Leica FlexLine

TS02/TS06/TS09

User Manual

Version 2.0
English

- when it has to be **right**

Leica
Geosystems

Introduction

Purchase

Congratulations on the purchase of a FlexLine 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 Leica Geosystems 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

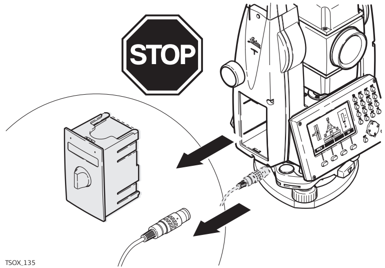
- Windows is a registered trademark of Microsoft Corporation.
- Bluetooth is a registered trademark of Bluetooth SIG, Inc.

All other trademarks are the property of their respective owners.

Validity of this manual

	Description
General	This manual applies to TS02, TS06, and TS09 instruments. Where there are differences between the various instruments they are clearly described. The following symbols will identify in each section where the instruments differ: • **TS02** for TS02. • **TS06** for TS06. • **TS09** for TS09.
Telescope	• **Measuring with Prism mode:** When measuring distances to a reflector with Electronic Distance Measurement (EDM) mode "Prism", the telescope uses a wide visible red laser beam, which emerges coaxially from the telescope's objective. • **Measuring with Non-Prism modes:** Instruments that are equipped with a reflectorless EDM additionally offer the EDM mode "Non-Prism". When meauring distances with this EDM mode, the telescope uses a narrow visible red laser beam, which emerges coaxially from the telescope's objective.

Warning



Do **NOT** remove the battery during operation of the instrument, or during the shutdown procedure.

This can result in a file system error and data loss!

Always switch off the instrument by pressing the On/Off key, and wait until the instrument has shutdown completely before removing the battery.

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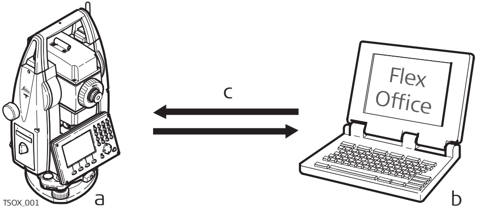
1 Description of the System

1.1 System Components

Main Components



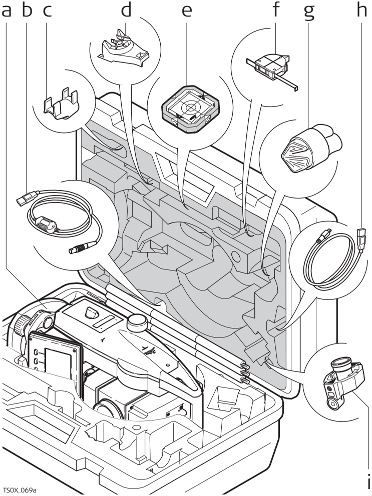
a) FlexLine instrument with FlexField firmware
b) Computer with FlexOffice software
c) Data transfer

Component	Description
FlexLine instrument	An instrument for measuring, calculating and capturing data. Ideally suited for tasks from simple surveys to complex applications. Equipped with a FlexField firmware package to complete these tasks. The various lines have a range of accuracy classes and support different features. All lines can be connected with FlexOffice to view, exchange and manage data.
FlexField firmware	The firmware package installed on the instrument. Consists of a standard base operating system with optional additional features.

Component	Description
FlexOffice software	An office software consisting of a suite of standard and extended programs for the viewing, exchanging, managing and post processing of data.
Data transfer	Data can be always transferred between a FlexLine instrument and a computer via a data transfer cable. For instruments equipped with a Communication side cover data can also be transferred via USB memory stick, USB cable, or Bluetooth.

1.2 Container Contents

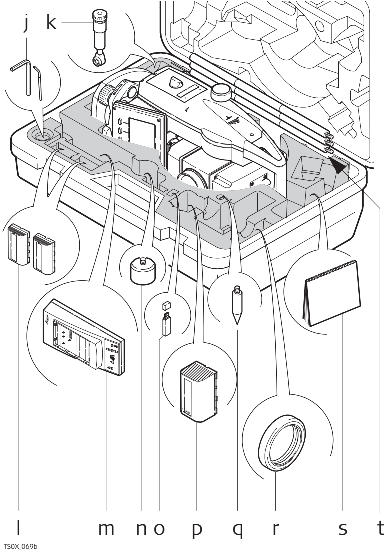
Container contents part 1 of 2



a) Instrument with supplied tribrach
b) GEV189 data cable (USB-RS232)*
c) GLI115 clip-on bubble*
d) GHT196 holder for height meter*
e) CPR105 flat prism*
f) GHM007 height meter*
g) Protective cover / Lens hood*
h) GEV223 data cable (USB-mini USB) - for instruments with a Communication side cover
i) GMP111 mini prism*

* Optional

Container contents part 2 of 2

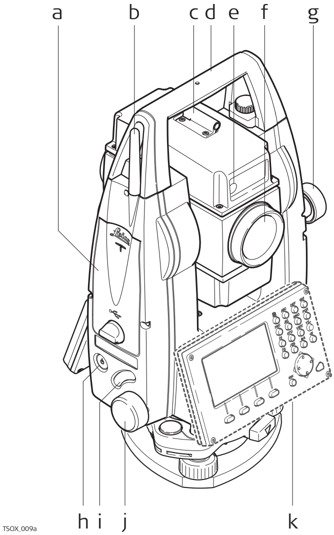


- j) Adjustment tools
- k) GFZ3 diagonal eyepiece*
- l) GEB211 batteries*
- m) GKL211 battery charger*
- n) GAD105 flat or mini prism adapter*
- o) MS1 Leica industrial grade USB memory stick - for instruments with a Communication side cover
- p) GEB221 battery*
- q) Tip for mini prism pole*
- r) Counterweight for diagonal eyepiece*
- s) User manual
- t) GLS115 mini prism pole*

* Optional

1.3 Instrument Components

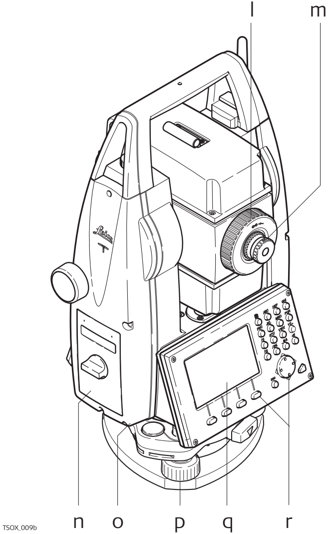
Instrument components part 1 of 2



a) Compartment for USB memory stick and USB cable ports*
b) Bluetooth antenna*
c) Optical sight
d) Detachable carrying handle with mounting screw
e) Electronic Guide Light (EGL)*
f) Objective with integrated Electronic Distance Measurement (EDM). Exit for EDM laser beam
g) Vertical drive
h) On/Off key
i) Trigger key
j) Horizontal drive
k) Second keyboard*

* Optional

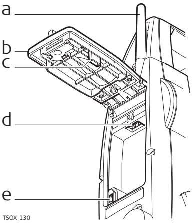
Instrument components part 2 of 2



l) Focusing telescope image
m) Eyepiece; focusing graticule
n) Battery cover
o) Serial interface RS232
p) Foot screw
q) Display
r) Keyboard

Communication side cover

A Communication side cover is optional for **TS02** **TS06** and included for **TS09**.



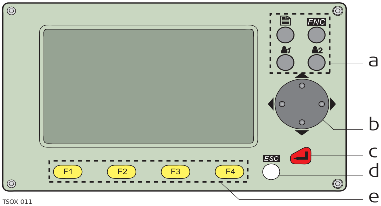
a) Bluetooth antenna
b) Compartment lid
c) USB memory stick cap storage
d) USB host port
e) USB device port

2 User Interface

2.1 Keyboard

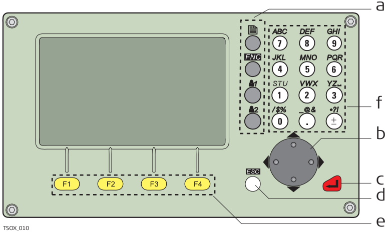
Keyboard

Standard keyboard



TSOX_011

Alphanumeric keyboard

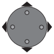


TSOX_010

a) Fixed keys
b) Navigation key
c) **ENTER** key
d) **ESC** key
e) Function keys **F1** to **F4**
f) Alphanumeric keypad

Keys

Key	Description
	Page key. Displays the next screen when several screens are available.
FNC	**FNC** key. Quick-access to measurement supporting functions.

Key	Description
	User key 1. Programmable with a function from the FNC menu.
	User key 2. Programmable with a function from the FNC menu.
	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.
F1, F2, F3, F4	Function keys that are assigned the variable functions displayed at the bottom of the screen.
	Alphanumeric keypad for entry of text and numerical values.

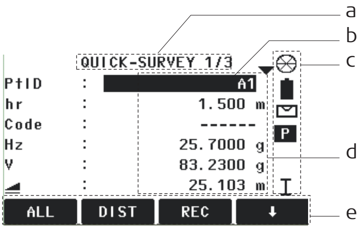
Sidecover keys

Key	Description
	On / Off key. Switches the instrument on or off.

Key	Description
	Trigger key. Quick key programmable with functions **ALL** or **DIST,** if desired. **TS06** **TS09** Programmable with both of the functions. **TS02** Programmable with one of the functions. The trigger key can be programmed in the **Settings** screen. Refer to "4.1 General Settings".

2.2 Screen

Screen



S_TSOX_001

a) Title of screen
b) Focus in screen. Active field
c) Status icons
d) Fields
e) Softkeys

All shown screens are examples. It is possible that local firmware versions are different to the basic version.

2.3 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.
P	Prism EDM mode for measuring to prisms and reflective targets.
NP	Non-Prism EDM mode for measuring to all targets.
!	Offset is active.
012	Keypad is set to numeric mode.
ABC	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.
	Leica standard prism is selected.
	Leica mini prism is selected.
	Leica 360° prism is selected.
	Leica 360° mini prism is selected.
	Leica reflector tape is selected.
	User defined prism is selected.
	Bluetooth is connected. If there is a cross beside the icon, the Bluetooth communication port is selected, but the status is inactive.
	USB communication port is selected.

2.4 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.
ALL	To start distance and angle measurements and save the measured values.
DIST	To start distance and angle measurements without saving the measured values.
EDM	To view and change EDM settings. Refer to "4.2 EDM Settings".
ENH	To open the manual coordinate entry screen.
EXIT	To exit the screen or application.
FIND	To search for an entered point.
INPUT	**TS02** To activate alphanumerical softkeys for text entry.
P/NP	To toggle between Prism and Non-Prism EDM modes.
LIST	To display the list of available points.

Key	Description
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.
PREV	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.
⇤	To return to the first softkey level.

2.5 Operating Principles

Turn instrument on/off

Use the On/Off key on the side cover of the instrument.

Selection of language

After switching on the instrument the user is able to choose their preferred language. The language choice screen is only shown if multiple languages are loaded onto the instrument and **Lang.choice: On** is set in the instrument settings. Refer to "4.1 General Settings".

Alphanumeric keypad

The alphanumerical 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 written above that key will be displayed. By pressing several times you can toggle through the characters.
  For example: 1->S->T->U->1->S....

Standard keyboard

To enter characters using a standard keypad, select **INPUT** and the softkeys will change to represent the alphanumerical characters available in edit mode. Select the appropriate softkey for entry of the character.

Edit fields

☞ **ESC** Deletes any change and restores the previous value.

◄ Moves the cursor to the left.

► Moves the cursor to the right.

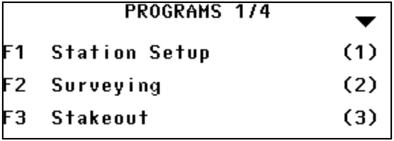
▲ Inserts a character at the cursor position.

▼ 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 "2.6 Pointsearch".
+/-	In the alphanumeric character set "+" and "-" are treated as normal alphanumeric characters with no mathematical function. "+" / "-" only appear in front of an entry.



In this example selecting 2 on an alphanumeric keyboard would start the Surveying application.

2.6 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.

ENH=0
To set all ENH 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

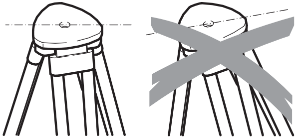
Description

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.

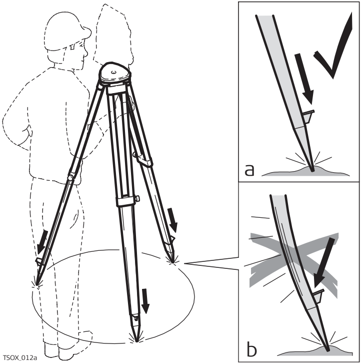
Important features

- 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

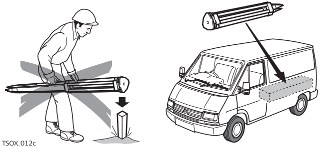

TSOX_012b

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.

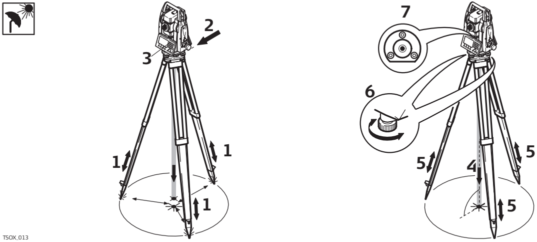
a In order to guarantee a firm foothold sufficiently press the tripod legs into the ground.
b When pressing the legs into the ground note that the force must be applied along the legs.



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, and, if tilt correction is set to 1- or 2-axis, the laser plummet will be activated automatically, and the **Level/Plummet** screen appears. Otherwise, press **FNC** from within any application and select **Level/Plummet**.
4. Move the tripod legs (1) and use the tribrach footscrews (6) to center the plummet (4) over the ground point.
5. Adjust the tripod legs (5) to level the circular level (7).
6. By using the electronic level, turn the tribrach footscrews (6) 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 (2).
8. Repeat steps 6. and 7. until the required accuracy is achieved.

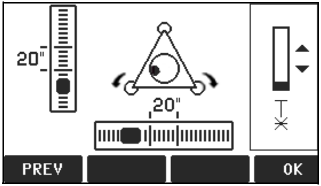
Level up with the electronic level step-by-step

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

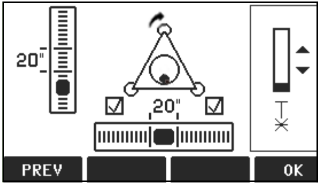
1. Turn the instrument until it is parallel to two footscrews.
2. Center the circular level approximately by turning the footscrews of the tribrach.
3. Turn on the instrument, and, if tilt correction is set to 1- or 2-axis, the laser plummet will be activated automatically, and the **Level/Plummet** screen appears. Otherwise, press **FNC** from within any application and select **Level/Plummet**.

   ☞ 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.

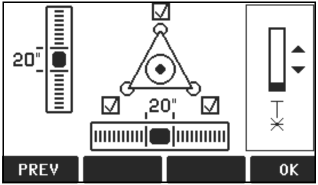
4. Center the electronic level of the first axis by turning the two footscrews. Arrows show the direction of rotation required. When the electronic level is centered the arrows are replaced by checkmarks.



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



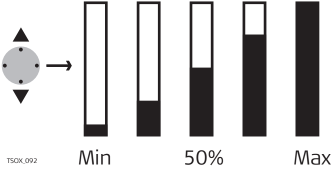
☞ When the electronic level is centered and three checkmarks are shown, the instrument has been perfectly levelled up.



6. Accept with **OK**.

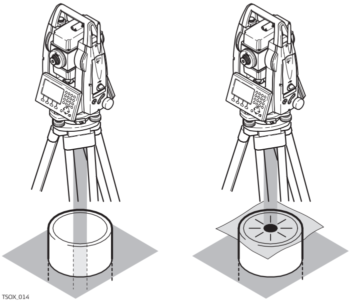
Change the intensity of the laser plummet

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



In the **Level/Plummet** 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

☞

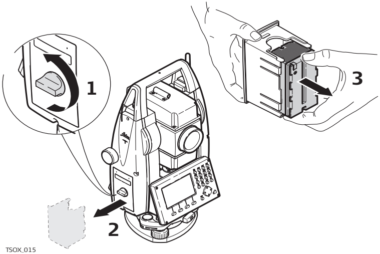
Charging / first-time use

- 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 only one charge/discharge cycle.
- The permissible temperature range for charging is between 0°C to +40°C/ +32°F to +104°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 Leica Geosystems, it is not possible to charge the battery if the temperature is too high.

Operation / discharging

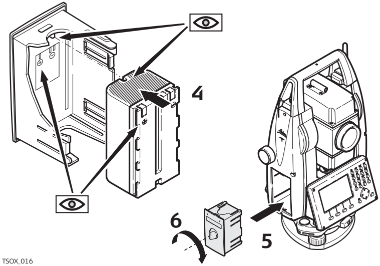
- The batteries can be operated from -20°C to +50°C/-4°F to +122°F.
- Low operating temperatures reduce the capacity that can be drawn; very high operating temperatures reduce the service life of the battery.
- For Li-Ion batteries, we recommend carrying out a single discharging and charging cycle when the battery capacity indicated on the charger or on a Leica Geosystems product deviates significantly form the actual battery capacity available.

Change the battery step-by-step



Open the battery compartment (1) and remove the battery holder (2).

Remove the battery from the battery holder (3).



Insert the new battery into the battery holder (4), ensuring that the contacts are facing outward. The battery should click into position.

Insert the battery holder back into the battery compartment (5) and turn the knob to lock the battery holder in place (6).

☞ The polarity of the battery is displayed inside the battery housing.

3.3 Data Storage

Description

An internal memory is included in all instruments. The FlexField 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 LEMO cable connected to the serial interface RS232 port.
For instruments fitted with a Communication side cover, data can also be transferred from the internal memory to a computer or other device via:

- a USB memory stick inserted into the USB host port,
- a USB cable connected to the USB device port, or
- via a Bluetooth connection.

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

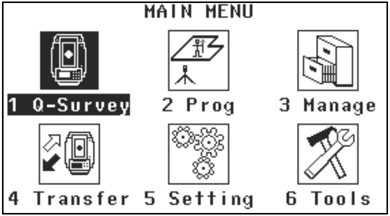
3.4 Main Menu

Description

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

☞ If desired, the instrument can be configured to start in a user defined place after the Level/Plummet screen, instead of the **MAIN MENU**. Refer to "5.2 Start Up Sequence".

MAIN MENU



Description of the MAIN MENU functions

Function	Description
Q-Survey	**Quick Survey** program to begin measuring immediately. Refer to "3.5 Q-Survey Application".
Prog	To select and start applications. Refer to "9 Applications".
Manage	To manage jobs, data, codelists, formats, system memory and USB memory stick files. Refer to "10 Data Management".
Transfer	To export and import data. Refer to "10.2 Exporting Data".
Setting	To change EDM configurations, communication parameters and general instrument settings. Refer to "4 Setting".
Tools	To access instrument related tools such as check and adjust calibrations, personal start up settings, PIN code settings, licence keys and system information. Refer to "5 Tools".

3.5 Q-Survey Application

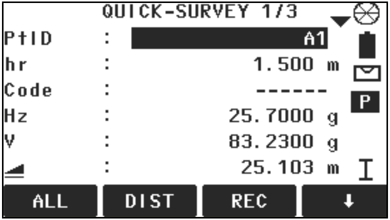
Description

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

Access

Select **Q-Survey** from the **MAIN MENU**.

QUICK-SURVEY



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

⬇ **STATION**
To enter station data and set the station.

⬇ **Hz=0**
To set the orientation to horizontal direction = 0.

⬇ **Hz← / Hz→**
To set the horizontal angle reading to the left (anticlockwise) or to the right (clockwise).

The procedure for **Q-Survey** is identical to the procedure for the application **Surveying**. Therefore this procedure is only described once within the application chapter. Refer to "9.3 Surveying".

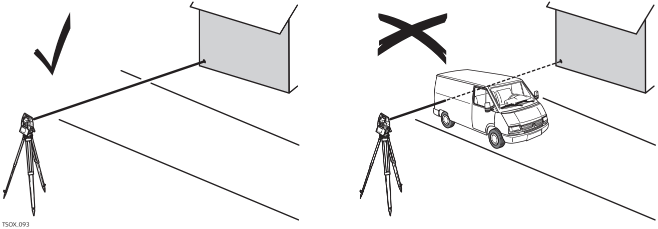
3.6 Distance Measurements - Guidelines for Correct Results

Description

A laser distancer (EDM) is incorporated into the FlexLine instruments. In all versions, 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
- Non-Prism measurements

Non-Prism measurements



- 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.

Prism measurements

- 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 interferring in the beam path.

⚠ **Warning**

Due to laser safety regulations and measuring accuracy, using the Long Range Reflectorless EDM is only allowed to prisms that are more than 1000 m (3300 ft) away.

Red laser to prism

- Prism (>3.5 km) 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).

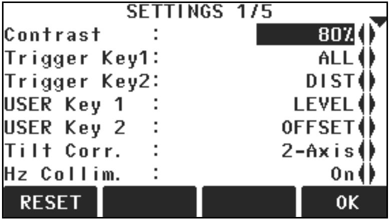
4 Setting

4.1 General Settings

Access

1. Select **Setting** from the **MAIN MENU**.
2. Select **General** from the **SETTINGS MENU**.
3. Press to scroll through the screens of available settings.

SETTINGS

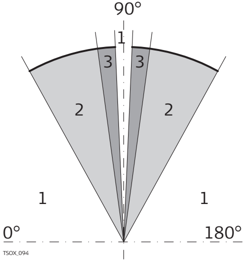


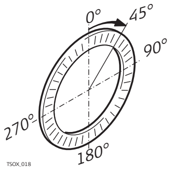
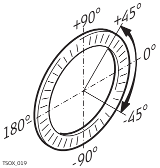
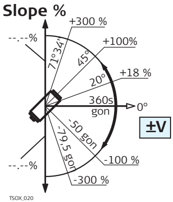
DelLang
To delete a selected language.

Field	Description	
Contrast	**0%** to **100%**	Sets the display contrast in 10% steps.
Trigger Key1 / Key2	Trigger Key 1 is the top end of the trigger key. Trigger Key 2 is the lower end of the trigger key.	
	Off	The trigger key is deactivated.

Field	Description	
	ALL	Sets the trigger key with the same function as **ALL**.
	DIST	Sets the trigger key with the same function as **DIST**.
USER Key 1 / Key 2	Configures or with a function from the FNC menu. Refer to "6 Functions".	
Tilt Corr.	**Off**	Tilting compensation deactivated.
	1-axis	Vertical angles refer to the plummet line.
	2-axis	Vertical angles refer to the plummet line and the horizontal directions are corrected by the standing axis tilt. For corrections depending on the **Hz Corr:** setting, refer to the table "Tilt and horizontal corrections".
☞	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 it's measuring range and interrupting the measuring process by indicating an error.	

Field	Description	
Hz Corr.	**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. For corrections depending on the **Tilt Corr:** setting, refer to the table "Tilt and horizontal corrections".
	Off	Horizontal corrections are deactivated.
Beep	The beep is an acoustic signal after each key stroke.	
	Normal	Normal volume.
	Loud	Increased volume.
	Off	Beep is deactivated.
Sector Beep	**On**	Sector Beep sounds at right angles (0°, 90°, 180°, 270° or 0, 100, 200, 300 gon).

Field	Description	
	 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.	
	Off	Sector Beep is deactivated.
Hz Increment	**Right**	Set horizontal angle to clockwise direction measurement.
	Left	Set horizontal angle to counter-clockwise direction measurement. Counter-clockwise directions are displayed but are saved as clockwise directions.
V-Setting	Sets the vertical angle.	

<table>
<tr><th>Field</th><th colspan="3">Description</th></tr>
<tr><td></td><td>Zenith</td><td>
</td><td>Zenith=0°; Horizon=90°.</td></tr>
<tr><td></td><td>Horiz.</td><td>
</td><td>Zenith=90°; Horizon=0°. Vertical angles are positive above the horizon and negative below it.</td></tr>
<tr><td></td><td>Slope %</td><td>
</td><td>45°=100%; Horizon=0°. Vertical angles are expressed in % with positive above the horizon and negative below it.
☞ The % value increases rapidly. --.--% appears on the display above 300%.</td></tr>
</table>

Field	Description	
Face I Def.	Sets the face I in relation to the position of the vertical drive.	
	V-Left	Sets face I to be when the vertical drive is on the left of the instrument.
	V-Right	Sets face I to be when the vertical drive is on the right of the instrument.
Language	Sets the chosen language. An unlimited number of languages can be uploaded onto the instrument. The current loaded language(s) are shown. A selected language can be deleted by pressing **DelLang**. This function is available on page 2 of the **SETTINGS** screen if more than one language is installed, and the selected language is not the chosen operating language.	
Lang. Choice	If multiple languages are loaded, a screen to choose the language can be shown directly after switching on the instrument.	
	On	The language screen is shown as the startup screen.
	Off	The language screen is not shown as the startup screen.
Angle Unit	Sets the units shown for all angular fields.	

