam must be perpendicular to the reflector tape and it must be well adjusted.
 - Make sure the additive constant belongs to the selected target (reflector).
-

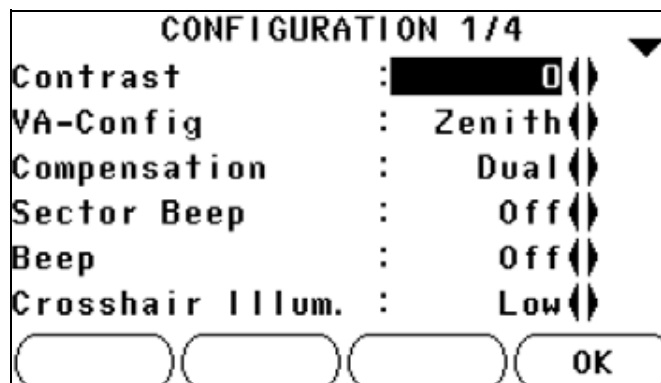
4 Configuration

4.1 Main Configuration

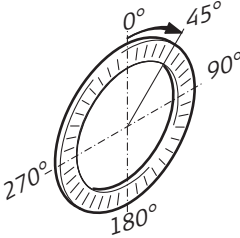
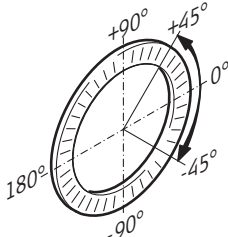
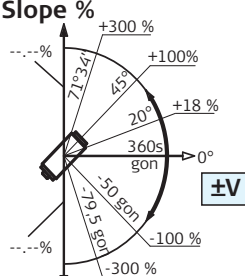
Access


1. Select **Config** from the **MAIN MENU**.
2. Select **Main Configuration** from the **SYSTEM CONFIGURATION** menu.
3. Press  to scroll through the screens of available settings.

CONFIGURATION




Field	Description
Contrast	0 to 10 Sets the display contrast in 10 steps.
VA-Config	Sets the vertical angle reference.


Field	Description
	<p>Zenith</p>  <p>Zenith=0°; Horizon=90°.</p>
	<p>Horiz.</p>  <p>Zenith=90°; Horizon=0°. Vertical angles are positive above the horizon and negative below it.</p>
	<p>Slope %</p>  <p>45° = 100%; Horizon=0°. Vertical angles are expressed in % with positive above the horizon and negative below it.</p> <p>☞ The % value increases rapidly. ---% appears on the display above 300%.</p>

Field	Description	
Compensation 	Off	Tilting compensation deactivated.
	Single	Vertical angles refer to the plummet line.
	Dual	Vertical angles refer to the plummet line and the horizontal directions are corrected by the standing axis tilt.
		If the instrument is used on an unstable base, for example a shaking platform or ship, the compensator should be deactivated. This avoids the compensator drifting out of its measuring range and interrupting the measuring process by indicating an error.
Sector Beep	On	Sector Beep sounds at right angles (0°, 90°, 180°, 270° or 0, 100, 200, 300 gon).


Field	Description
	<div style="text-align: center;"> <p>90° 0° 180°</p> </div> <p>Off Sector Beep is deactivated.</p> <p>1. No beep. 2. Fast beep; from 95.0 to 99.5 gon and 105.0 to 100.5 gon. 3. Permanent beep; from 99.5 to 99.995 gon and from 100.5 to 100.005 gon.</p>
Beep	<p>The beep is an acoustic signal after each key stroke.</p> <p>Normal Normal volume. Loud Increased volume. Off Beep is deactivated.</p>
Crosshar Illum.	<p>Low, Medium or High Sets the illumination level of the crosshairs.</p>
Data Output	<p>Sets the location for data storage.</p> <p>Internal All data is recorded in the internal memory.</p>

Field	Description
	<p>RS232 Data is recorded via the serial interface. This Data Output setting is only required if an external storage device is connected and measurements are started at the instrument with MEAS/REC or MeasRec. This setting is not required if the instrument is totally controlled by a datalogger.</p>
GSI Format	<p>Sets the GSI output format.</p> <p>GSI 8 81..00+12345678</p> <p>GSI 16 81..00+1234567890123456</p>
Mask	<p>Sets the GSI output mask.</p> <p>Mask1 PtID, HA, VA, SD, ppm+mm, hr, hi.</p> <p>Mask2 PtID, HA, VA, SD, E, N, Z, hr.</p>
HA Collimation	<p>On Horizontal corrections are activated. For normal operation the horizontal correction should remain active. Each measured horizontal angle will be corrected, depending on the vertical angle.</p> <p>Off Horizontal corrections are deactivated.</p>

Field	Description
Auto-Off	<p>On The instrument switches off after 20 minutes without any activity , for example no key pressed or vertical and horizontal angle deviation is $\leq \pm 3''$.</p> <p>Off Automatic switch-off is deactivated.  Battery discharges quicker.</p> <p>Sleep Economy mode. Instrument is recovered by any key stroke.</p>
Min. Reading	<p>Sets the number of decimal places shown for all angular fields. This is for data display and does not apply to data export or storage.</p> <p>For Angle Unit</p> <p>° ' " : (0° 00' 01" / 0° 00' 05" / 0° 00' 10").</p> <p>Dec.deg: (0.0001 / 0.0005 / 0.001).</p> <p>Gon: (0.0001 / 0.0005 / 0.001).</p> <p>Mil: (0.01 / 0.05 / 0.1).</p>
Angle Unit	<p>Sets the units shown for all angular fields.</p> <p>° ' " Degree sexagesimal. Possible angle values: 0° to 359°59'59"</p>

Field	Description
	dec. deg Degree decimal. Possible angle values: 0° to 359.999°
	gon Gon. Possible angle values: 0 gon to 399.999 gon
	mil Mil. Possible angle values: 0 to 6399.99mil.
	The setting of the angle units can be changed at any time. The actual displayed values are converted according to the selected unit.
Pressure Unit	Sets the units shown for all pressure fields. hPa Hecto Pascal. mbar Millibar. mmHg Millimeter mercury. inHg Inch mercury.
Code storage	Sets if the codeblock is saved before or after the measurement. Refer to "7 Coding".
HA Increment	Right Set horizontal angle to clockwise direction measurement.

Field	Description
	<p>Left Set horizontal angle to counter-clockwise direction measurement. Counter-clockwise directions are displayed but are saved as clockwise directions.</p>
Distance Unit	<p>Sets the units shown for all distance and coordinate related fields.</p> <p>Meter Meters [m].</p> <p>US-ft US feet [ft].</p> <p>INT-ft International feet [fi].</p> <p>ft-in/16 US feet-inch-1/16 inch [ft].</p>
Temperature Unit	<p>Sets the units shown for all temperature fields.</p> <p>°C Degree Celsius.</p> <p>°F Degree Fahrenheit.</p>
Face I Def.	<p>Sets the face I in relation to the position of the vertical drive.</p> <p>V-Left Sets face I to be when the vertical drive is on the left of the instrument.</p> <p>V-Right Sets face I to be when the vertical drive is on the right of the instrument.</p>

Field	Description
Identifier	 Only used for the Setout application. The identifier can be up to four characters and is added at the start, or end, of a point number of a point to be set out.

4.2 Communication Setup

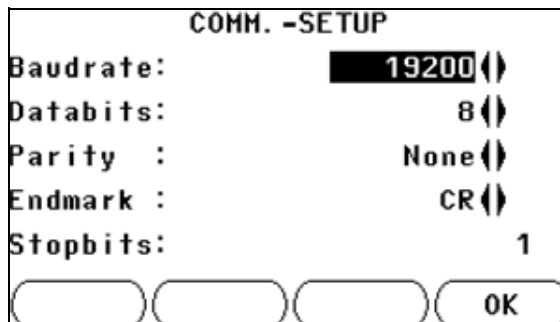
Description

For data transfer the communication parameters of the instrument must be set.

Access

1. Select **Config** from the **MAIN MENU**.
2. Select **Comm Setup** from the **SYSTEM CONFIGURATION** menu.

COMM. -SETUP



```

COMM. -SETUP
Baudrate: 19200 (↑)
Databits: 8 (↑)
Parity : None (↑)
Endmark : CR (↑)
Stopbits: 1
[ ] [ ] [ ] [ OK ]
  
```

Field	Description
Baudrate	Speed of data transfer from receiver to device in bits per second. 2400, 4800, 9600, 14400, 19200
Databits	Number of bits in a block of digital data. 7 Data transfer is realised with 7 databits. 8 Data transfer is realised with 8 databits.
Parity	Even Even parity. Available if data bit is set to 7. Odd Odd parity. Available if data bit is set to 7. None No parity. Available if data bit is set to 8.
Endmark	CR/LF The terminator is a carriage return followed by a line feed. CR The terminator is a carriage return.
Stopbits	1 Number of bits at the end of a block of digital data.

4.3 EDM Configuration

Description

The settings on this screen define the active EDM, **E**lectronic **D**istance **M**easurement. Different settings for measurements are available with Non-Prism (RL) and Prism (IR) EDM modes.

Access

1. Select **Config** from the **MAIN MENU**.
2. Select **EDM Configuration** from the **SYSTEM CONFIGURATION** menu.

EDM CONFIGURATION

EDM CONFIGURATION	
Mode :	IR-Fine(↔)
Prism :	Circular (↔)
Constant :	4.0 mm
Laser-Beam :	Off(↔)
<div style="display: flex; justify-content: space-around; margin-top: 10px;"> ATMOS PPM OK >>> </div>	

ATMOS

To enter atmospheric data ppm.

PPM

To enter an individual ppm value.

>>> SCALE

To enter projection scale details.


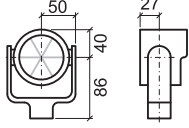
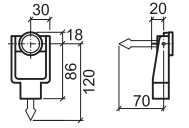
>>> SIGNAL

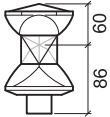


To view EDM Signal reflection value.

>>> FREQ.

To view the EDM frequency.

Field	Description
Mode	IR-Fine Fine measuring mode for high precision measurements with prisms (2 mm + 2 ppm).

Field	Description
	<p>IR-Quick Quick measuring mode with higher measuring speed and reduced accuracy (5 mm + 2 ppm).</p> <p>IR-Cont. Continuous distance measuring (5 mm + 2 ppm).</p> <p>IR-Foil Distance measurement using Retro reflective targets (5 mm + 2 ppm).</p> <p>RL-Fine Short range. For distance measurements without prisms (3 mm + 2 ppm)</p> <p>RL-Cont. Continuous distance measurement without prisms (5 mm + 2 ppm).</p> <p>RL-Prism Long range. For distance measurement with prisms (5 mm + 2 ppm).</p> <p> With the RL-EDM each object in the beam is measured (possibly also branches, cars, etc.).</p>
Prism	<p>Circular  Constant: 0.0 mm</p> <p>Miniprism  Constant: +17.5 mm</p>

Field	Description
	<p>360° prism  Constant: +23.1 mm</p> <p>360° Mini prism   Constant: +30.0 mm</p> <p>USER Is set at "Prismconst" (-mm +34.4) User prism = 14.0 mm constant = -14.0 mm + 34.4 mm Input: = 20.4 mm</p> <p>JPMINI Mini prism Constant: +34.4 mm</p>
Constant	Entry of a user specific prism constant. Input can only be made in mm. Limit value: -999.9 mm to +999.9 mm.
Laser-Beam	<p>Off Visible laser beam is deactivated.</p> <p>On Visible laser beam for visualising the target point is activated.</p>

**ATMOSPHERIC
DATA (PPM)**

This screen enables the entry of atmospheric parameters. Distance measurement is influenced directly by the atmospheric conditions of the air in which the measurements are taken. In order to take these influences into consideration distance measurements are corrected using atmospheric correction parameters.

The refraction correction is taken into account in the calculation of the height differences and the horizontal distance. Refer to "14.7 Scale Correction" for the application of the values entered in this screen.



When PPM=0 is selected, the standard atmosphere of 1013.25 mbar, 12°C, and 60% relative humidity will be applied.

**PROJECTION
SCALE**

This screen enables entry of the scale of projection. Coordinates are corrected with the PPM parameter. Refer to "14.7 Scale Correction" for the application of the values entered in this screen.

**Enter individual
PPM**

This screen enables the entry of individual scaling factors. Coordinates and distance measurements are corrected with the PPM parameter. Refer to "14.7 Scale Correction" for the application of the values entered in this screen.

**EDM SIGNAL
REFLECTION**

This screen tests the EDM signal strength (reflection strength) in steps of 1%. Enables optimal aiming at distant, barely visible, targets. A percentage bar and a beeping sound, indicate the reflection strength. The faster the beep the stronger the reflection.

4.4 Start Sequence

Description

Through the Startup tool, it is possible to record a user defined sequence of key presses so that, after switching on the instrument, a particular screen can be displayed instead of the **MAIN MENU**. For example, the general **SYSTEM CONFIGURATION** screen for configuring the instrument settings.

Access

1. Select **Config** from the **MAIN MENU**.
 2. Select **Start Sequence** from the **SYSTEM CONFIGURATION** menu.
-

Auto start step-by-step

1. Press **RECORD** in the **AUTO START** screen.
 2. Press **OK** to confirm the information message and begin the recording process.
 3. The next key presses are stored, up to a maximum of 16. To end the recording press **ESC**.
 4. If the auto start **Status:** is set to **Active**, the stored key presses will be executed automatically after switching on the instrument.
-



The automatic start sequence has the same effect as pressing the keys manually. Certain instrument settings can not be made in this way. Relative entries such as automatically setting EDM **Mode: IR-Quick** upon switching on the instrument, are not possible.

4.5 System Information

Description

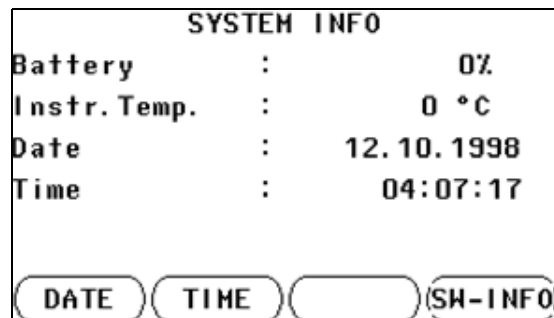
The System information screens display instrument, system and firmware information, as well as settings for the date and time.

Access

1. Select **Config** from the **MAIN MENU**.
2. Select **System Information** from the **SYSTEM CONFIGURATION** menu.

SYSTEM INFORMATION

This screen displays information about the instrument and operating system.



DATE

To change the date and format.

TIME

To change the time.

SW-INFO

To display details of the firmware package installed on the instrument.

Next step

Press **SW-INFO** to view the firmware package information.

**SOFTWARE-
INFORMATION**

Field	Description
Battery	Remaining battery power, for example 40%.
Instr.Temp	Measured instrument temperature.
Date	Displays the current date.
Time	Displays the current time.

5 Calibration

Description

The **CALIBRATION** menu contains tools to be used for the electronic adjustment of the instrument and for setting adjustment reminders. Using these tools helps to maintain the measuring accuracy of the instrument.

Access

1. Select **Calibr.** from the **MAIN MENU**.
2. Select a calibration option from the **CALIBRATION** screen.

Calibration options

In the **CALIBRATION** screen there are several calibration options.

Menu selection	Description
HA-Collimation	Refer to "11.3 Calibrating Line-of-Sight and Vertical Index Error".
VA-Index	Refer to "11.3 Calibrating Line-of-Sight and Vertical Index Error".
View Calibration Data	Displays the current calibration values that have been set for HA-Collimation and VA-index.

6 Functions


6.1 Overview

Description

Functions can be accessed by pressing **FNC** from any measurement screen. **FNC** opens the functions menu and a function can be selected and activated.

Functions

Function	Description
Distance-Offset	Refer to "6.2 Distance Offset".
Z-Coordinate	Refer to "6.3 Z-Coordinate".
Laserbeam	Activates/deactivates the visible laser beam for illuminating the target point.
Electr.Level/Laser pl	Activates the laser plummet and electronic level.
Control Distance	Refer to "6.5 Control Distance".
RL/IR Toggle	Changes between the two EDM modes. Refer to "4.3 EDM Configuration".
2 Dist. Offset	Refer to "6.4 2 Dist. Offset".

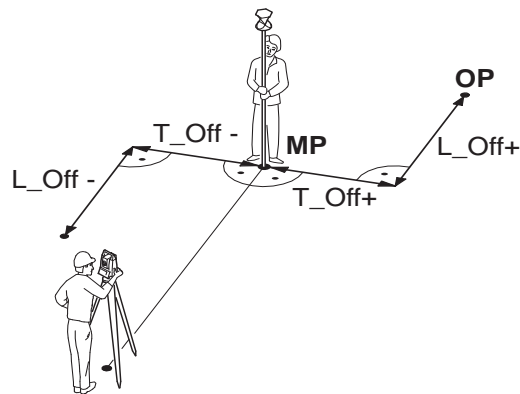
Function	Description
Delete last Obs.	<p>Deletes the last recorded data block. This can be either a measurement block or a code block.</p> <p> Deleting the last record is not reversible! Only records recorded in Topography can be deleted.</p>
Screen Illumination	Activates and deactivates the display illumination light.
Free Coding	Starts Coding application to select a code from a codelist or enter a new code. Same functionality like the softkey CODE .
Configuration	Refer to "4.1 Main Configuration".
Continous-EDM Mode	Refer to "6.6 Continuous-EDM Mode".

6.2 Distance Offset

6.2.1 Overview

Description

This function calculates the target point coordinates if it is not possible to set up the reflector, or to aim at the target point directly. The offset values (length, trav. and/or height offset) can be entered. The values for the angles and distances are calculated to determine the target point.

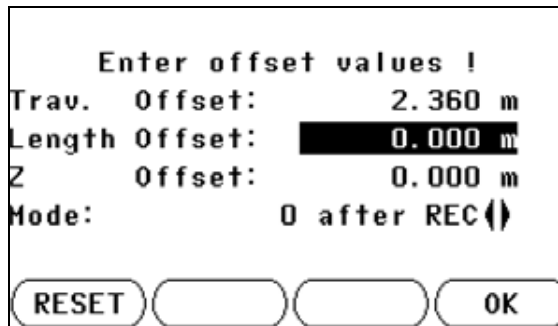


MP	Measurement point
OP	Offset point
T_Off	Length offset
L_Off	Cross offset
H_Offset+	Offset point is higher than measurement

Access

1. Press **FNC** when within any application.
2. Select **Distance-Offset** from the **FUNCTIONS** menu.


Enter offset values



RESET

To reset offset values to 0.

Field	Description
Trav. Offset	Perpendicular offset. Positive if the offset point is to the right of the measured point.
Length Offset	Longitudinal offset. Positive if the offset point is further away than the measured point.
Z Offset	Height offset. Positive if the offset point is higher than the measured point.
Mode	Period for which the offset is to apply. 0 after REC The offset values are reset to 0 after the point is saved. Continous The offset values are applied to all further measurements.

Field	Description
	The offset values are always reset to 0 when the application is quit.

