Leica TPS400 Series
User Manual

Version 4.0
English

- when it has to be **right**

Leica Geosystems

Electronical Total Station

Congratulations on your purchase of a new Leica Geosystems Total Station.

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

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

Product identification

The model and the serial number of your product is indicated on the type plate.

Enter the model and the serial number in your manual and always refer to this information when you need to contact your agency or Leica Geosystems authorized service workshop.

Type: _____ Serial no.: _____

Symbols used in this manual

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

DANGER

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

WARNING

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

CAUTION

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

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

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 all TPS400 Series instruments. Where there are differences between the various models they are clearly described.
Telescope	In regard to the instrument EDM, a TPS400 instrument may be equipped with one of two types of telescopes, which offer the same performance but differ in some technical details. The two different types can be distinguished by a rectangular (telescope type 1) or round (telescope type 2) shaped element, which is visible in the centre of the objective lens.
	Where there are technical differences between the two telescope types they are marked by the following pictograms, referring to the first or second type described above:
	**Telescope Type 1** • When measuring distances to a reflector with EDM mode "IR" this telescope type uses a wide infrared laser beam, which emerges coaxially from the telescope's objective. • Instruments that are equipped with a reflectorless EDM additionally offer the EDM modes "RL" and "RL-Prism". When using these EDM modes a narrow visible red laser beam is used to measure distances.

	Description
	**Telescope Type 2** • When measuring distances to a reflector with EDM mode "IR" this telescope type uses a wide visible red laser beam, which emerges coaxially from the telescope's objective. • Instruments that are equipped with a reflectorless EDM additionally offer the EDM modes "RL" and "RL-Prism". When using these EDM modes a narrow visible red laser beam is used to measure distances.

Contents - Overview

Contents

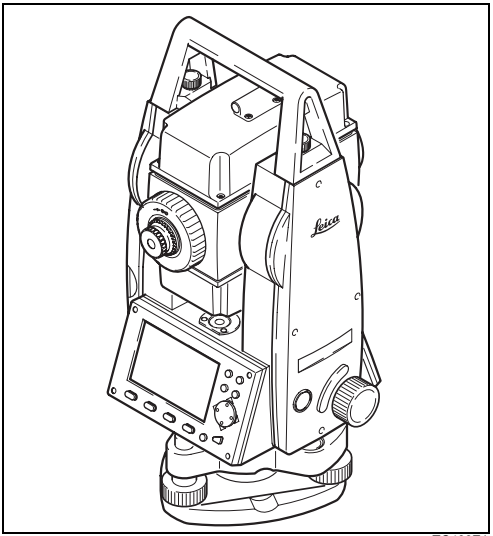
Introduction

The Leica Geosystems TPS400 is a high-quality electronic total station designed for the construction site.

Its innovative technology makes the daily surveying jobs easier.

The product is ideally suited for simple construction surveys and setting out tasks.

The easy operation of the product functions can be learned without problems in no time.

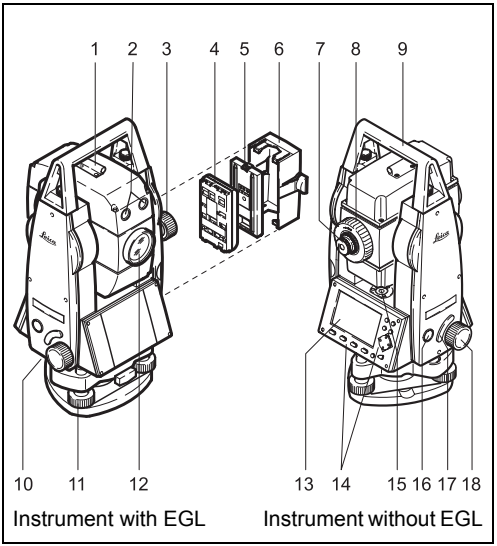


TC400Z1

Special features

- Easy and quickly to learn !
- Interactive keys; with large and clear LCD.
- Small, light-weight and easy-to-use.
- Measurements without reflector with the integrated visible laser beam (TCR products).
- Additional trigger key on side cover.
- Continuous drives for horizontal and vertical angles (tangent screws).
- With laser plummet as standard.