Field	Description	
	° ' "	Degree sexagesimal. Possible angle values: 0° to 359°59'59''
	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.	
Min. Reading	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.	
	For **Angle Unit**	**° ' ''**: (0° 00' 01" /0° 00' 05"/0° 00' 10").
		Dec.deg: **(**0.0001 / 0.0005 / 0.001).
		Gon: **(**0.0001 / 0.0005 / 0.001).
		Mil: **(**0.01 / 0.05 / 0.1).
Dist. Unit	Sets the units shown for all distance and coordinate related fields.	
	Meter	Meters [m].
	US-ft	US feet [ft].
	INT-ft	International feet [fi].

Field	Description	
	ft-in/16	US feet-inch-1/16 inch [ft].
Dist.Decimal	Sets the number of decimal places shown for all distance fields. This is for data display and does not apply to data export or storage.	
	3	Displays distance with three decimals.
	4	Displays distance with four decimals.
Temp. Unit	Sets the units shown for all temperature fields.	
	°C	Degree Celsius.
	°F	Degree Fahrenheit.
Press.Unit	Sets the units shown for all pressure fields.	
	hPa	Hecto Pascal.
	mbar	Millibar.
	mmHg	Millimeter mercury.
	inHg	Inch mercury.
Grade Unit	Sets how the slope gradient is calculated.	
	h:v	Horizontal : Vertical, for example 5 : 1.
	v:h	Vertical : Horizontal, for example 1 : 5.
	%	(v/h x 100), for example 20 %.

Field	Description	
Data Output	Sets the location for data storage.	
	Int.Mem.	All data is recorded in the internal memory.
	Interf.	Data is recorded via the serial interface or the USB device port, depending on the port selected in the **COMMUNICATION PARAMETERS** screen. This **Data Output** setting is only required if an external storage device is connected and measurements are started at the instrument with DIST/REC or ALL. This setting is not required if the instrument is totally controlled by a datalogger.
GSI Format	Sets the GSI output format.	
	GSI 8	81..00+12345678
	GSI 16	81..00+1234567890123456
GSI Mask	Sets the GSI output mask.	
	Mask1	PtID, Hz, V, SD, ppm+mm, hr, hi.
	Mask2	PtID, Hz, V, SD, E, N, H, hr.

Field	Description	
	Mask3	StationID, E, N, H, hi (Station). StationID, Ori, E, N, H, hi (Station Result). PtID, E, N, H (Control). PtID, Hz, V (Set Azimuth). PtID, Hz, V, SD, ppm+mm, hr, E, N, H (Measurement).
Code record	Sets if the codeblock is saved before or after the measurement. Refer to "7 Coding".	
Code	Sets if the code will be used for one, or many, measurements.	
	Reset after REC	The set code is cleared from the measurement screen after **ALL** or **REC** is selected.
	Permanent	The set code remains in the measurement screen until manually deleted.
Display ill.	**Off** to **100%**	Sets the display illumination in 20% steps.
Reticle ill.	**Off** to **100%**	Sets the reticle illumination in 20% steps.
Displ.Heater	**On**	The display heater is activated.
	Off	The display heater is deactivated.
	The display heater is automatically activated when the display illumination is on and the instrument temperature is $\leq$ 5°C.	
Pre-/Suffix		Only used for the Stakeout application.

Field	Description	
	Prefix	Adds the character entered for **Identifier** in front of the original point number of the point to be staked.
	Suffix	Adds the character entered for **Identifier** at the end of the original point number of the point to be staked.
	Off	The staked point is stored with the same point number as the point to be staked.
Identifier	☞	Only used for the Stakeout 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 staked.	
Sort Type	**Time**	Lists are sorted by time of entry.
	PtID	Lists are sorted by Point IDs.
Sort Order	**Descen.**	Lists are ordered in descending order of sort type.
	Ascen.	Lists are ordered in ascending order of sort type.
Double PtID	Sets if multiple points are able to be recorded with the same point ID in the same job.	
	Allowed	Allows multiple points with the same point ID.

Field	Description	
	Not Allowed	Does not allow multiple points with the same point ID.
Auto-Off	**Enable**	The instrument switches off after 20 minutes without any activity , for example no key pressed or vertical and horizontal angle deviation is ≤ ±3".
	Disable	Automatic switch-off is deactivated.
		☞ Battery discharges quicker.
V After DIST	Sets if the vertical angle value recorded is the value that is displayed when **DIST** or when **REC** is pressed. The vertical angle field in a measurement screen always shows the running angle, regardless of this setting.	
	Hold	The vertical angle value that is recorded is the value that was in the vertical angle field at the time **DIST** was pressed.
	Running	The vertical angle value that is recorded is the value in the vertical angle field at the time **REC** is pressed.
	☞	This setting is not applicable for the application Tie Distance or the functions Hidden Point and Height Transfer. For these, the vertical angle is always running and the value recorded is the value when **REC** is pressed.

Tilt and horizontal corrections

Setting		Correction			
Tilt correction	**Horizontal correction**	**Incline longitudinal**	**Incline transversal**	**Horizontal collimation**	**Tilting axis**
Off	**On**	No	No	Yes	Yes
1-Axis	**On**	Yes	No	Yes	Yes
2-Axis	**On**	Yes	Yes	Yes	Yes
Off	**Off**	No	No	No	No
1-Axis	**Off**	Yes	No	No	No
2-Axis	**Off**	Yes	No	No	No

4.2 EDM Settings

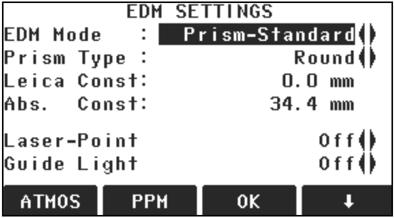
Description

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

Access

1. Select **Settings** from the **MAIN MENU**.
2. Select **EDM** from the **SETTINGS MENU**.

EDM SETTINGS



ATMOS
To enter atmospheric data ppm.

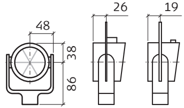
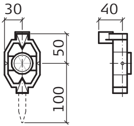
PPM
To enter an individual ppm value.

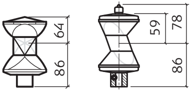
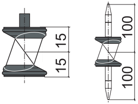
⬇ **SCALE**
To enter projection scale details.

⬇ **SIGNAL**
To view EDM Signal reflection value.

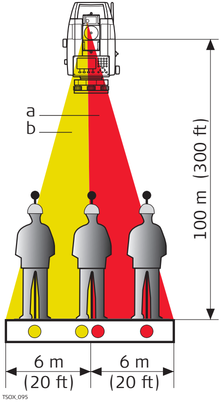
⬇ **FREQ.**
To view the EDM frequency.

Field	Description	
EDM mode	**Prism-Standard**	Fine measuring mode for high precision measurements with prisms.
	Non-Prism-Std.	For distance measurements without prisms.
	Non-Prism-Track.	For continuous distance measurements without prisms.
	Prism (>3.5km)	For long range distance measurements with prisms.
	Prism-Fast	Quick measuring mode with prisms, with higher measuring speed and reduced accuracy.

Field	Description		
	Prism-Tracking	For continuous distance measurements with prisms.	
	Tape	For distance measurements using Retro reflective targets.	
	FlexPoint	Included for **TS06** and **TS09**.Optional for **TS02**. Allows short distances, ~30 m, to be measured without a reflector.	
Prism Type	**Round**		Standard prism GPR121/111 Leica Constant: 0.0 mm
	Mini		GMP111 Leica Constant: +17.5 mm GMP111-0 Leica Constant: 0.0 mm
	JpMini	Miniprism	Leica Constant: +34.4 mm

Field	Description		
	360°		GRZ4/122 Leica Constant: +23.1 mm
	360° Mini		GRZ101 Leica Constant: +30.0 mm
	User1 / User2	The user can define two of their own prisms. Constants can be entered in mm in either **Leica Const:** or **Abs. Const:**. For example: User prism constant **Leica Const:** **Abs. Const:**	 = -30.0 mm = +4.4 mm (34.4 + -30 = 4.4) = -30.0 mm
	Tape		Leica Constant: +34.4 mm
	None	**Without prism**	Leica Constant: +34.4 mm

Field	Description	
Leica Const.	This field displays the Leica prism constant for the selected **Prism Type:** Where **Prism Type:** is **User 1** or **User 2** this field becomes editable to set a user defined constant. Input can only be made in mm. Limit value: -999.9 mm to +999.9 mm.	
Abs. Const	This field displays the absolute prism constant for the selected **Prism Type:**. Where **Prism Type:** is **User 1** or **User 2** this field becomes editable to set a user defined constant. Input can only be made in mm. Limit value: -999.9 mm to +999.9 mm.	
Laser-Point	**Off**	Visible laser beam is deactivated.
	On	Visible laser beam for visualising the target point is activated.
Guide Light	**Off**	Guide Light is deactivated.
	On	Guide Light is activated. The person at the prism can be guided by the flashing lights directly to the line of sight. The light points are visible up to a distance of 150 meters. This is useful when staking out points. Working range: 5 m to 150 m (15 ft to 500 ft). Positioning accuracy: 5 cm at 100 m (1.97" at 330 ft).

Field	Description
	 a) Flashing red diode b) Flashing yellow diode

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 Leica 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.

4.3 Communication Parameters

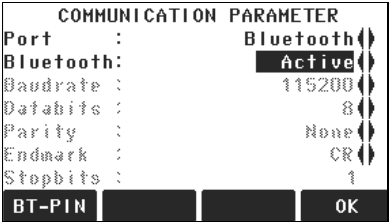
Description

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

Access

1. Select **Settings** from the **MAIN MENU**.
2. Select **Comm** from the **SETTINGS MENU**.

COMM. - PARAMETERS



BT-PIN

To set a PIN code for the Bluetooth connection.

This softkey is only available for instruments with a Communication side cover. The default Bluetooth PIN is '0000'.

RESET

To reset the fields to the default Leica standard settings.

Field	Description	
Port	Instrument port. If a Communication side cover is fitted the options are selectable. If there is no Communication side cover the value is set to **RS232** and is uneditable.	
	RS232	Communication is via the serial interface.
	USB	Communication is via the USB host port.
	Bluetooth	Communication is via Bluetooth.
	Automatically	Communication is set to auto detect.
Bluetooth	**Active**	Bluetooth sensor is activated.
	Inactive	Bluetooth sensor is deactivated.

The following fields are active only when **Port: RS232** is set.

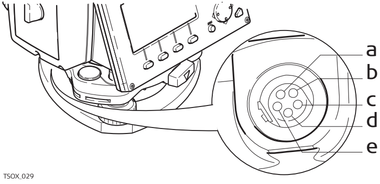
Field	Description	
Baudrate	Speed of data transfer from receiver to device in bits per second.	
	1200, 2400, 4800, 9600, 14400, 19200, 38400, 57600, 115200	
Databits	Number of bits in a block of digital data.	
	7	Data transfer is realised with 7 databits.
	8	Data transfer is realised with 8 databits.
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.
Acknowlge	**On**	Acknowledgement expected from other device after data transfer received. An error message will display if no acknowledgement is returned.
	Off	No acknowledgement expected after data transfer.

Leica standard settings

When **RESET** is selected the communication parameters are reset to the default Leica standard settings:

- 115200 Baud, 8 Databit, No Parity, CR/LF Endmark, 1 Stopbit.

Interface plug connections



a) External battery
b) Not connected / inactive
c) GND
d) Data reception (TH_RXD)
e) Data transfer (TH_TXD)

5 Tools

5.1 Adjust

Description

The **ADJUSTMENTS** 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 **TOOLS** from the **MAIN MENU**.
2. Select **Adjust** from the **TOOLS MENU**.
3. Select an Adjustment option from the **ADJUSTMENTS** screen.

Adjustment options

In the **ADJUSTMENT** screen there are several adjustment options.

Menu selection	Description
Hz-Collimation	Refer to "11.3 Adjusting Line-of-Sight and Vertical Index Error".
V-Index	Refer to "11.3 Adjusting Line-of-Sight and Vertical Index Error".
Tilt Axis	Refer to "11.4 Adjusting the Tilting Axis Error".
View Adjustment Data	Displays the current adjustment values that have been set for Hz-Collimation, V-index and Tilt Axis.

Menu selection	Description
Adjust Reminder	Defines the time period from the last adjustment to when a reminder message should display to do another adjustment. Options are: **Never**, **2 weeks**, **1 month**, **3 months**, **6 months**, **12 months**. The message will display the next time the instrument is switched on after the time period has been reached.

5.2 Start Up 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 after the Level/Plummet screen instead of the **MAIN MENU**. For example, the general **SETTINGS** screen for configuring the instrument settings.

Access

1. Select **TOOLS** from the **MAIN MENU**.
2. Select **Startup** from the **TOOLS 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: Prism-Fast** upon switching on the instrument, are not possible.

5.3 System Information

Description

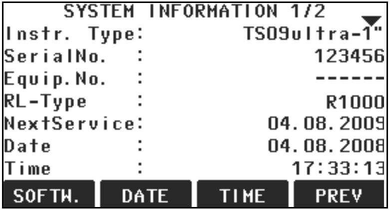
The System information screens display instrument, system and firmware information, as well as settings for the date and time.

Access

1. Select **Tools** from the **MAIN MENU**.
2. Select **SysInfo** from the **TOOLS MENU.**

SYSTEM INFORMATION

This screen displays information about the instrument and operating system.



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

DATE
To change the date and format.

TIME
To change the time.

Next step

Press **SOFTW.** to view the firmware package information.

SOFTWARE-INFORMATION

☞ Before selecting **FORMAT**, to format the internal memory, ensure that all important data is first transferred to a computer. Jobs, formats, codelists, configuration files, uploaded languages and firmware will be deleted by formatting.

Field	Description
Instr. -Firmware	Displays the firmware version number installed on the instrument.
Build No.	Displays the build number of the firmware.
Active Language	Displays the current language and version number selected for the instrument.
EDM-Firmware	Displays the version number of the EDM firmware.
Maintenance End	Displays the end date of the maintenance agreement for the instrument.
Application Information	Displays a list of the applications available on the instrument. A tick will display in the check box beside each application that is licensed.

5.4 Licence Keys

Description

To fully activate hardware functionality, firmware applications and firmware contracts, licence keys may be required on the instrument. For all instruments, licence keys can be manually entered or uploaded via FlexOffice. For instruments fitted with a Communication side cover licence keys can also be uploaded via a USB memory stick.

Access

1. Select **Tools** from the **MAIN MENU**.
2. Select **Lic.Key** from the **TOOLS MENU**.

Enter licence key

Field	Description
Method	Method of licence key entry. Either **Manual Entry** or **Upload Key File**.
Key	Licence key. Available when **Method: Manual Entry**.

☞

Selecting **DELETE** from this screen will delete all firmware licence keys on the instrument and the firmware maintenance licence.

Next step

IF	THEN
a licence key is manually entered.	**OK** processes the entry. An acceptance or error message will display depending on the value entered. Both messages require confirmation.

IF	THEN
a licence key is to be uploaded.	**OK** begins the upload of the licence key file.

5.5 Instrument Protection with PIN

Description

The instrument can be protected by a Personal Identification Number. If PIN protection is activated,the instrument will always prompt for a PIN code entry before starting up. If a wrong PIN has been entered five times, a Personal UnblocKing (PUK) code is required. This can be found on the instrument delivery papers.

Activate PIN code step-by-step

1. Select **TOOLS** from the **MAIN MENU**.
2. Select **PIN** from the **TOOLS MENU**.
3. Activate PIN protection by setting **Use PIN Code: On**.
4. Enter a personal PIN Code (max. 6 numerics) in the **New PIN-Code** field.
5. Accept with OK.

☞ Now the instrument is protected against unauthorised use. After switching on the instrument PIN code entry is necessary.

Lock instrument step-by-step

If PIN protection is activated, it is possible to lock the instrument from within any application without switching off the instrument.

1. Press **FNC** when within any application.
2. Select **Lock with PIN** from the **FUNCTIONS** menu.

Entering the PUK code

If a wrong PIN has been entered five times, the system will prompt for a Personal UnblocKing code. The PUK code can be found on the instrument delivery papers.
If the PUK code entered is correct then the instrument will start up and reset the PIN code to default value **0** and **Use PIN Code: Off**.

Deactivate PIN code step-by-step

1. Select **TOOLS** from the **MAIN MENU.**
2. Select **PIN** from the **TOOLS MENU**.
3. Enter the current PIN in **PIN-CODE:**.
4. Press **OK**.
5. Deactivate PIN protection by setting Use **PIN Code: Off.**
6. Accept with **OK**.

☞ The instrument is now no longer protected against unauthorised use.

5.6 Loading Software

Description

To load application software or an additional language, connect the instrument to FlexOffice via the serial interface and load using "FlexOffice - Software Upload". Refer to the FlexOffice online help for further information.
For instruments fitted with a Communication side cover, the software can be loaded via a USB memory stick. This process is described below.

Access

1. Select **Tools** from the **MAIN MENU**.
2. Select **Load FW** from the **TOOLS MENU**.

☞

- **Load FW** is only an option on the **TOOLS MENU** for those instruments fitted with a Communication side cover.
- Never disconnect the power supply during the system upload process. The battery must be at least 75% capacity before commencing the upload.

Loading firmware and languages step-by-step

1. To load firmware and languages: Select **Firmware**. The **Select File** screen will appear.

   To load only languages: Select **Languages only** and skip to step 4.
2. Select the firmware file from the system folder of the USB memory stick. All firmware and language files must be stored in the system folder to be transferred to the instrument.
3. Press **OK**.

4. The **Upload Languages** screen will appear displaying all language files in the system folder of the USB memory stick. Select **Yes** or **No** for a language file to be uploaded. At least one language must be set to **Yes**.
5. Press **OK**.
6. Press **Yes** on the power warning message to proceed and upload the firmware and/or selected languages.
7. Once successfully loaded, the system will shutdown and restart again automatically.

6 Functions

6.1 Overview

Description

Functions can be accessed by pressing **FNC**, or from any measurement screen.

- **FNC** opens the functions menu and a function can be selected and activated.
- or , activates the specific function assigned to the key. Any function from the function menu can be assigned to these keys. Refer to "4.1 General Settings".

Functions

Function	Description
Level/Plummet	Activates the laser plummet and electronic level.
Offset	Refer to "6.2 Target Offset".
Non-Prism/Prism Toggle	Changes between the two EDM modes. Refer to "4.2 EDM Settings".
Delete Last Record	Deletes the last recorded data block. This can be either a measurement block or a code block. Deleting the last record is **not** reversible! Only records recorded in Surveying can be deleted.

Function	Description
Height transfer	Determines the height of the instrument from measurements to target points with known heights. Begins the application Station Setup at the **Enter target point!** screen. The setup method is already set to **Height Transfer**. Refer to "9.2 Station Setup".
Hidden point	Refer to "6.3 Hidden Point".
Free Coding	Starts Coding application to select a code from a codelist or enter a new code. Same functionality like the softkey **CODE**.
Laserpointer	Activates/deactivates the visible laser beam for illuminating the target point.
Main Menu	Returns to the **MAIN MENU**.
Display-Light On /Off	Activates and deactivates the display illumination light.
Distance unit	Sets the distance measurement unit.
Angle unit	Sets the angle measurement unit.
Lock with PIN	Refer to "5.5 Instrument Protection with PIN".
Check Tie	Refer to "6.4 Check Tie".
Main settings	Refer to "4.1 General Settings".
EDM Tracking	Refer to "6.5 EDM Tracking".
Backsight Check	Refer to "6.6 Backsight Check".

6.2 Target Offset

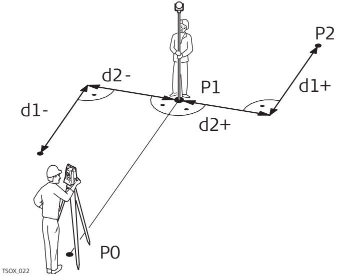
6.2.1 Overview

Availability

TS02 ✓ **TS06** ✓ **TS09** ✓

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.

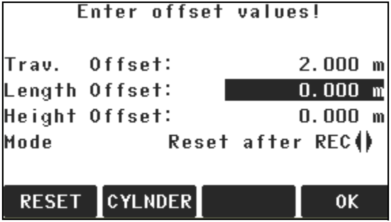


P0	Instrument station
P1	Measured point
P2	Calculated offset point
d1+	Length offset, postive
d1-	Length offset, negative
d2+	Trav. offset, positive
d2-	Trav. offset, negative

Access

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

Enter offet values



RESET
To reset offset values to 0.

CYLNDER
To enter cylindrical offsets.

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.
Height Offset	Height offset. Positive if the offset point is higher than the measured point.
Mode	Period for which the offset is to apply. **Reset after REC** The offset values are reset to 0 after the point is saved. **Permanent** 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

- Either, 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.
- Or, press **CYLNDER** to enter cylindrical offsets. Refer to "6.2.2 Cylinder Offset Subapplication".

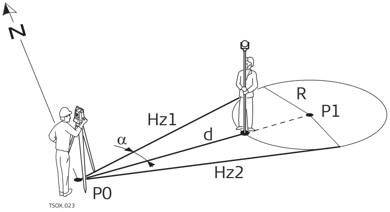
6.2.2 Cylinder Offset Subapplication

Availability

TS02	✓	TS06	✓	TS09	✓

Description

Determines the coordinates of the center point of cylindrical objects and their radius. The horizontal angle to points on both the left and right sides of the object are measured, and the distance to the object as well.

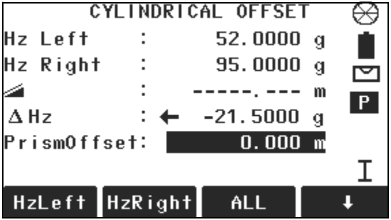


P0	Instrument station
P1	Center point of cylindrical object
Hz1	Horizontal angle to a point on the left side of the object
Hz2	Horizontal angle to a point on the right side of the object
d	Distance to the object in the middle between Hz1 and Hz2
R	Radius of cylinder
α	Azimuth from Hz1 to Hz2

Access

Press **CYLNDER** from Target Offset **Enter offset values**.

CYLINDRICAL OFFSET



HzLeft
To trigger measurement for the left side of the object.

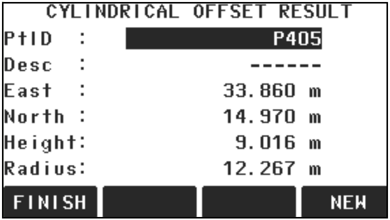
HzRight
To trigger measurement for the right side of the object.

Field	Description
Hz Left	Measured horizontal direction to the left side of the object. Using the vertical hair, aim at the left side of the object, then press **HzLeft**.
Hz Right	Measured horizontal direction to the right side of the object. Using the vertical hair, aim at the right side of the object, then press **HzRight.**
	Slope distance to the reflector.
ΔHz	Deviation angle. Rotate the instrument to aim in the direction of the center point of the cylindrical object, such that ΔHz is zero.
Prism Offset	Prism offset distance between the center of the prism and the surface of the object to be measured. If the EDM mode is Non-Prism, the value is set to zero automatically.

Next step

Once **ΔHz:** is zero, press **ALL** to complete the measurement and display the results.

CYLINDRICAL OFFSET RESULT



FINISH
To record results and return to **Enter offset values** screen.

NEW
To measure a new cylindrical object.

Field	Description
PtID	Defined point ID of the center point.
Desc	Description of the center point if desired.
East	Easting coordinate of the center point.
North	Northing coordinate of the center point.
Height	Height of the point measured with the reflector. This is not the calculated height of the center point.
Radius	Radius of the cylinder.

Next step

Press **FINISH** to return to the **Enter offset values** screen. From the **Enter offset values** screen, press **OK** to return to the application where **FNC** was selected.