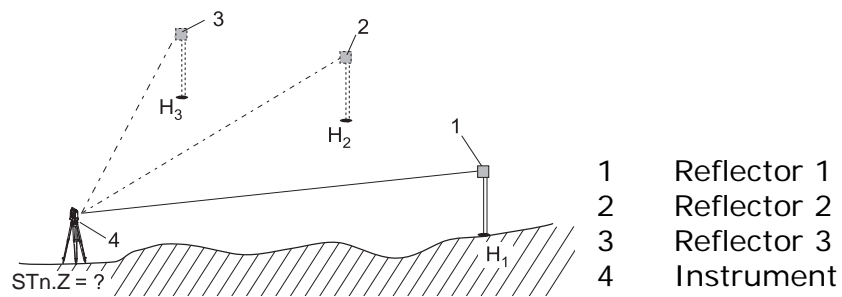
Next step

Press **OK** to calculate the corrected values and return to the application from which the offset function was started. The corrected angle and distances are displayed as soon as a valid distance measurement has been triggered or exists.

6.3 Z-Coordinate

Description

This function determines the height of the instrument from measurements to a maximum of five target points, with known heights, in two faces. With measurements to several targets, the improvement is indicated in the "d" value.



Access

1. Press **FNC** when within any application.
2. Select **Z-Coordinate** from the **FUNCTIONS** menu.

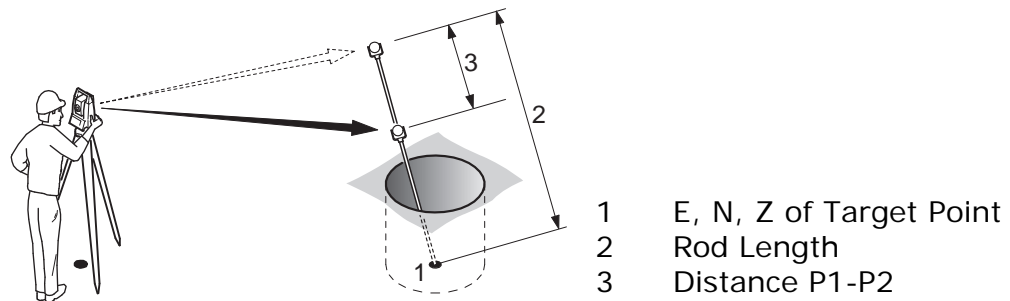
Z-Coordinate step-by-step

1. Select a known point and input the reflector height
 - **PtHgt**: To enter the height of a fixpoint.
 - **Inst.h.:** To enter the height transfer values for the instrument.
2. Press **MeasRec** to complete the measurement and display the calculated height.
 - **AddTg**: Adds another height of a known point.
 - **FACE**: Measures to the same target in second face.
 - **OK**: Saves the changes and sets the station height.

6.4 2 Dist. Offset

Description

This function is used for measurements to a point that is not directly visible, using a special hidden point pole.



Access

1. Press **FNC** when within any application.
2. Select **2 Dist. Offset** from the **FUNCTIONS** menu.

Next step

If required, press **POLE** to define the pole or EDM configuration.

2D-POLE CONFIGURATION

Field	Description
Mode	Changes the EDM Mode.
Prism	Changes the prism type.
Constant	Displays the prism constant.

Field	Description
Pole Length	Total length of pole.
Dist. P1-P2	Spacing between the centers of the prisms P1 and P2.
Meas. Tol	Limit for the difference between the given and measured spacing of the prisms. If the tolerance value is exceeded, the function will issue a warning.

Next step

In the **2 DIST. OFFSET** screen, measure to the first and second prisms using **MeasRec** and the **2 DIST. OFFSET RESULT** screen is displayed.

2 DIST. OFFSET RESULT

Displays Easting, Northing and Height coordinates of the target point.

2 DIST. OFFSET RESULT	
Pt. :	P408
Comm. :	-----
E :	21.554 m
N :	10.143 m
Z :	11.867 m
<div style="display: flex; justify-content: space-between; align-items: center;"> (FINISH) () () (NEW) </div>	

FINISH

To record results and return to application where **FNC** was selected.

NEW

To return to the **2 DIST. OFFSET** screen.

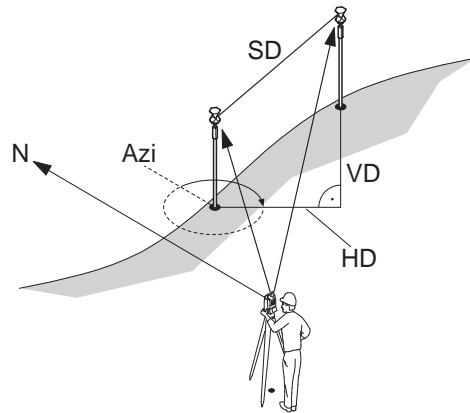
Next step

Press **FINISH** to return to the application where **FNC** was selected.

6.5 Control Distance

Description

This function calculates and displays the slope and horizontal distance, height difference, azimuth, grade, and coordinate differences between the last two measured points. Valid distance measurements are required for the calculation.



Azi Azimuth
SD Slope distance
VD Height distance
HD Horizontal distance

Access

1. Press **FNC** when within any application.
 2. Select **Control Distance** from the **FUNCTIONS** menu.
-

**CONTROL
DISTANCE**

Field	Description
Bearing	Difference in bearing between the two points.
Grade	Difference in gradient between the two points.
d HD	Difference in horizontal distance between the two points.
d SD	Difference in slope distance between the two points.
d VD	Difference in height between the two points.
d N	Difference in Northing coordinate between the two points.
d E	Difference in Easting coordinate between the two points.
d Z	Difference in the height coordinate between the two points.

Messages

The following are important messages or warnings that may appear.

Messages	Description
Less than two valid measurements!	The values cannot be calculated as there are less than two valid measurements.

Next step

Press **OK** to return to the application where **FNC** was selected.

6.6 Continuous-EDM Mode

Description

This function activates or deactivates the tracking measurement mode. The new setting is displayed for about one second and then set. The function can only be activated from within the same EDM mode and prism type. The following options are available.

Mode	Continuous measurement mode Off <=> On
IR	IR-Quick <=> IR-Cont. / IR-Quick <=> IR-Cont..
RL	RL-Fine <=> RL-Cont..



The last active measurement mode remains set when the instrument is switched off.

7 Coding

7.1 Standard Coding

Description

Codes contain information about recorded points. With the help of coding, points can be assigned to a particular group simplifying later processing.

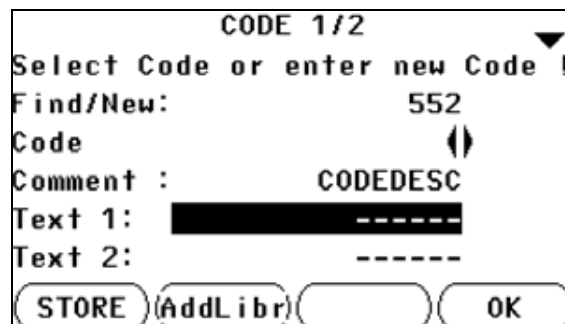
GSI coding

Codes are always stored as free codes (WI41-49), that means that codes are not directly linked to a point. They are stored before or after the measurement depending on the setting made. Point codes (WI71-79) are not available.

Access

- Either, select **Topography** from the **APPLICATIONS** menu and press **>>> CODE**
- Or, press **FNC** when within any application and select **Free Coding**.

CODE



STORE

To record the code without measurement.

AddLibr

To add the entered code to the codelist.

Field	Description
Find/New	Code name. After entry, the firmware searches for a matching code name, and displays these in the code field. If a matching code name doesn't exist this value becomes the new code name.
Code	List of existing code names.
Comment	Additional remarks.
Text1 to Text8	More information lines, freely editable. Used to describe attributes of the code.

Extend / edit codes

To each code a description and a maximum of 8 attributes with up to 16 characters each can be assigned. Existing code attributes, displayed in fields **Text 1:** to **Text 8:**, can be overwritten freely with the following exceptions: The codelist editor of GeoMax office software can assign a status to the attributes.

- Attributes with status "fixed" are write-protected. They cannot be overwritten or edited.
- For attributes with status "Mandatory" an input or a confirmation is required.
- Attributes with status "Normal" can be edited freely.

7.2 Rapid Coding


Description

Using the rapid code function, a predefined code can be called directly via the keypad on the instrument. The code is selected by entering a two digit number, the measurement is then triggered and the measured data and code saved. A total of 99 rapid codes can be assigned. The rapid code number is assigned in accordance with the order in which the codes were entered, for example, 01 -> first code in the code list ... 10 -> tenth code in the code list. Alternatively each code can be assigned a unique one or two digit number in the GeoMax office software.

Access

1. Select **Appl.** from the **MAIN MENU**.
2. Select **Topography** from the **APPLICATIONS** menu.
3. Select **Start**
4. Press **>>> R-CODE**

Rapid coding step-by-step

1. Press **>>> R-CODE**.
2. Enter a two digit number on the keypad.
 -  A two digit code must always be entered on the keypad even if only a one digit code was assigned in the GeoMax office software. For example: 4 -> enter 04.

3. The code is selected, the measurement triggered and the measured data and code saved. The name of the selected code is displayed after the measurement.
4. Press **>>> R-CODE** again to end rapid coding.

Messages


The following are important messages or warnings that may appear.

Messages	Description
Attrib. cannot be changed !	Attribute with fixed status cannot be changed.
No codelist available !	No codelist in memory. Manual input for code and attributes are called automatically.
Code not found !	No code is assigned to the entered number.

8 Applications - Getting Started

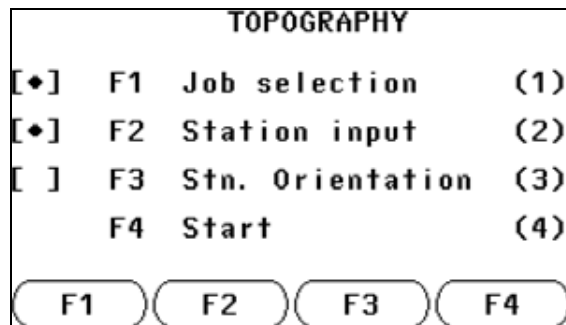
8.1 Starting an Application

Access

1. Select **Appl.** from the **MAIN MENU**.
2. Press  to move through the screens of applications.
3. Press a function key, **F1 - F4**, to select the specified application in the **APPLICATIONS** menu.

Pre-settings screens

Pre-settings for Topography is shown as an example. Any additional settings for particular applications are explained within the chapters for those applications.



[♦] = Setting has been made.
 [] = Setting has not been made.

F1-F4
 To select menu item.

Field	Description
Job selection	To define the job where data will be saved. Refer to "8.2 Setting the Job".
Station input	To define the current position of the instrument station. Refer to "8.3 Setting the Station".
Stn. Orientation	To define the orientation, horizontal direction, of the instrument station. Refer to "8.4 Setting the Orientation".
Start	Starts the selected application.

8.2 Setting the Job

Description

All data is saved in Jobs, like file directories. Jobs contain measurement data of different types, for example measurements, codes, fixed points, or stations. Jobs are individually manageable and can be exported, edited or deleted separately.

Access

Select **Job selection** in **Pre-settings** screen.

SELECT JOB

```

SELECT JOB      2/2
Job   : ██████████ J101(↔)
User  :           S DAY
Date  :           12.10.1998
Time  :           04:07:17

(CREATE) ( ) ( ) (OK)
    
```

CREATE
To create a new job.

Field	Description
Job	Name of an existing job to be used.
User	Name of operator, if entered.
Date	Date the selected job was created.
Time	Time the selected job was created.

Next step

- Either, press **OK** to continue with the selected job.
- Or, press **CREATE** to open the **CREATE NEW JOB** screen and create a new job.

Recorded data

Once a job is set up, all subsequent recorded data will be stored in this job.

If no job was defined and an application was started, or if in **Measure** and a measurement was recorded, then the system automatically creates a new job and names it "DEFAULT".

Next step

Press **OK** to confirm the job and return to the **Pre-Settings** screen.

8.3 Setting the Station

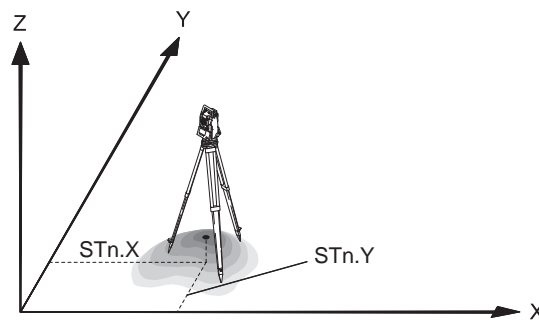
Description

All measurements and coordinate computations are referenced to the set station coordinates.

The station coordinates that are set must include:

- at least grid coordinates (E, N), and
- the station height, if required.

The coordinates can be entered manually or selected from the memory.



Directions

- X Easting
- Y Northing
- Z Height

Station coordinates

- Stn.X Easting coordinate of station
- Stn.Y Northing coordinate of station

Access

Select **Station input** in the **Pre-settings** screen.

Station input

Field	Description
Stn	Station name of a previously saved station position.
Inst.h.	Height of the instrument from the ground surface.



If no station was set and an application was started, or if in **Measure** and a measurement was recorded, then the last station is set as the current station.

Next step

The **Enter instrument height** screen appears once the station coordinates have been entered. Enter the instrument height if desired and press **OK** to return to the **Pre-Settings** screen.

8.4 Setting the Orientation

8.4.1 Overview

Description

All measurements and coordinate computations are referenced to the orientation of the set station. The orientation can be entered manually or determined from points that are either measured or selected from the memory.

Access

Select **Stn. Orientation** in the **Pre-settings** screen and choose:

- **Angle** To enter a new bearing. Refer to "8.4.2 Manual Orientation".
- **Coordinates** To calculate and set the orientation using existing coordinates. A maximum of five target points can be used. Refer to "8.4.3 Orientation with Coordinates".

8.4.2 Manual Orientation

Access

Select **Angle** in the **STN.ORIENTATION** screen.

**MANUAL ANGLE
SETTING**

The screenshot shows a screen titled "ANGLE SETTING" with the following fields and values:

Pt. :	301
Tgt. h. :	1.500 m
Brg :	0° 00' 00"

At the bottom of the screen, there are four buttons: (MeasRec), EDM, REC, and OSet.

OSet

To set **Bearing: 0**

Field	Description
Pt.	Point ID of the backsight point.
Tgt.h.	Height of the reflector.

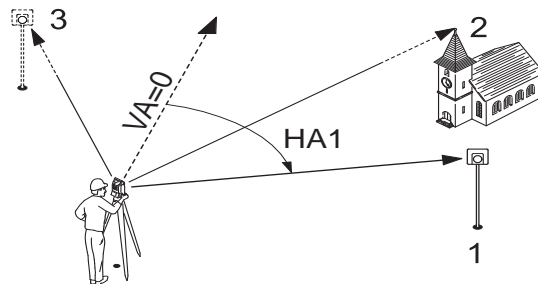
Field	Description
Brg	Horizontal direction of the station.

Next step

- Either, press **MeasRec** to measure and record the distance and horizontal angles. This will calculate and set the orientation and return to the **Pre-Settings** screen.
- Or, press **REC** to record the horizontal direction only. This will set the orientation and return to the **Pre-Settings** screen.

8.4.3 Orientation with Coordinates

Diagram



Known coordinates

- 1 Target point
- 2 Target point
- 3 Target point

Calculations

- HA1 Station orientation

Access

Select **Coordinates** in the **STN-ORIENTATION** screen.

Orientation with coordinates

Field	Description
BS	Point ID of the backsight point.

Next step

Find an existing backsight point in the pointsearch or enter ENZ coordinates for a new point. Press **OK** to continue to **Sight target point**.

Sight target point

Field	Description
BS	Point ID of the selected, or entered backsight point.

Next step

After each measurement the message, **Do you want to take additional measurements** appears. Selecting:

- **Yes** returns to the **Sight target point** screen to take an additional measurement. A maximum of five target points can be used.
- **No** proceeds to the **ORIENTATION RESULT** screen.

Result calculation

If more than one target point is measured then the orientation is computed using the "least squares method".

IF	THEN
the orientation is only measured in face II	the horizontal direction is based on face II.

IF	THEN
the orientation is measured only in face I or a mixture of I and II	the horizontal direction is based on face I.
a target point is measured several times in the same face	the last valid measurement is used for the computation.

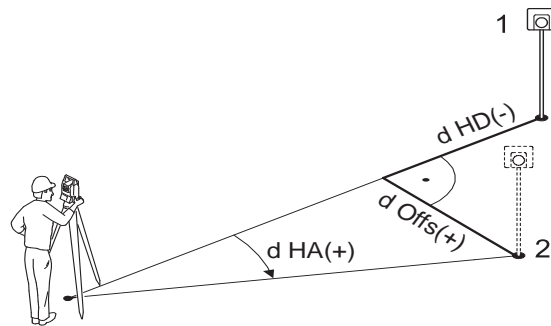
Orientation results

Field	Description
NoPts	Number of points used in the calculation.
Stn	Station name for which the orientation has been set.
HACor	Horizontal correction
StDev	Standard deviation indicating the potential variance between the true orientation and that calculated.

Next step

- Either, press **Resid** to display the residuals.
- Or, press **OK** to set the orientation and return to the **Pre-Settings** screen.

Orientation residuals



- 1 Actual
- 2 Design
- P2 Target point
- d Offs Height correction
- d HD Correction in horizontal distance
- d HA Correction in horizontal direction

Field	Description
BsPt	Point IDs of the target points used in calculating the orientation.
d HA	The difference in horizontal direction to the target point.
d HD	The difference in horizontal distance to the target point.
d Z	The difference in height to the target point.



If no orientation was set and an application was started, or if in **Measure** and a measurement was recorded, then the current horizontal direction is set as the orientation.

Next step

Select **Start** to begin the application.

9 Applications

9.1 Common Fields

Description of fields

The following table describes common fields that are found within the firmware applications. These fields are described here once and not repeated in the application chapters unless the field has a specific meaning within that application.

Field	Description
Pt., Pt. 1	Point ID of the point.
Tgt.h.	Height of the reflector.
HA	Horizontal direction to the point.
VA	Vertical angle to the point.
HD	Horizontal distance to the point.
SD	Slope distance to the point.
Z	Height to the point.
E	Easting coordinate of the point.
N	Northing coordinate of the point.
Z	Height coordinate of the point.

9.2 Topography

Description

Topography is an application used for the measurement of an unlimited number of points. It is comparable to **Measure** from the **MAIN MENU**, but includes pre-settings for the job, station and orientation prior to beginning a survey.

Access

1. Select **Appl.** from the **MAIN MENU**.
2. Select **Topography** from the **APPLICATIONS** menu.
3. Complete application pre-settings. Refer to "8 Applications - Getting Started".

TOPOGRAPHY

TOPOGRAPHY 1/3		Circular	
Pt. :	P401	<input type="checkbox"/>	
Tgt. h. :	1.500 m	<input checked="" type="checkbox"/>	
Code :	552	<input checked="" type="checkbox"/>	IR
HA :	23°07'48"		
VA :	74°54'25"		
HD :	----- m		I
(MeasRec)	CODE	EDM	>>>

>>> IndivPt

To switch between individual and current point numbers.

>>> CODE

To find/enter codes. Refer to "7.1 Standard Coding".

>>> R-CODE

To activate rapid coding. Refer to "7.2 Rapid Coding".

Next step

- Either, press **MeasRec** to record another point.
 - Or, press **ESC** to exit the application.
-

9.3 Set Out

Description

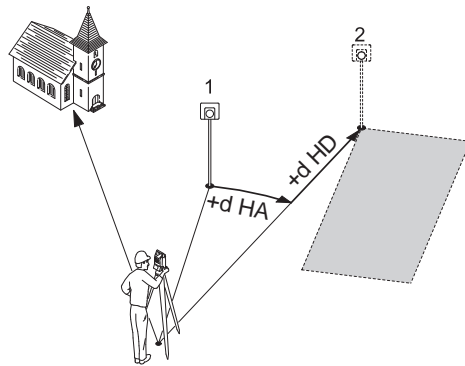
Set Out is an application used to place marks in the field at predetermined points. These predetermined points are the points to be set out. The points to be set out may already exist in a job on the instrument, or be manually entered.