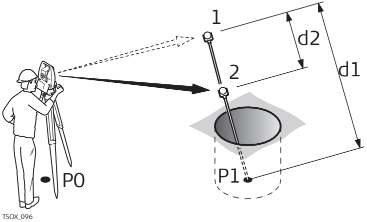
6.3 Hidden Point

Availability

TS02 ✓	TS06 ✓	TS09 ✓

Description

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



P0	Instrument station
P1	Hidden point
1-2	Prisms 1 and 2
d1	Distance between prism 1 and the hidden point
d2	Distance between prism 1 and 2

Access

1. Press **FNC** when within any application.
2. Select **Hidden Point** from the **FUNCTIONS** menu.

Next step

If required, press **ROD/EDM** to define the rod or EDM settings.

ROD SETTINGS

Field	Description
EDM-Mode	Changes the EDM Mode.

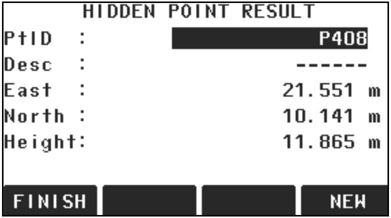
Field	Description
Prism type	Changes the prism type.
Prism Const	Displays the prism constant.
Rod Length	Total length of hidden point rod.
Dist. R1-R2	Spacing between the centers of the prisms R1 and R2.
Meas. Tol	Limit for the difference between the given and measured spacing of the prisms. If the tolerance value is exceeded, the function will issue a warning.

Next step

In the **HIDDEN POINT** screen, measure to the first and second prisms using **ALL** and the **HIDDEN POINT RESULT** screen is displayed.

HIDDEN POINT RESULT

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



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

NEW
To return to the **HIDDEN POINT** screen.

Next step

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

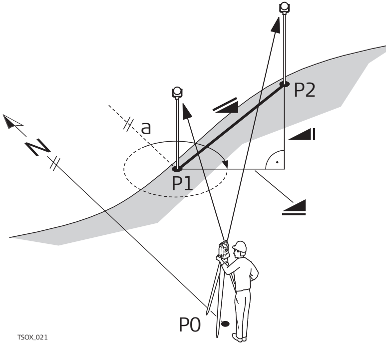
6.4 Check Tie

Availability

TS02 ✓	TS06 ✓	TS09 ✓

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.



a Azimuth
Slope distance
Height distance
Horizontal distance
P0 Instrument station
P1 First point
P2 Second point

Access

1. Press **FNC** when within any application.
2. Select **Check Tie** from the **FUNCTIONS** menu.

CHECK TIE

Field	Description
Bearing	Difference in bearing between the two points.
Grade	Difference in gradient between the two points.
	Difference in horizontal distance between the two points.
	Difference in slope distance between the two points.
Δ	Difference in height 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.

6.5 EDM Tracking

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.

EDM Mode	Tracking measurement mode Off <=> On
Prism	Prism-Standard <=> Prism-Tracking / Prism-Fast <=> Prism-Tracking.
Non-Prism	Non-Prism-Standard <=> Non-Prism-Track.

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

6.6 Backsight Check

Availability

TS02 ✓ **TS06** ✓ **TS09** ✓

Description

This function enables the user to remeasure to the point(s) used for Station Setup. This is useful to check if the station position is still correct after measuring some points.

Access

1. Press **FNC** when within any application.
2. Select **Backsight Check** from the **FUNCTIONS** menu.

BACKSIGHT CHECK This screen is exactly the same as the Stake Out screen, except that the available PtIDs are restricted to the points used for the last orientation. Refer to "9.4 Stakeout" for information about the screen.

Next step Once the accuracy of the station position has been confirmed, press **ESC** to return to the application where **FNC** was selected.

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.
Codes are stored in codelists, with each codelist supporting a maximum of 200 codes.

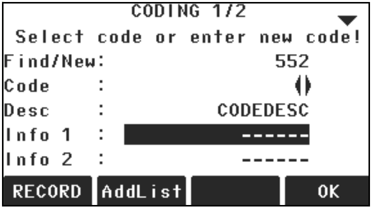
GSI coding

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.
A code is always recorded for each measurement as long as the code is displayed in the **Code:** field. For a code not to be recorded, the **Code:** field must be cleared. This can be set to occur automatically. Refer to "4.1 General Settings".

Access

- Either, select **Q-Survey** from the **MAIN MENU** and press ⬇ **CODE**.
- Or, press **FNC** when within any application and select **Free Coding.**

CODING



RECORD
To record the code without measurement.

AddList
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.
Desc.	Additional remarks.
Info1 to **Info8**	More information lines, freely editable. Used to describe attributes of the code.
Q-CODE	Two digit quick code assigned to the code. Refer to "7.2 Quick Coding".

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 **Info 1:** to **Info 8:**, can be overwritten freely with the following exceptions:

The codelist editor of FlexOffice 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 Quick Coding

Availability

TS02 -	**TS06** ✓	**TS09** ✓

Description

Using the quick 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 quick codes can be assigned.
The quick code number can be assigned when the code is created in the **CODING** screen, in the Codelist Manager in FlexOffice, or it 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.

Access

1. Select **Prog** from the **MAIN MENU**.
2. Select **Surveying** from the **PROGRAMS** menu.
3. Select **Start**
4. Press ⬇ **Q-CODE**

Quick coding step-by-step

1. Press ⬇ **Q-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.
   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 ⬇ **Q-CODE** again to end quick 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.

FlexOffice

Codelists can be easily created and uploaded to the instrument using the supplied FlexOffice software.

8 Applications - Getting Started

8.1 Overview

Description

Applications are predefined programs, that cover a wide spectrum of surveying duties and facilitate daily work in the field. The following applications are available, although application packages for each FlexLine instrument may vary from that stated below:

Application	TS02	TS06	TS09
Station Setup	✓	✓	✓
Surveying	✓	✓	✓
Stakeout	✓	✓	✓
Reference Line	✓	✓	✓
Reference Arc	Optional	✓	✓
Tie Distance	✓	✓	✓
Area & DTM-Volume	✓	✓	✓
Remote Height	✓	✓	✓
Construction	✓	✓	✓
COGO	Optional	✓	✓
Reference Plane	Optional	✓	✓
Road 2D	Optional	✓	✓

Application	TS02	TS06	TS09
Roadworks 3D	Not available	Optional	✓
TraversePRO	Not available	Optional	✓

☞ Only softkeys unique to the applications are explained in the application chapters. Refer to "2.4 Softkeys" for descriptions of the common softkeys.

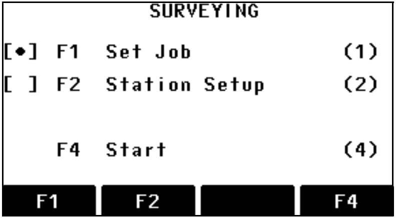
8.2 Starting an Application

Access

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

Pre-settings screens

Pre-settings for Surveying 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
Set Job	To define the job where data will be saved. Refer to "8.3 Setting the Job".
Station Setup	To determine the station coordinates and station orientation. Refer to "8.4 Station Setup".
Start	Starts the selected application.

8.3 Setting the Job

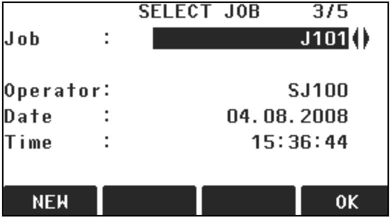
Description

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 **Set Job** in **Pre-settings** screen.

SELECT JOB



NEW
To create a new job.

Field	Description
Job	Name of an existing job to be used.
Operator	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 **NEW** to open the **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 **Q-Survey** and a measurement was recorded, then the system automatically creates a new job and names it "DEFAULT".

Next step

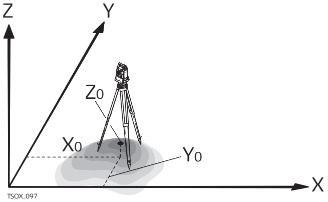
Press **OK** to confirm the job and return to the **Pre-Settings** screen.

8.4 Station Setup

Description

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

Station coordinate calculation



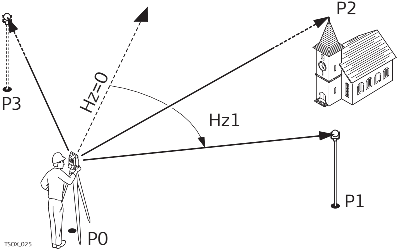
Directions

X	Easting
Y	Northing
Z	Height

Station coordinates

X0	Easting coordinate of station
Y0	Northing coordinate of station
Z0	Height of station

Station orientation calculation



P0 Instrument station

Known coordinates

P1 Target point

P2 Target point

P3 Target point

Calculations

Hz1 Station orientation

Access

Select **Station Setup** in Pre-settings screen.

Next step

The Station Setup application begins. Refer to "9.2 Station Setup" for information on the Station Setup process.

☞ If no station was set and an application was started, or if in **Q-Survey** and a measurement was recorded, then the last station is set as the current station and the current horizontal direction is set as the orientation.

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
PtID, Point, Point 1	Point ID of the point.
hr	Height of the reflector.
Hz	Horizontal direction to the point.
V	Vertical angle to the point.
	Horizontal distance to the point.
	Slope distance to the point.
	Height to the point.
East	Easting coordinate of the point.
North	Northing coordinate of the point.
Height	Height coordinate of the point.

9.2 Station Setup

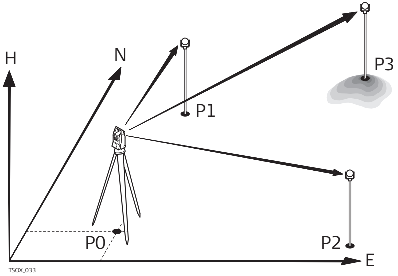
9.2.1 Starting Station Setup

Availability

TS02 ✓ TS06 ✓ TS09 ✓

Description

Station Setup is an application used when setting up a station, to determine the station coordinates and station orientation. A maximum number of 10 known points can be used to determine the position and orientation.



P0	Instrument station
P1	Known point
P2	Known point
P3	Known point

Setup methods

The following setup methods are available:

- Orientation with Angle
- Orientation with Coordinates

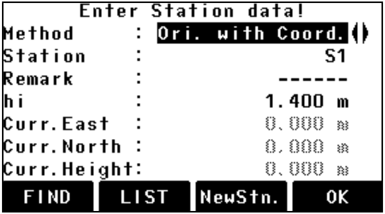
- Resection
- Height Transfer

Each setup method requires different input data and a different number of target points.

Access

1. Select **Prog** from the **MAIN MENU**.
2. Select **Station Setup** from the **PROGRAMS** menu.
3. Complete application pre-settings. Refer to "8 Applications - Getting Started".
4. **Set Accuracy Limit**:
   - Set the standard deviation limits for the position, Height, Hz orientation, and the Face I-II difference.
   - Press **OK** to save the limits and return to the **Pre-settings** screen.
5. Select **Start** to begin the application.

Enter Station Data



NewStn.
To enter new station coordinates.

Next steps

1. Select the desired setup method.
2. For all methods except Resection, press **NewStn.** to enter new station coordinates, or press **FIND** or **LIST** to select an existing point. For the Resection method, the new station coordinates are calculated later.
3. For all methods except Ori. with Angle, press **OK** to continue to the **Enter target data** screen. For the Ori. with Angle method, **OK** continues to the **MANUAL ANGLE SETTING** screen. Refer to "9.2.2 Measuring the target points" , "MANUAL ANGLE SETTING".
4. **Enter target data**: Enter the PtID of the target. Press **OK** to search for the point in the internal memory. Select the desired point or enter new coodinates and continue to the **Sight target point** screen. Refer to "9.2.2 Measuring the target points", "Sight target point".

9.2.2 Measuring the target points

MANUAL ANGLE SETTING

Available for **Method**: **Ori. with Angle** only.
Enter the PtID and height of the target. Measure the Hz angle and repeat the measurement in face II if desired. Press Set to set the new orientation. The station setup is complete.

Sight target point

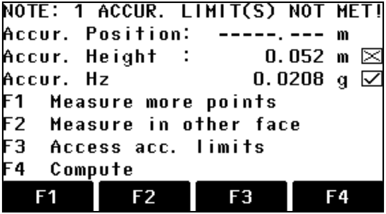
The remaining screens are available for all methods except Ori. with Angle.
In the **Sight target point** screen:

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.

Sight the target point and select **ALL**, or **DIST** and **REC** to measure to the target point.

Accuracy Results



F1 Measure more points
To return to the **Enter target data** screen to measure more points.

F2 Measure in other face
To measure the same target point in another face.

F3 Access acc. limits
To change the accuracy limit values.

F4 Compute
To calculate and display the station coordinates.

Next step

- Either, press **F1** or **F2** to continue measurements.
- Or, press **F4 Compute** to calculate the station position and orientation.

- If a target point is measured several times in the same face, only 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.

9.2.3 Station Setup Results

Computation procedure

The computation of the station position is done via the **Method** selected in **Enter Station Data**.
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.

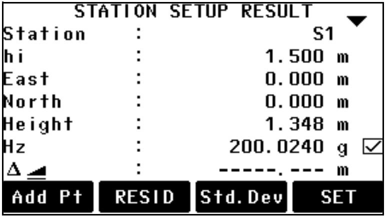
- The original averaged face I and face II measurements are used for the computation process.
- All measurements are treated with the same accuracy, whether these are measured in single or dual face.
- Easting and Northing are determined by the least squares method, which includes standard deviation and improvements for horizontal direction and horizontal distances.
- The final height (H) 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.

Access

Press **F4 Compute** in the **Accuracy Results** screen.

STATION SETUP RESULT

This screen displays calculated station coordinates. The final computed results depend on the **Method** selected in **Enter Station Data**.
Standard deviations and residuals for accuracy assessments are provided.



Add Pt
To return to the **Enter target data** screen to enter the next point.

RESID
To display residuals. Refer to "Target Residuals".

StdDev
To display the standard deviation of the station coordinates and orientation.

SET
To set the station coordinates and/or orientation.

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.

Description of fields

Field	Description
Station	Current station ID.
hi	Current instrument height.
East	Calculated Easting coordinate of the station.
North	Calculated Northing coordinate of the station.

Field	Description
Height	Calculated Height coordinate of the station.
Hz	Current Hz angle with the new orientation.
Δ	Available for **Method**: **Height Transfer** or **Ori. with Coord.** with only 1 target point. Difference between the calculated and measured HorizD from the station to the design target.
Accur.Position	If the standard deviation for position in E and N is calculated, a checkbox is displayed. The checkbox is checked if the calculated position is within the standard deviation limits or crossed if it is not.
Accur.Height H	If the standard deviation for Height is calculated, a checkbox is displayed. The checkbox is checked if the calculated Height is within the standard deviation limits or crossed if it is not.
Accur.Hz Ori.	If the standard deviation for the Hz Orientation angle is calculated, a checkbox is displayed. The checkbox is checked if the calculated Hz Orientation is within the standard deviation limits or crossed if it is not.
Remark	Description of the station if entered by the user.
Δ Ori.Corr.	Hz orientation correction between the old and the new North direction.
Scale	Available for **Method**: **Resection**. The calculated scale, if available.

Field	Description
Apply Scale	**Yes** or **No**. Select **Yes** to use the calculated scale as the system PPM scale. This overwrites any PPM scale previously set in the EDM Settings screens. Select **No** to keep the existing PPM value in the system and not apply the calculated scale.

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.
Max 10 points supported!	10 points have already been measured and another point is selected. The system supports a maximum of 10 points.
Invalid data - no position computed!	The measurements may not allow final station coordinates (Eastings, Northings) to be computed.

Messages	Description
Invalid data - no height computed!	Either the target height is invalid or insufficient measurements are available to compute a final station height.
Face I - II limit exceeded!	This error occurs if a point was measured in one face and the measurement in the other face differs by more than the specified accuracy limit for the horizontal or vertical angle.
No data measured! Measure point again!	There is insufficient data measured to be able to compute a position or height. Either there are not enough points used or no distance measured.

Next step

Press **SET** to set the station coordinates and/or orientation and return to the **PROGRAMS** menu.

9.3 Surveying

Availability

TS02 ✓ **TS06** ✓ **TS09** ✓

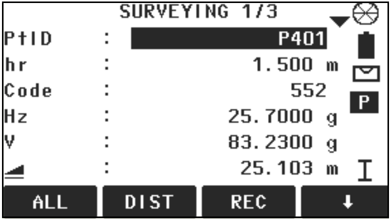
Description

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

Access

1. Select **Prog** from the **MAIN MENU**.
2. Select **Surveying** from the **PROGRAMS** menu.
3. Complete application pre-settings. Refer to "8 Applications - Getting Started".

SURVEYING



⬇ **IndivPt**
To switch between individual and current point numbers.

⬇ **DATA**
To view measurement data.

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

⬇ **Q-CODE**
To activate quick coding. Refer to "7.2 Quick Coding".

Field	Description
Remark / Code	Remark or Code name depending on the coding method. Three coding methods are available: 1. Remark coding: This text is stored with the corresponding measurement. The code is not related to a codelist, it is just a simple remark. A codelist on the instrument is not necessary. 2. Expanded coding with codelist: Press ⬇ **CODE**. The code that was entered is searched for within the code list and it is possible to add attributes to the code. The field name will change to **Code:**. 3. Quick coding: Press ⬇ **Q-CODE** and enter the shortcut to the code. The code is selected and the measurement starts. The field name will change to **Code**:.

Next step

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

9.4 Stakeout

Availability

TS02 ✓ TS06 ✓ TS09 ✓

Description

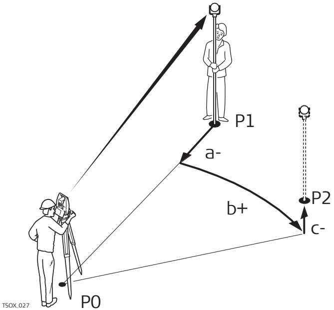
Stakeout is an application used to place marks in the field at predetermined points. These predetermined points are the points to be staked. The points to be staked may already exist in a job on the instrument, or be manually entered.

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

Stakeout modes

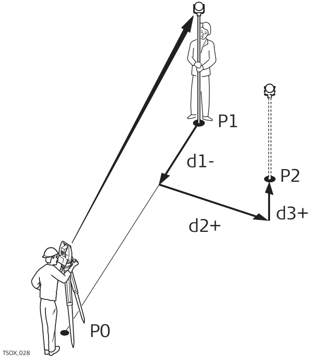
Points can be staked using different modes: Polar mode, Orthogonal to station mode and Cartesian mode.

Polar Stakeout mode



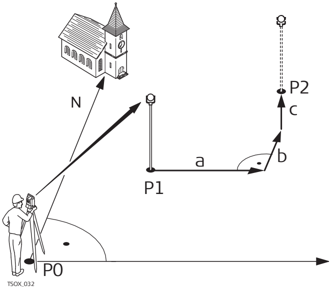
P0	Instrument station
P1	Current position
P2	Point to be staked
a-	Δ :Difference in horizontal distance
b+	Δ Hz: Difference in direction
c+	Δ :Difference in height

Orthogonal to Station Stakeout mode



P0 Instrument station
P1 Current position
P2 Point to be staked
d1- Δ Length: Difference in longitudinal distance
d2+ Δ Trav: Difference in perpendicular distance
d3+ Δ Height: Difference in height

Cartesian Stakeout mode

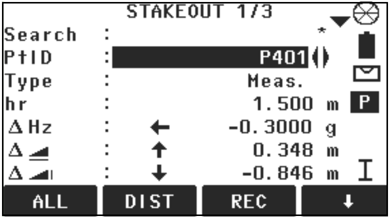


P0	Instrument station
P1	Current position
P2	Point to be staked
a	Δ East:Difference in Easting coordinate
b	Δ North: Difference in Northing coordinate
c	Δ Height: Difference in height

Access

1. Select **Prog** from the **MAIN MENU**.
2. Select **STAKEOUT** from the **PROGRAMS** menu.
3. Complete application pre-settings. Refer to "8 Applications - Getting Started".

STAKEOUT



MANUAL
To manually enter coordinates of a point.

B&D
To enter the direction and horizontal distance to a stake 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 **PtID**: If a matching point doesn't exist the pointsearch screen opens.
Type	Displays the type of point selected. • **Measured**, or • **Fixpoint**
Δ Hz	Angle offset: Positive if stake out point is to the right of the measured point.

Field	Description
Δ	Horizontal offset: Positive if stake out point is further away than the measured point.
Δ	Height offset: Positive if stake out point is higher than the measured point.
ΔLength	Longitudinal offset: Positive if stake out point is further away than the measured point.
ΔTrav.	Perpendicular offset: Positive if stake out point is to the right of the measured point.
ΔHeight	Height offset: Positive if stake out point is higher than the measured point.
ΔEast	Easting offset: Positive if stake out point is to the right of the measured point.
ΔNorth	Northing offset: Positive if stake out point is further away than the measured point
ΔHeight	Height offset: Positive if stake out point is higher than the measured point.

Next step

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

9.5 Reference Element - Reference Line

9.5.1 Overview

Availability	TS02 ✓ TS06 ✓ TS09 ✓
Description	Reference element is an overarching name for the two reference applications, Reference Line and Reference Arc. Reference Line is an application that facilitates the easy stake 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 • Grid stake out • Stake out points • Line segmentation stake out
Access	1. Select **Prog** from the **MAIN MENU**. 2. Select **Reference Element** from the **PROGRAMS** menu. 3. Complete application pre-settings. Refer to "8 Applications - Getting Started". 4. Select **RefLine**
Next step	Define the base line for the reference line.

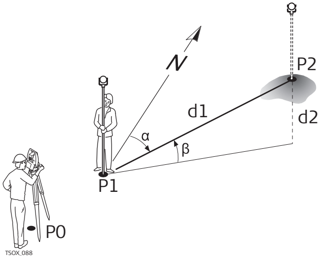
9.5.2 Defining the Base Line

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 reference 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.



Base line

P0	Instrument station
P1	Start point
P2	End point
d1	Known distance
d2	Difference in height
α	Azimuth
β	Elevation angle between the start and end points

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

Next step

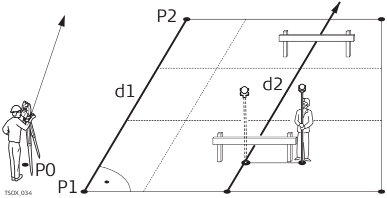
After defining the base line the **REFERENCE LINE - MAIN** screen will appear for defining the reference line.

9.5.3 Defining the Reference Line

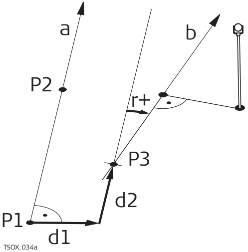
Description

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



P0	Instrument station
P1	Start point
P2	End point
d1	Base line
d2	Reference line

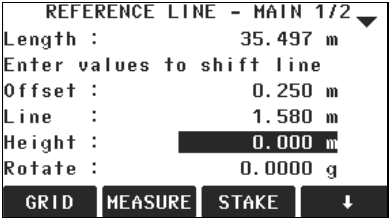


P1	Base point
P2	Base point
a	Base line
d1	Parallel offset
d2	Longitudinal offset
P3	Reference point
r+	Rotation parameter
b	Reference line

Access

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

REFERENCE LINE - MAIN



GRID
To stake out a grid relative to the reference line.

MEASURE
To measure Line & Offset.

STAKE
To stake out points orthogonal to the reference line.

⬇ **NewBL**
To define a new base line.

⬇ **SHIFT=0**
To reset all offset values to 0.

⬇ **SEGMENT**
To subdivide a reference line into a definable number of segments and stake out the new points on the reference line.

Field	Description
Length	Length of the base line.

Field	Description	
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.	
Height	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).	
Ref.Hgt	**Point 1**	Height differences are computed relative to the height of the first reference point.
	Point 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.

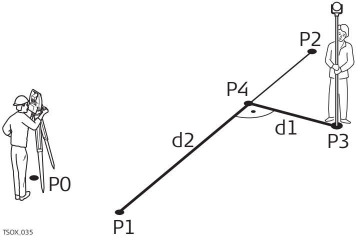
Next step

Select a softkey option, **MEASURE**, **STAKE**, **GRID** or **⬇SEGMENT**, to proceed a subapplication.

9.5.4 Subapplication Measure Line & Offset

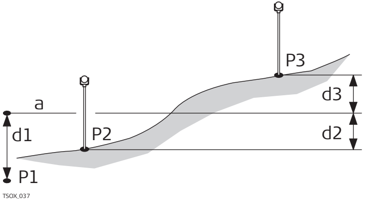
Description

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.



P0	Instrument station
P1	Start point
P2	End point
P3	Measured point
P4	Reference point
d1	Δ Offset
d2	Δ Line

Example of height difference relative to first reference point



P1 Start point
P2 Target point
P3 Target point
a Reference height
d1 Height difference between start point and the reference height
d2 Height difference between P2 and the reference height
d3 Height difference between P3 and the reference height

Access

Press **MEASURE** in the **REFERENCE LINE - MAIN** screen.

Measure line & offset

Field	Description
ΔLine	Calculated distance longitudinal to the reference line.
ΔOffset	Calculated distance perpendicular from the reference line.
Δ	Calculated height difference relative to the defined reference height.

Next step

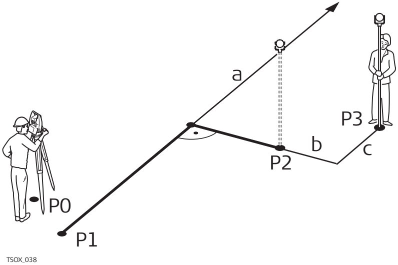
- Either, press **ALL** to measure and record.
- Or, press **PREV** to return to the **REFERENCE LINE - MAIN** screen.

9.5.5 Subapplication Stakeout

Description

The stakeout subapplication calculates the difference between a measured point and the calculated point. The orthogonal (ΔLine, ΔOffset, Δ) and polar (ΔHz, Δ , Δ) differences are displayed.

Example orthogonal stakeout



P0	Instrument station
P1	Reference point
P2	Stake out point
P3	Measured point
a	Reference line
b	Δ Parallel offset
c	Δ Longitudinal offset

Access

Press **STAKE** from the **REFERENCE LINE - MAIN** screen.

Orthogonal stakeout

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

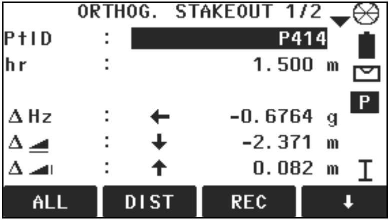
Field	Description
Line	Longitudinal offset: Positive if stake out point is further away from the reference line.
Offset	Perpendicular offset: Positive if stake out point is to the right of the reference line.
Height	Height offset: Positive if stake out point is higher than the reference line.

Next step

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

ORTHOG. STAKEOUT

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 stake out point.



NextPt

To add the next point to be staked out.

Field	Description
ΔHz	Horizontal direction from the measured point to the stake out point. Positive if the telescope must be turned clockwise to the stake out point.
Δ	Horizontal distance from the measured point to the stake out point. Positive if the stake out point is further away than the measured point.
Δ	Height difference from the measured point to the stake out point. Positive if the stake out point is higher than the measured point.
ΔOffset	Perpendicular distance from the measured point to the stake out point. Positive if the stake out point is to the right of the measured point.
ΔLine	Longitudinal distance from the measured point to the stake out point. Positive if the stake out point is further away than the measured point.

Next step

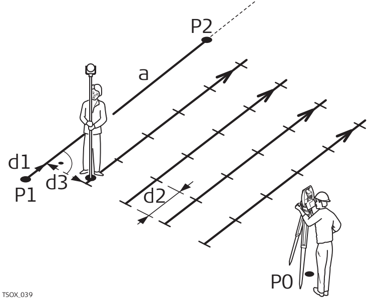
- Either, press **ALL** to measure and record.
- Or, press ⬇ **PREV** to return to the **REFERENCE LINE - MAIN** screen.

9.5.6 Subapplication Grid Stakeout

Description

The Grid subapplication calculates and displays the stake out elements for the points on the grid, orthogonal (ΔLine, ΔOffset, Δ) and polar (ΔHz, Δ , Δ). The grid is defined without boundaries. It can be extended over the first and second base points of the reference line.

Example Grid Stakeout



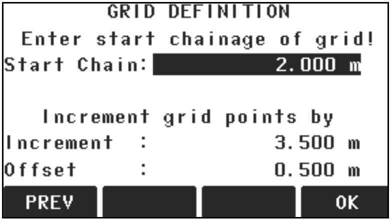
a	Reference line
P0	Instrument station
P1	Start point
P2	End point
d1	Start distance
d2	Increment
d3	Line offets

Access

Press **GRID** from the **REFERENCE LINE - MAIN** screen.

GRID DEFINITION

Enter the chainage and the increment of grid points in length and cross direction of the reference line.



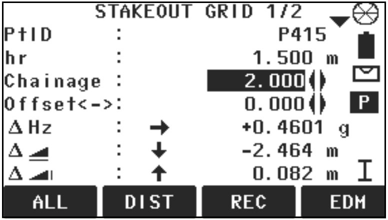
Field	Description
Start Chain	Distance from the reference line start point to the beginning grid start point.
Increment	Length of incrementation.
Offset	Offset distance from the reference line.

Next step

Press **OK** to proceed to the **STAKEOUT GRID** screen.

STAKEOUT GRID

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 stake out point.



Field	Description
Line <->	Grid increment values. The stake out point is in the direction from the first to the second reference point.
Offset <->	Offset increment values. The stake out point is to the right of the reference line.
ΔHz	Horizontal direction from the measured point to stake out point. Positive if the telescope must be turned clockwise to the stake out point.
Δ	Horizontal distance from the measured point to stake out point. Positive if the stake out point is further away than the measured point.

Field	Description
Δ ◢	Height difference from the measured point to the stake out point. Positive if the stake out point is higher than the measured point.
ΔLine	Longitudinal distance from the measured point to the stake out point. Positive if stake out point is further away than the measured point.
ΔOffset	Perpendicular distance from the measured point to the stake out point. Positive if stake out point is to the right of the measured point.

Next step

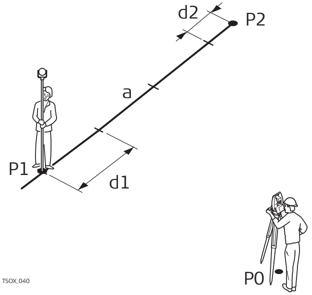
- Either, press **ALL** to measure and record.
- Or, press **ESC** to return to the **DEFINE GRID** screen and from there, press **PREV** to return to the **REFERENCE LINE - MAIN** screen.

9.5.7 Subapplication Line Segmentation

Description

The line segmentation subapplication calculates and displays the stake out elements for the points along the line, orthogonal (ΔLine, ΔOffset, Δ) and polar (ΔHz, Δ , Δ). Line Segmentation is limited to the reference line, between the defined start and end points of the line.

Example Line Segmentation Stakeout



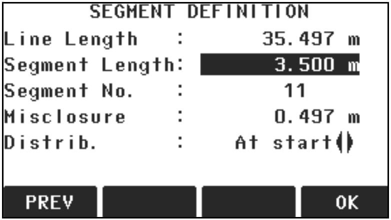
P0	Instrument station
P1	First reference point
P2	Second reference point
a	Reference line
d1	Segment length
d2	Misclosure

Access

Press ⬇ **SEGMENT** from the **REFERENCE LINE - MAIN** screen.

SEGMENT DEFINITION

Enter either the number of segments, or the length of segments and define how the remaining line length is treated. This misclosure can be placed at the start, at the end or distributed evenly along the line.



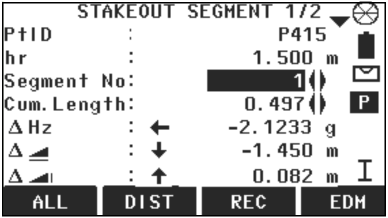
Field	Description
Line Length	Calculated length of the defined reference line.
Segment Length	Length of each segment. Updated automatically if the number of segments is entered.
Segment No.	Number of segments. Updated automatically if the segment length is entered.
Misclosure	Any remaining line length after segment length has been entered.
Distribution	Method of misclosure distribution. **None** All of the misclosure will be placed after the last segment. **At start** All of the misclosure will be placed before the first segment.

Field	Description	
	Equal	The misclosure will be equally distributed between all segments.

Next step
Press **OK** to proceed to the **STAKEOUT SEGMENT** screen.

STAKEOUT SEGMENT

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 stake out point.



Field	Description
Segment No	Segment number. Includes the misclosure segment, if applicable.
Cum.Length	Sum of the segment lengths. Changes with the current number of segments. Includes the misclosure segment length if applicable.

Field	Description
ΔHz	Horizontal direction from the measured point to the stake out point. Positive if the telescope must be turned clockwise to the stake out point.
Δ	Horizontal distance from the measured point to the stake out point. Positive if the stake out point is further away than the measured point.
Δ	Height difference from the measured point to the stake out point. Positive if the stake out point is higher than the measured point.
ΔLine	Longitudinal distance from the measured point to the stake out point. Positive if stake out point is further away than the measured point.
ΔOffset	Perpendicular distance from the measured point to the stake out point. Positive if stake out point is to the right of 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.

Messages	Description
Coordinates invalid !	No coordinates or invalid coordinates for a point. Ensure that points used have at least Easting and Northing coordinates.
Save via RS232 !	**Data Outpu**t: is set to **Interf.** in the **SETTINGS** menu. To be able to successfully start reference line, **Data Output:** must be set to **Int.Mem**.

Next step

- Either, press **ALL** to measure and record.
- Or, press **ESC** to return to the **DEFINE SEGMENT** screen and from there, press **PREV** to return to the **REFERENCE LINE - MAIN** screen.
- Or, continue selecting **ESC** to exit the application.

9.6 Reference Element - Reference Arc

9.6.1 Overview

Availability

TS02 Optional **TS06** ✓ **TS09** ✓

Description

Reference element is an overarching name for the two reference applications, Reference Line and Reference Arc.
The Reference Arc application allows the user to define a reference arc and then complete the following tasks with respect to the arc:

- Line & offset
- Stakeout (Point, Arc, Chord, Angle)

Access

1. Select **Prog** from the **MAIN MENU**.
2. Select **Reference Element** from the **PROGRAMS** menu.
3. Complete application pre-settings. Refer to "8 Applications - Getting Started".
4. Select **RefArc**.

Next step

Define the reference arc.

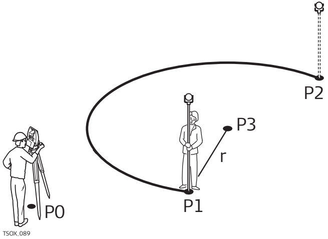
9.6.2 Defining the Reference Arc

Description

The reference arc can be defined by;

- a center point and start point,
- a start point, end point, and radius, or
- by three points.

All points can be either measured, manually entered, or selected from the memory.



Reference arc
P0 Instrument station
P1 Start point
P2 End point
P3 Center point
r Radius of arc

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

Access

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

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

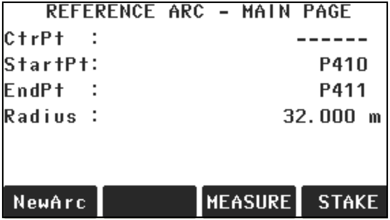
Reference Arc - Measure to start point

Field	Description
StartPt	Point ID of the start point.
CtrPt	Point ID of the center point.
MidPt	Point ID of the mid point.

Field	Description
EndPt	Point ID of the end point.
Radius	Radius of the arc.

Next step
After defining the reference arc the **REFERENCE ARC - MAIN PAGE** screen will appear.

REFERENCE ARC - MAIN PAGE



NewArc
To define a new base arc.
MEASURE
To measure Line & Offset.
STAKE
To stake out.

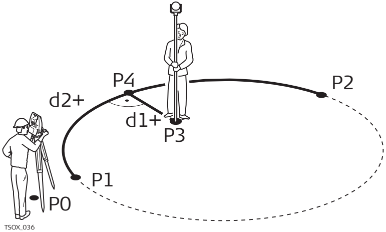
Next step
Select a softkey option, **MEASURE** or **STAKE**, to proceed a subapplication.

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.

Example reference arc - measure line & offset



P0	Instrument station
P1	Start point
P2	End point
P3	Measured point
P4	Reference point
d1-	Δ Offset
d2+	Δ Line

Access

Press **MEASURE** from the **REFERENCE ARC - MAIN PAGE** screen.

Measure Line & Offset

Field	Description
ΔLine	Calculated distance longitudinal to the reference arc.
ΔOffset	Calculated distance perpendicular from the reference arc.
Δ	Calculated height difference relative to the start point of reference arc.

Next step

- Either, press **ALL** to measure and record.
- Or, press ⬇ **PREV** to return to the **REFERENCE ARC - MAIN PAGE** screen.

9.6.4 Subapplication Stakeout

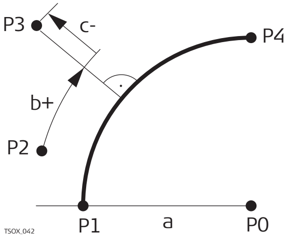
Description

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

- Stake out point
- Stake out arc
- Stake out chord
- Stake out angle

Stake out point

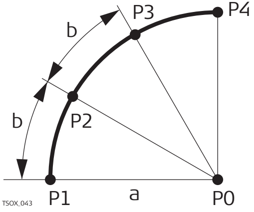
To stake out a point by entering a line and an offset value.



P0	Center point of arc
P1	Start point of arc
P2	Measured point
P3	Stake out point
P4	End point of arc
a	Radius of arc
b+	Line offset
c-	Perpendicular offset

Stake out arc

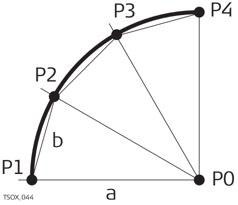
To stake out a series of equidistant points along the arc.



P0	Center point of arc
P1	Start point of arc
P2	Stake out point
P3	Stake out point
P4	End point of arc
a	Radius of arc
b	Arc length

Stake out chord

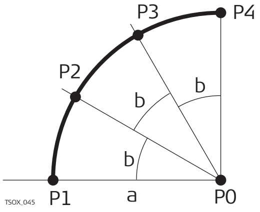
To stake out a series of equidistant chords along the arc.



P0	Center point of arc
P1	Start point of arc
P2	Stake out point
P3	Stake out point
P4	End point of arc
a	Radius of arc
b	Chord length

Stake out angle

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



P0	Center point of arc
P1	Start point of arc
P2	Stake out point
P3	Stake out point
P4	End point of arc
a	Radius of arc
b	Angle

Access

1. Press **STAKE** from the **REFERENCE ARC - MAIN PAGE** screen.
2. Select one of the four methods of stake out available.

Stake out point, arc, chord or angle

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

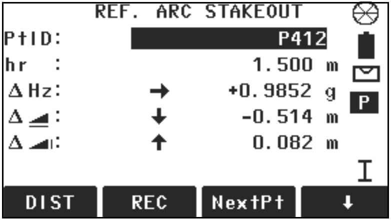
Field	Description	
Distrb.	For stakeout arc: Method of misclosure distribution. If the entered arc length is not an integer of the whole arc, there will be a misclosure.	
	None	All of the misclosure will be added to the last arc-section.
	Equal	The misclosure will be equally distributed between all sections.

Field	Description	
	Start Arc	All of the misclosure will be added to the first arc-section.
	Start & End	The misclosure will be added half to the first arc-section and half to the last arc-section.
Arc Length	For stakeout arc: The length of the arc-segment to stake out.	
Chord Length	For stakeout chord: The length of the chord to stake out.	
Angle	For stake out angle: The angle around the center point of the arc, of the points to be staked out.	
Line	For stake 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. For stake out point: Longitudinal offset from the reference arc.	
Offset	Perpendicular offset from the reference arc.	

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

REF. ARC STAKEOUT

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 stake out point.



NextPt
To add the next point to be staked out.

Field	Description
ΔHz	Horizontal direction from the measured point to the stake out point. Positive if the telescope must be turned clockwise to the stake out point.
Δ	Horizontal distance from the measured point to the stake out point. Positive if the stake out point is further away than the measured point.
Δ	Height difference from the measured point to the stake out point. Positive if the stake out point is higher than the measured point.

Next step

- Either, press ⬇ **ALL** to measure and record.
- Or, press ⬇ **PREV** to return to the **REFERENCE ARC - MAIN PAGE** screen.
- Or, continue selecting **ESC** to exit the application.

9.7 Tie Distance

Availability TS02 ✓ TS06 ✓ TS09 ✓

Description

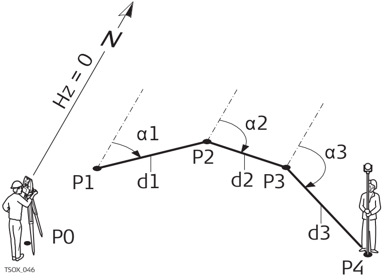
Tie Distance is an application used to compute slope distance, horizontal distance, height difference and azimuth of two target points which are either measured, selected from the memory, or entered using the keypad.

Tie distance methods

The user can choose between two different methods:

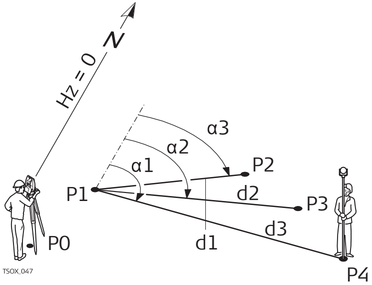
- Polygonal: P1-P2, P2-P3, P3-P4.
- Radial: P1-P2, P1-P3, P1-P4.

Polygonal method



P0	Instrument station
P1-P4	Target points
d1	Distance from P1-P2
d2	Distance from P2-P3
d3	Distance from P3-P4
α1	Azimuth from P1-P2
α2	Azimuth from P2-P3
α3	Azimuth from P3-P4

Radial method



P0	Instrument station
P1-P4	Target points
d1	Distance from P1-P2
d2	Distance from P1-P3
d3	Distance from P1-P4
α1	Azimuth from P1-P4
α2	Azimuth from P1-P3
α3	Azimuth from P1-P2

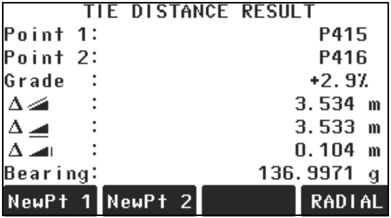
Access

1. Select **Prog** from the **MAIN MENU**.
2. Select **Tie Distance** from the **PROGRAMS** menu.
3. Complete application pre-settings. Refer to "8 Applications - Getting Started".
4. Select **Polygonal** or **Radial**.

Tie distance measurements

After completing the measurements required, the **TIE DISTANCE RESULT** screen will appear.

TIE DISTANCE RESULT - Polygonal method



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.
Δ	Slope distance between point 1 and point 2.
Δ	Horizontal distance between point 1 and point 2.
Δ	Height difference between point 1 and point 2.
Bearing	Azimuth between point 1 and point 2.

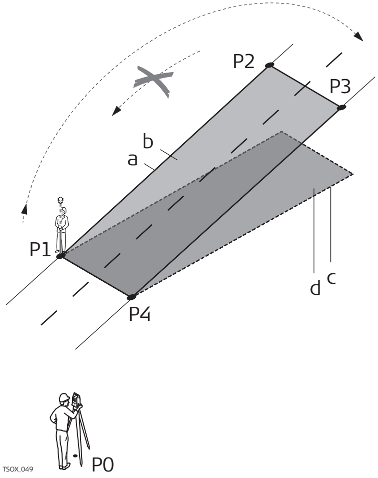
Next step Press **ESC** to exit the application.

9.8 Area & DTM Volume

Availability	**TS02** ✓	**TS06** ✓	**TS09** ✓

Description

Area & DTM Volume 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 can be computed by automatically creating a digital terrain model (DTM).



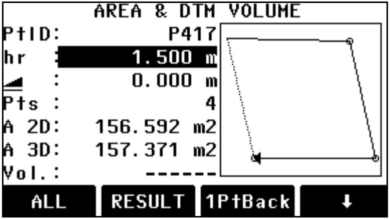
P0	Instrument station
P1	Target point which defines the sloped reference plane
P2	Target point which defines the sloped reference plane
P3	Target point which defines the sloped reference plane
P4	Target point
a	Perimeter (3D), polygonal length from the start point to the current measured point of the area (3D)
b	Area (3D), projected onto the sloped reference plane
c	Perimeter (2D), polygonal length from the start point to the current measured point of the area (2D)
d	Area (2D), projected onto the horizontal plane

Access

1. Select **Prog** from the **MAIN MENU**.
2. Select **Area & DTM-Volume** from the **PROGRAMS** menu.
3. Complete application pre-settings. Refer to "8 Applications - Getting Started".

AREA & DTM VOLUME

The graphic always shows the area projected onto the reference plane. The points used for defining the reference plane are indicated by a ∘ .



1PtBACK
: To undo measurement or selection of the previous point.

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

⬇ **BreakLn**
: To measure or select points on the breakline. These points are then used to calculate a volume.

⬇ **Def. 3D**
: To manually define the sloped reference plane by selecting or measuring three points.

☞ The breakline points must be located within the boundary of the defined area.

Area calculation

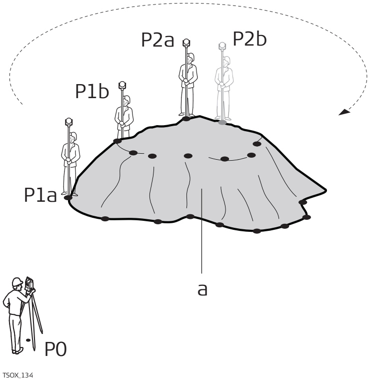
The 2D and 3D areas are calculated automatically and displayed once three points have been measured or selected. The 3D area is calculated automatically based on the following;

- The system will use the three points which cover the largest area.
- If there are two or more equal largest areas, the system will use the area with the shortest perimeter.

- If the largest areas have equal perimeters, the system will use the area with the last measured point.

A reference plane for the 3D area calculation can be manually defined by selecting **Def. 3D**.

Graphical representation

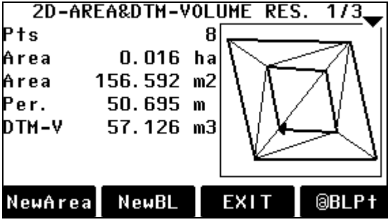


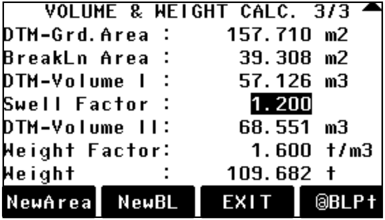
P0 Instrument station
P1a.. Boundary point
P2a.. Breakline point
a Volume as calculated by the triangulated irregular network (TIN)

Next step

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

2D-AREA & DTM VOLUME RESULT





Field	Description
Area (2D)	Area calculated by projection onto a horizontal plane.
Area (3D)	Area calculated by projection onto an automatically or manually defined reference plane.
DTM-Grd.Area	Area defined by ground points, calculated by triangulated irregular network (TIN).
BreakLn Area	Area defined by breakline points, calculated by TIN.
DTM-Volume I	Volume as calculated by TIN.
Swell Factor	Factor that gives the relationship between the volume of a material as found in nature, to the volume of the same material after excavation. Refer to the table "Swell Factors" for more information on swell factors.

Field	Description
DTM-Volume II	Volume of the material after excavation from its original location. **DTM-Volume II** = **DTM-Volume I** x **Swell Factor**.
Weight Factor	Weight in tons per m^3 of material. Editable field.
Weight	Total weight of material after being excavated. **Weight** = **DTM-Volume II** x **Weight Factor**.

Swell Factors

According to DIN18300, the following soil classes have the given swell factors.

Soil class	Description	Swell factor
1	Topsoil containing unorganic material, as well as humus or organic animals.	1.10 - 1.37
2	Fluent soil types of fluid to semi-fluid consistency.	n/a
3	Easily degradable soil types. Cohesionless to hardly cohesive sands.	1.06 - 1.32
4	Moderately degradable soil types. Mixture of sand, silt and clay.	1.05 - 1.45
5	Hard to degrade soil types. Same soil types as classes 3 and 4, but with a greater ratio of stones bigger than 63mm and between 0.01 m^3 to 0.1 m^3 in volume.	1.19 - 1.59

Soil class	Description	Swell factor
6	Rock types that have an inner mineral cohesiveness, however are fragmented, slaty, soft or weathered.	1.25 - 1.75
7	Hard to degrade rock types with a strong inner mineral cohesiveness and minimal fragmenting or weathering.	1.30 - 2.00

Swell factor examples: The values given are approximate only. Values may be different depending on various soil factors.