The application can continuously display differences, between current position and desired set out position.

Set Out modes

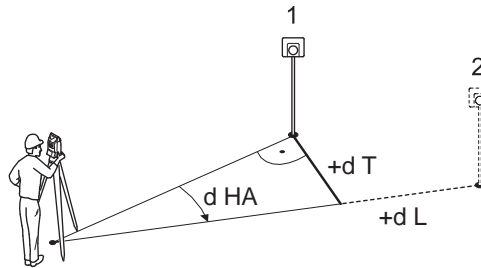
Points can be set out using different modes: Polar mode, Orthogonal to station mode and Cartesian mode.

Polar Set Out mode



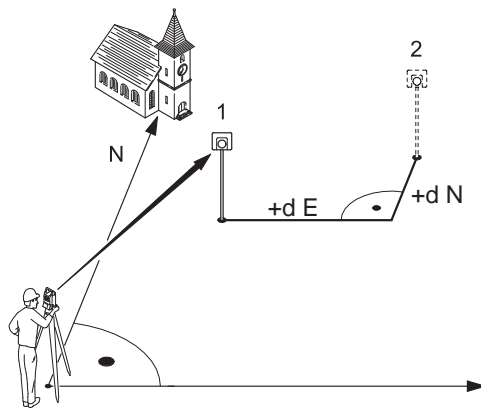
- 1 Current position
- 2 Point to be set out
- dHD Longitudinal offset: positive if point to be set out is further away.
- dHA Angle offset: positive if point to be set out is to the right of the actual direction.

Orthogonal to Station Set Out mode



- 1 Current position
- 2 Point to be set out
- dL Longitudinal offset: positive if nominal point is further away.
- dT Transversal offset, perpendicular to line-of-sight: positive if nominal point is to the right of the measured point.
- dHA Angle offset: positive if nominal point is to the right of the actual direction.

Cartesian Set Out mode

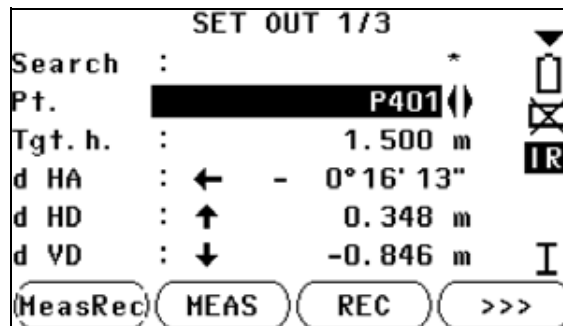


- 1 Current position
- 2 Point to be set out
- d E Easting offset between point to be set out and actual point
- d N Northing offset between point to be set out and actual point

Access

1. Select **Appl.** from the **MAIN MENU**.
2. Select **Set Out** from the **APPLICATIONS** menu.
3. Complete application pre-settings. Refer to "8 Applications - Getting Started".

SET OUT




MANUAL

To manually enter coordinates of a point.

>>> B&D

To enter the direction and horizontal distance to a set out point.



Press  to move through the pages. The bottom three measurement fields on the screen will change for the Polar, Orthogonal or Cartesian modes.

Field	Description
Search	Value for Point ID search. After entry, the firmware searches for matching points, and displays these in Pt. : If a matching point doesn't exist the pointsearch screen opens.
d HA	Angle offset: Positive if set out point is to the right of the measured point.
d HD	Horizontal offset: Positive if set out point is further away than the measured point.

Field	Description
d VD	Height offset: Positive if set out point is higher than the measured point.
d Length	Longitudinal offset: Positive if set out point is further away than the measured point.
d Trav.	Perpendicular offset: Positive if set out point is to the right of the measured point.
d Z	Height offset: Positive if set out point is higher than the measured point.
d N	Northing offset: Positive if set out point is further away than the measured point
d E	Easting offset: Positive if set out point is to the right of the measured point.

Next step

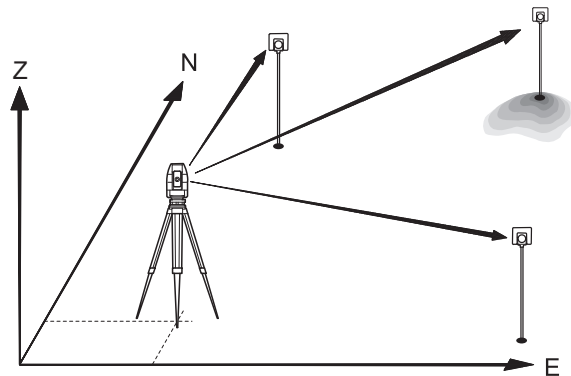
- Either, press **MeasRec** to record measurements for a set out point.
- Or, press **ESC** to exit the application.

9.4 Resection

9.4.1 Starting Resection

Description

Resection is an application used to determine the instrument's position from measurements to known points. A minimum of two known points and a maximum of 5, can be used to determine the position.



Access

1. Select **Appl.** from the **MAIN MENU**.
2. Select **Resection** from the **APPLICATIONS** menu.
3. Complete application pre-settings. Refer to "8 Applications - Getting Started".

4. **Def Accuracy Limit:**

- **Status: On** to activate a warning message if the calculated standard deviation exceeds the limit.
- Set the accuracy limits for the Easting, Northing and Height coordinates and the standard deviation angle.
- Press **SET** to save the limits and return to the **Pre-settings** screen.

5. Select **Start** to begin the application.

Enter target data

Enter the name of the station and the height of the instrument in the **Enter station data** screen and press **OK**.

Next step

To access the **Sight target point** screen:

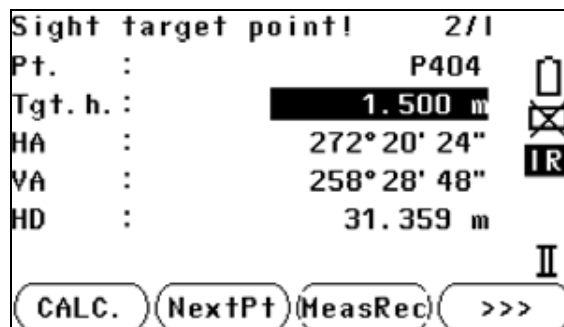
- Either, press **OK** after entering the target data fields.
- Or, press **>>> SKIP** to skip entering the target data fields again when measuring the same point in another face.

Sight target point

In the **Sight target point** screen:

2 / I: Indicates that the second point was measured in face I.

2 / I II: Indicates that the second point was measured in faces I and II.



CALC.

To calculate and display the station coordinates, if at least two points and a distance were measured.

NextPt

To return to the **Enter target data** screen to select the next known point.

Next step

- Either, press **NextPt** to measure the next known point.
- Or, press **CALC.** to calculate the station position.

9.4.2 Measuring Information

Measurement sequences

The following measurement sequences are possible:

- Horizontal direction and vertical-angles only (resection)
- Distance and horizontal direction and vertical-angle
- Horizontal direction and vertical-angles to some point(s) and horizontal direction and vertical angles plus distance to other point(s).

Single face I, single face II, or dual face I and II measurements are always possible. No specific point sequence or specific face sequences are required.

Dual face measurements

When measuring the same target in both faces, the reflector height may not be changed when observing in the second face. Error checks are made for dual face measurements to ensure the same point is sighted with the other face.



- If a target point is measured several times in the same face the last valid measurement is used for computation.
- For the calculation of the station position, measured target points can be re-measured, included in calculations, or excluded from calculations.

Measurements not included in computations

Target points with 0.000 height are discarded for height processing. If a target point has a valid height of 0.000 m, use 0.001 m to include it for height processing.

9.4.3 Computation Procedure

Description

The measuring procedure automatically determines the method of evaluation, for example resection or three point resection. If more than the minimum required measurements are performed, the procedure uses a least squares adjustment to determine the 3D position and averages orientation and height measurements.

- The original averaged face I and face II measurements are used for the computation process.
- All measurements are treated with the same accuracy, whether these are measured in single or dual face.

- Easting and Northing are determined by the least squares method, which includes standard deviation and improvements for horizontal direction and horizontal distances.
 - The final height (Z) is computed from averaged height differences based on the original measurements.
 - The horizontal direction is computed with the original averaged face I and face II measurements and the final computed plan position.
-

9.4.4 Resection Results

Access

Press **CALC.** from the **Sight target point** screen after at least two points and a distance have been measured.

STATION COORDINATES

This screen displays calculated station coordinates. The final computed results are Easting, Northing and Height coordinates of the present instrument station, including the instrument height. Standard deviations and residuals for accuracy assessments are provided.

STATION COORDINATES	
Stn. :	S201
Inst. h. :	1.400 m
Stn. N :	-0.000 m
Stn. E :	-0.000 m
Stn. Z :	0.000 m
<div style="display: flex; justify-content: space-around; border: 1px solid black; padding: 5px;"> BACK RESID StdDev OK </div>	

RESID

To display residuals. Refer to "Target Residuals".

StdDev

To display the standard deviation of the coordinates and angle.



If the instrument height was set to 0.000 in the setup screen, then the station height refers to the height of the tilting axis.

Next step

Press **RESID** to display the target residuals.

Target Residuals

The **TARGET RESIDUALS** screen displays the computed residuals for the horizontal and vertical distances and the horizontal direction. Residual = Calculated value - Measured value.

Messages

The following are important messages or warnings that may appear.

Messages	Description
Selected point has no valid data!	This message occurs if the selected target point has no Easting or Northing coordinate.

Messages	Description
Max 5 points supported!	5 points have already been measured and another point is selected. The system supports a maximum of 5 points.
Invalid data - no position computed!	The measurements may not allow final station coordinates (Eastings, Northings) to be computed.
Invalid data - no height computed!	Either the target height is invalid or insufficient measurements are available to compute a final station height.
HA (I - II) > 0.9 deg, measure point again!	This error occurs if a point was measured in one face and the measurement in the other face differs by more than $180^\circ \pm 0.9^\circ$ for the horizontal angle.
VA (I - II) > 0.9 deg, measure point again!	This error occurs if a point was measured in one face and the measurement in the other face differs by more than $360^\circ - V \pm 0.9^\circ$ for the vertical angle.
More points or distance required!	There is insufficient data measured to be able to compute a position. Either there are not enough points used or not enough distances measured.

Next step

Press **OK** to return to the **APPLICATIONS** menu.

9.5 Point Projection - Line

9.5.1 Overview

Description

Point Projection - Line is an application that facilitates the easy set out or checking of lines, for example, for buildings, sections of road, or simple excavations. It allows the user to define a reference line and then complete the following tasks with respect to that line:

- Line & offset
- Set out points

Access

1. Select **Appl.** from the **MAIN MENU**.
2. Select **Point Projection** from the **APPLICATIONS** menu.
3. Complete application pre-settings. Refer to "8 Applications - Getting Started".
4. Select **Line**

Next step

Define the base line for the reference line.

9.5.2 Defining the Base Line

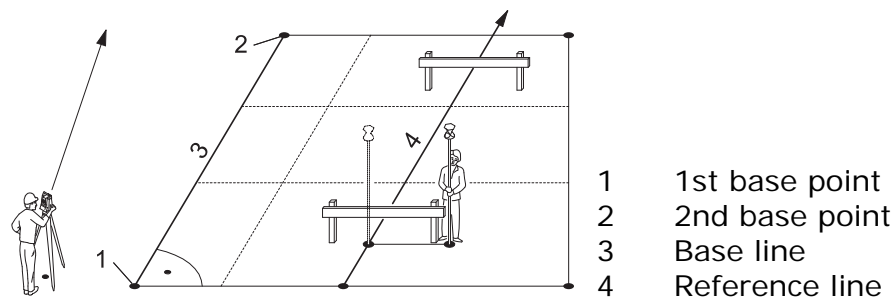
Description

A reference line can be defined by referencing a known base line. The reference line can be offset either longitudinally, in parallel or vertically to the base line, or be rotated around the first base point as required. Furthermore the refer-

ence height can be selected as the first point, second point or interpolated along the reference line.

Define the base line

The base line is fixed by two base points. All points can be either measured, manually entered, or selected from the memory.



Define the base line by measuring or selecting the start and end points of the line.

Next step

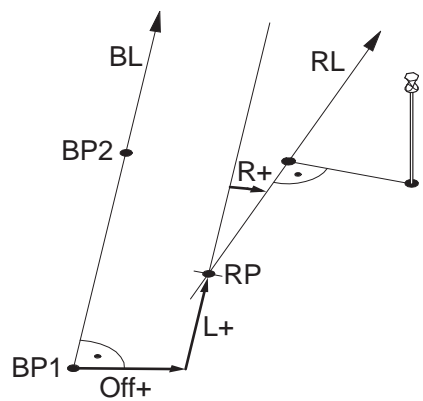
After defining the base line the **POINT PROJECTION - MAIN** screen will appear for defining the reference line.

9.5.3 Defining the Reference Line

Description

The base line can be offset from, either longitudinally, in parallel or vertically, or be rotated around the first base point. This new line created from the offsets is called the reference line. All measured data refers to the reference line.

Reference line



- BP Base point
- BL Base line
- RP Reference point
- RL Reference line
- Off Parallel offset
- L Longitudinal offset
- R Rotation parameter

Access

After completing the measurements required for defining the base line, the **POINT PROJECTION - MAIN** screen will appear.

**REFERENCE LINE
- MAIN**

```

POINT PROJECTION - MAIN 1/2
Length :          35.502 m
Enter values to shift line:
Offset :          0.250 m
Line :           1.580 m
Z :              0.000 m
Rotate :         0°00'00"
NewBL (MEASURE) (SET OUT) (RESET)
    
```

NewBL

To define a new base line.

MEASURE

To measure Line & Offset.

SET OUT

To set out points orthogonal to the reference line.

Field	Description
Length	Length of the base line.
Offset	Parallel offset of the reference line relative to the base line (P1-P2). Positive values are to the right of the base line.
Line	Longitudinal offset of the start point, reference point (P3), of the reference line in the direction of base point 2. Positive values are towards base point 2.
Z	Height offset of the reference line to the selected reference height. Positive values are higher than the selected reference height.
Rotate	Rotation of the reference line clockwise around the reference point (P3).

Field	Description	
Ref.Hgt	Pt. 1	Height differences are computed relative to the height of the first reference point.
	Pt. 2	Height differences are computed relative to the height of the second reference point.
	Interpolated	Height differences are computed along the reference line.
	No Height	Height differences are not computed or shown.

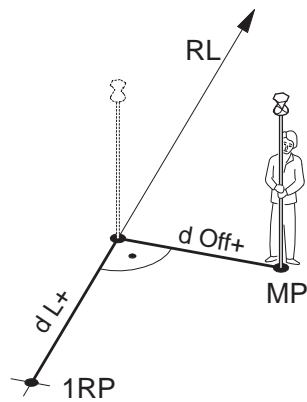
Next step

Select a softkey option, **MEASURE** or **SET OUT** to proceed a subapplication.

9.5.4 Subapplication Measure Line & Offset

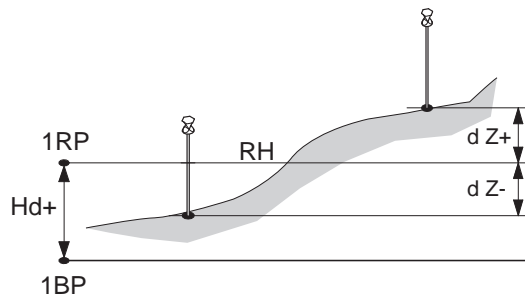
Description

The Measure Line & Offset subapplication calculates from measurements or coordinates, longitudinal offsets, parallel offsets and height differences of the target point relative to the reference line.



- RL Reference line
- 1RP Start point
- MP Measured point
- dL Longitudinal offset
- dOff Parallel offset

Example of height difference relative to first reference point



- 1RP 1st reference point
- 1BP 1st base point
- RH Reference height
- Hd Height difference between reference and base point
- d Z Height difference from reference height

Access

Press **MEASURE** in the **POINT PROJECTION - MAIN** screen.

Measure line & offset

Field	Description
d Line	Calculated distance longitudinal to the reference line.
d Offset	Calculated distance perpendicular from the reference line.
d VD	Calculated height difference relative to the defined reference height.

Next step

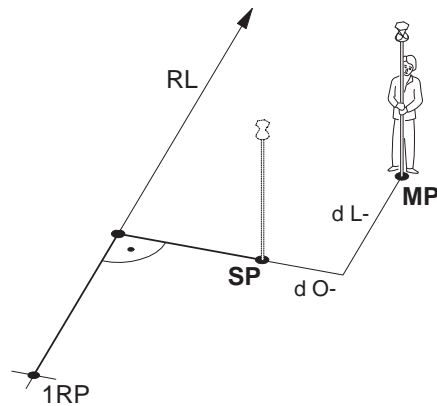
- Either, press **MeasRec** to measure and record.
- Or, press **>>> BACK** to return to the **POINT PROJECTION - MAIN** screen.

9.5.5 Subapplication Setout

Description

The setout subapplication calculates the difference between a measured point and the calculated point. The orthogonal (dLine, dOffset, dVD) and polar (dHA, dHD, dVD) differences are displayed.

Example orthogonal setout



- 1RP 1st reference point
- SP Set out point
- MP Measured point
- RL Reference line
- dL Longitudinal offset
- dO Parallel offset

Access

Press **SETOUT** from the **POINT PROJECTION - MAIN** screen.

Orthogonal setout

Enter the set out elements for the target points to be set out relative to the reference line.

Field	Description
Line	Longitudinal offset: Positive if set out point is further away from the reference line.
Offset	Perpendicular offset: Positive if set out point is to the right of the reference line.

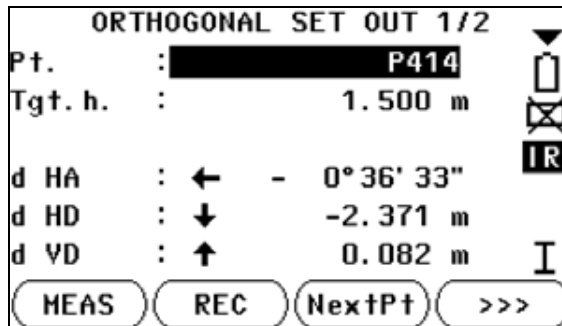
Field	Description
Z	Height offset: Positive if set out point is higher than the reference line.

Next step

Press **OK** to proceed to measurement mode.

ORTHOGONAL SET OUT

The signs for the distance and angle differences are correction values (required minus actual). The arrows indicate the direction to move to get to the set out point.



NextPt

To add the next point to be set out.

Field	Description
d HA	Horizontal direction from the measured point to the set out point. Positive if the telescope must be turned clockwise to the set out point.

Field	Description
d HD	Horizontal distance from the measured point to the set out point. Positive if the set out point is further away than the measured point.
d VD	Height difference from the measured point to the set out point. Positive if the set out point is higher than the measured point.
d Offset	Perpendicular distance from the measured point to the set out point. Positive if the set out point is to the right of the measured point.
d Line	Longitudinal distance from the measured point to the set out point. Positive if the set out point is further away than the measured point.

Messages

The following are important messages or warnings that may appear.

Messages	Description
Base line too short !	Base line is shorter than 1 cm. Choose base points such that the horizontal separation of both points is at least 1 cm.
Coordinates invalid !	No coordinates or invalid coordinates for a point. Ensure that points used have at least Easting and Northing coordinates.

Messages	Description
Save via RS232 !	Data Output: is set to RS232 in the CONFIGURATION menu. To be able to successfully start point projection, Data Output: must be set to Internal .

Next step

- Either, press **MeasRec** to measure and record.
- Or, press **>>> BACK** to return to the **POINT PROJECTION - MAIN** screen.
- Or, continue selecting **ESC** to exit the application.

9.6 Point Projection - Arc

9.6.1 Overview

Description

The Point Projection - Arc application allows the user to define a reference arc and then complete the following tasks with respect to the arc:

- Line & offset
- Set out (Point, Arc, Chord, Angle)

Access

1. Select **Appl.** from the **MAIN MENU**.
2. Select **Point Projection** from the **APPLICATIONS** menu.

3. Complete application pre-settings. Refer to "8 Applications - Getting Started".
4. Select **Arc**.

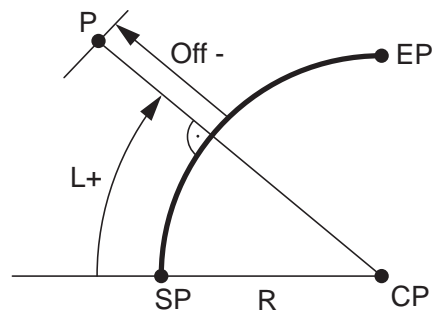
Next step

Define the reference arc.

9.6.2 Defining the Reference Arc

Description

The reference arc can be defined by a center point and start point, or a start point, end point, and radius. All points can be either measured, manually entered, or selected from the memory.



- SP Start point
- EP End point
- CP Center point
- R Radius of arc
- L Distance from start of arc, following curve
- Off Perpendicular distance from arc



All arcs are defined in a clockwise direction and all calculations are made in two dimensions.

Access

Select **Arc** and then the method to define the arc by:

- **Centre, Start Point.**
- **Start and End Pt, Radius.**

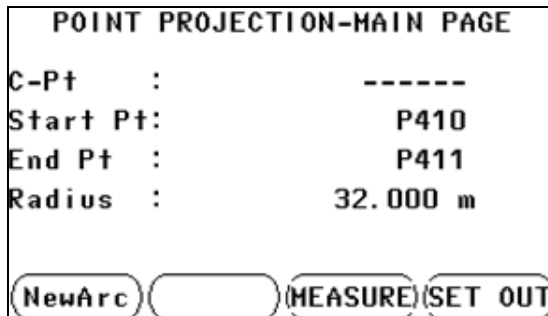
**Point Projection
Arc - Measure to
start point**

Field	Description
Start Pt	Point ID of the start point.
C-Pt	Point ID of the center point.
End Pt	Point ID of the end point.
Radius	Radius of the arc.

Next step

After defining the reference arc the **POINT PROJECTION-MAIN PAGE** screen will appear.

**POINT PROJEC-
TION-MAIN PAGE**



NewArc

To define a new base arc.

MEASURE

To measure Line & Offset.

SET OUT

To set out.

Next step

Select a softkey option, **MEASURE** or **SET OUT**, to proceed a subapplication.

9.6.3 Subapplication Measure Line & Offset

Description

The Measure Line & Offset subapplication calculates from measurements or coordinates, longitudinal and orthogonal offsets and height differences of the target point relative to the reference arc.

Access

Press **MEASURE** from the **POINT PROJECTION-MAIN PAGE** screen.

Measure Line & Offset

Field	Description
d Line	Calculated distance longitudinal to the reference arc.
d Offset	Calculated distance perpendicular from the reference arc.
d VD	Calculated height difference relative to the start point of reference arc.

Next step

- Either, press **MeasRec** to measure and record.
- Or, press **>>> BACK** to return to the **REFERENCE ARC - MAIN PAGE** screen.

9.6.4 Subapplication Setout

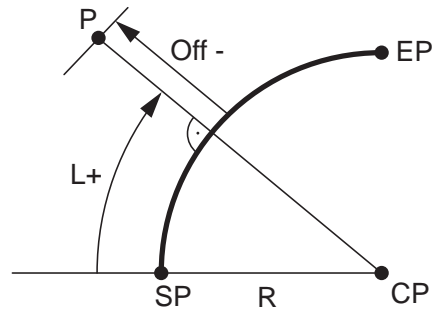
Description

The setout subapplication calculates the difference between a measured point and the calculated point. The reference arc application supports four ways to set out:

- Set out point
- Set out arc
- Set out chord
- Set out angle

Set out point

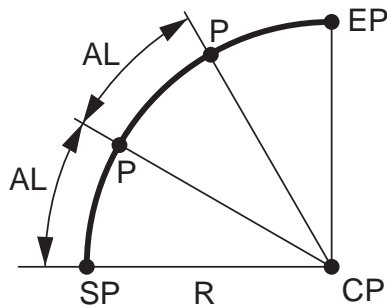
To set out a point by entering a line and an offset value.



- CP Center point of arc
- SP Start point of arc
- EP End point of arc
- P Set out point
- R Radius of arc
- L Line offset
- Off Perpendicular offset

Set out arc

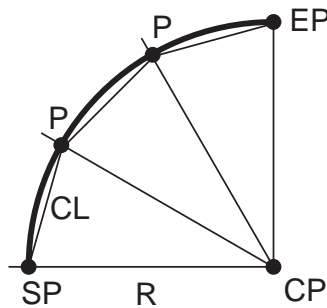
To set out a series of equidistant points along the arc.



- CP Center point of arc
- SP Start point of arc
- EP End point of arc
- P Set out point(s)
- R Radius of arc
- AL Arc length

Set out chord

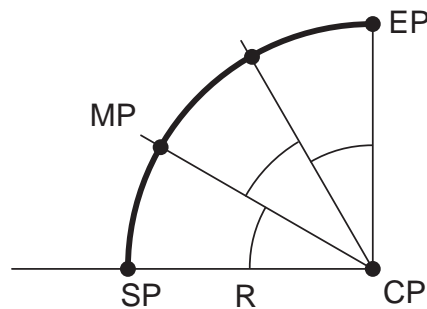
To set out a series of equidistant chords along the arc.



- CP Center point of arc
- SP Start point of arc
- EP End point of arc
- P Set out point(s)
- R Radius of arc
- CL Chord length

Set out angle

To set out a series of points along the arc defined by the angle segments from the center point of the arc.



- CP Center point of arc
- SP Start point of arc
- EP End point of arc
- MP Measured point
- R Radius of arc
- b Central angle

Access

1. Press **SET OUT** from the **POINT PROJECTION-MAIN PAGE** screen.
2. Select one of the four methods of set out available.

Set out point, arc, chord or angle

Enter the set out values. Press **PT -/PT +** to toggle through the calculated set out points.

Field	Description
Misclosure	For set out arc: Method of misclosure distribution. If the entered arc length is not an integer of the whole arc, there will be a misclosure.
No distribution	All of the misclosure will be added to the last arc-section.

Field	Description
	<p>Equal The misclosure will be equally distributed between all sections.</p> <p>Start Arc All of the misclosure will be added to the first arc-section.</p>
Arc Length	For set out arc: The length of the arc-segment to set out.
Chord Length	For set out chord: The length of the chord to set out.
Angle	For set out angle: The angle around the center point of the arc, of the points to be set out.
Line	<p>For set out arc, chord and angle: Longitudinal offset from the reference arc. This is calculated by the arc length, chord length or angle and the selected misclosure distribution.</p> <p>For set out point: Longitudinal offset from the reference arc.</p>
Offset	Perpendicular offset from the reference arc.

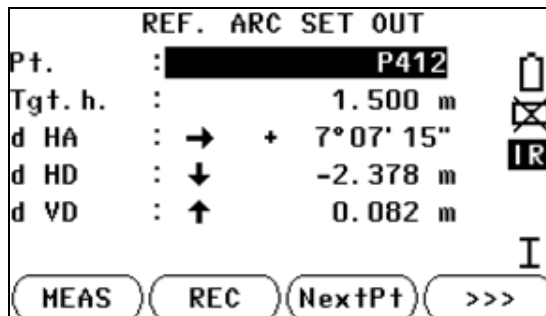
Next step

Press **OK** to proceed to measurement mode.

REF. ARC SET OUT

The signs for the distance and angle differences are correction values (required minus actual). The arrows indicate the direction to move to get to the set out point.





NextPt

To add the next point to be set out.

Field	Description
d HA	Horizontal direction from the measured point to the set out point. Positive if the telescope must be turned clockwise to the set out point.
d HD	Horizontal distance from the measured point to the set out point. Positive if the set out point is further away than the measured point.
d VD	Height difference from the measured point to the set out point. Positive if the set out point is higher than the measured point.

Next step

- Either, press >>> **MeasRec** to measure and record.
- Or, press >>> **BACK** to return to the **POINT PROJECTION-MAIN PAGE** screen.
- Or, continue selecting **ESC** to exit the application.

9.7 Missing Line (MLM)

Description

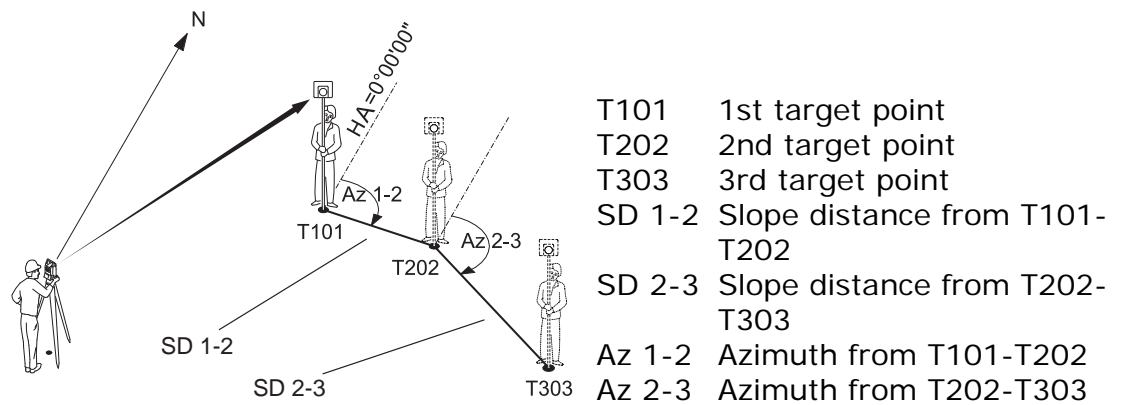
Missing Line (MLM) is an application used to compute slope distance, horizontal distance, height difference and azimuth of two target points which are either measured, selected from the memory, or entered using the keypad.

Missing line methods

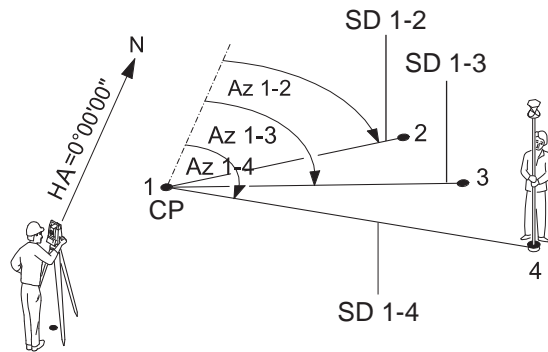
The user can choose between two different methods:

- Polygonal: P1-P2, P2-P3, P3-P4.
- Radial: P1-P2, P1-P3, P1-P4.

Polygonal method



Radial method



- 1-4 Target points
- SD 1-2 Slope distance from 1-2
- SD 1-3 Slope distance from 1-3
- SD 1-4 Slope distance from 1-4
- Az 1-2 Azimuth from 1-2
- Az 1-3 Azimuth from 1-3
- Az 1-4 Azimuth from 1-4
- CP Center point

Access

1. Select **Appl.** from the **MAIN MENU**.
2. Select **Missing Line (MLM)** from the **APPLICATIONS** menu.
3. Complete application pre-settings. Refer to "8 Applications - Getting Started".
4. Select **Polygon** or **Radial**.

Missing line measurements

After completing the measurements required, the **MISSING LINE RESULT** screen will appear.

**MISSING LINE
RESULT - Polyg-
onal method**

MISSING LINE RESULT 1/2	
Pt. 1:	P415
Pt. 2:	P416
Grade :	+2.9%
d SD :	3.535 m
d HD :	3.534 m
d VD :	0.104 m
<input type="button" value="NewPt 1"/> <input type="button" value="NewPt 2"/> <input type="button" value=""/> <input type="button" value="RADIAL"/>	

NewPt 1

To calculate an additional line.
Application starts again at point 1.

NewPt 2

To set point 2 as the starting point
of a new line. A new point 2 must
be measured.

RADIAL

To switch to radial method.

Field	Description
Grade	Grade [%] between point 1 and point 2.
d SD	Slope distance between point 1 and point 2.
d HD	Horizontal distance between point 1 and point 2.
d VD	Height difference between point 1 and point 2.
Bearing	Azimuth between point 1 and point 2.

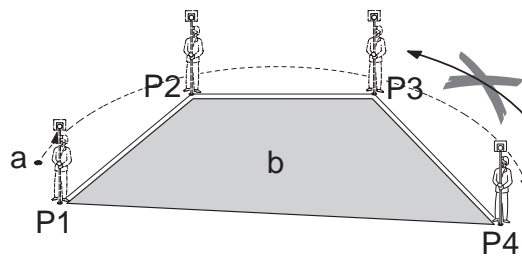
Next step

Press **ESC** to exit the application.

9.8 Area

Description

Area is an application used to compute online areas to a maximum of 50 points connected by straights. The target points have to be measured, selected from memory, or entered via the keypad in a clockwise direction. The calculated area is projected onto the horizontal plane (2D) or projected onto the sloped reference plane defined by three points (3D). Furthermore a volume with constant height can be calculated in relation to the area (2D/3D).



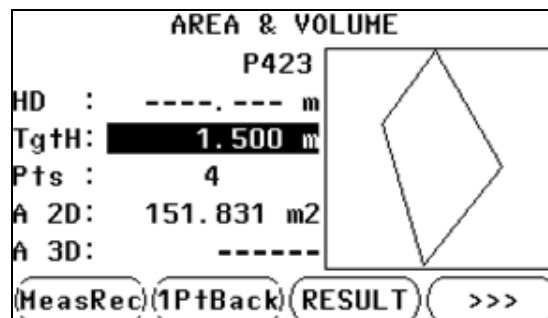
- P0 Instrument station
- P1 Start point
- P2-4 Target points
- a Perimeter, polygonal length from start point to the current measured point.
- b Calculated area always closed to the start point P1, projected onto the horizontal plane.

Access

1. Select **Appl.** from the **MAIN MENU**.
2. Select **Area** from the **APPLICATIONS** menu.
3. Complete application pre-settings. Refer to "8 Applications - Getting Started".

AREA & VOLUME

The graphic always shows the area projected onto the horizontal plane.



1PtBACK

To undo measurement or selection of the previous point.

RESULT

To display and record additional results (perimeter, volume).

>>> VOLUME

To calculate a volume with constant height. The heights have to be entered or measured.

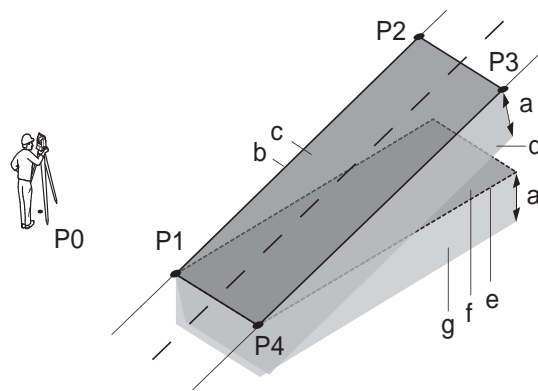
>>> Def. 3D

To define the sloped reference plane by selecting or measuring three points.



The 2D area is calculated and displayed once three points have been measured or selected. The 3D area is calculated once the sloped reference plane is defined by three points.

Graphical representation

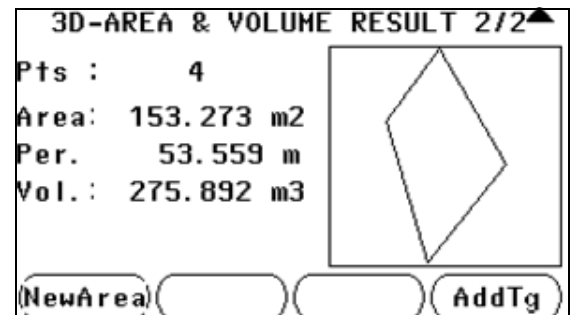
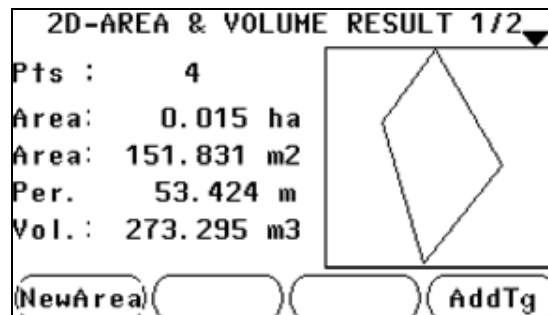


- P0 Instrument station
- P1 Target point which defines the sloped reference plane
- P2 Target point which defines the sloped reference plane
- P3 Target point which defines the sloped reference plane
- P4 Target point
- a Constant height
- b Perimeter (3D), polygonal length from the start point to the current measured point of the area (3D)
- c Area (3D), projected onto the sloped reference plane
- d Volume (3D) = $a \times c$
- e Perimeter (2D), polygonal length from the start point to the current measured point of the area (2D)
- f Area (2D), projected onto the horizontal plane
- g Volume (2D) = $f \times a$

Next step

Press **RESULT** to calculate area and volume and proceed to the **Area & Volume Result** screens.

2D/3D-AREA & VOLUME RESULT



Perimeter and volume are updated if further area points are added.

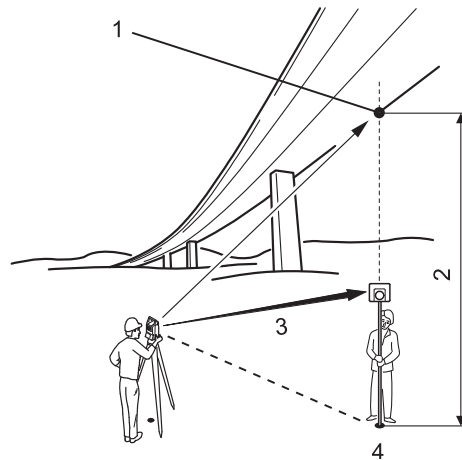
Next step

- Either, press **NewArea** to define a new area.
- Or, press **AddTg** to add a new target point to the existing area.
- Or, press **ESC** to exit the application.

9.9 Remote Elevation (REM)

Description

Remote Elevation (REM) is an application used to compute points directly above the base prism without a prism at the target point.



- 1 Remote point
- 2 Height difference
- 3 Slope distance
- 4 Base point

Access

1. Select **Appl.** from the **MAIN MENU**.
2. Select **Remote Elevation (REM)** from the **APPLICATIONS** menu.
3. Complete application pre-settings. Refer to "8 Applications - Getting Started".

Remote elevation measurement

Measure to the base point or press **Tgt. h=?** to determine an unknown reflector height.

Next step

After measuring, the **REMOTE ELEVATION** screen appears.