Soil type	Swell factor	Weight per cubic metre
Silt	1.15 - 1.25	2.1 t
Sand	1.20 - 1.40	1.5 - 1.8 t
Clay	1.20 - 1.50	2.1 t
Topsoil, humus	1.25	1.5 - 1.7 t
Sandstone	1.35 - 1.60	2.6 t
Granite	1.35 - 1.60	2.8 t

Next step

- Press **NewArea** to define a new area.
- Press **NewBL** to define a new breakline area and calculate a new volume.
- Press **@BLPt** to add a new point to the existing breakline area and calculate a new volume.
- Or, press **EXIT** to exit the application.

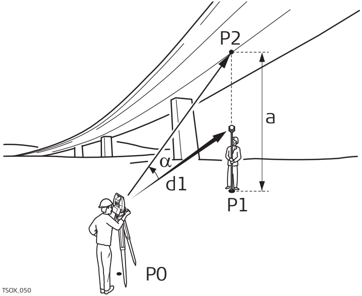
9.9 Remote Height

Availability

TS02 ✓ TS06 ✓ TS09 ✓

Description

Remote Height is an application used to compute points directly above the base prism without a prism at the target point.



P0	Instrument station
P1	Base point
P2	Remote point
d1	Slope distance
a	Height difference from P1 to P2
α	Vertical angle between base point and remote point

Access

1. Select **Prog** from the **MAIN MENU**.
2. Select **Remote Height** from the **PROGRAMS** menu.
3. Complete application pre-settings. Refer to "8 Applications - Getting Started".

Remote height measurement

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

Next step

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

REMOTE HEIGHT - Aim at remote point

Aim the instrument at the inaccessible remote point.

Field	Description
Δ	Height difference between the base point and the remote point.
Height	Height of the remote point.
East	Calculated Easting coordinate for the remote point.
North	Calculated Northing coordinate for the remote point.
Δ East	Calculated difference in Easting coordinate between the base point and the remote point.
Δ North	Calculated difference in Northing coordinate between the base point and the remote point.
Δ Height	Calculated difference in Height between the base point and 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

Availability	TS02 ✓ TS06 ✓ TS09 ✓
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 **Prog** from the **MAIN MENU**. 2. Select **Construction** from the **PROGRAMS** menu. 3. Select **Set EDM**: to set the EDM settings. Refer to "4.2 EDM Settings". 4. Select: • **New construction line** - To define a new construction site, or • **Continue previous site** - To continue with a previous construction site (skips set-up).
☞	If coordinates were entered by **ENH** 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 staking out relative to the defined construction line. The on-screen graphics show the position of the prism relative to the stake out point. Below the graphic, the exact values are displayed, combined with arrows to show the direction for staking out the point.

☞

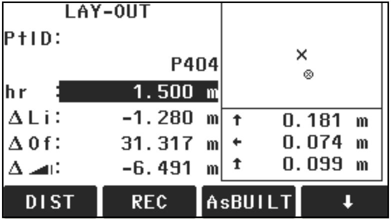
- Be aware that the line start point and the line end point are measured in the previous coordinate system. When staking out these points they appear in the old system and appear as shifted.
- During use of the application the previous orientation and station parameters will be replaced by the new calculated 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 construction line** from the Construction pre-settings screen and measure start and end points of the line.
- Or, select **Continue previous site** from the Construction pre-settings screen.

LAY-OUT

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



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

⬇ ShiftLN
To enter values for shifting the line.

Field	Description
ΔLi	Longitudinal offset: Positive if target point is further away than the measured point.
ΔOf	Perpendicular offset: Positive if target point is to the right of the measured point.
Δ	Height offset: Positive if target point is higher than the measured point.

Next step

- Either, press **AsBUILT** to check point locations relative to a contruction 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 Δ◢ 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.

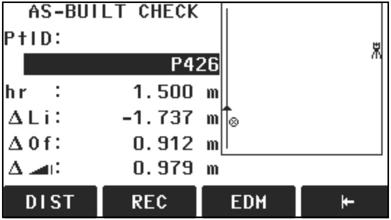
The height of the line start point is always used as the reference height!

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 stake out points.

⬇ **ShiftLN**
To enter values for shifting the line.

Field	Description
ΔLi	Longitudinal offset: Positive if measured point is further along the construction line from the start point.

Field	Description
ΔOf	Perpendicular offset: Positive if measured point is to the right of the construction line.
Δ	Calculated difference in height: Positive if measured point is higher than the construction line start point height.

9.11 COGO

9.11.1 Starting COGO

Availability

TS02 Optional **TS06** ✓ **TS09** ✓

Description

COGO is an application used to perform **co**ordinate **geo**metry calculations such as, coordinates of points, bearings between points and distances between points
The COGO calculation methods are:

- Inverse and Traverse
- Intersections
- Offset
- Extension

Access

1. Select **Prog** from the **MAIN MENU**.
2. Select **COGO** from the **PROGRAMS** menu.
3. Complete application pre-settings. Refer to "8 Applications - Getting Started".
4. Select from the **COGO MAIN MENU**:

- **Inverse & Traverse**
- **Intersection**
- **Offset**
- **Extension**

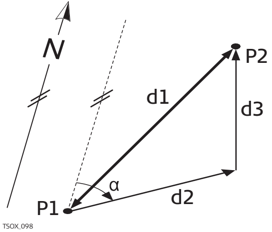
9.11.2 Inverse and Traverse

Access

1. Select **Inverse & Traverse** from the **COGO MAIN 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

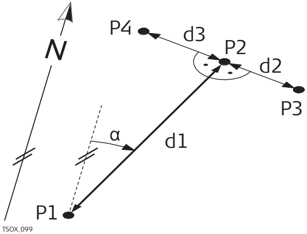
P1	First known point
P2	Second known point

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	COGO point without offset
P3	COGO point with positive offset
P4	COGO point with negative offset

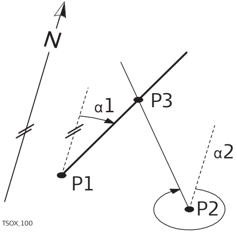
9.11.3 Intersections

Access

1. Select **Intersection** from the **COGO MAIN MENU**.
2. Select the desired COGO method:
   - **Brg-Brg**
   - **Brg-Dst**
   - **Dst-Dst**
   - **Ln-Ln**

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.



TSOX_100

Known

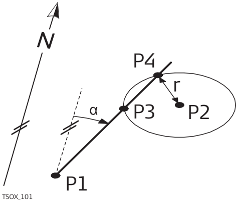
P1	First known point
P2	Second known point
α1	Direction from P1 to P3
α2	Direction from P2 to P3

Unknown

P3	COGO 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.



TSOX_101

Known

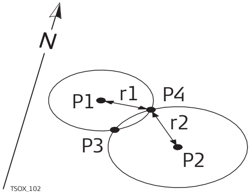
P1	First known point
P2	Second known point
α	Direction from P1 to P3 and P4
r	Radius, as the distance from P2 to P4 or P3

Unknown

P3	First COGO point
P4	Second COGO point

Distance-Distance

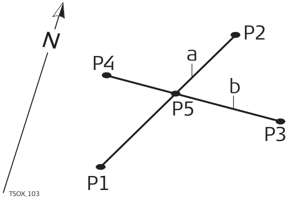
Use the distance-distance subapplication to calculate the intersection point of two circles. The circles are defined by the known point as the center point and the distance from the known point to the COGO point as the radius.



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 COGO point
P4 Second COGO 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 COGO point

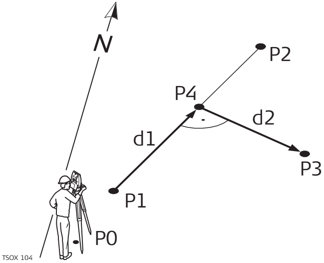
9.11.4 Offsets

Access

1. Select **Offset** from the **COGO MAIN MENU**.
2. Select the desired COGO method:
   - **DistOff**
   - **Set Pt**
   - **Plane**

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

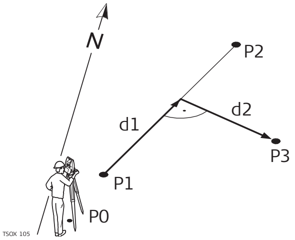
P0	Instrument station
P1	Start point
P2	End point
P3	Offset point

Unknown

d1	Δ Line
d2	Δ Offset
P4	COGO (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

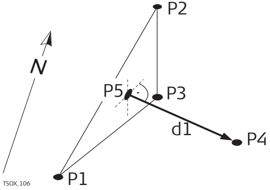
P0 Instrument station
P1 Start point
P2 End point
d1 Δ Line
d2 Δ Offset

Unknown

P3 COGO point

Plane offset

Use the plane offset subapplication to calculate the coordinates of a new point and its height and offset, in relation to a known plane and offset point.



Known

P1 Point 1 which defines plane
P2 Point 2 which defines plane
P3 Point 3 which defines plane
P4 Offset point

Unknown

P5 COGO (intersection) point
d1 Offset

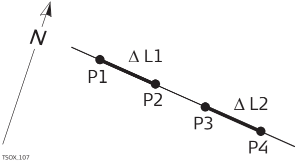
9.11.5 Extension

Access

Select **Extension** from the **COGO MAIN 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
ΔL1, ΔL2	Distance
Unknown	
P2, P4	Extended COGO points

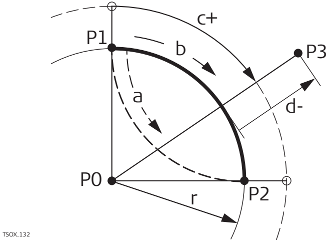
9.12 Road 2D

Availability

TS02	Optional	**TS06**	✓	**TS09**	✓

Description

Road 2D is an application used to measure or stake out points relative to a defined element. The element can be a line, curve or spiral. Chainage, incremental stake outs and offsets (left and right) are supported.

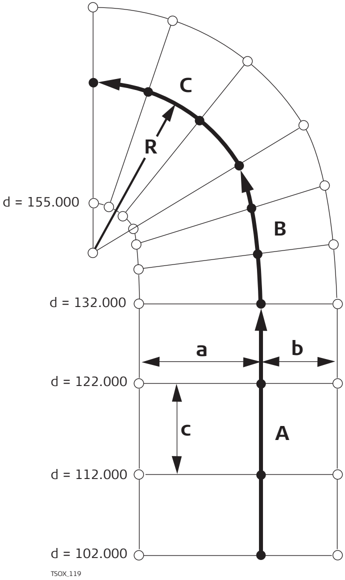


P0	Center point
P1	Start point of arc
P2	End point of arc
P3	Point to stake
a	Anti-clockwise
b	Clockwise
c+	Distance from start of arc, following curve
d-	Perpendicular offset from arc
r	Radius of arc

Access

1. Select **Prog** from the **MAIN MENU**.
2. Select **ROAD 2D** from the **PROGRAMS** menu.
3. Complete application pre-settings. Refer to "8 Applications - Getting Started".
4. Select the element type:
   - **Line**
   - **Curve**
   - **Spiral**

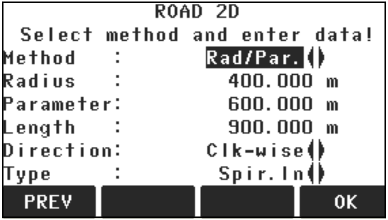
Elements



A	Straight
B	Spiral
C	Curve
R	Radius
a	Perpendicular offset left
b	Perpendicular offset right
c	Increment
d	Chainage

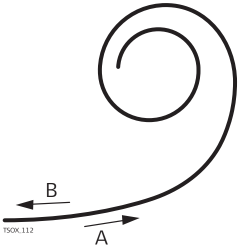
Define the element step-by-step

1. Enter, measure or select from memory the start and end points.
2. For curve and spiral elements the **ROAD 2D** 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**.



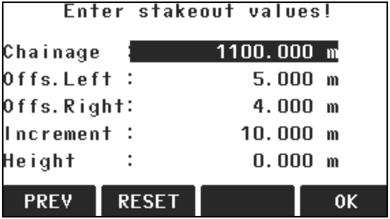
Spiral type
A Spiral in
B Sprial out

4. When the element has been defined the **ROAD 2D - MAIN PAGE** appears.

Chainage and method

Enter the chainage values and press:
- **STAKE**: to select the point and offset (center, left or right), to stake out and start the measurement. The correction from actual point to stake 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 stakeout values



Next step

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

9.13 Roadworks 3D

9.13.1 Starting Roadworks 3D

Availability	**TS02** -	**TS06** Optional	**TS09** ✓

Description

Roadworks 3D is an application used to stake out points or for as-built checks relative to a road alignment, including slopes. It supports the following features:

- Horizontal alignments with the elements straight, curve, and spiral (entry and exit as well as partial).
- Vertical alignments with the elements straight, curve and quadratic parabola.
- Upload of horizontal and vertical alignments which are in gsi data format of FlexOffice Road Line Editor.
- Creation, view and deletion of alignments onboard.
- Use of design height of vertical alignments or manually entered heights.
- Log file via Format manager of FlexOffice.

Roadworks 3D methods

Roadworks 3D has the following subapplications:

- Subapplication Check
- Subapplication Stake
- Subapplication Check Slope
- Subapplication Stake Slope

☞ The application can be trialled 15 times. After 15 trials, it is neccessary to enter the licence code.

Roadworks 3D step-by-step

1. Create or upload road alignments.
2. Select horizontal and/or vertical alignment files.
3. Define stake/check/slope parameter.
4. Select one of the Roadworks 3D subapplications

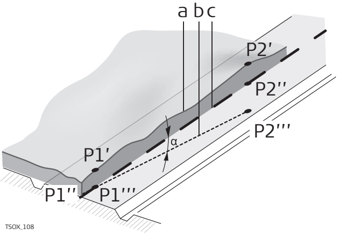
☞

- The alignment file data has to be in the same data structure as FlexOffice Road Line Editor. These gsi files have unique identifiers for each element which are used by the application.
- The alignments must be continuous because geometrical gaps and chainage equations are not supported.
- The file name for the horizontal alignment file must have the prefix ALN, for example, ALN_HZ_Axis_01.gsi. The file name for the vertical alignment files must have the prefix PRF, for example PRF_VT_Axis_01.gsi. File names can be 16 characters long.
- The uploaded or created road alignments are permanent and stored even if the application is closed.
- Road alignments can be deleted onboard or via FlexOffice Data Exchange Manager.
- Road alignments cannot be edited onboard. This needs to be done via FlexOffice Road Line Editor.

9.13.2 Basic Terms

Elements of a road project

Road projects consist, in general, of a horizontal and a vertical alignment.



Any project point P1 has E, N and H coordinates in a determined coordinate system and has three positions.

P1 '	Position on natural surface
P1 "	Position on vertical alignment
P1 '"	Position on horizontal alignment

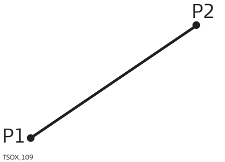
With a second point P2 the alignment is defined.

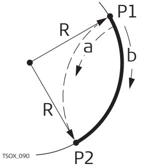
P1 ' P2 '	Projection of the alignment onto the natural surface.
P1 '' P2 ''	Vertical alignment
P1 ''' P2 '''	Horizontal alignment
α	Grade angle between the vertical and horizontal alignment.

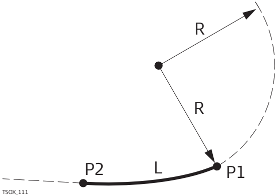
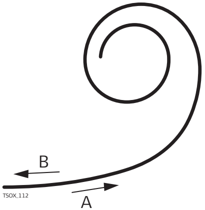
a	Natural surface
b	Horizontal alignment
c	Vertical alignment

Horizontal geometry elements

For onboard input Roadworks 3D supports the following elements for horizontal alignments.

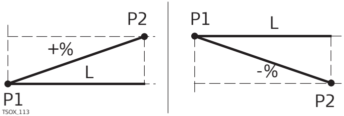
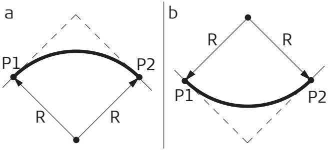
Element	Description
Straight	A straight has to be defined by: • Start point (P1) and end point (P2) with known Easting and Northing coordinates.  P1 Start point P2 End point
Curve	A circular curve has to be defined by: • Start point (P1) and end point (P2) with known Easting and Northing coordinates. • Radius (R). • Direction: Clockwise (b) or Anticlockwise (a).

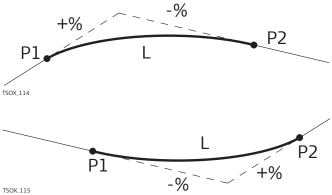
Element	Description
	 P1 Start point P2 End point R Radius a Anticlockwise direction b Clockwise direction
Spiral / Clothoid	A spiral is a transition curve whose radius changes along its length. A spiral has to be defined by: • Start point (P1) and end point (P2) with known Easting and Northing coordinates. • Radius at the start of the spiral (R). • Spiral parameter ($A = \sqrt{L \cdot R}$) or length (L) of the spiral. • Direction: Clockwise or Anticlockwise. • Spiral type: Spiral in or Spiral out.

Element	Description
	 P1 Start point P2 End point R Radius L Length
Spiral types	• Entry spiral (Spiral in = A): Spiral with a radius of infinity at the start and a given radius at the end. • Exit spiral (Spiral out = B): Spiral with a given radius at the start and radius of infinity at the end. • Partial/Ovoid spiral: A spiral with a given radius at the start and another given radius at the end.  A Entry spiral B Exit spiral

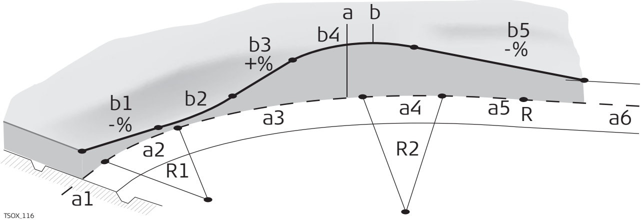
Vertical geometry elements

For onboard input Roadworks 3D supports the following elements for vertical alignments.

Element	Description
Straight	A straight has to be defined by: • Start chainage and start height of P1. • End chainage and end height of P2, or length (L) and slope (%).  P1 Start point P2 End point L Length % Slope
Transition curve	A circular curve has to be defined by: • Start chainage and start height of P1. • End chainage and end height of P2. • Radius (R). • Type: Convex (crest) or Concave (sag).  a Convex b Concave P1 Start point P2 End point R Radius

Element	Description
Quadratic parabola	A quadratic parabola has the advantage that the rate of change of grade is constant, resulting in a "smoother" curve. A quadratic parabola has to be defined by: • Start chainage and start height of P1. • End chainage and end height of P2. • Parameter, or Length (L), grade of entry straight (Grade In) and grade of exit straight (Grade Out).  P1 Start point P2 End point L Length % Slope

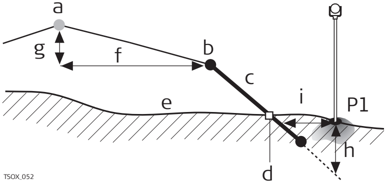
Horizontal and vertical geometry elements combined



a = Horizontal alignment (top view)		b = Vertical alignment (front view)	
R1	Radius 1	b1	Straight
R2	Radius 2	b2	Curve
a1	Straight	b3	Straight
a2	Curve with R1	b4	Parabola
a3	Partial spiral with R1 and R2	b5	Straight
a4	Curve with R2		
a5	Spiral out with R2 and R=∞		
a6	Straight	•	Tangent point

☞ Start and end chainage and tangent points can be different for the horizontal and vertical alignments.

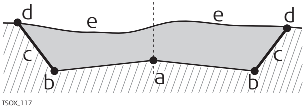
Slope elements

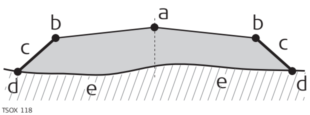


P1	Measured point
a	Horizontal alignment
b	Hinge point
c	Slope
d	Catch point
e	Natural surface
f	Defined offset
g	Defined height difference
h	Cut situation for defined slope
i	Δ Offset to catch point

Explanation of the slope elements:

a) **Horizontal alignment** at a defined chainage.
b) **Hinge point**, is defined by entered offset left/right and height difference.
c) **Slope** = ratio.
d) **Catch point**, or daylight point, indicates the point of intersection between the slope and the natural surface. Both the hinge point and the catch point lie on the slope.
e) **Natural surface**, is the undisturbed surface before project construction.

Cut / Fill	Description
Cut situation	 a Horizontal alignment b Hinge point c Slope d Catch point e Natural surface

Cut / Fill	Description	
Fill situation		a Horizontal alignment b Hinge point c Slope d Catch point e Natural surface

9.13.3 Creating or Uploading Alignment Files

Description

Create horizontal and vertical road alignment files with FlexOffice Road Line Editor and upload them onto the instrument using the Data Exchange Manager. Alternatively, horizontal and vertical road alignments can be created onboard the instrument.

Access

1. Select **Prog** from the **MAIN MENU**.
2. Select **3D Roadworks** from the **PROGRAMS** menu.
3. Complete application pre-settings. Refer to "8 Applications - Getting Started".

Select alignment files

Field	Description
Horiz. Aln	List of available horizontal alignment files. Using a horizontal alignment file is mandatory.
Verti. Aln	List of available vertical alignment files. Using a vertical alignment file is not mandatory. A height can be defined manually instead.

Next step

- Either, press **New** to name and define a new alignment file.
- Or, press **OK** to select an existing alignment file and proceed to the **Define Stake/Check/Slope** values screen.

Define Stake/Check/Slope values

STAKE
To start the subapplication **Stake**.

CHECK
To start the subapplication **Check**.

STK_SLP
To start the subapplication **Stake Slope**.

↓ CH_SLP
To start the subapplication **Check Slope**.

Field	Description	
Offs. Left	Horizontal offset to the left of the horizontal alignment.	
Offs. Right	Horizontal offset to the right of the horizontal alignment.	
Ht.Diff.	Vertical offset, either up or down, from the horizontal alignment.	
Def.Chain	Defined chainage for stake out.	
Increment	Value by which the defined chainage can be incremented or decremented in subapplications Stake and Stake Slope.	
Height	**Manual Height**	Height reference for height calculations. If enabled this height is used for all subapplications.
	Use Design Height	The height reference for height calculations is the selected vertical alignment file.
Manual Ht.	Height to be used for **Manual Height**.	

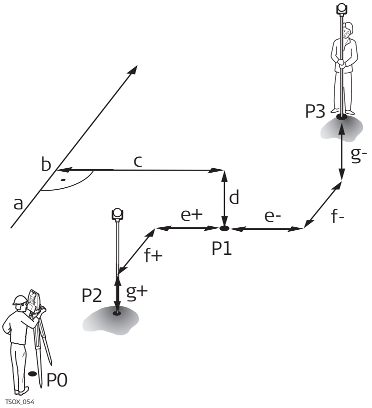
Next step

Select a softkey option, **STAKE**, **CHECK**, **STK_SLP** or ⬇ **CH_SLP**, to proceed a subapplication.

9.13.4 Subapplication Stake

Description

The subapplication Stake is used to stake out points relative to an existing alignment. The height difference is relative to a vertical alignment or manually entered height.

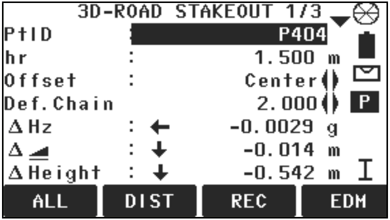


P0	Instrument station
P1	Target point
P2	Measured point
P3	Measured point
a	Horizontal alignment
b	Defined chainage
c	Offset
d	Height difference
e+	Δ Offset, positive
e-	Δ Offset, negative
f+	Δ Chainage, positive
f-	Δ Chainage, negative
g+	Δ Height, positive
g-	Δ Height, negative

Access

Press **STAKE** from the **Define Stake/Check/Slope** values screen.

3D-ROAD STAKEOUT



Field	Description
Def.Chain	Selected chainage to stake out.
ΔHz	Angle offset: Positive if the stake out point is to the right of the measured point.
Δ	Horizontal offset: Positive if the stake out point is further away than the measured point.
ΔHeight	Height offset: Positive if the stake out point is higher than the measured point.
ΔChain	Longitudinal offset: Positive if the stake out point is further away than the measured point.
ΔOffset	Perpendicular offset: Positive if the stake out point is to the right of the measured point.