REMOTE ELEVATION - Aim at remote point

Aim the instrument at the inaccessible remote point.

Field	Description
d VD	Height difference between the base point and the remote point.
Z	Height of the remote point.

Next step

- Either, press **OK** to save the measurement and record the calculated coordinates of the remote point.
 - Or, press **BASE** to enter and measure a new base point.
 - Or, press **ESC** to exit the application.
-

9.10 Construction

9.10.1 Starting Construction

Description

Construction is an application used to define a construction site by combining set-up of the instrument along a construction line, measuring and staking out points in relation to the line.

Access

1. Select **Appl.** from the **MAIN MENU**.
2. Select **Construction** from the **APPLICATIONS** menu.
3. Select **EDM:** to set the EDM configuration. Refer to "4.3 EDM Configuration".
4. Select:
 - **New line** - To define a new construction site, or
 - **Continue with line** - To continue with a previous construction line (skips set-up).



If coordinates were entered by **COORD** and measured to known points, a plausibility check displays the calculated line length, the actual length and the difference.

Next step

Measure to the line start and end points and the **LAY-OUT** screen appears.

9.10.2 Layout

Description

Search or enter points for setting out relative to the defined construction line. The on-screen graphics show the position of the prism relative to the set out point. Below the graphic, the exact values are displayed, combined with arrows to show the direction for setting out the point.



- Be aware that the line start point and the line end point are measured in the previous coordinate system. When setting out these points they appear in the old system and appear as shifted.
 - During use of the application the previous orientation and station parameters will be replaced by the new calculated ones. The line start point will be set to E=0, N=0.
 - The height of the line start point is always used as the reference height!
-

Access

- Either, select **New line** from the Construction pre-settings screen and measure start and end points of the line.
 - Or, select **Continue with line** from the Construction pre-settings screen.
-

LAY-OUT

The graphics are scaled to give a better overview. Therefore it is possible that the set out point moves in the graphic.

LAY-OUT			
Pt. :	P404		x
Tgt. h.	1.500 m		⊗
d Lin	-1.280 m	↑	0.178 m
d Off	31.321 m	+	0.073 m
d VD	-6.491 m	↑	1.600 m
(HeasRec) MEAS (AsBUILT) >>>			

AsBUILT

To switch to AsBuilt mode to check points relative to the construction line.

>>> ShiftLN

To enter values for shifting the line.

Field	Description
d Lin	Longitudinal offset: Positive if target point is further away than the measured point.
d Off	Perpendicular offset: Positive if target point is to the right of the measured point.
d VD	Height offset: Positive if target point is higher than the measured point.

Next step

- Either, press **AsBUILT** to check point locations relative to a construction line.
- Or, press **>>> ShiftLN** to enter offset values for shifting the construction line.

9.10.3 As Built Check

Description

The As built screen displays the line, offset and height offset of a measured point in relation to the construction line. The on-screen graphics show the position of the measured point relative to the construction line.



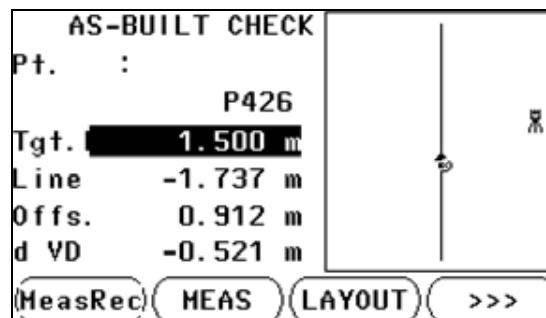
The height of the line start point is always used as the reference height!

Access

Press **AsBUILT** from the **LAY OUT** screen.

AS-BUILT CHECK

The graphics are scaled to give a better overview. Therefore it is possible that the station point moves in the graphics.



LAYOUT

To switch to Layout mode to set out points.

>>> ShiftLN

To enter values for shifting the line.

Field	Description
Line	Longitudinal offset: Positive if measured point is further along the construction line from the start point.
Offs.	Perpendicular offset: Positive if measured point is to the right of the construction line.
d VD	Calculated difference in height: Positive if measured point is higher than the construction line start point height.

9.11 Calculations

9.11.1 Starting Calculations

Description

Calculations is an application used to perform coordinate geometry calculations such as, coordinates of points, bearings between points and distances between points.

The calculation methods are:

- Inverse and Traverse
 - Intersections
 - Offset
 - Extension
-

Access

1. Select **Appl.** from the **MAIN MENU**.
 2. Select **Calculations** from the **APPLICATIONS** menu.
 3. Complete application pre-settings. Refer to "8 Applications - Getting Started".
 4. Select from the **Calculations** menu:
 - **Inverse & Traverse**
 - **Intersection**
 - **Offset**
 - **Extension**
-

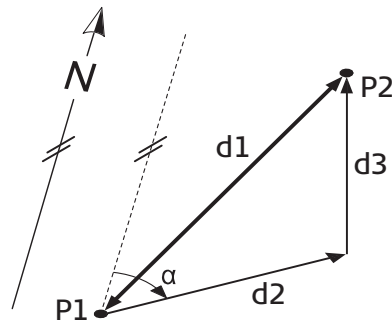
9.11.2 Inverse and Traverse

Access

1. Select **Inverse & Traverse** from the **Calculations** menu.
2. Select **Inverse** or **Traverse**.

Inverse

Use the inverse subapplication to calculate the distance, direction, height difference and grade between two known points.



Known

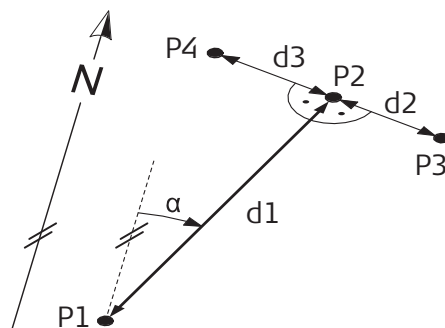
- P1 First known point
- P2 Second known point

Unknown

- α Direction from P1 to P2
- d1 Slope distance between P1 and P2
- d2 Horizontal distance between P1 and P2
- d3 Height difference between P1 and P2

Traverse

Use the traverse subapplication to calculate the position of a new point using the bearing and the distance from a known point. Offset optional.



Known

- P1 Known point
- α Direction from P1 to P2
- d1 Distance between P1 and P2
- d2 Positive offset to the right
- d3 Negative offset to the left

Unknown

- P2 Calculated point without offset
- P3 Calculated point with positive offset
- P4 Calculated point with negative offset

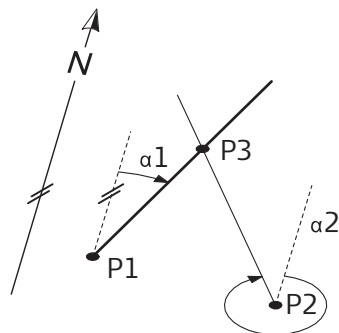
9.11.3 Intersections

Access

1. Select **Intersection** from the **Calculations** menu.
 2. Select the desired Calculations method:
 - **Bearing-Bearing**
 - **Bearing-Distance**
 - **Distance-Distance**
 - **Line Intersection**
-

Bearing-Bearing

Use the bearing-bearing subapplication to calculate the intersection point of two lines. A line is defined by a point and a direction.



Known

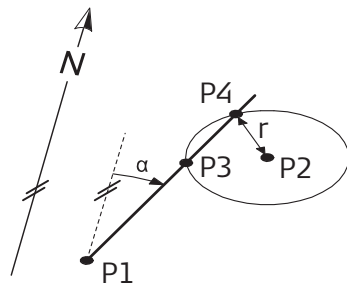
- P1 First known point
- P2 Second known point
- α_1 Direction from P1 to P3
- α_2 Direction from P2 to P3

Unknown

- P3 Calculated point

Bearing-Distance

Use the bearing-distance subapplication to calculate the intersection point of a line and a circle. The line is defined by a point and a direction. The circle is defined by the center point and the radius.



Known

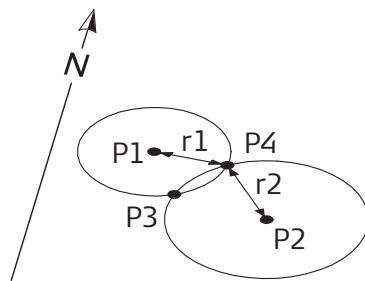
- P1 First known point
- P2 Second known point
- α Direction from P1 to P3 and P4
- r Radius, as the distance from P2 to P4 or P3

Unknown

- P3 First calculated point
- P4 Second calculated point

**Distance-
Distance**

Use the distance-distance subapplication to calculate the intersection point of two circles. The circles are defined by the known point as the center point and the distance from the known point to the calculated point as the radius.



Known

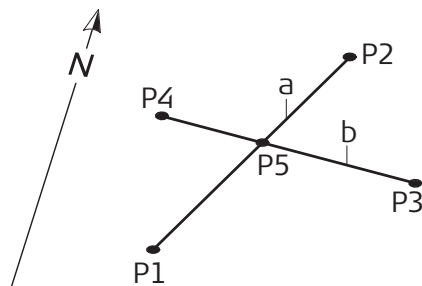
- P1 First known point
- P2 Second known point
- r1 Radius, as the distance from P1 to P3 or P4
- r2 Radius, as the distance from P2 to P3 or P4

Unknown

- P3 First calculated point
- P4 Second calculated point

By Points

Use the line-line subapplication to calculate the intersection point of two lines. A line is defined by two points.



Known

- P1 First known point
- P2 Second known point
- P3 Third known point
- P4 Fourth known point
- a Line from P1 to P2
- b Line from P3 to P4

Unknown

- P5 Calculated point

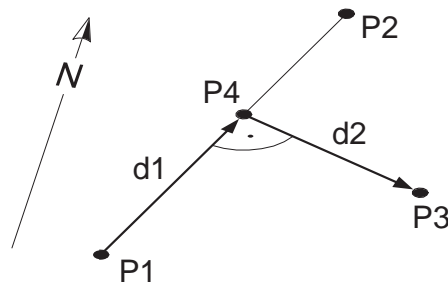
9.11.4 Offsets

Access

1. Select **Offset** from the **Calculations** menu.
2. Select the desired Calculations method:
 - Distance-Offset
 - Set Pt by Dist-Offset

Distance - Offset

Use the distance-offset subapplication to calculate the distance and offset of a known point, with the basepoint in relation to a line.



Known

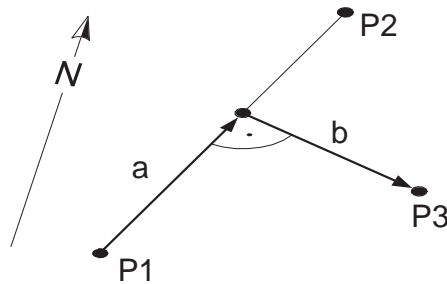
- P1 Start point
- P2 End point
- P3 Offset point

Unknown

- d1 Difference in line
- d2 Difference in offset
- P4 Calculated (base) point

Set point by....

Use the set point subapplication to calculate the coordinates of a new point in relation to a line from known longitudinal and offset distances.



Known

- P1 Start point
- P2 End point
- a Difference in line
- b Difference in offset

Unknown

- P3 Calculated point

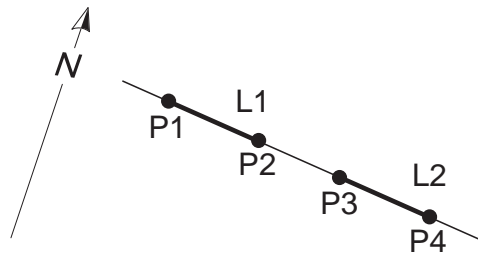
9.11.5 Extension

Access

Select **Extension** from the **Calculations** menu.

Extension

Use the Extension subapplication to calculate the extended point from a known base line.



Known

- P1 Baseline start point
- P3 Baseline end point
- dL1, dL2 Distance

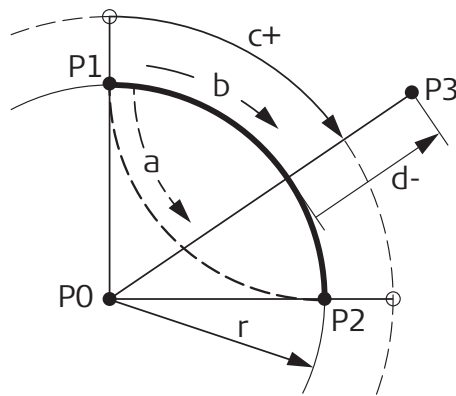
Unknown

- P2, P4 Extended calculated points

9.12 Road Alignment

Description

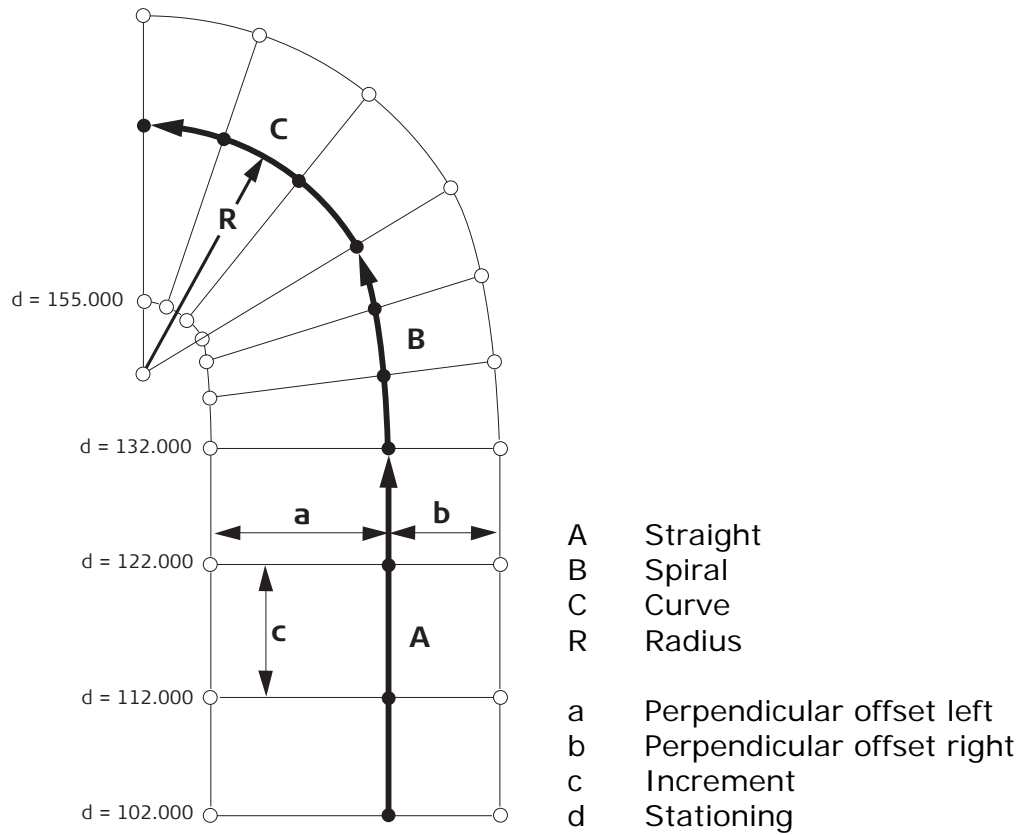
Road Alignment is an application used to measure or set out points relative to a defined element. The element can be a line, curve or spiral. Chainage, incremental set outs and offsets (left and right) are supported.



- P0 Center point
- P1 Start point of arc
- P2 End point of arc
- P3 Point to set out
- a Anti-clockwise
- b Clockwise
- c+ Distance from start of arc, following curve
- d- Perpendicular offset from arc
- r Radius of arc

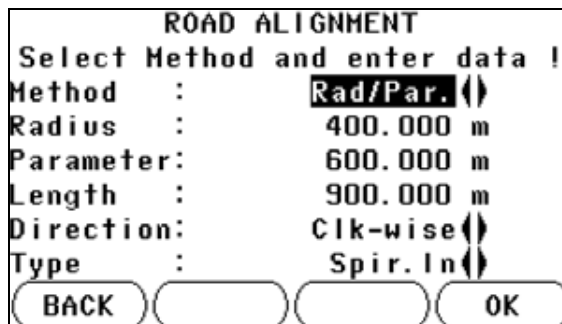
Access

1. Select **Appl.** from the **MAIN MENU**.
2. Select **Road Alignment** from the **APPLICATIONS** menu.
3. Complete application pre-settings. Refer to "8 Applications - Getting Started".
4. Select the element type:
 - **Straight**
 - **Curve**
 - **Spiral**

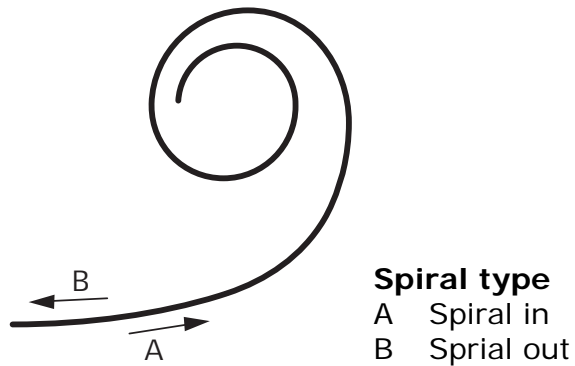


Define the element step-by-step

1. Enter, measure or select from memory the start and end points.
2. For curve and spiral elements the **ROAD ALIGNMENT** screen for defining the element appears.



3. For a curve element:
 - Enter the radius and curve direction.
 - Press **OK**.
- For a spiral element:
 - Select the method to be used, **Rad/Par** or **Rad/Len**.
 - Enter the radius and parameter, or radius and length, depending on the method chosen.
 - Select the type and direction of the spiral.
 - Press **OK**.



4. When the element has been defined the **ROAD ALIGNMENT-MAIN PAGE** appears.

Station and method

Enter the station values and press:

- **SET OUT:** to select the point and offset (center, left or right), to set out and start the measurement. The correction from actual point to set out point is shown on the display.
- **MEASURE:** to measure, or select points from memory, to calculate the chainage, line and offset from the defined element.

Enter set out values

Enter set out values!	
Station :	1100.000 m
Offs.Left :	5.000 m
Offs.Right:	4.000 m
Increment :	10.000 m
Z :	0.000 m
[BACK] [RESET] [] [OK]	

Next step

- If in set out mode, press **OK** to begin staking out.
 - Or, if in measurement mode, press **MeasRec** to measure and record.
-

10 Data Management

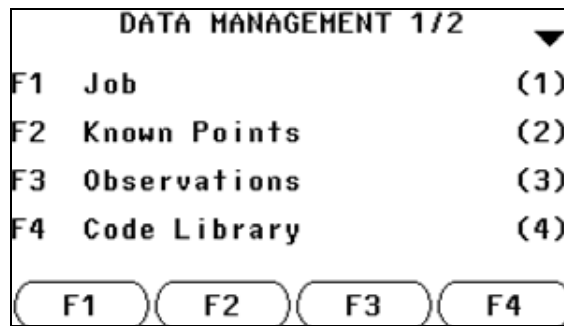
10.1 Data Management

Access

Select **Data** from the **MAIN MENU**.


**DATA MANAGE-
MENT**

The Data Management menu contains all functions for entering, editing, checking and deleting data in the field.



F1-F4
To select menu item.

Menu item	Description
Job	To view, create and delete jobs. Jobs are a summary of data of different types, for example, known points, observations or codes. The job definition consists of the job name and user. The system generates time and date at the time of creation.

Menu item	Description
Known Points	To view, create, edit and delete known points. Valid points contain at least the point ID and the coordinates E, N or Z.
Observations	To view and delete observation data. Observation data available in the internal memory can be searched for via a specific point search, or by viewing all points within a job.
Code Library	To view, create, edit and delete codes. To each code a description and a maximum of 8 attributes with up to 16 characters each can be assigned.
Clear Memory	To delete individual jobs, fixpoints and measurements of a specific job or all jobs in the memory.  Deleting the memory cannot be undone. After confirming the message all data is permanently deleted.
Memory Information	Displays job specific memory information such as the number of stored stations and fixpoints within a job, the number of recorded data blocks, for example measured points, or codes within a job.

Next step

- Either, select a menu option using **F1 - F4**.
- Or, press **ESC** to return to the **MAIN MENU**.

10.2 Data Transfer

Description

Job data can be exported from the internal memory of the instrument. Data can be exported via the RS232 serial interface.

A receiver, such as a laptop, is connected to the RS232 port. The receiver requires GeoMax office software or another third party software.

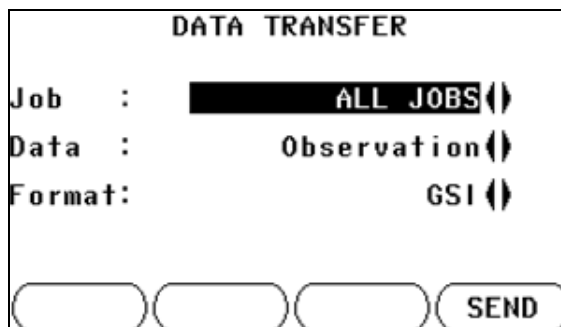


If the receiver is too slow in processing data the data could be lost. With this type of data transfer the instrument is not informed about the performance of the receiver (no protocol). Therefore the success of this type of transfer is not checked.

Access

Select **Transfer** from the **MAIN MENU**.

DATA TRANSFER



SEND

To begin data transfer

Field	Description
Job	Select whether to transfer all job related data or a single job data file.
Data	Data type to be transferred. Observation or Known points
Format	Format type. GSI or a user defined ASCII format

Next step

Press **SEND**.

Exportable job data formats

Job data can be exported from a job in gsi file type, or any other user defined ASCII format. A format is defined in GeoMax office software. Refer to the online help for information on creating format files.

RS232 example job data output

Within the **Data** setting **Observation**, a data set could be shown as follows:

11....+00000D19	21..022+16641826	22..022+09635023
31..00+00006649	58..16+00000344	81..00+00003342
82..00-00005736	83..00+00000091	87..10+00001700

GSI-IDs			GSI-IDs continued		
11	△	PtID	41-49	△	Codes and attributes
21	△	Horizontal direction	51	△	ppm [mm]
22	△	Vertical angle	58	△	Prism constants
25	△	Orientation	81-83	△	(E, N, Z) Target point
31	△	Slope distance	84-86	△	(E, N, Z) Station point
32	△	Horizontal distance	87	△	Reflector height
33	△	Height difference	88	△	Instrument height

10.3 Working with GeoMax Office Software

Description

The program package is used for the data exchange between the instrument and a computer. It contains several auxiliary programs in order to support the instrument.

Installation on a computer

The installation program can be found on the CD-ROM supplied. Insert the CD and follow the on-screen instructions. Please note that the software can only be installed on computers with MS Windows 2000, XP and Vista operating systems.



For more information refer to the comprehensive online help.

11 Check & Calibrate

11.1 Overview

Description

GeoMax instruments are manufactured, assembled and adjusted to the best possible quality. Quick temperature changes, shock or stress can cause deviations and decrease the instrument accuracy. It is therefore recommended to check and adjust the instrument from time to time. This can be done in the field by running through specific measurement procedures. The procedures are guided and have to be followed carefully and precisely as described in the following chapters. Some other instrument errors and mechanical parts can be adjusted mechanically.

Electronic calibration

The following instrument errors can be checked and calibrated electronically:

- Horizontal collimation error, also called line-of-sight error.
- Vertical index error, and simultaneously the electronic level.



For determining these errors, it is necessary to measure in both faces, but the procedure can be started in any face.

Mechanical calibration

The following instrument parts can be calibrated mechanically:

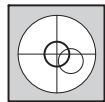
- Circular level on the instrument and tribrach.
- Laser plummet.
- Screws on the tripod.



During the manufacturing process, the instrument errors are carefully determined and set to zero. As mentioned, these errors can change and it is highly recommended to redetermine them in the following situations:

- Before the instrument is used for the first time.
- Before every high precision survey.
- After rough or long periods of transport.
- After long periods of work or storage.
- If the temperature difference between current environment and the temperature at the last calibration is more than 10°C (18°F).

11.2 Preparation



Before determining the instrument errors, level-up the instrument using the electronic level.

The tribrach, the tripod and the ground should be very stable and secure from vibrations or other disturbances.



The instrument should be protected from direct sunlight in order to avoid thermal expansion on one side only.



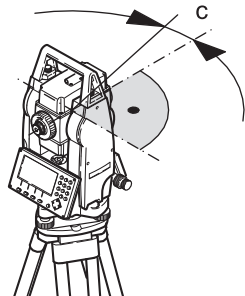
Before starting to work, the instrument has to become acclimatised to the ambient temperature. Approximately two minutes per °C of temperature

difference from storage to working environment, but at least 15 min, should be taken into account.

11.3 Calibrating Line-of-Sight and Vertical Index Error

Line-of-sight error

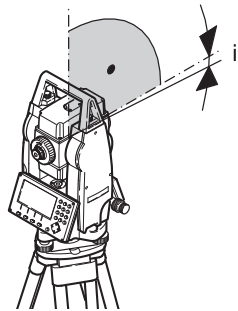
The line-of-sight error, or horizontal collimation error is the deviation from the perpendicular between the tilting axis and the line of sight. The effect of the line-of-sight error to the horizontal direction increases with the vertical angle.



c Horizontal collimation, or line-of-sight, error

Vertical index error

The vertical circle should read exactly 90° (100 gon) when the line of sight is horizontal. Any deviation from this figure is termed vertical index error. This is a constant error that affects all vertical angle readings.



i Vertical index error
 By determining the vertical index error the electronic level is calibrated automatically

Access

1. Select **Calibr.** from the **MAIN MENU**.
- Select:
 - **HA-Collimation**, or
 - **VA-Index**.

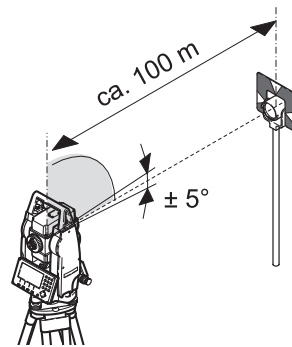


The procedures and conditions required to correct line-of-sight and vertical index errors are the same, therefore the procedure will only be described once.

Check and calibrate step-by-step

1. Level the instrument with the electronic level. Refer to "3 Operation"- "Level up with the electronic level step-by-step".

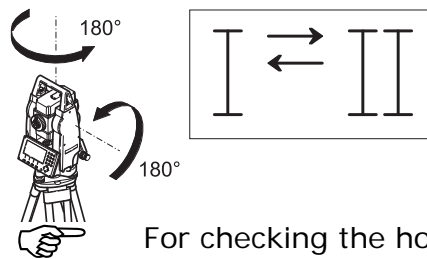
2.



Aim at a point approximately 100 m from the instrument which is within 5° of the horizontal.

3. Press **REC** to measure to the target point.

4.



Change face and aim at the target point again

For checking the horizontal aim, the difference in HA and VA are displayed.

5. Press **MeasRec** to measure to the target point.



The old and new calculated values are displayed.

6. Either:
- Press **OK** to save the new adjustment data, or
 - Press **ESC** to exit without saving the new calibration data.

Messages

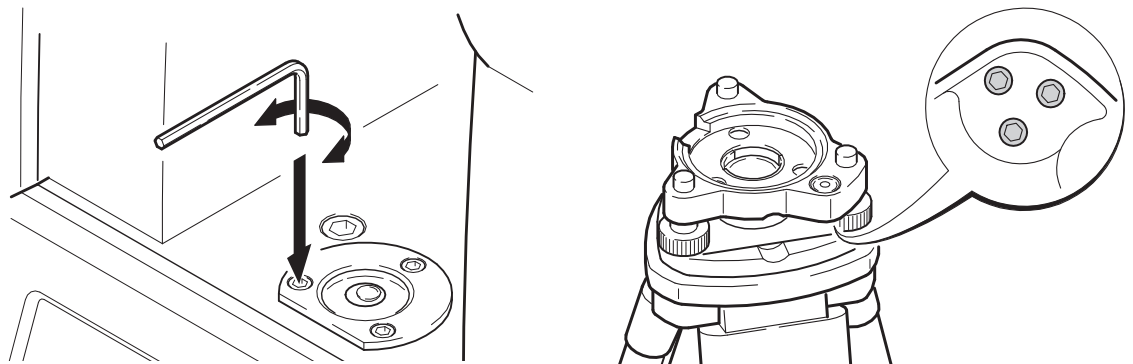
The following are important messages or warnings that may appear.

Messages	Description
VA-angle not suitable for calibration !	The vertical angle deviates from the required horizontal / line-of-sight, or in face II the vertical angle deviates by more than 5° from the target point. Aim at the target point with an accuracy of min. 5° or, when adjusting the tilt axis, 27° above or beneath the horizontal plane. Confirmation of the message required.
Results out of tolerance. Previous values retained !	Computed values out of tolerance. The previous values are retained and measurements should be repeated. Confirmation of the message required.
HA-angle not suitable for calibration !	Horizontal angle in face II deviates by more than 5° from the target point. Aim on the target point with an accuracy of min. 5°. Confirmation of the message required.
Measurement Error. Try again.	Measurement error appears when, for example, there is an unstable set up. Repeat the process. Confirmation of the message required.

Messages	Description
Time limit exceeded ! Please repeat calibration !	Time difference between measurements for results storage exceeds 15 minutes. Repeat the process. Confirmation of the message required.

11.4 Calibrating the Circular Level of the Instrument and Tribrach

Calibrate the circular level step-by-step



1. Place and secure the tribrach onto the tripod, and then secure the instrument onto the tribrach.
2. Using the tribrach footscrews, level the instrument with the electronic level. To activate the electronic level, press **FNC** from within any application and select **Electr.Level/Laserpl.**
3. The bubbles of the instrument and tribrach levels must be centered. If one or both circular levels are not centered, adjust as follows.

Instrument: If the bubble extends beyond the circle, use the Allen key supplied to center it with the adjustment screws.

Tribrach: If the bubble extends beyond the circle, adjust it using the adjustment pin in conjunction with the adjustment screws. Turn the adjustment screws:

 - To the left: and the bubble approaches the screw.
 - To the right: and the bubble goes away from the screw.
4. Repeat step 3. on the instrument and tribrach until both circular levels are centered and no further adjustments are necessary.



After the adjustment, no adjustment screw should be loose.

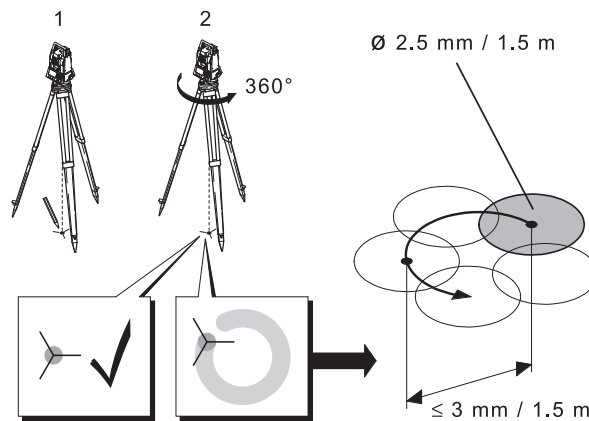
11.5 Inspecting the Laser Plummet of the Instrument




The laser plummet is integrated into the vertical axis of the instrument. Under normal conditions of use, the laser plummet does not need adjusting. If an

adjustment is necessary due to external influences, the instrument has to be returned to a GeoMax service department.

Inspect the laser plummet step-by-step



1. Set up the instrument on the tripod approximately 1.5 m above the ground and level up.
2. To activate the laser plummet, turn on the instrument, press **FNC** from within any application and select **Electr.Level/Laserpl.**
 Inspection of the laser plummet should be carried out on a bright, smooth and horizontal surface, such as a sheet of paper.
3. Mark the center of the red laser dot on the ground.
4. Turn the instrument slowly through 360°, carefully observing the movement of the red laser dot.

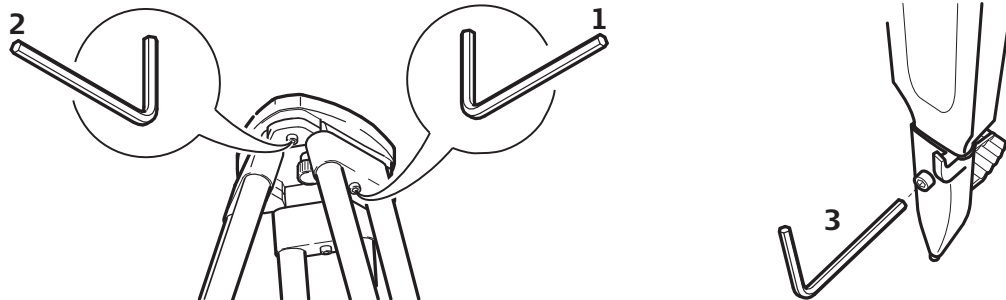


The maximum diameter of the circular movement described by the center of the laser dot should not exceed 3 mm at a height of 1.5 m.

5. If the center of the laser dot makes a clearly circular movement, or moves more than 3 mm away from the point which was first marked, an adjustment may be required. Call your nearest GeoMax service department. Depending on brightness and surface type, the size of the laser dot can vary. At a height of 1.5 m an average diameter of 2.5 mm is estimated.

11.6 Servicing the Tripod

Service the tripod step-by-step



The connections between metal and timber components must always be firm and tight.

1. Tighten the leg cap screws moderately with the allen key supplied.
 2. Tighten the articulated joints on the tripod head just enough to keep the tripod legs open when lifting the tripod off the ground.
 3. Tighten the screws of the tripod legs.
-

12 Care and Transport

12.1 Transport

Transport in the field

When transporting the equipment in the field, always make sure that you either:

- carry the product in its original transport container, or
 - carry the tripod with its legs splayed across your shoulder, keeping the attached product upright.
-

Transport in a road vehicle

Never carry the product loose in a road vehicle, as it can be affected by shock and vibration. Always carry the product in its transport container and secure it.

Shipping

When transporting the product by rail, air or sea, always use the complete original GeoMax packaging, transport container and cardboard box, or its equivalent, to protect against shock and vibration.

Shipping, transport of batteries

When transporting or shipping batteries, the person in charge of the product must ensure that the applicable national and international rules and regulations are observed. Before transportation or shipping, contact your local passenger or freight transport company.

Field adjustment

After transport inspect the field adjustment parameters given in this user manual before using the product.

12.2 Storage

Product

Respect the temperature limits when storing the equipment, particularly in summer if the equipment is inside a vehicle. Refer to "14 Technical Data" for information about temperature limits.

Field adjustment

After long periods of storage inspect the field adjustment parameters given in this user manual before using the product.

Batteries

- Refer to "14.6 General Technical Data of the Instrument" for information about storage temperature range.
 - A storage temperature range of -0°C to +20°C/+32°F to +68°F in a dry environment is recommended to minimise self-discharging of the battery.
 - At the recommended storage temperature range, batteries containing a 10% to 50% charge can be stored for up to one year. After this storage period the batteries must be recharged.
 - Remove batteries from the product and the charger before storing.
 - After storage recharge batteries before using.
 - Protect batteries from damp and wetness. Wet or damp batteries must be dried before storing or use.
-

12.3 Cleaning and Drying

**Objective,
eyepiece and
reflectors**

- Blow dust off lenses and prisms.
 - Never touch the glass with your fingers.
 - Use only a clean, soft, lint-free cloth for cleaning. If necessary, moisten the cloth with water or pure alcohol. Do not use other liquids; these may attack the polymer components.
-

**Fogging of
prisms**

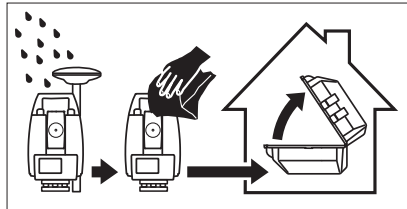
Prisms that are cooler than the ambient temperature tend to fog. It is not enough simply to wipe them. Keep them for some time inside your jacket or in the vehicle to allow them to adjust to the ambient temperature.

Damp products

Dry the product, the transport container, the foam inserts and the accessories at a temperature not greater than 40°C /104°F and clean them. Do not repack until everything is completely dry. Always close the transport container when using in the field.

Cables and plugs

Keep plugs clean and dry. Blow away any dirt lodged in the plugs of the connecting cables.



13 Safety Directions

13.1 General

Description

The following directions should enable the person responsible for the product, and the person who actually uses the equipment, to anticipate and avoid operational hazards.

The person responsible for the product must ensure that all users understand these directions and adhere to them.

13.2 Intended Use

Permitted use

- Measuring horizontal and vertical angles.
 - Measuring distances.
 - Recording measurements.
 - Visualizing the aiming direction and vertical axis.
 - Data communication with external appliances.
 - Computing by means of software.
-

Adverse use

- Use of the product without instruction.
- Use outside of the intended limits.
- Disabling safety systems.

- Removal of hazard notices.
- Opening the product using tools, for example screwdriver, unless this is specifically permitted for certain functions.
- Modification or conversion of the product.
- Use after misappropriation.
- Use of products with obviously recognisable damages or defects.
- Use with accessories from other manufacturers without the prior explicit approval of GeoMax.
- Aiming directly into the sun.
- Inadequate safeguards at the working site, for example when measuring on roads.
- Deliberate dazzling of third parties.
- Controlling of machines, moving objects or similar monitoring application without additional control- and safety installations.

 **Warning**

Adverse use can lead to injury, malfunction and damage.

It is the task of the person responsible for the equipment to inform the user about hazards and how to counteract them. The product is not to be operated until the user has been instructed on how to work with it.

13.3 Limits of Use

Environment

Suitable for use in an atmosphere appropriate for permanent human habitation: not suitable for use in aggressive or explosive environments.

 **Danger**

Local safety authorities and safety experts must be contacted before working in hazardous areas, or in close proximity to electrical installations or similar situations by the person in charge of the product.

13.4 Responsibilities

Manufacturer of the product

GeoMax AG, CH-9443 Widnau, hereinafter referred to as GeoMax, is responsible for supplying the product, including the user manual and original accessories, in a completely safe condition.

Manufacturers of non GeoMax accessories

The manufacturers of non GeoMax accessories for the product are responsible for developing, implementing and communicating safety concepts for their products, and are also responsible for the effectiveness of those safety concepts in combination with the GeoMax product.

Person in charge of the product

The person in charge of the product has the following duties:

- To understand the safety instructions on the product and the instructions in the user manual.

- To be familiar with local regulations relating to safety and accident prevention.
- To inform GeoMax immediately if the product and the application becomes unsafe.

 **Warning**

The person responsible for the product must ensure that it is used in accordance with the instructions. This person is also accountable for the training and the deployment of personnel who use the product and for the safety of the equipment in use.

13.5 Hazards of Use

 **Warning**

The absence of instruction, or the inadequate imparting of instruction, can lead to incorrect or adverse use, and can give rise to accidents with far-reaching human, material, financial and environmental consequences.