Field	Description
Def. East	Calculated East coordinate of the stake out point.
Def. North	Calculated North coordinate of the stake out point.
Def. Height	Calculated Height of the stake out point.

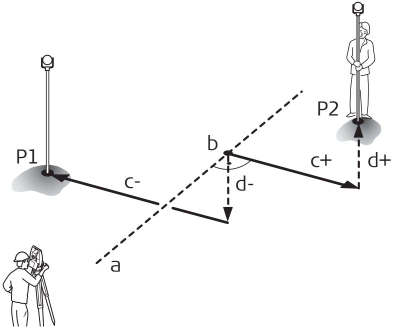
Next step

- Either, press ⬇ **ALL** to measure and record.
- Or, press **ESC** to return to the **Define Stake/Check/Slope** values screen.

9.13.5 Subapplication Check

Description

The subapplication Check is used for as-built checks. The points can be measured or selected from the memory. The chainage and offset values are relative to an existing horizontal alignment, and the height difference is relative to a vertical alignment or manually entered height.



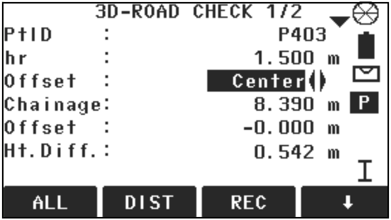
P0	Instrument station
P1	Target point
P2	Target point
a	Horizontal alignment
b	Chainage
c+	Offset, positive
c-	Offset, negative
d+	Height difference, positive
d-	Height difference, negative

☞ Defined chainage and Increment values will not be considered in the subapplication Check.

Access

Press **CHECK** from the the **Define Stake/Check/Slope** values screen.

3D-ROAD CHECK



Field	Description
Offset	Defined horizontal offset. Left, Right or Center.
Chainage	Current chainage from measured point.
Offset	Perpendicular offset to alignment.
Ht.Diff	Height difference between the measured point and the defined height.
ΔEast	Calculated difference in Easting coordinate between the measured point and the alignment element.
ΔNorth	Calculated difference in Northing coordinate between the measured point and the alignment element.

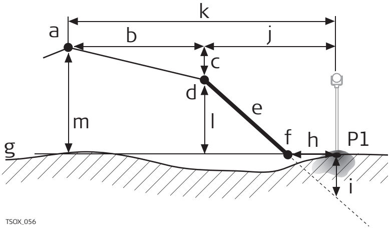
Next step

- Either, press **ALL** to measure and record.
- Or, press **ESC** to return to the **Define Stake/Check/Slope** values screen.

9.13.6 Subapplication Stake Slope

Description

The subapplication Stake Slope is used to stake out the catch point, which is the intersection point of a defined slope with the natural surface.
The slope is always defined as starting from a hinge point. If the parameter offset right/left and height difference are not entered, the point at the defined chainage on the horizontal alignment is the hinge point.

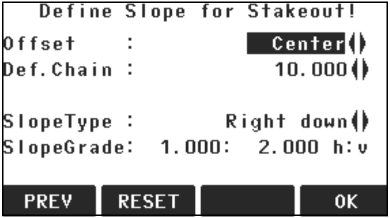


P1	Measured point
a	Horizontal alignment
b	Defined offset
c	Defined height difference
d	Hinge point
e	Defined slope
f	Catch point
g	Natural surface
h	Δ Offset to catch point
i	Cut/fill to catch point
j	Offset to hinge point
k	Offset to alignment
l	Height difference to hinge point
m	Height difference to alignment

Access

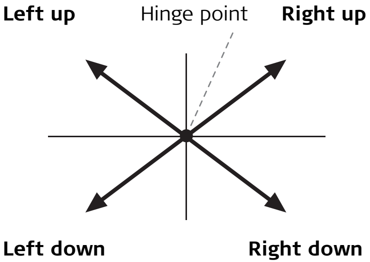
Press **STK-SLP** from the **Define Stake/Check/Slope** values screen.

Define Slope for StakeOut



Field	Description
Offset	Horizontal offset from the horizontal alignment to define the hinge point.
Def.Chain	Defined chainage for stakeout.
SlopeType	Type of slope. Refer to "Slope Type".
SlopeGrade	Slope ratio. Refer to "Slope Grade".

Slope Type



Left up
: Creates an upward plane extending to the left of the defined hinge point.

Right up
: Creates an upward plane extending to the right of the defined hinge point.

Left down
: Creates a downward plane extending to the left of the defined hinge point.

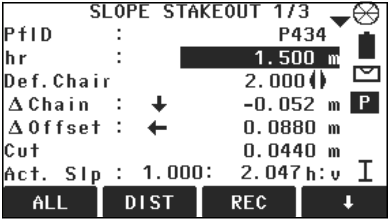
Right down
: Creates a downward plane extending to the right of the defined hinge point.

Slope Grade

Ratio of the slope. The unit for slope grade is defined in the **SETTINGS** screen. Refer to "4.1 General Settings".

Next step
Press **OK** to proceed to the **SLOPE STAKEOUT** screen.

SLOPE STAKEOUT

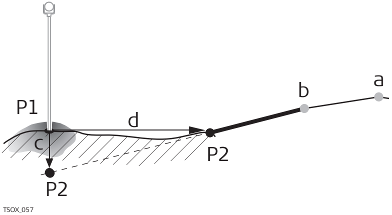


Field	Description
Def.Chain	Defined chainage for stake out.
ΔChain	Difference between the defined chainage and the measured chainage.
ΔOffset	Horizontal offset between the catch point of defined slope and the measured position.
Cut/Fill	Vertical offset between the catch point of the defined slope and the measured position. A cut is above the slope, a fill is below the slope.
Act. Slp	Measured slope of the reflector position to the hinge point.
Offs. Hng	Measured offset to the horizontal alignment including offset right and offset left.

Field	Description
ΔH Hng	Height difference to the hinge point. The vertical offset between the defined height at the current chainage, and the measured position, including the defined height difference.
Hng	Slope distance from the measured point to the hinge point.
Height	Height value of the measured point.
Act. Ch.	The measured chainage.
Offs. Aln	Measured offset to the horizontal alignment excluding offset right and offset left.
ΔH Aln	Height difference to the alignment. The vertical offset between defined height at the current chainage, and the measured position, excluding the defined height difference.
Aln	Slope distance from the measured point to the alignment.

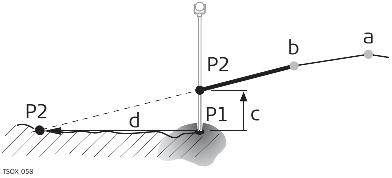
Sign convention

Cut situation



P1	Measured point
P2	Catch point
a	Horizontal alignment
b	Hinge point
c	Cut
d	Δ Offset to catch point

Fill situation



P1	Measured point
P2	Catch point
a	Horizontal alignment
b	Hinge point
c	Fill
d	Δ Offset to catch point

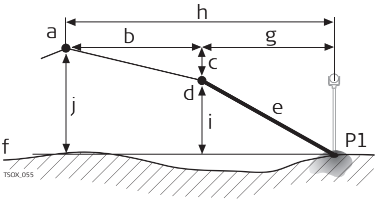
Next step

- Either, press **ALL** to measure and record.
- Or, press **ESC** to return to the **Define Stake/Check/Slope** values screen.

9.13.7 Subapplication Check Slope

Description

The subapplication Check Slope is used for as-built checks and to get information about slopes, for example on a natural surface. If the parameter offset left/right and height difference are not entered, the point on the horizontal alignment is the hinge point.



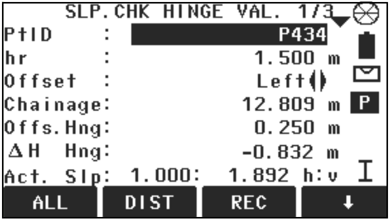
P1	Measured point
a	Horizontal alignment
b	Defined offset
c	Defined height difference
d	Hinge point
e	Actual slope
f	Natural surface
g	Offset to hinge point
h	Offset to alignment
i	Height difference to hinge point
j	Height difference to alignment

☞ Defined chainage and increment values will not be considered in the subapplication Check.

Access

Press ⬇ **CH-SLP** from the **Define Stake/Check/Slope** values screen.

Check slope values



Field	Description
Offset	Defined horizontal offset. Left, Right or Center.
Chainage	Current chainage from measured point.
Offs. Hng	Offset to hinge. Measured offset to the horizontal alignment including offset right and offset left.
ΔH Hng	Height difference to the hinge point. The vertical offset between the defined height at the current chainage, and the measured position including defined height difference.
Act. Slp	The measured slope ratio of the measured point to the hinge point.
Hng	Slope distance from the measured point to the hinge point.
Height	Height value of the measured point.

Field	Description
Offs. Aln	Measured offset to the horizontal alignment excluding offset right and offset left.
ΔH Aln	Height difference to the alignment. The vertical offset between defined height at the current chainage, and the measured position, excluding the defined height difference.
Aln	Slope distance from the measured point to the alignment.

Next step

- Either, press **ALL** to measure and record.
- Or, press **ESC** to return to the **Define Stake/Check/Slope** values screen.
- Or, continue selecting **ESC** to exit the application.

9.14 TraversePRO

9.14.1 Overview

Availability

TS02 - **TS06** Optional **TS09** ✓

The application TraversePRO can be trialled 15 times. After 15 trials, it is necessary to enter a licence code.

Description

TraversePRO is an application used to establish control networks whereby other survey operations such as topographic surveys or point stake outs can be completed.

The TraversePRO methods include 2D helmert transformation, compass rule and transit rule.

2D Helmert transformation

A helmert transformation is calculated based on two control points. These must be the start point and the end, or closing , station. Shift, rotation and scale factor will be computed and applied to the traverse.
Starting a traverse without an initial backsight measurement will automatically result in a helmert transformation.

Compass rule

The coordinate misclosure will be distributed with respect to the length of the traverse legs. The compass rule assumes that the biggest error comes from the longest traverse observations. This method is suitable when the precision of the angles and distances are approximately equal.

Transit rule

The coordinate misclosure will be distributed with respect to the coordinate changes in Easting and Northing. Use this method if the angles were measured with a higher precision than the distances.

TraversePRO step-by-step

1. Start and configure TraversePRO.
2. Enter station data.
3. Select starting method.
4. Measure a backsight point or go directly to step 5.
5. Measure a foresight point.
6. Repeat for the number of sets.
7. Move to the next station.

TraversePRO options

- It is also possible to observe sideshots and check points during the traverse, however, check points are not included in the traverse adjustment.
- At the end of the traverse, results are displayed and an adjustment may be calculated if desired.

9.14.2 Starting and Configuring TraversePRO

Access

1. Select **Prog** from the **MAIN MENU**.
2. Select **Traverse** from the **PROGRAMS** menu.
3. Complete application pre-settings.
   - **Set Job**:

     Only one traverse per job is allowed. If an adjusted or finished traverse is already part of the selected job, then select another job. Refer to "8 Applications - Getting Started".
   - **Set Tolerances**:

     Use Tol.: YES to activate the use of tolerances.
     Enter limits for horizontal direction (the difference between measured and calculated azimuth to the closing point), distance (the distance between known and measured closing point), and for differences in Easting, Northing and Height. If the adjustment results, or the deviation for a check point, exceed these limits a warning message appears.
     Press **OK** to save the limits and return to the **Pre-settings** screen.
4. Select **Start** to begin the application.

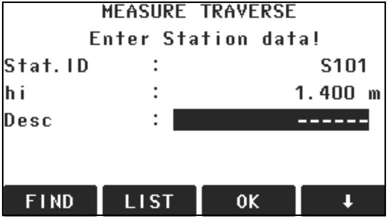
☞ It is not recommended to start a traverse if the memory is almost full. Doing so, may mean the traverse measurements and results cannot be saved. Accordingly, a message is displayed if less than 10% of the memory is free.

Traverse configuration

Field	Description
Traverse ID	Name of the new traverse.
Descr	Description, if desired.
Operator	Name of the user who will be using the new traverse, if desired.
Method	**B'F'F''B''** All points are measured in face I, then all points are measured in face II in reverse sequential order. **B'B''F''F'** The backsight point is measured in face I immediately followed by face II. Other points are measured in alternating face order. **B'F'** All points are measured in face I only.
Nr. of Sets	Number of sets. Limited to 10.
Use Face-Tol	Important when measuring with face I and II. This checks if both measurements are within a defined limit. If the limit is exceeded, a warning message is displayed.
Face Tol.	The limit that will be used for checking the face tolerance.

Next step
Press **OK** to confirm the traverse configuration and proceed to the **MEASURE TRAVERSE** screen.

MEASURE TRAVERSE - Enter Station data



LEVEL
To access the electronic level / plummet screen

Field	Description
Stat. ID	Name of the station.
hi	Height of the instrument.
Descr.	Description of the station, if desired.

Every Traverse must start on a known point.

Next step
Press **OK** to confirm station data and proceed to the **TRAVERSE START** screen.

9.14.3 Measuring Traverse

Access

From the **TRAVERSE START** screen select one of the following:

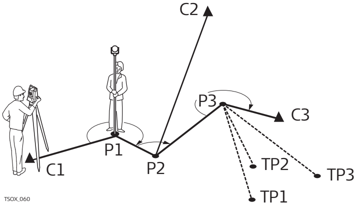
1. **Without known Backsight**: Starts the traverse without a known backsight. The measurements begin to a foresight point.
2. **With known Backsight**: Starts the traverse with a known backsight.
3. With known Azimuth: Starts the traverse with a user-defined azimuth.

Without known backsight

Start a traverse without a known backsight

- Start on a known point without an intial measurement to a known backsight.
- Stop on a known point, or make a final foresight measurement to a known closing point.

If the coordinates of the start station are unknown, the Station Setup application can be run before the traverse. A Helmert transformation will be performed at the end of the traverse.
If the traverse is left open, then the calculations are based on the system azimuth.

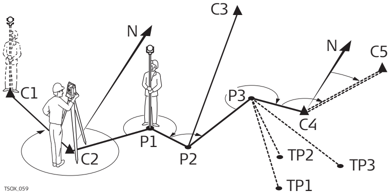


C1, C3	Control points
C2	Check point
P1...P3	Traverse points
TP1...TP3	Topographic points

With known backsight

Start a traverse with a known backsight

- Start on a known point with an intial measurement to a known backsight.
- Stop on a known point and optionally measure to a known closing point.



C1, C2	Control points
C4, C5	Control points
C3	Check point
P1...P3	Traverse points
TP1...TP3	Topographic points
N	North direction

With known azimuth

Start a traverse with a known azimuth

- Start on a known point, aim to any direction (e.g. a tower) and define this direction as the reference. This method is often used to define a 0-direction.
- Stop/end the traverse either on a known point or a traverse point and then measure to a known closing point, or leave the traverse open. Refer to "9.14.5 Closing a Traverse".

If using the current system azimuth, for example from the Station Setup application, then simply confirm the suggested Hz-value in the **Set Horizontal Angle** screen.

Measure traverse - Sight backsight

Field	Description
BS ID	Point ID of the backsight point.

Field	Description
Desc.	Description of the backsight point.
Stat. ID	Name of the station.
Code	Point code, if desired.

Next step
Depending on the traverse method configured, after the measurement either the **Sight Backsight Point** screen stays active for measuring the backsight point in a second face, or the **Sight Foresight Point** screen appears for measuring the foresight point.

Measure traverse - Sight foresight

Next step
Depending on the traverse method configured, after the measurement either the **Sight Foresight Point** screen stays active for measuring the foresight point in a second face, or the **Sight Backsight Point** screen appears for measuring the backsight point.

Interrupt a set

To interrupt a set, press **ESC** to exit the backsight or foresight screen. The CONTINUE WITH.... screen will appear.

CONTINUE WITH...

Field	Description
Redo last measurement	Returns to last measured point, can be either a backsight or a foresight point. The last measurement is not stored.

Field	Description
Redo whole station	Returns to first sight point screen. The data from the last station is not stored.
Exit traverse	Returns to the **PROGRAMS** menu. The traverse stays active and can be continued later. The data from the last station is lost.
PREV	Returns to the previous screen where **ESC** was pressed.

Repetitive loop for the number of sets

Alternating between screens for the backsight and foresight measurements continues according to the configured number of sets.
The number of sets and the face are indicated in the top right corner of the screen. For example 1/I means set 1 in face I.

9.14.4 Moving ahead

Number of defined sets is achieved

When the number of defined sets is achieved, the **TRAVERSE MAIN** screen is displayed automatically.The accuracy of the set measurements is checked. The set can be accepted or redone.

Moving ahead with the Traverse

From the **TRAVERSE MAIN** screen, select an option to move ahead with the traverse, or press **ESC** to redo the last station.

Field	Description
Survey Sideshot	Enables the measurement of standard survey and topographic points. Measured points are stored with a TraversePRO flag. If the traverse is finally adjusted, these points will be updated. **DONE** To exit the **Measure Sideshots** screen and returns to the **TRAVERSE MAIN** screen.
Move to next Station	Move to the next station. The instrument can either be left on or turned off. If the instrument is turned off and then turned on again later, the message **Last traverse not yet finished or processed - continue?** will display. Selecting YES will re-open the Traverse to continue at the new station. The start screen for the next station is similar to the **Enter Station Data** screen. The point ID of the foresight point of the last station is suggested as station ID automatically. Run through the loop of backsight and foresight measurements until the number of sets is reached.

Field	Description
Measure Checkpoint	By measuring a check point it is possible to check whether the Traverse is still within certain deviations. A check point is excluded from the traverse calculation and adjustment, however, all measurement data and results observed from a check point are stored. 1. Enter the name of the check point and the height of the reflector. 2. Press **OK** to go to the next screen. 3. Measure the check point. The differences in Easting, Northing and Height are displayed. A message will appear if the tolerances defined in the TraversePRO configuration are exceeded.

Next step

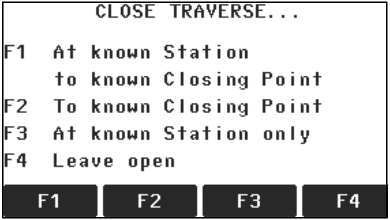
Close the traverse by selecting **CLOSE** in the **Sight Foresight** screen after a backsight point measurement, but before the foresight point measurement.

9.14.5 Closing a Traverse

Access

Close the traverse by selecting **CLOSE** in the **Sight Foresight** screen after a backsight point measurement, but before the foresight point measurement.

CLOSE TRAVERSE



F1 - F4 To select menu item.

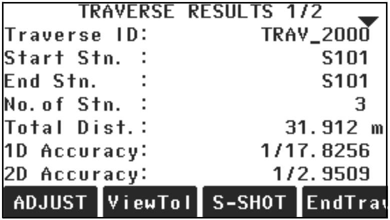
Field	Description
At known Station to known Closing Point	To close a traverse at a known station to a known closing point. Use when setup on the closing station, and the coordinates for the station and the closing point are known. If this method is chosen a distance measurement is mandatory. 1. Input the data for both points. 2. Measure to the closing point. 3. The results are displayed.

Field	Description
To known Closing Point	To close a traverse to a known closing point. Use when setup on an unknown station and only the coordinates of the closing point are known. 1. Input the data for the point. 2. Measure to the closing point. 3. The results are displayed.
At known Station only	To close a traverse at a known station only. Use when setup on the closing station and the coordinates for it are known. 1. Input the data for the closing station. 2. The results are displayed.
Leave open	To leave the traverse open. There is no last traverse station. 1. The results are displayed.

Next step

Select an option, from the **CLOSE TRAVERSE** menu to proceed to the **TRAVERSE RESULTS** screen.

TRAVERSE RESULTS



ADJUST
To calculate an adjustment. Unavailable when the traverse is left open.

ViewTol
To view the tolerances for the traverse.

S-SHOT
To measure a sideshot.

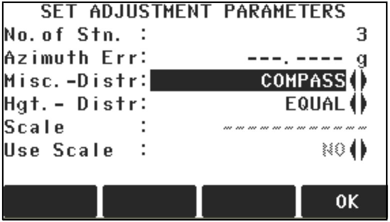
EndTrav
To record the results and end the traverse.

Field	Description
Traverse ID	Name of the traverse.
Start Stn.	Point ID of the start station.
End Stn.	Point ID of the end station.
No. of Stn.	Number of stations in the traverse.
Total Dist.	Total distance of the traverse.
1D Accuracy	Accuracy in 1D. $1/\left(\frac{\text{Length of Traverse}}{\text{Height Misclosure}}\right)$
2D Accuracy	Accuracy in 2D. $1/\left(\frac{\text{Length of Traverse}}{\text{Linear Misclosure}}\right)$

Field	Description
L. of Error	Length/distance error.
Azimuth Err.	Azimuth closure error.
ΔEast, ΔNorth, ΔHeight	Calculated coordinates.

Next step
Press **ADJUST** from the **TRAVERSE RESULTS** screen to calculate the adjustments.

SET ADJUSTMENTS PARAMETERS



Field	Description
No. of Stn.	Number of stations in the traverse.
Azimuth Err	Azimuth closure error.
Misc.-Distr	For misclosure distribution.

Field	Description
☞	Angle misclosures are distributed equally. **COMPASS** For surveys where angles and distances were measured with equal precision. **TRANSIT** For surveys where angles were measured with a higher precision than the distances.
Hgt.-Distr	The height error can be distributed equally, by distance or not at all.
Scale	PPM value defined by the calculated distance between start and end point divided by the distance measured.
Use Scale	Whether to use the calculated ppm.

☞

- Depending on the number of measured points the calculation may take some time. A message is displayed during the processing.
- Adjusted points are stored as fixpoints with an additional prefix, for example point BS-154.B is stored as CBS-154.B.
- After the adjustment the TraversePRO application is exited and the system returns to the **MAIN MENU**.

Messages The following are important messages or warnings that may appear.

Messages	Description
Memory is almost full. Continue?	This message occurs if less than 10% of the memory is free. It is not recommended to start a traverse if the memory is almost full. Doing so, may mean that the traverse measurements and the results cannot be saved.
Current job contains an adjusted traverse. Select a different job.	Only one traverse per job is allowed. Another job must be selected.
Last traverse not yet finished or processed - continue?	The TraversePRO program was quit without closing a traverse. The traverse can be continued on a new station, left unfinished, or a new traverse started and the old traverse data overwritten.
Do you really want to start a new traverse? All existing traverse data will be overwritten.	Confirmation of this message will start a new traverse and the old traverse data will be overwritten.
REDO last station? Measurements on this station will be overwritten.	Confirming returns to the first sight point screen for the previous station measurements. The data from the last station is not stored.

Messages	Description
QUIT Traverse Application? Current Station data will be lost.	Quitting the application returns to the **MAIN MENU**. The traverse can be continued later, but the current station data will be lost.
Tolerances exceeded. Accept?	The tolerance limits have been exceeded. If not accepted, the calculations can be redone.
Traverse points are recalculated and newly stored.	An information message displayed while the adjustment is calculated.

Next step

- Either, after the adjustment the TraversePRO application is exited.
- Or, press **ESC** to exit the application.

9.15 Reference Plane

Availability

TS02 Optional **TS06** ✓ **TS09** ✓

Description

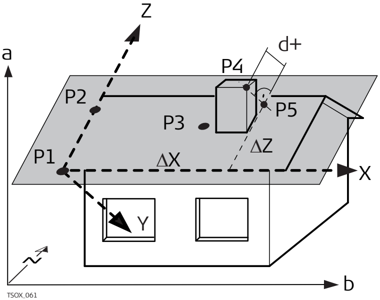
Reference Plane is an application used to measure points relative to a reference plane. It can be used for the following tasks:

- Measuring a point to calculate and store the perpendicular offset to the plane.
- Calculating the perpendicular distance from the intersection point to the local X- and Z-axis. The intersection point is the footprint point of the perpendicular vector from the measured point through the defined plane.

- Viewing, storing and staking out the coordinates of the intersection point.

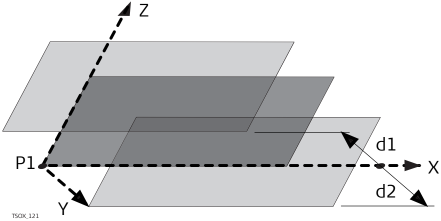
A reference plane is created by measuring three points on a plane. These three points define a local coordinate system:

- The first point is the origin of a local coordinate system.
- The second point defines the direction of the local Z-axis.
- The third point defines the plane.