Precautions:

All users must follow the safety directions given by the manufacturer and the directions of the person responsible for the product.

 **Caution**

Watch out for erroneous measurement results if the product has been dropped or has been misused, modified, stored for long periods or transported.

Precautions:

Periodically carry out test measurements and perform the field adjustments indicated in the user manual, particularly after the product has been subjected to abnormal use and before and after important measurements.

 **Danger**

Because of the risk of electrocution, it is very dangerous to use poles and extensions in the vicinity of electrical installations such as power cables or electrical railways.

Precautions:

Keep at a safe distance from electrical installations. If it is essential to work in this environment, first contact the safety authorities responsible for the electrical installations and follow their instructions.



 **Warning**

If the product is used with accessories, for example masts, staffs, poles, you may increase the risk of being struck by lightning.

Precautions:

Do not use the product in a thunderstorm.

 **Caution**

Be careful when pointing the product towards the sun, because the telescope functions as a magnifying glass and can injure your eyes and/or cause damage inside the product.

Precautions:


Do not point the product directly at the sun.

 **Warning**

During dynamic applications, for example set out procedures there is a danger of accidents occurring if the user does not pay attention to the environmental conditions around, for example obstacles, excavations or traffic.

Precautions:

The person responsible for the product must make all users fully aware of the existing dangers.

 **Warning**

Inadequate securing of the working site can lead to dangerous situations, for example in traffic, on building sites, and at industrial installations.

Precautions:

Always ensure that the working site is adequately secured. Adhere to the regulations governing safety and accident prevention and road traffic.

 **Warning**

If computers intended for use indoors are used in the field there is a danger of electric shock.

Precautions:

Adhere to the instructions given by the computer manufacturer with regard to field use in conjunction with GeoMax products.

 **Caution**

If the accessories used with the product are not properly secured and the product is subjected to mechanical shock, for example blows or falling, the product may be damaged or people may sustain injury.

Precautions:

When setting-up the product, make sure that the accessories are correctly adapted, fitted, secured, and locked in position.

Avoid subjecting the product to mechanical stress.

 **Caution**

During the transport, shipping or disposal of batteries it is possible for inappropriate mechanical influences to constitute a fire hazard.

Precautions:

Before shipping the product or disposing of it, discharge the batteries by running the product until they are flat.

When transporting or shipping batteries, the person in charge of the product must ensure that the applicable national and international rules and regulations are observed. Before transportation or shipping contact your local passenger or freight transport company.

 **Warning**

Using a battery charger not recommended by GeoMax can destroy the batteries. This can cause fire or explosions.

Precautions:

Only use chargers recommended by GeoMax to charge the batteries.

 **Warning**

Batteries not recommended by GeoMax may be damaged if charged or discharged. They may burn and explode

Precautions:

Only charge and discharge batteries recommended by GeoMax.

 **Warning**

High mechanical stress, high ambient temperatures or immersion into fluids can cause leakage, fire or explosions of the batteries.

Precautions:

Protect the batteries from mechanical influences and high ambient temperatures. Do not drop or immerse batteries into fluids.

 **Warning**

Short circuited battery terminals can overheat and cause injury or fire, for example by storing or transporting in pockets if battery terminals come in contact with jewellery, keys, metallized paper or other metals.

Precautions:

Make sure that the battery terminals do not come into contact with metallic objects.

 **Warning**

If the product is improperly disposed of, the following can happen:

- If polymer parts are burnt, poisonous gases are produced which may impair health.
- If batteries are damaged or are heated strongly, they can explode and cause poisoning, burning, corrosion or environmental contamination.
- By disposing of the product irresponsibly you may enable unauthorised persons to use it in contravention of the regulations, exposing themselves and third parties to the risk of severe injury and rendering the environment liable to contamination.
- Improper disposal of silicone oil may cause environmental contamination.

Precautions:



The product must not be disposed with household waste.

Dispose of the product appropriately in accordance with the national regulations in force in your country.

Always prevent access to the product by unauthorised personnel.

Product specific treatment and waste management information can be downloaded from the GeoMax home page at <http://www.geomax-positioning.com/treatment> or received from your GeoMax dealer.

13.6 Laser Classification

13.6.1 General

General

The following directions (in accordance with the state of the art - international standard IEC 60825-1 (2007-03) and IEC TR 60825-14 (2004-02)) provide instruction and training information to the person responsible for the product and the person who actually uses the equipment, to anticipate and avoid operational hazards.

The person responsible for the product must ensure that all users understand these directions and adhere to them.



Products classified as laser class 1, class 2 and class 3R do not require:

- laser safety officer involvement,
- protective clothes and eyewear,
- special warning signs in the laser working area

if used and operated as defined in this user manual due to the low eye hazard level.



Products classified as laser class 2 or class 3R may cause dazzle, flash-blindness and afterimages, particularly under low ambient light conditions.

13.6.2 Distancer, Measurements with Reflectors

General

The EDM module built into this product produces a visible laser beam which emerges from the telescope objective.

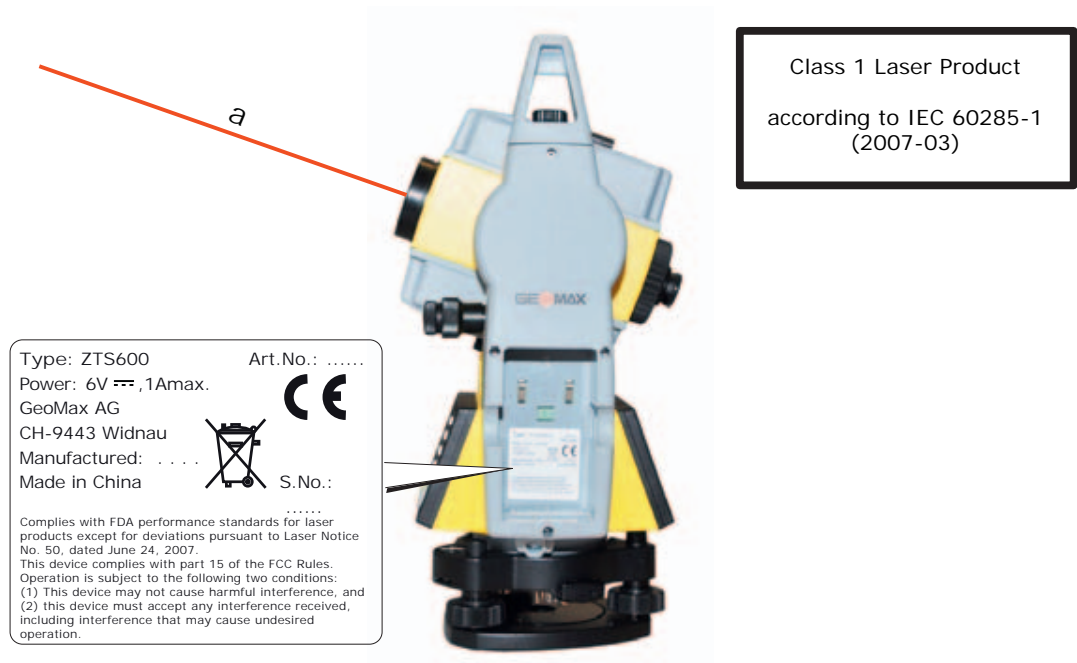
The laser product described in this section, is classified as laser class 1 in accordance with:

- IEC 60825-1 (2007-03): "Safety of laser products".
- EN 60825-1 (2007-10): "Safety of laser products".

Class 1 laser products are safe under reasonably foreseeable conditions of operation and are not harmful to the eyes provided that the products are used and maintained in accordance with this user manual.

Description	Value
Maximum average radiant power	0.33 mW
Pulse duration	800 ps
Pulse repetition frequency	100 MHz - 150 MHz
Wavelength	650 nm - 690 nm

Labelling



13.6.3 Distancer, Measurements without Reflectors

General

The EDM module built into the product produces a visible laser beam which emerges from the telescope objective.

The laser product described in this section is classified as laser class 3R in accordance with:

- IEC 60825-1 (2007-03): "Safety of laser products".
- EN 60825-1 (2007-10): "Safety of laser products".

Class 3R laser products:

Direct intrabeam viewing may be hazardous (low-level eye hazard), in particular for deliberate ocular exposure. The risk of injury for laser class 3R products is limited because of:

- unintentional exposure would rarely reflect worst case conditions of (e.g.) beam alignment with the pupil, worst case accommodation,
- inherent safety margin in the maximum permissible exposure to laser radiation (MPE), natural aversion behaviour for exposure to bright light for the case of visible radiation.

Description	Value
Maximum average radiant power	5.00 mW
Pulse duration	800 ps
Pulse repetition frequency	100 MHz - 150 MHz
Wavelength	650 nm - 690 nm
Beam divergence	0.2 mrad x 0.3 mrad
NOHD (Nominal Ocular Hazard Distance) @ 0.25s	80 m / 262 ft

 **Warning**

From a safety perspective class 3R laser products should be treated as potentially hazardous.

Precautions:

Prevent direct eye exposure to the beam. Do not direct the beam at other people.

 **Warning**

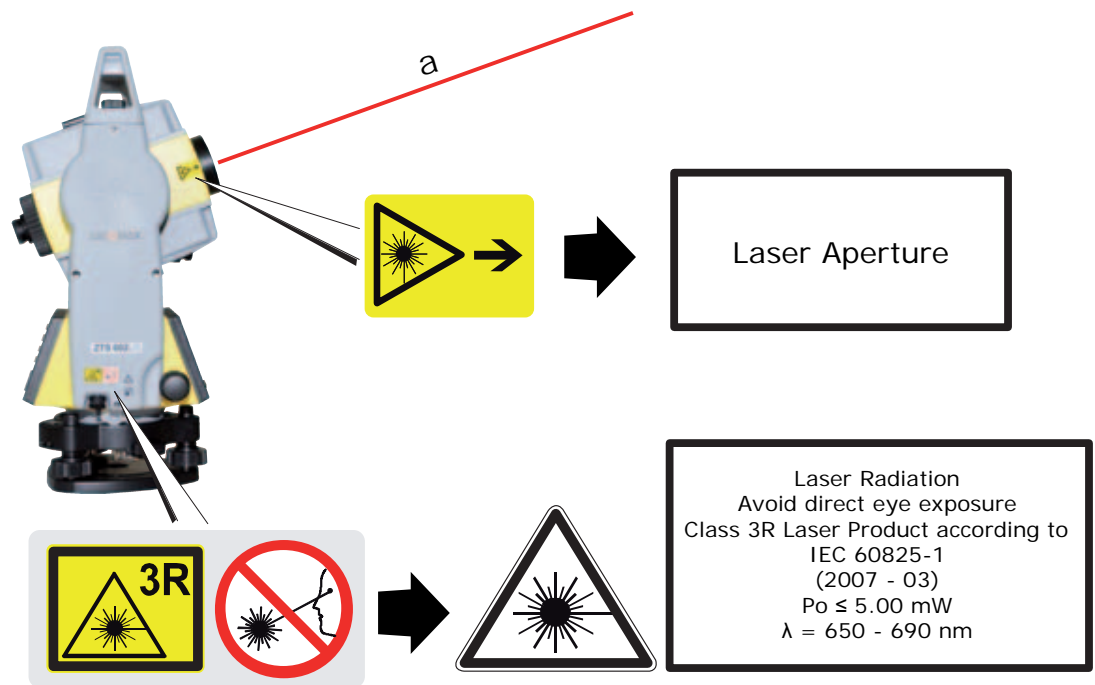
Potential hazards are not only related to direct beams but also to reflected beams aimed at reflecting surfaces such as prisms, windows, mirrors, metallic surfaces etc.

Precautions:

Do not aim at areas that are essentially reflective, such as a mirror, or which could emit unwanted reflections.


Do not look through or beside the optical sight at prisms or reflecting objects when the laser is switched on, in laser pointer or distance measurement mode. Aiming at prisms is only permitted when looking through the telescope.


Labelling




a Laser beam

Type: ZTS600 Art.No.:

Power: 6V , 1Amax.

GeoMax AG 

CH-9443 Widnau 

Manufactured: S.No.:

Made in China

.....
 Complies with FDA performance standards for laser products except for deviations pursuant to Laser Notice No. 50, dated June 24, 2007.
 This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:
 (1) This device may not cause harmful interference, and
 (2) this device must accept any interference received, including interference that may cause undesired operation.



13.6.4 Laser Plummet

General

The laser plummet built into the product produces a visible red laser beam which emerges from the bottom of the product.

The laser product described in this section, is classified as laser class 2 in accordance with:

- IEC 60825-1 (2007-03): "Safety of laser products".
- EN 60825-1 (2007-10): "Safety of laser products".

Class 2 laser products:

These products are safe for momentary exposures but can be hazardous for deliberate staring into the beam.

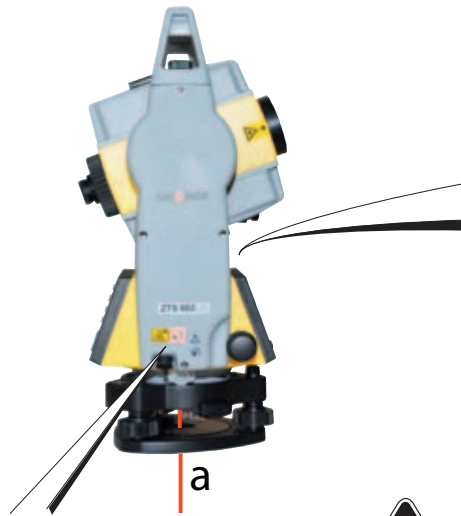
Description	Value
Maximum radiant power	1.00 mW
Pulse duration	c.w.
Pulse repetition frequency	c.w.
Wavelength	620 nm - 690 nm

 **Warning**

From a safety perspective class 2 laser products are not inherently safe for the eyes.

Precautions:

Avoid staring into the beam or pointing the beam at other people.



Type: ZTS600 Art.No.:



Power: 6V $\overline{\text{---}}$,1Amax.

GeoMax AG

CH-9443 Widnau

Manufactured:

Made in China

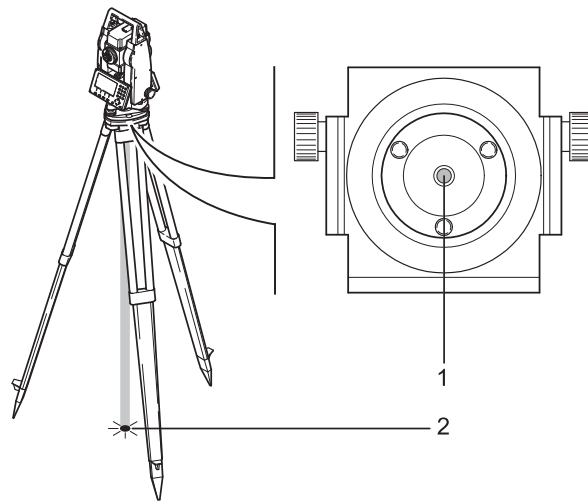
  S.No.:

Complies with FDA performance standards for laser products except for deviations pursuant to Laser Notice No. 50, dated June 24, 2007.
 This device complies with part 15 of the FCC Rules.
 Operation is subject to the following two conditions:
 (1) This device may not cause harmful interference, and
 (2) this device must accept any interference received, including interference that may cause undesired operation.



Laser Radiation
 Do not stare into the beam
 Class 2 Laser Product
 according to IEC 60825-1
 (2007 - 03)
 Po ≤ 1.00 mW
 λ = 620 - 690 nm

2 Will be replaced by a Class 3R warning label if applicable



- 1 Exit for laser beam
- 2 Laser beam

13.7 Electromagnetic Compatibility EMC

Description

The term Electromagnetic Compatibility is taken to mean the capability of the product to function smoothly in an environment where electromagnetic radiation and electrostatic discharges are present, and without causing electromagnetic disturbances to other equipment.

 **Warning**

Electromagnetic radiation can cause disturbances in other equipment.

Although the product meets the strict regulations and standards which are in force in this respect, GeoMax cannot completely exclude the possibility that other equipment may be disturbed.

 **Caution**

There is a risk that disturbances may be caused in other equipment if the product is used in conjunction with accessories from other manufacturers, for example field computers, personal computers, two-way radios, non-standard cables or external batteries.

Precautions:

Use only the equipment and accessories recommended by GeoMax. When combined with the product, they meet the strict requirements stipulated by the guidelines and standards. When using computers and two-way radios, pay attention to the information about electromagnetic compatibility provided by the manufacturer.

 **Caution**

Disturbances caused by electromagnetic radiation can result in erroneous measurements.

Although the product meets the strict regulations and standards which are in force in this respect, GeoMax cannot completely exclude the possibility that the product may be disturbed by very intense electromagnetic radiation, for example, near radio transmitters, two-way radios or diesel generators.

Precautions:

Check the plausibility of results obtained under these conditions.


 **Warning**

If the product is operated with connecting cables attached at only one of their two ends, for example external supply cables, interface cables, the permitted level of electromagnetic radiation may be exceeded and the correct functioning of other products may be impaired.

Precautions:

While the product is in use, connecting cables, for example product to external battery, product to computer, must be connected at both ends.

13.8 FCC Statement, Applicable in U.S.

 **Warning**

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC rules.

These limits are designed to provide reasonable protection against harmful interference in a residential installation.

This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation.

If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and the receiver.


- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.


Warning


Changes or modifications not expressly approved by GeoMax for compliance could void the user's authority to operate the equipment.

Labelling

Type: ZTS600 Art.No.:

Power: 6V , 1Amax.

GeoMax AG 

CH-9443 Widnau 

Manufactured: S.No.:

Made in China

Complies with FDA performance standards for laser products except for deviations pursuant to Laser Notice No. 50, dated June 24, 2007.
This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:
(1) This device may not cause harmful interference, and
(2) this device must accept any interference received, including interference that may cause undesired operation.



14 Technical Data

14.1 Angle Measurement

Accuracy

Available angular accuracies	Standard deviation HA, VA, ISO 17123-3	Display resolution			
		["]	[°]	[mgon]	[mil]
2	0.6	1	0.0001	0.1	0.01
3	1.0	1	0.0001	0.1	0.01
5	1.5	1	0.0001	0.1	0.01
7	2	1	0.0001	0.1	0.01

Characteristics

Absolute, continuous, diametric. Updates each 0.1 to 0.3 s.

14.2 Distance Measurement with Reflectors

Range

Reflector	Range A		Range B		Range C	
	[m]	[ft]	[m]	[ft]	[m]	[ft]
Standard prism	1800	6000	3000	10000	3500	12000
3 prisms	2300	7500	4500	14700	5400	17700
360° prism	800	2600	1500	5000	2000	7000
Foil 60 mm x 60 mm	150	500	250	800	250	800
Mini prism	800	2600	1200	4000	2000	7000
360° Mini prism	450	1500	800	2600	1000	3300

Shortest measuring distance: 1.5 m

Atmospheric conditions

- Range A: Strong haze, visibility 5 km; or strong sunlight, severe heat shimmer
- Range B: Light haze, visibility about 20 km; or moderate sunlight, slight heat shimmer
- Range C: Overcast, no haze, visibility about 40 km; no heat shimmer

Accuracy

Accuracy refers to measurements to standard reflectors.

EDM measuring mode	Standard deviation ISO 17123-4	Measurement time, typical [s]
IR-Fine	2 mm + 2 ppm	2.4
IR-Quick	5 mm + 2 ppm	0.8
IR-Cont.	5 mm + 2 ppm	<0.15
IR-Foil	5 mm + 2 ppm	2.4

Beam interruptions, severe heat shimmer and moving objects within the beam path can result in deviations of the specified accuracy.