X	X-axis of local coordinate system.
Y	Y-axis of local coordinate system.
Z	Z-axis of local coordinate system.
P1	First point, origin of local coordinate system.
P2	Second point
P3	Third point
P4	Measured point. This point is probably not located on the plane.
P5	Intersection point of the perpendicular vector from P4 to the defined plane. This point is definitely located on the defined plane.
d+	Perpendicular distance from P4 to the plane.
ΔX	Perpendicular distance from P5 to the local Z-axis.
ΔZ	Perpendicular distance from P5 to the local X-axis.

The perpendicular distance to the plane can be positive or negative.



P1	Origin of plane
X	X-axis of plane
Y	Y-axis of plane
Z	Z-axis of plane
d1	Positive offset
d2	Negative offset

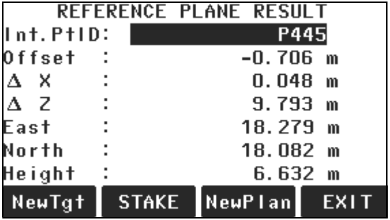
Access

1. Select **Prog** from the **MAIN MENU**.
2. Select **Ref Plane** from the **PROGRAMS** menu.
3. Complete application pre-settings. Refer to "8 Applications - Getting Started".

Measure plane and target points

1. Once the plane has been defined by three points, the **Measure Target point** screen appears.
2. Measure and record the target point. The results are displayed in the **REFERENCE PLANE RESULT** screen.

REFERENCE PLANE RESULT



NewTgt
To record and save the intersection point and to proceed to measure a new target point.

STAKE
To display stake out values for the intersection point.

NewPlan
To define a new reference plane.

Field	Description
Int. PtID	Point ID of the intersection point, the perpendicular projection of the target point on the plane.
Offset	Calculated perpendicular distance between target point and plane (intersection point).
Δ X	Perpendicular distance from the intersection point to the local Z-axis.
Δ Z	Perpendicular distance from the intersection point to the local X-axis.
East	Easting coordinate of the intersection point.
North	Northing coordinate of the intersection point.
Height	Height of the intersection point.

10 Data Management

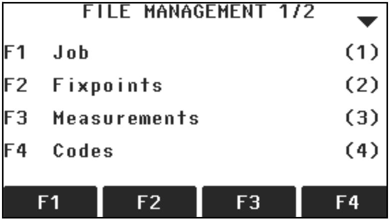
10.1 File Management

Access

Select **Manage** from the **MAIN MENU**.

FILE MANAGEMENT

The File 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, fixed points, measurements 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
Fixpoints	To view, create, edit and delete fixpoints. Valid fixed points contain at least the point ID and the coordinates E, N or H.
Measurements	To view, edit and delete measurement data. Measurement data available in the internal memory can be searched for via a specific point search, or by viewing all points within a job. The PtID, hr, code and code details can be edited. ☞ If the details of a point have been edited, any new calculations will use the new point details. However, any previously stored calculation results based on the original coordinates of the point will not be updated.
Codes	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.
Formats	To view and delete data format files.
Delete Job 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.

Menu item	Description
Memory Statistics	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, and the memory space occupied.
USB-File Manager	To view, delete, rename and create folders and files stored on the USB memory stick. Only available if the instrument is fitted with a Communication side cover and a USB memory stick is inserted. Refer to "10.4 Working with a USB Memory Stick"and "Appendix B Directory Structure".

Next step

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

10.2 Exporting Data

Description

Job data, format files, configuration sets and codelists 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 FlexOffice 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.

The USB device port
For instruments fitted with a Communication side cover.
The USB device can be connected to the USB device port housed in the Communication side cover. The USB device requires FlexOffice or another third party software.

A USB memory stick
For instruments fitted with a Communication side cover. A USB memory stick can be inserted and removed from the USB host port housed in the Communication side cover. No additional software is required for the transfer.

XML Export

The exporting of XML data has some special requirements.

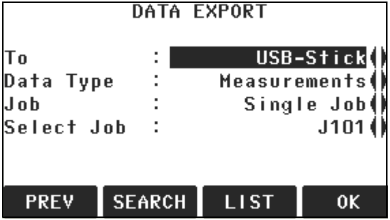
- XML standards do not allow a mix of imperial and metric measurement systems. When exporting XML data, all measurements will be converted to the same measurement system as set for the distance unit. For example, if the distance unit is set to a metric unit (metre), the pressure and temperature units will be converted to metric units as well, even if they are set to imperial units on the instrument.
- The angle unit MIL is not supported by XML. When exporting XML data, measurements using this unit are converted to dec.deg.
- The distance unit ft-in/16 is not supported by XML. When exporting XML data, measurements using this unit are converted to feet.

- Points with Height coordinates only, are not supported by XML. These points are given the E and N values of 0.

Access

1. Select **Transfer** from the **MAIN MENU**.
2. Select **Export Data**.

DATA EXPORT



SEARCH
To search for jobs or formats within the internal memory.

LIST
To list all jobs or formats within the internal memory.

Field	Description
To	USB memory stick or RS232 serial interface.
Data Type	Data type to be transferred. **Measurements**, **Fixpoints**, **Meas. & Fixpoints**, **Road Data, Code, Format, Configuration, or Backup.**
Job	Select whether to export all job related data or a single job data file.
Select Job	Displays the selected job or road alignment file.

Field	Description
Format	If **Data Type: Format** Select whether to export all formats or a single format.
Formatname	If **Format: Single Format** Name of the format to be transferred.

Export data step-by-step

1. Press **OK** in the **DATA EXPORT** screen after selecting the export details.
2. If export is to a USB memory stick, select the desired file location and press **OK.**

Data type	**Default folder on USB memory stick**
Job data:	Jobs
Format files:	Formats
Codes:	Codes

3. Select the data format, enter the file name and press OK or SEND.
   If the data format is ASCII, the **ASCII EXPORT DEFINITION** screen appears. Continue with step 4. For all other data format types, a message will display confirming the successful export of data.

4. Define the delimiter value and the data fields of the file and press **OK**. A message will display confirming the successful export of data.

A '+', '-', '.' or alphanumerical characters should not be used as delimiter values in ASCII files. These characters can also be part of the point id or coordinate values and if so, will generate errors where they occur in the ASCII file.

Road data, **Format** and **Backup** data types, and the **ASCII** data format, are only available for data exports to a USB memory stick, not via the RS232 serial interface.

All jobs, formats, codelists and configurations will be stored in the backup folder created on the USB memory stick. The job data will be stored as individual database files for each job, which can then be imported again. Refer to "10.3 Importing Data".

Exportable job data formats

Job data can be exported from a job in dxf, gsi, csv and xml file types, or any other user defined ASCII format. A format can be defined in FlexOffice Format Manager. Refer to the online help of FlexOffice for information on creating format files.

RS232 example job data output

Within the **Data Type** setting **Measurements**, 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, H) Target point
31	≙	Slope distance	84-86	≙	(E, N, H) Station point
32	≙	Horizontal distance	87	≙	Reflector height
33	≙	Height difference	88	≙	Instrument height

10.3 Importing Data

Description

For instruments fitted with a Communication side cover, data can be imported to the internal memory of the instrument via a USB memory stick.

Importable data formats

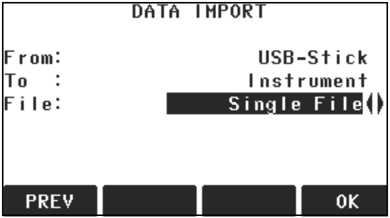
When importing data, the instrument automatically stores the file in a directory folder based on the file extension. The following data formats can be imported:

Data Type	File extension	Recognised as
GSI	.gsi, .gsi (road)	Fixpoints
DXF	.dxf	Fixpoints
LandXML	.xml	Fixpoints
ASCII	any ASCII file extension e.g. .txt	Fixpoints
Format	.frt	Format file
Codelist	.cls	Codelist file
Configuration	.cfg	Configuration file

Access

1. Select **Transfer** from the **MAIN MENU**.
2. Select **Import Data**.

DATA IMPORT

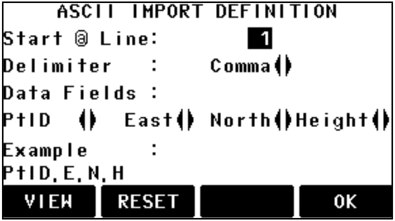


Field	Description
From	**USB-Stick**
To	**Instrument**
File	Import a single file or a backup folder.

☞ Importing a backup folder will overwrite the existing configuration file and code lists on the instrument, and all existing formats and jobs will be deleted.

Import data step-by-step

1. Press **OK** in the **DATA IMPORT** screen to proceed to the USB memory stick file directory.
2. Select the file or backup folder on the USB memory stick to be imported and press **OK**.
3. For a file: Define the Job name for the imported file, and, if requested, the file definition and layers, and press **OK** to import. If a Job with the same name already exists in the internal memory, a message will appear with the options to overwrite the existing job, attach the new points to the current job, or rename the job for the file being imported.
   If new points are attached to the current job, and the same point ID already exists, the existing point ID will be renamed with a numerical suffix. For example, PointID23 will be renamed to PointID23_1. The maximum renamed suffix is 10, e.g. PointID23_10.
   For a backup folder: Take note of the warning message displayed and press **OK** to proceed and import the folder.

4. 

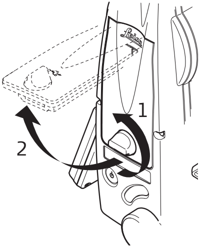
If the file is an ASCII file, the **Define ASCII Import** screen will appear. Define the delimiter value and the data fields of the file and press OK to continue.

5. A message will display once the file or backup folder has been successfully imported.

A '+', '-', '.' or alphanumerical characters should not be used as delimiter values in ASCII files. These characters can also be part of the point id or coordinate values and if so, will generate errors where they occur in the ASCII file.

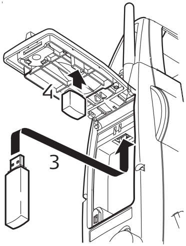
10.4 Working with a USB Memory Stick

Insert a USB memory stick step-by-step



Open the compartment lid on the Communication side cover.

The USB host port is located underneath the top edge of the compartment.



Insert the USB memory stick into the USB host port.

The cap of a Leica industrial grade USB memory stick can be stored on the underside of the compartment lid.

Close the compartment lid and turn the knob to lock the compartment closed.

☞ Always return to the **MAIN MENU** before removing the USB memory stick.

☞ Whilst other USB memory sticks may be used, Leica Geosystems recommends Leica industrial grade USB memory sticks and cannot be held responsible for data loss or any other error that may occur when using a non-Leica USB memory stick.

☞
- Keep the USB memory stick dry.
- Use it only within the specified temperature range, -40°C to +85°C (-40°F to +185°F).
- Protect the USB memory stick from direct impacts.

Failure to follow these instructions could result in data loss and/or permanent damage to the USB memory stick.

Format a USB memory stick step-by-step

Formatting the USB memory stick before starting to store data is required if a completely new USB memory stick is used, or if all existing data needs to be deleted.

☞ The formatting function on the instrument only works for Leica USB memory sticks. All other USB memory sticks should be formatted on a computer.

1. Select **Manage** from the **MAIN MENU**.
2. Select **USB-File Manager** from the **FILE MANAGEMENT** menu.
3. Press ⬇ **FORMAT** in the **USB-File Manager** screen.
4. A warning message will appear.

☞ By activating the format command all data will be lost. Make sure that all important data on the USB memory stick has been backed up before formatting the USB memory stick.

5. Press **YES** to format the USB memory stick.

A message will display once the formatting of the USB memory stick is completed. Press **OK** to return to the **USB-File Manager** screen.

10.5 Working with Bluetooth

Description

Instruments fitted with a Communication side cover can communicate with external devices via a Bluetooth connection. The instrument Bluetooth is a slave only. The Bluetooth of the external device will be the master, and therefore will control the connection and any data transfer.

Establishing a connection step-by-step

1. On the instrument ensure that the communication parameters are set to **Bluetooth** and **Active**. Refer to "4.3 Communication Parameters".
2. Activate Bluetooth on the external device. The steps required depend on the Bluetooth driver and other device specific configurations. Refer to the device user manual for information on how to configure and search for a Bluetooth connection.

   The instrument will appear on the external device as "TS0x_y_zzzzzzz", where x = the FlexLine series (TS02, TS06 or TS09), y = the angular accuracy in arc seconds, and z = the serial number of the instrument. For example, TS02_3_1234567.
3. Some devices ask for the identification number of the Bluetooth. The default number for a FlexLine Bluetooth is 0000. This can be changed by:

   a. Select **Settings** from the **MAIN MENU**.

   b. Select **Comm** from the **SETTINGS MENU**.

   c. Press **BT-PIN** from the **COMMUNICATION PARAMETER** screen.

   d. Enter a new Bluetooth PIN number in **PIN-Code:**
   e. Press **OK** to confirm the new Bluetooth PIN.
4. When the external Bluetooth device has located the instrument for the first time, a message will display on the instrument stating the name of the external device and requesting confirmation that connection to this device should be allowed.
   - Press **YES** to allow, or
   - Press **NO** to disallow this connection
5. The instrument Bluetooth sends out the instrument name and serial number to the external Bluetooth device.
6. All further steps must be made in accordance to the user manual of the external device.

Transferring data via Bluetooth

Using FlexOffice Data Exchange Manager, data files can be transferred from the instrument to a local folder via the Bluetooth connection. The transfer is made through the serial port configured on the computer as the Bluetooth Serial Port, however, for faster data transfer speeds we recommend using the USB or RS232 connections.
For more information about FlexOffice Data Exchange Manager refer to the comprehensive online help.
For transferring data using other external devices or software programs, refer to the user manual of the device or software. The FlexLine Bluetooth does not establish or manage the data transfer.

10.6 Working with Leica FlexOffice

Description

The program package FlexOffice 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 FlexOffice can only be installed on computers with MS Windows 2000, XP and Vista operating systems.

☞ For more information about FlexOffice refer to the comprehensive online help.

11 Check & Adjust

11.1 Overview

Description

Leica Geosystems 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 adjustment

The following instrument errors can be checked and adjusted electronically:

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

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

Mechanical adjustment

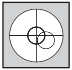
The following instrument parts can be adjusted mechanically:

- 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 **Level/Plummet** is the first screen to appear after turning on the instrument.
The tribrach, the tripod and the ground should be very stable and secure from vibrations or other disturbances.

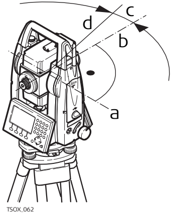
The instrument should be protected from direct sunlight in order to avoid thermal expansion on one side only.

☞ 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 Adjusting Line-of-Sight and Vertical Index Error

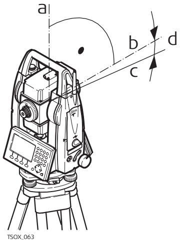
Line-of-sight error

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.



a Tilting axis
b Line perpendicular to tilting axis
c Horizontal collimation, or line-of-sight, error
d Line-of-sight

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.



a Mechanical vertical axis of the instrument, also called standing axis
b Axis perpendicular to the vertical axis. True 90°
c Vertical angle is reading 90°
d Vertical index error

☞ By determining the vertical index error the electronic level is adjusted automatically

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Access

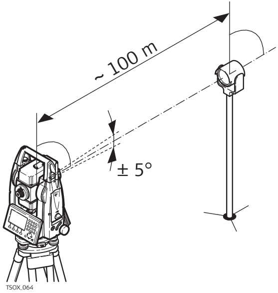
1. Select **Tools** from the **MAIN MENU**.
2. Select **Adjust** from the **TOOLS MENU**.

- Select:
  - **HZ-collimation**, or
  - **V-Index**.

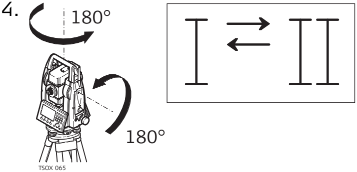
☞ The procedures and conditions required to correct line-of-sight and vertical index errors are the same, therefore the procedure will only be described once.

Check and adjust 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 Hz and V are displayed.

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

   ☞ The old and new calculated values are displayed.

6. Either:
   - Press **MORE** to measure another set to the same target point. The final adjustment values will be the calculated average from all the measurements.
   - Press **OK** to save the new adjustment data, or
   - Press **ESC** to exit without saving the new adjustment data.

Messages

The following are important messages or warnings that may appear.

Messages	Description
V-angle not suitable for adjustment !	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.
Hz-angle not suitable for adjustment !	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.

Messages	Description
Measurement Error. Try again.	Measurement error appears when, for example, there is an unstable set up. Repeat the process. Confirmation of the message required.
Time limit exceeded ! Please repeat adjustment !	Time difference between measurements for results storage exceeds 15 minutes. Repeat the process. Confirmation of the message required.

11.4 Adjusting the Tilting Axis Error

Description

The tilting axis error is caused by the deviation between the mechanical tilting axis and the line perpendicular to the vertical axis. This error affects horizontal angles. To determine this error, it is neccessary to point to a target located significantly below or above the horizontal plane.

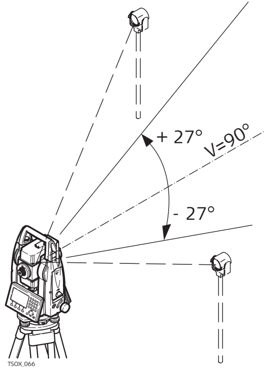
☞ The horizontal collimation error has to be determined before starting this procedure.

Access

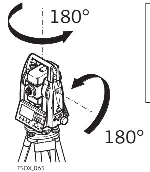
1. Select **Tools** from the **MAIN MENU.**
2. Select **Adjust** from the **TOOLS MENU**.
3. Select **Tilt Axis**.

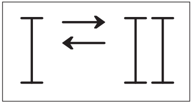
Check and adjust step-by-step

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 at least 27° (30 gon) above or beneath the horizontal plane.



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

4. 



Change face and aim at the target point again

For checking the aim, the difference in Hz and V are displayed.

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

   The old and new calculated values are displayed.

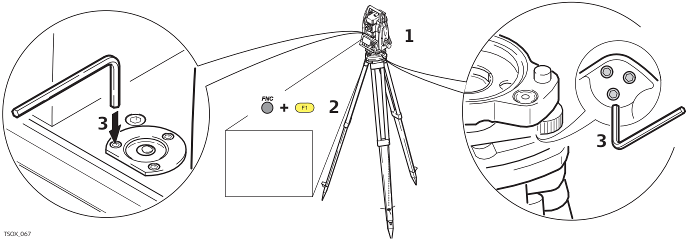
6. Either:
   - Press **MORE** to measure another set to the same target point. The final adjustment values will be the calculated average from all the measurements.
   - Press **OK** to save the new adjustment data, or
   - Press **ESC** to exit without saving the new adjustment data.

Messages

The same messages or warning as in "11.3 Adjusting Line-of-Sight and Vertical Index Error" may appear.

11.5 Adjusting the Circular Level of the Instrument and Tribrach

Adjust 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, turn on the instrument, and, if tilt correction is set to 1- or 2-axis, the **Level/Plummet** screen appears automatically. Alternatively, press **FNC** from within any application and select **Level/Plummet**.
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.

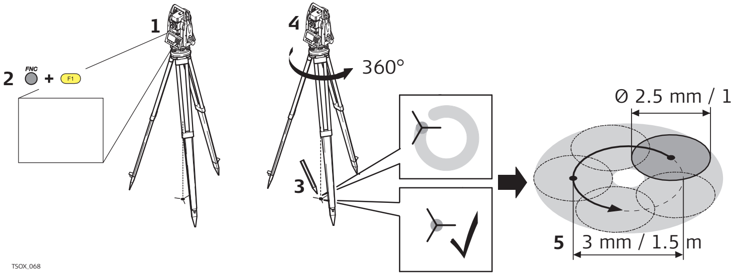
4. Repeat step 3. on the instrument and tribrach until both circular levels are centered and no further adjustments are necessary.

☞ After the adjustment, no adjustment screw should be loose.

11.6 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 Leica 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, and, if tilt correction is set to 1- or 2-axis, the laser plummet will be activated automatically, and the **Level/Plummet** screen appears. Otherwise, press **FNC** from within any application and select **Level/Plummet**.

   ☞ 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.

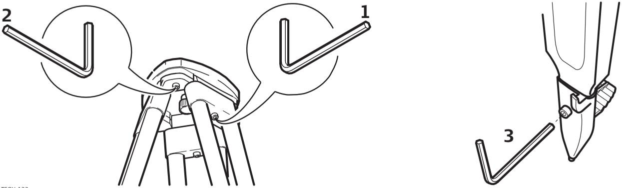
   ☞ The maximum diameter of the circular movement described by the center of the laser dot should not exceed 3 mm at a height of 1.5 m.

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 Leica 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.

11.7 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 Leica Geosystems 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.

Li-Ion batteries

- Refer to "14.6 General Technical Data of the Instrument" for information about storage temperature range.
- Batteries can be stored within a -40 to +55°C/-40°F to +131°F temperature range, however a storage temperature range of -20°C to +30°C/-4°F to +86°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

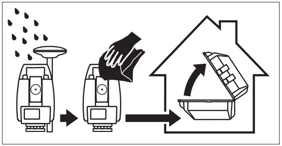
Prisms that are cooler than the ambient temperature tend to fog. It is not enough simply to wipe them. Keep them for some time inside your jacket or in the vehicle to allow them to adjust to the ambient temperature.

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 Leica Geosystems.
- 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

Leica Geosystems AG, CH-9435 Heerbrugg, hereinafter referred to as Leica Geosystems, is responsible for supplying the product, including the user manual and original accessories, in a completely safe condition.

Manufacturers of non Leica Geosystems accessories

The manufacturers of non Leica Geosystems 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 Leica Geosystems 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 Leica Geosystems immediately if the product and the application becomes unsafe.
- To ensure that the national laws, regulations and conditions for the operation of radio transmitters are respected.

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 stakeout 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 Leica Geosystems 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 Leica Geosystems can destroy the batteries. This can cause fire or explosions.

Precautions:

Only use chargers recommended by Leica Geosystems to charge the batteries.

Warning

High mechanical stress, high ambient temperatures or immersion into fluids can cause leackage, 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 Leica Geosystems home page at http://www.leica-geosystems.com/treatment or received from your Leica Geosystems dealer.

Warning

Only Leica Geosystems authorized service workshops are entitled to repair these products.

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.

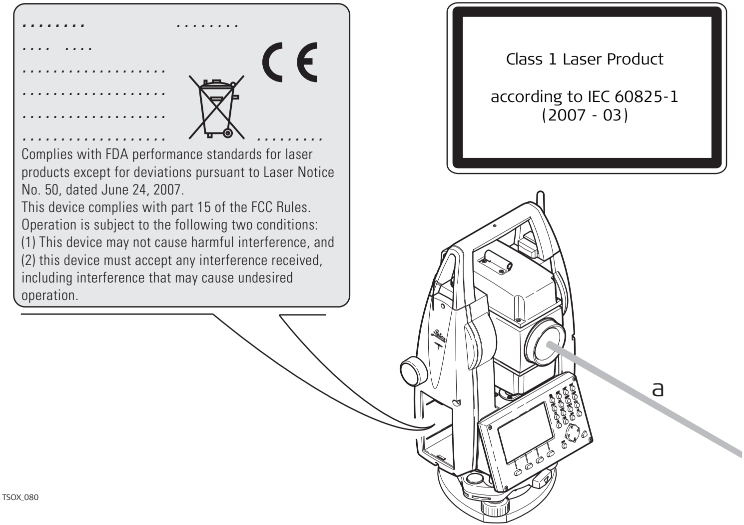
The laser product described in this section, is classified as laser class 1 in accordance with:

- 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



a Laser beam

13.6.3 Distancer, Measurements without Reflectors (Non-Prism mode)

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 (R400/R1000)
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

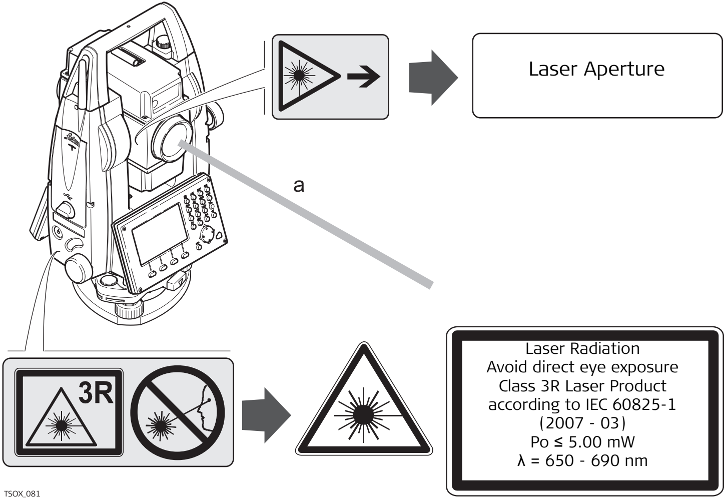
Potential hazards are not only related to direct beams but also to reflected beams aimed at reflecting surfaces such as prisms, windows, mirrors, metallic surfaces etc.