Characteristics

Principle:	Phase measurement
Type:	Coaxial, visible red laser
Carrier wave:	658 nm
Measuring system:	System analyser basis 100 MHz - 150 MHz

14.3 Distance Measurement without Reflectors (RL mode)

Range

SR

Kodak Gray Card	Range D		Range E		Range F	
	[m]	[ft]	[m]	[ft]	[m]	[ft]
White side, 90 % reflective	150	490	180	590	>200	>660
Grey side, 18 % reflective	80	260	100	330	>400	>1310

LR

Kodak Gray Card	Range D		Range E		Range F	
	[m]	[ft]	[m]	[ft]	[m]	[ft]
White side, 90 % reflective	180	590	270	880	>350	>1150
Grey side, 18 % reflective	100	330	150	490	>200	>660

Display unambiguous: up to 1200 m

Atmospheric conditions

Range D: Object in strong sunlight, severe heat shimmer
 Range E: Object in shade, or overcast
 Range F: Day, night and twilight

Accuracy

Standard measuring	Standard deviation ISO 17123-4	Measure time, typical [s]	Measure time, maximum [s]
0 m - 350 m	3 mm + 2 ppm	3 - 6	12

Beam interruptions, severe heat shimmer and moving objects within the beam path can result in deviations of the specified accuracy.

Continuous measuring*	Standard deviation	Measure time, typical [s]
Continuous	5 mm + 3 ppm	0.25

* Accuracy and measure time depend on atmospheric conditions, target object and observation situation.

Characteristics

Type: Coaxial, visible red laser
Carrier wave: 658 nm
Measuring system: System analyser basis 100 MHz - 150 MHz

14.4 RL to Prism

Range

SR & LR (with reflector)	Range A		Range B		Range C	
	[m]	[ft]	[m]	[ft]	[m]	[ft]
Standard pris	2000	6560	5000	16400	>7500	>24610



SR & LR (with reflector)	Range A		Range B		Range C	
	[m]	[ft]	[m]	[ft]	[m]	[ft]
Reflector foil 60 mm x 60 mm	500	1640	300	980	1500	4920

Range of measurement: From 1000 m up to 12000 m

Display unambiguous: Up to 12 km

Atmospheric conditions

Range A: Strong haze, visibility 5 km; or strong sunlight, severe heat shimmer

Range B: Light haze, visibility about 20 km; or moderate sunlight, slight heat shimmer

Range C: Overcast, no haze, visibility about 40 km; no heat shimmer

Accuracy

Standard measuring	Standard deviation ISO 17123-4	Measure time, typical [s]	Measure time, maximum [s]
RL Prism	5 mm + 2 ppm	2.5	12

Beam interruptions, severe heat shimmer and moving objects within the beam path can result in deviations of the specified accuracy.

Characteristics

Principle:	Phase measurement
Type:	Coaxial, visible red laser
Carrier wave:	658 nm
Measuring system:	System analyser basis 100 MHz - 150 MHz

14.5 Conformity to National Regulations

Conformity to national regulations



Hereby, GeoMax, declares that the instrument is in compliance with the essential requirements and other relevant provisions of applicable European Directives. The declaration of conformity may be consulted at <http://www.geomax-positioning.com>.

14.6 General Technical Data of the Instrument

Telescope

Magnification:	30 x
Free Objective aperture:	40 mm
Focusing:	1.7 m/5.6 ft to infinity
Field of view:	1°30'/1.66 gon. 2.7 m at 100 m

Compensation

Quadruple axis compensation (2-axis compensator with HA-collimation and VA-Index).

Angular accuracy	Setting accuracy		Setting range	
	["]	[mgon]	[']	[gon]
2	0.5	0.2	±4	0.07
3	1	0.3	±4	0.07
5	1.5	0.5	±4	0.07
7	2	0.7	±4	0.07

Level

Circular level sensitivity:	6'/2 mm
Electronic level resolution:	2"

Control unit Display: 280 x 160 pixels, LCD, backlit, 8 lines with 31 characters each.

Instrument Port

Name	Description
RS232	5 pin HiRose for power, communication, data transfer.

Instrument Dimensions

Height: 360 mm ± 5 mm (including tribrach and carry handle)
Width: 175 mm
Length: 150 mm
Carry case: 468x254x355 (LxBxH)

Weight

Instrument: 4.2 kg - 4.5 kg (depending on hardware configuration)
Tribrach: 760 g

Tilting axis height

Without tribrach: 196 mm
With tribrach: 240 mm ±5 mm

Recording

Memory Type	Capacity [KB]	Capacity (Datablocks / Known points)
Internal memory	576	10,000 datablocks, or 16,000 known points



Laser plummet

Type:	Visible red laser class 2
Location:	In standing axis of instrument
Accuracy:	Deviation from plumbline: 1.5 mm (2 sigma) at 1.5 m instrument height
Diameter of laser point:	2.5 mm at 1.5 m instrument height

Power

External supply voltage: (via serial interface)	Nominal voltage 12.8 V DC, Range 11.5 V-14 V
--	--

Battery ZBA101

Type:	NiMh
Voltage:	6 V
Capacity:	4200 mAh
Number of measurements: (angle + distance)	approximately 9000

Environmental specifications
Temperature

Type	Operating temperature		Storage temperature	
	[°C]	[°F]	[°C]	[°F]
Instrument	-20 to +50	-4 to +122	-40 to +70	-40 to +158
Battery	-20 to +50	-4 to +122	-20 to +35	-4 to +35

Protection against water, dust and sand

Type	Protection
Instrument	IP54 (IEC 60529)

Humidity

Type	Protection
Instrument	Max 95% non condensing. The effects of condensation are to be effectively counter-acted by periodically drying out the instrument.

Automatic corrections

The following automatic corrections are made:

- Line of sight error
- Earth curvature
- Standing axis tilt
- Vertical index error
- Refraction
- Compensator index error
- Circle eccentricity

14.7 Scale Correction

Use of scale correction

By entering a scale correction, reductions proportional to distance can be taken into account.

- Atmospheric correction.
- Reduction to mean sea level.



**Atmospheric
correction**

- Projection distortion.
-

The distance displayed is correct if the scale correction in ppm, mm/km, which has been entered corresponds to the atmospheric conditions prevailing at the time of the measurement.

The atmospheric correction includes:

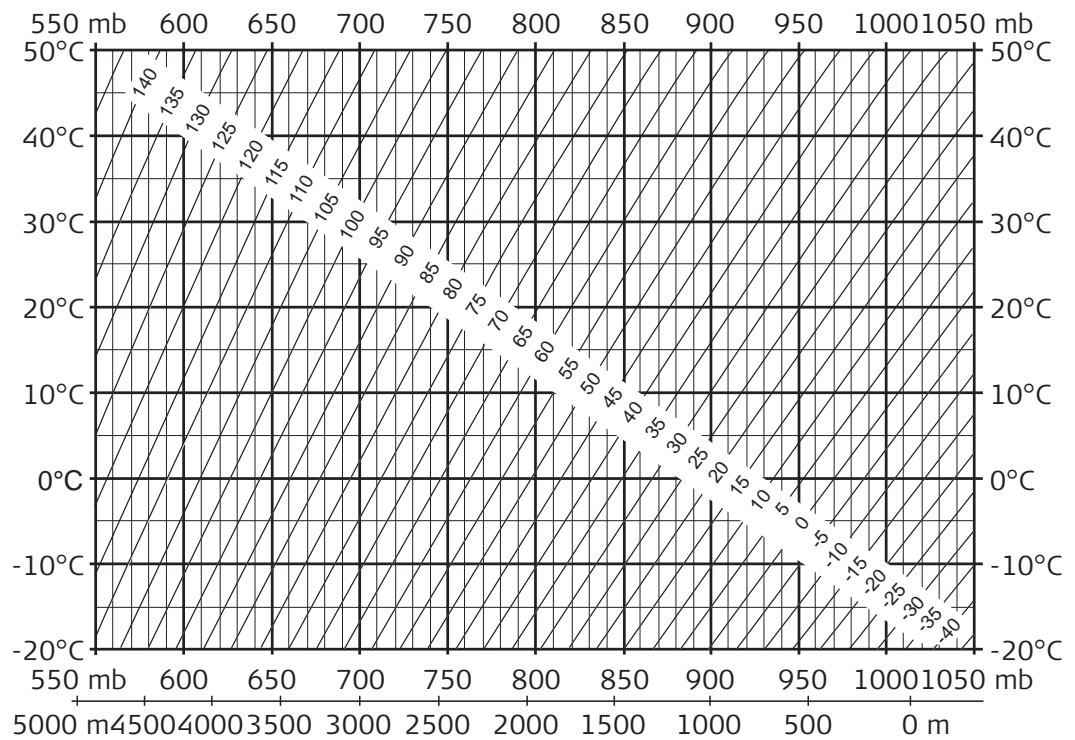
- Adjustments for air pressure
- Air temperature

For highest precision distance measurements, the atmospheric correction should be determined with:

- An accuracy of 1 ppm
 - Air temperature to 1°C
 - Air pressure to 3 mbar
-

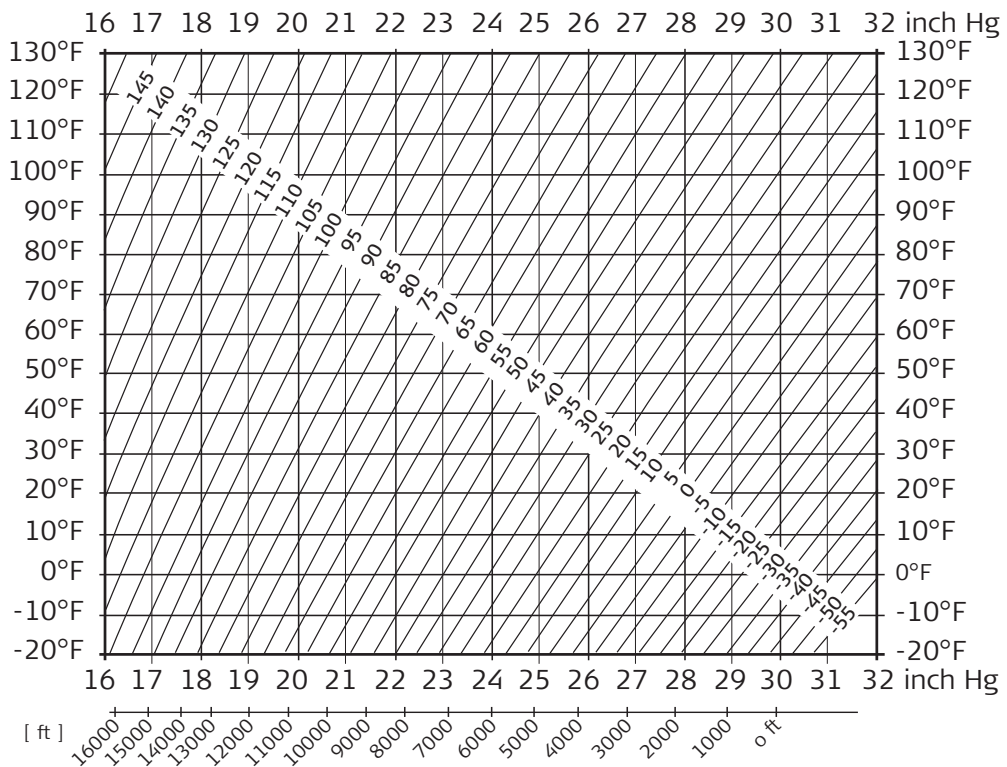
Atmospheric corrections °C

Atmospheric corrections in ppm with temperature [°C], air pressure [mb] and height [m] at 60 % relative humidity.



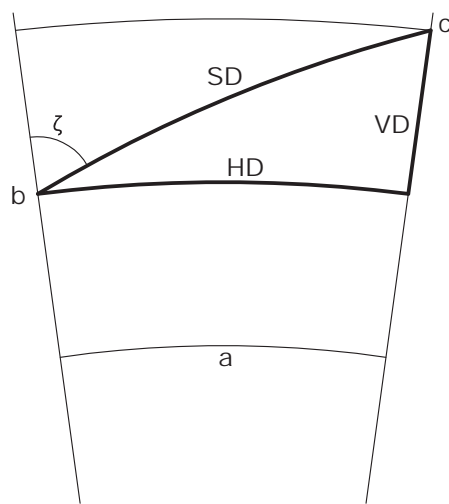
Atmospheric correction °F

Atmospheric corrections in ppm with temperature [°F], air pressure [inch Hg] and height [ft] at 60 % relative humidity.



14.8 Reduction Formulas

Formulas



- a Mean Sea Level
- b Instrument
- c Reflector
- SD Slope distance
- HD Horizontal distance
- VD Height difference

The instrument calculates the slope distance, horizontal distance, and height difference in accordance with the following formulas. Earth curvature ($1/R$) and mean refraction coefficient ($k = 0.13$) are automatically taken into account when calculating the horizontal distance and height difference. The calculated horizontal distance relates to the station height and not to the reflector height.

Slope distance

$$SD = D_0 \cdot (1 + ppm \cdot 10^{-6}) + mm$$

SD Displayed slope distance [m]
 D₀ Uncorrected distance [m]
 ppm Atmospheric scale correction [mm/km]
 mm prism constant [mm]

Horizontal distance

$$HD = Y - A \cdot X \cdot Y$$

HD Horizontal distance [m]
 Y SD * sinζ
 X SD * cosζ
 ζ = Vertical circle reading
 A (1 - k/2)/R = 1.47 * 10⁻⁷ [m⁻¹]
 k = 0.13 (mean refraction coefficient)
 R = 6.378 * 10⁶ m (radius of the earth)

Height difference

$$VD = X + B \cdot Y^2$$

VD Height difference [m]
 Y SD * sinζ
 X SD * cosζ
 ζ = Vertical circle reading
 B (1 - k)/2R = 6.83 * 10⁻⁸ [m⁻¹]
 k = 0.13 (mean refraction coefficient)
 R = 6.378 * 10⁶ m (radius of the earth)

15 International Limited Warranty, Software License Agreement

International Limited Warranty

This product is subject to the terms and conditions set out in the International Limited Warranty which you can download from the GeoMax home page at <http://www.geomax-positioning.com> or collect from your GeoMax distributor.

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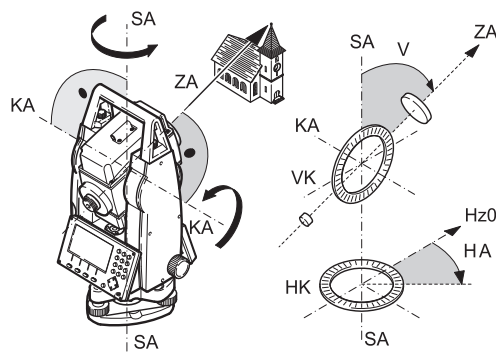


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16 Glossary

Instrument axis



ZA = Line of sight / collimation axis
Telescope axis = line from the reticle to the center of the objective.

SA = Standing axis
Vertical rotation axis of the telescope.

KA = Tilting axis
Horizontal rotation axis of the telescope. Also known as the Trunion axis.

V = Vertical angle / zenith angle

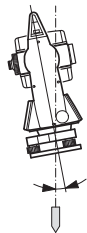
VK = Vertical circle
With coded circular division for reading the vertical angle.

HA = Horizontal direction

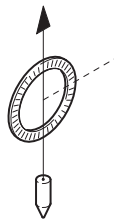
HK = Horizontal circle
With coded circular division for reading the horizontal angle.

Plumb line / compensator

Direction of gravity. The compensator defines the plumb line within the instrument.

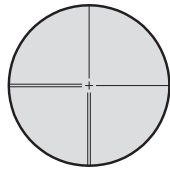
Standing axis inclination

Angle between plumb line and standing axis. Standing axis tilt is not an instrument error and is not eliminated by measuring in both faces. Any possible influence it may have on the horizontal direction or vertical angle is eliminated by the dual axis compensator.

Zenith

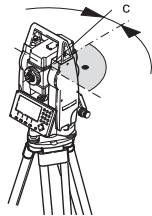
Point on the plumb line above the observer.

Reticle



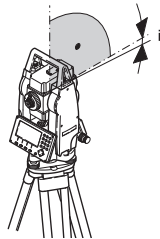
Glass plate within the telescope with reticle.

Line-of-sight error (horizontal collimation)



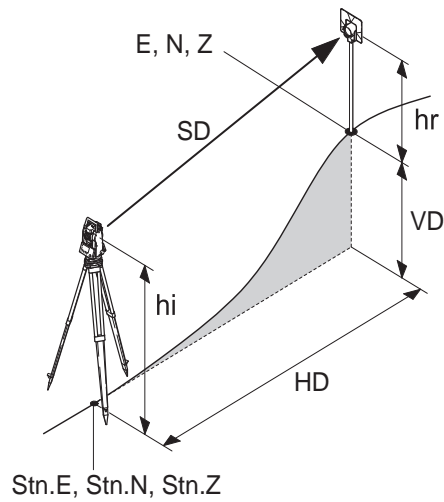
The line-of-sight error (c) is the deviation from the perpendicular between the tilting axis and line of sight. This could be eliminated by measuring in both faces.

Vertical index error



With a horizontal line of sight the vertical circle reading should be exactly 90° (100 gon). The deviation from this value is termed the Vertical index error (i).

Explanation of displayed data



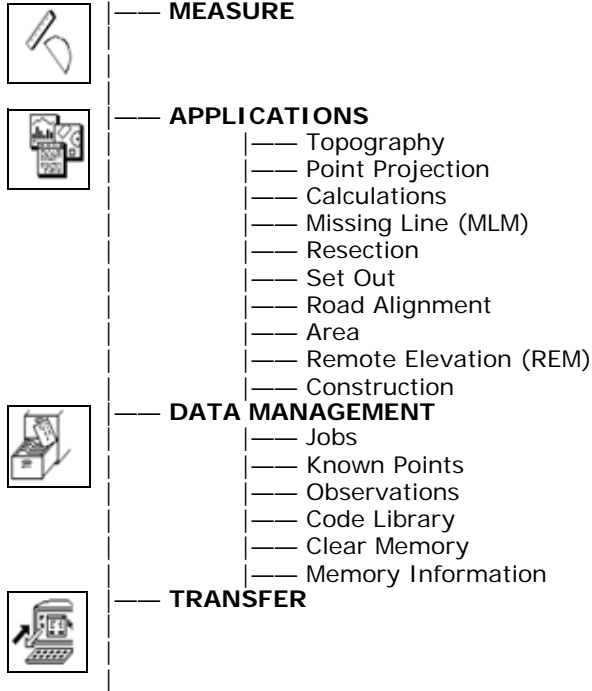
- SD Indicated meteorological corrected slope distance between instrument tilting axis and center of prism/laser dot
- HD Indicated meteorological corrected horizontal distance
- VD Height difference between station and target point
- hr Reflector height above ground
- hi Instrument height above ground
- E,N,Z Easting, Northing and Height coordinates of target point
- Stn.E, Stn.N, Stn.Z Easting, Northing and Height coordinates of station

Appendix A Menu Tree



Depending on local firmware versions the menu items may differ.

Menu Tree



**CONFIGURATION**

- Main Configuration
- Comm. Setup
- EDM Configuration
- Start Sequence
- System Information

**CALIBRATIONS**

- HA-Collimation
 - VA-Index
 - View Calibration Data
-

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GeoMax ZTS600 Series



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