Precautions:

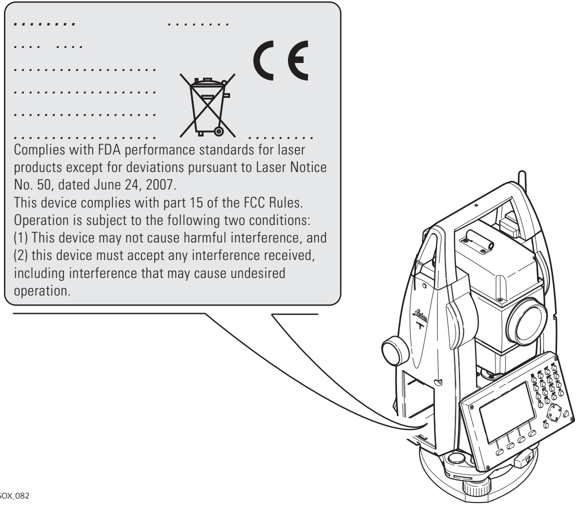
Do not aim at areas that are essentially reflective, such as a mirror, or which could emit unwanted reflections.

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


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.

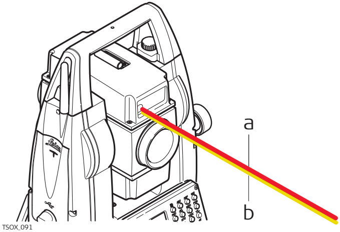
TSOX_082

13.6.4 Electronic Guide Light EGL

General

The integrated Electronic Guide Light produces a visible LED beam from the front side of the telescope. Depending on the type of telescope the EGL may be designed differently.

☞ The product described in this section, is excluded from the scope of IEC 60825-1 (2007-03): "Safety of laser products".
The product described in this section, is classified as exempt group in accordance with IEC 62471 (2006-07) and does not pose any hazard provided that the product is used and maintained in accordance with this user manual.



a LED beam red
b LED beam yellow

13.6.5 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".

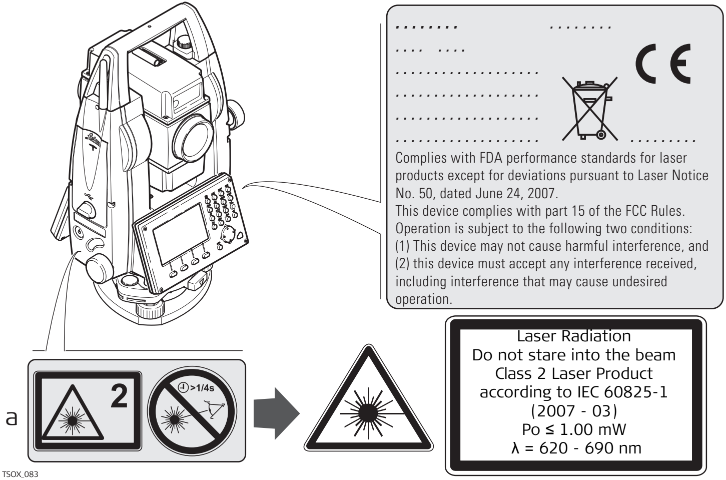
Class 2 laser products:
These products are safe for momentary exposures but can be hazardous for deliberate staring into the beam.

Description	Value
Maximum average radiant power	1.00 mW
Pulse duration	0-100%
Pulse repetition frequency	1 kHz
Wavelength	620 nm - 690 nm

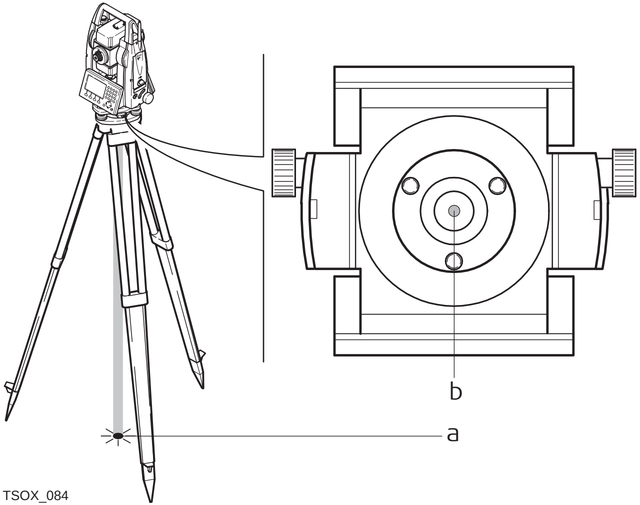
⚠ **Warning**

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.

Labelling



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



TSOX_084

a Laser beam
b Exit for laser beam

13.7 Electromagnetic Compatibility EMC

Description

The term Electromagnetic Compatability 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, Leica Geosystems 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 Leica Geosystems. 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, Leica Geosystems 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.

Bluetooth Use of product with Bluetooth:

⚠ **Warning**

Electromagnetic radiation can cause disturbances in other equipment, in installations, in medical devices, for example pacemakers or hearing aids and in aircraft. It can also affect humans and animals.

Precautions:

Although the product meets in combination with radio or digital cellular phone devices recommended by Leica Geosystems the strict regulations and standards which are in force in this respect, Leica Geosystems cannot completely exclude the possibility that other equipment may be disturbed or that humans or animals may be affected.

- Do not operate the product with radio or digital cellular phone devices in the vicinity of filling stations or chemical installations, or in other areas where an explosion hazard exists.
- Do not operate the product with radio or digital cellular phone devices near to medical equipment.
- Do not operate the product with radio or digital cellular phone devices in aircraft.

13.8 FCC Statement, Applicable in U.S.

Applicability

The greyed paragraph below is only applicable for FlexLine instruments without Bluetooth.

⚠ **Warning**

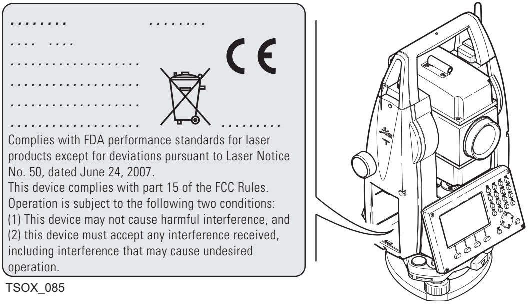
This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC rules.
These limits are designed to provide reasonable protection against harmful interference in a residential installation.
This equipment generates, uses and can radiate 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**

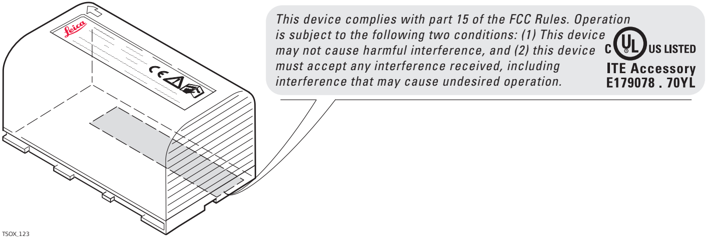
Changes or modifications not expressly approved by Leica Geosystems for compliance could void the user's authority to operate the equipment.

Labelling FlexLine instrument



TSOX_085

Labelling internal battery GEB211, GEB221



TSOX_123

14 Technical Data

14.1 Angle Measurement

Accuracy

Available angular accuracies	Standard deviation Hz, V, ISO 17123-3	Display resolution			
["]	[mgon]	["]	[°]	[mgon]	[mil]
1	0.3	0.1	0.0001	0.1	0.01
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 (GPR1)	1800	6000	3000	10000	3500	12000
3 prisms (GPR1)	2300	7500	4500	14700	5400	17700
360° prism (GPZ4, GPZ122)	800	2600	1500	5000	2000	7000
Reflector tape 60 mm x 60 mm	150	500	250	800	250	800
Mini prism (GMP101)	800	2600	1200	4000	2000	7000
360° Mini prism (GRZ101)	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]
	TS02 / TS06	TS09	
Prism-Standard	1.5 mm + 2 ppm	1 mm + 1.5 ppm	2.4
Prism-Fast	3 mm + 2 ppm	3 mm + 1.5 ppm	0.8
Prism-Tracking	3 mm + 2 ppm	3 mm + 1.5 ppm	<0.15
Tape	5 mm + 2 ppm	5 mm + 1.5 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 (Non-Prism mode)

Range

Power Pinpoint R400 (without reflector)

Kodak Gray Card	Range D		Range E		Range F	
	[m]	[ft]	[m]	[ft]	[m]	[ft]
White side, 90 % reflective	200	660	300	990	>400	>1310
Grey side, 18 % reflective	100	330	150	490	>200	>660

Ultra Pinpoint R1000 (without reflector)

Kodak Gray Card	Range D		Range E		Range F	
	[m]	[ft]	[m]	[ft]	[m]	[ft]
White side, 90 % reflective	600	1970	800	2630	>1000	>3280
Grey side, 18 % reflective	300	990	400	1310	>500	>1640

Range of Measurement: 1.5 m to 1200 m
Range of Measurement, FlexPoint: 1.5 m to 30 m
Display unambiguous: up to 1200 m

Atmospheric conditions

Range D: Object in strong sunlight, severe heat shimmer
Range E: Object in share, 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 - 500 m	2 mm + 2 ppm	3 - 6	12
>500 m	4 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.

Tracking measuring*	Standard deviation	Measure time, typical [s]
Tracking	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

Laser dot size

Distance [m]	Laser dot size, approximately [mm]
at 30	7 x 10
at 50	8 x 20

14.4 Distance Measurement Reflector (>3.5 km)

Range

Ultra&Power (with reflector)	Range A		Range B		Range C	
	[m]	[ft]	[m]	[ft]	[m]	[ft]
Standard prism (GPR1)	2200	7300	7500	24600	>10000	>33000
Reflector tape 60 mm x 60 mm	600	2000	1000	3300	1300	4200

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]
Long range	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

14.5.1 Products without Communication side cover

Conformity to national regulations

Hereby, Leica Geosystems AG, 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.leica-geosystems.com/ce.

14.5.2 Products with Communication side cover

Conformity to national regulations

- FCC Part 15 (applicable in US).
- Hereby, Leica Geosystems AG, declares that the instrument with Communication side cover is in compliance with the essential requirements and other relevant provisions of Directive 1999/5/EC. The declaration of conformity may be consulted at http://www.leica-geosystems.com/ce.

Class 1 equipment according European Directive 1999/5/EC (R&TTE) can be placed on the market and be put into service without restrictions in any EEA Member state.

- The conformity for countries with other national regulations not covered by the FCC part 15 or European directive 1999/5/EC has to be approved prior to use and operation.

Frequency band

2402 - 2480 MHz

Output power

Bluetooth:	2.5 mW

Antenna

Type:	Mono pole
Gain:	+2 dBi

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 Hz-collimation and V-Index).

Angular accuracy	Setting accuracy		Setting range	
["]	["]	[mgon]	[']	[gon]
1	0.5	0.2	±4	0.07
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

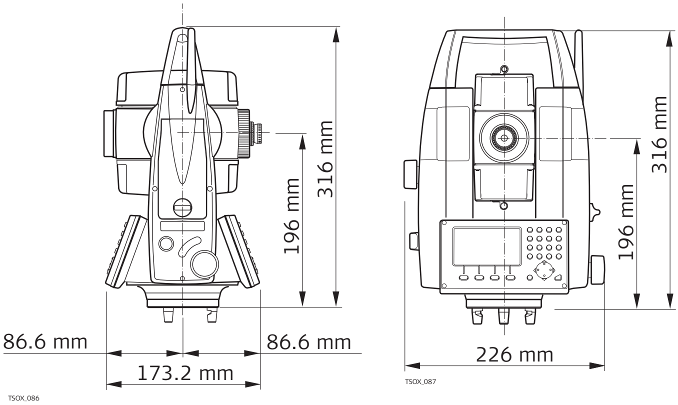
Display: 280 x 160 pixels, LCD, backlit, 8 lines with 31 characters each, heatable (temp. < -5°).

Instrument Ports

Name	Description
RS232	5 pin LEMO-0 for power, communication, data transfer. This port is located at the base of the instrument.
USB host port*	USB memory stick port for data transfer.
USB device port*	Cable connections from USB devices for communication and data transfer.
Bluetooth*	Bluetooth connections for communication and data transfer.

* Only for instruments fitted with a Communication side cover.

Instrument Dimensions



Weight

Instrument:	4.2 kg - 4.5 kg (depending on hardware configuration)
Tribrach:	760 g
Battery GEB211:	110 g
Battery GEB221:	210 g

Tilting axis height

Without tribrach:	196 mm
With tribrach (GDF111):	240 mm ±5 mm

Recording

Model	Memory Type	Capacity [MB]	Number of measurements
TS02	Internal memory	2	13,500
TS06 / TS09	Internal memory	10	60,000

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 GEB211

Type: Li-Ion
Voltage: 7.4 V
Capacity: 2.2 Ah
Operating time*: approximately 10 hours

* Based on a single measurement every 30 s at 25°C. Operating time may be shorter if battery is not new.

Battery GEB221

Type: Li-Ion
Voltage: 7.4 V
Capacity: 4.4 Ah
Operating time*: approximately 20 hours

* Based on a single measurement every 30 s at 25°C. Operating time may be shorter if battery is not new.

Environmental specifications

Temperature

Type	Operating temperature		Storage temperature	
	[°C]	[°F]	[°C]	[°F]
FlexLine instrument	-20 to +50	-4 to +122	-40 to +70	-40 to +158
Battery	-20 to +50	-4 to +122	-40 to +70	-40 to +158
USB memory stick	-40 to +85	-40 to +185	-50 to +95	-58 to +203

Protection against water, dust and sand

Type	Protection
FlexLine instrument	IP55 (IEC 60529)

Humidity

Type	Protection
FlexLine instrument	Max 95% non condensing. The effects of condensation are to be effectively counteracted by periodically drying out the instrument.

Arctic model

Operating range:	-35°C to +50°C (-31°F to +122°F)
☞	To minimise unavoidable slowdown of display performance for the Arctic option, switch display heating on and connect the external battery. Allow for a short warm-up time.

Electronic Guide Light EGL

Working range:	5 m to 150 m (15 ft to 500 ft)
Position accuracy:	5 cm at 100 m (1.97" at 330 ft)

Automatic corrections

The following automatic corrections are made:

- Line of sight error
- Tilting axis 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.
- Projection distortion.

Atmospheric correction

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:

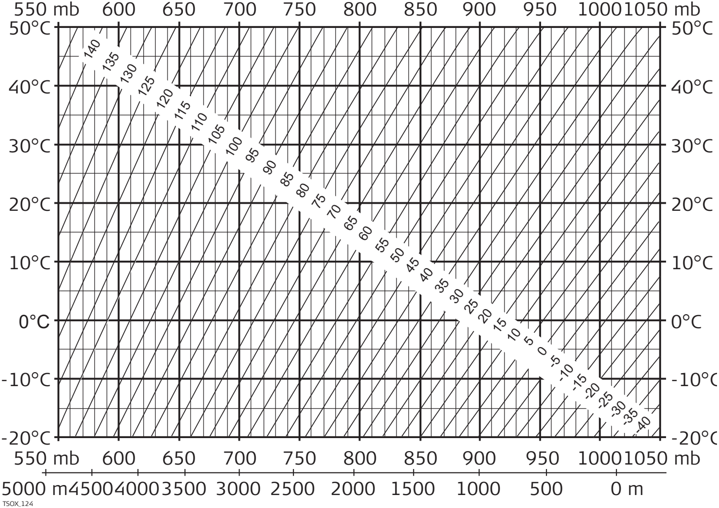
- Adjustments for air pressure
- Air temperature

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

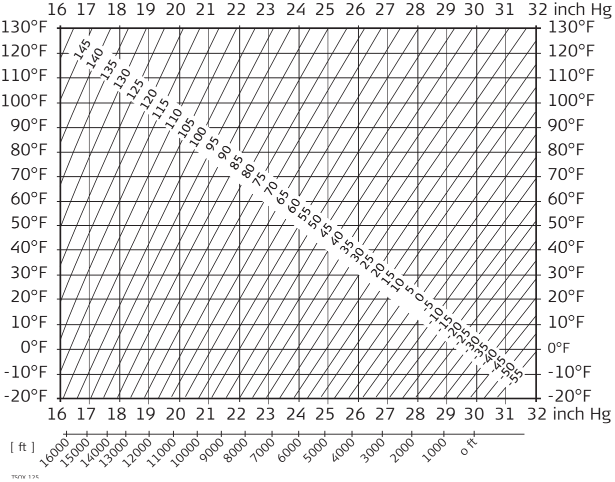
Atmospheric corrections °C

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



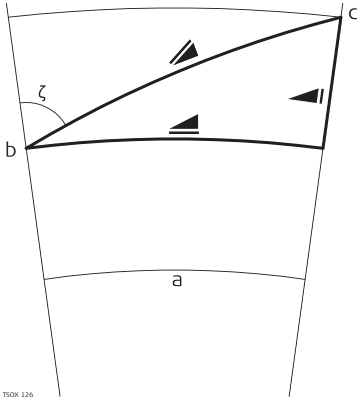
Atmospheric correction °F

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
Slope distance
Horizontal distance
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

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

TSOX_127

	Displayed slope distance [m]
D_0	Uncorrected distance [m]
ppm	Atmospheric scale correction [mm/km]
mm	prism constant [mm]

Horizontal distance

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

TSOX_128

	Horizontal distance [m]
Y	* sinζ
X	* cosζ
	ζ = Vertical circle reading
A	$(1 - k/2)/R = 1.47 * 10^{-7}$ $[m^{-1}]$
	k = 0.13 (mean refraction coefficient)
	$R = 6.378 * 10^6$ m (radius of the earth)

Height difference

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

TSOX_129

	Height difference [m]
Y	* sinζ
X	* cosζ
	ζ = Vertical circle reading
B	$(1 - k)/2R = 6.83 * 10^{-8}$ $[m^{-1}]$
	k = 0.13 (mean refraction coefficient)
	$R = 6.378 * 10^6$ 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 Leica Geosystems home page at http://www.leica-geosystems.com/internationalwarranty or collect from your Leica Geosystems distributor.

The foregoing warranty is exclusive and is in lieu of all other warranties, terms or conditions, express or implied, either in fact or by operation of law, statutory or otherwise, including warranties, terms or conditions of merchantability, fitness for a particular purpose, satisfactory quality and non-infringement, all of which are expressly disclaimed.

Software License Agreement

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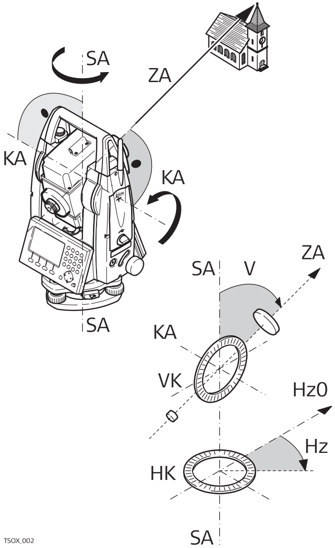
You must not install or use the software unless you have read and accepted the terms and conditions of the Leica Geosystems Software License Agreement. Installation or use of the software or any part thereof, is deemed to be an acceptance of all the terms and conditions of such License Agreement. If you do not agree to all or some of the terms of such License Agreement, you may not download, install or use the software and you must return the unused software together with its accompanying documentation and the purchase receipt to the dealer from whom you purchased the product within ten (10) days of purchase to obtain a full refund of the purchase price.

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.

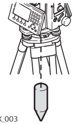
V = Vertical angle / zenith angle

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

Hz = Horizontal direction

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

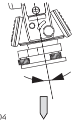
Plumb line / compensator



TS0X_003

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

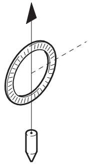
Standing axis inclination



TS0X_004

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.

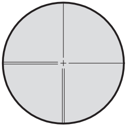
Zenith



TS0X_070

Point on the plumb line above the observer.

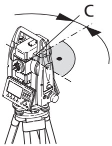
Reticle



TS0X_071

Glass plate within the telescope with reticle.

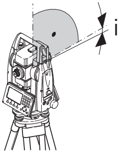
Line-of-sight error (horizontal collimation)



TS0X_005

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.

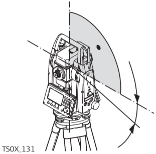
Vertical index error



TS0X_006

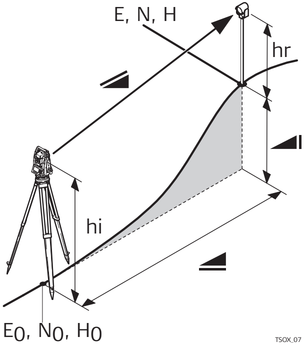
With a horizontal line of sight the vertical circle reading should be exactly 90°(100 gon). The deviation from this value is termed the Vertical index error (i).

Tilting axis error



The tilting axis error is the deviation within the horizontal rotation axis, between measurements in both faces.

Explanation of displayed data



- Indicated meteorological corrected slope distance between instrument tilting axis and center of prism/laser dot
- Indicated meteorological corrected horizontal distance
- Height difference between station and target point

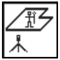
hr	Reflector height above ground
hi	Instrument height above ground
E_0, N_0, H_0	Easting, Northing and Height coordinates of station
E, N, H	Easting, Northing and Height coordinates of target point

Appendix A Menu Tree

☞ Depending on local firmware versions the menu items may differ.

Menu Tree

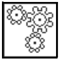
- **Q-Survey**



- **Programs**
  - Station Setup
  - Surveying
  - Stakeout
  - Reference Element
  - Tie Distance
  - Area & DTM-Volume
  - Remote Height
  - Construction
  - Cogo
  - Road 2D
  - Roadworks 3D
  - TraversePRO
  - Reference Plane

- **Manage**
  - Jobs
  - Fixpoints
  - Measurements
  - Codes
  - Formats
  - Delete Job Memory
  - Memory Statistics
  - USB-File Manager

- **Transfer**
  - Export Data
  - Import Data



- **Setting**

  - General
    - Contrast, Trigger Key 1, Trigger Key 2, USER Key 1, USER Key 2, Tilt Correction, Hz Correction, Beep, Sector Beep, HZ Increment, V-Setting, Face I Definition, Language, Language Choice, Angle Unit, Minimum Reading, Distance Unit, Distance Decimal, Temperature Unit, Pressure Unit, Grade Unit, Data Output, GSI Format, GSI Mask, Code record, Code, Display Illumination, Reticle Illumination, Display Heater, Pre-/Suffix, Identifier, Sort Type, Sort Order, Double Point ID, Auto-Off, V after DIST.

  - EDM Settings
    - EDM Setting, Atmospheric Data, Individual PPM, Projection Scale, EDM Signal Reflection, EDM Frequency

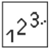
  

  - Communication Parameters
    - Communication Settings, Bluetooth PIN

- **Tools**

  - Adjust
    - Hz-Collimation
    - V-Index
    - Tilt Axis
    - View Adjustment Reminder
    - Adjustment Reminder

  - Start Up


|—— System Information
| |—— Instrument Information, Software Information, Set Date, SetTime
|
|

|—— Licence Key
|
|
|

|—— PIN
|
|
|

|—— Load Firmware
             |—— Firmware, Languages Only

Appendix B Directory Structure

Description

On the USB memory stick, files are stored in certain directories. The following diagram is the default directory structure.

Directory Structure

```
|—— CODES      • Codelists (*.cls)
|
|—— FORMATS    • Format files (*.frt)
|
|—— JOBS       • GSI, DXF, ASCII and LandXML files (*.*)
|              • Logfiles created from applications
|
|—— SYSTEM     • Firmware files (FlexField.fw and FlexField_EDM.fw)
|              • Language files (FlexField_Lang_xx.fw)
|              • Licence file (*.key)
|              • Configuration files (*.cfg)
|
```

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Z

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Original text

Leica Geosystems AG
Heinrich-Wild-Strasse
CH-9435 Heerbrugg
Switzerland
Phone +41 71 727 31 31

www.leica-geosystems.com

- when it has to be **right**