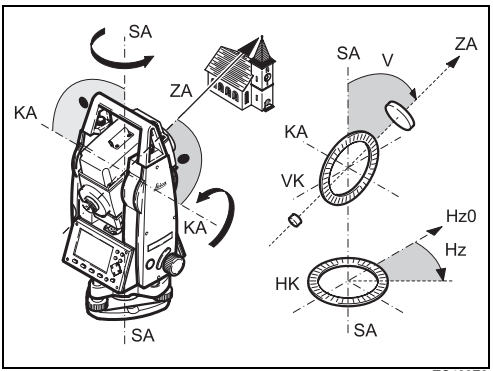
Important parts



TC400Z2

1) Optical sight
2) Integrated guide light EGL (optional)
3) Vertical drive
4) Battery
5) Battery stand for GEB111
6) Battery cover
7) Eyepiece; focussing graticule
8) Focussing telescope image
9) Detachable carrying handle with mounting screws
10) Serial interface RS232
11) Foot screw
12) Objective with integrated Electronic Distance Measurement (EDM); Beam exit
13) Display
14) Keyboard
15) Circular level
16) On/Off key
17) Trigger key
18) Horizontal drive

Technical terms and abbreviations



TC400Z3

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

SA = Standing axis
Vertical rotation axis of the telescope.

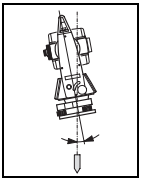
KA = Tilting axis
Horizontal rotation axis of the telescope (Trunion axis).

V = Vertical angle / zenith angle

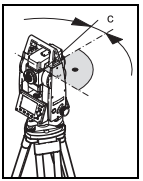
VK = Vertical circle
With coded circular division for reading the V-angle.

Hz = Horizontal direction

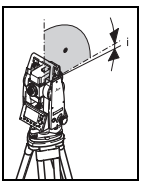
HK = Horizontal circle
With coded circular division for reading the Hz-angle.



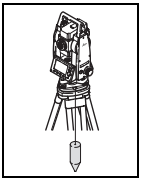
Standing axis inclination
Angle between plumb line and standing axis. Standing axis tilt is not an product error and is not eliminated by measuring in both faces. Any possible influence it may have on the Hz-direction resp. V-angle is elliminated by the dual axis compensator.



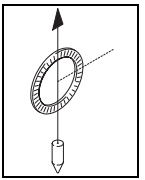
Line-of-sight error (Hz-collimation)
The line-of-sight error is the deviation from the perpendicular between tilting axis and line-of-sight. This could be eleminated by measuring in both faces.



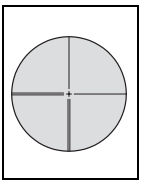
V-Index (Vertical index error)
With horizontal line-of-sight the V-circle reading should be exactly 90°(100gon). The deviation from this values is termed V-index (i).



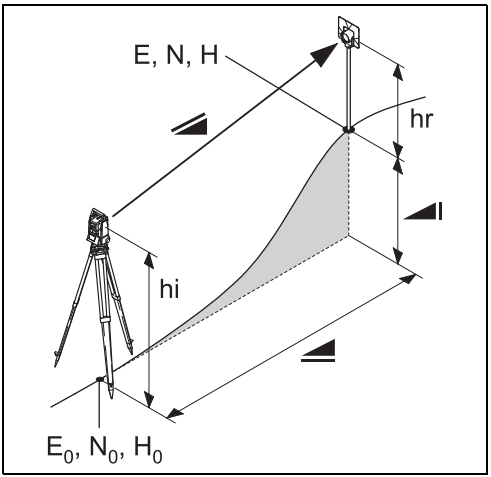
Plumb line / Compensator
Direction of gravity. The compensator defines the plumb line within the product.



Zenith
Point on the plumb line above the observer.



Reticle
Glass plate within the telescope with reticle.



TC400Z4

	Indicated meteorological corrected slope distance between product tilting axis and centre of prism/laser spot (TCR).
	Indicated meteorological corrected horizontal distance.
	Height difference between station and target point.
hr	Reflector height above ground
hi	product height above ground
E0	Station coordinate (Easting)
N0	Station coordinate (Northing)
H0	Station height
E	Easting of target point
N	Northing of target point
H	Height of target point

Area of applicability

This User Manual is valid for all products of the TPS400 Series.

PC Program Package Leica Geo Office Tools (LGO-Tools)

The program package LGO-Tools is used for the data exchange between the Total Station and the PC. It contains several auxiliary programs in order to support your use of the product.

Installation on the PC

The installation program can be found on the CD-ROM supplied. Please note that LGO-Tools can only be installed on computers with MS Windows 98, 2000 or XP operating systems.

☞ Any previous versions of LGO-Tools on your computer must be uninstalled first before installing the new version.

For the installation call program "**setup.exe**" in the directory **\LGO-Tools** on the CD-ROM and follow the input instructions of the installation program.

Program content

After successful installation the following programs appear:

Tools

- **Data Exchange Manager**
  For data exchange of coordinates, measurements, codelists and output formats between product and PC.
- **Coordinate Editor**
  Import/Export as well as creating and processing of coordinate files.
- **Codelist Manager**
  For creating and processing of codelists.
- **Software Upload**
  For loading system software and EDM-software.

☞ For EDM Software upload only LGO/LGO-Tools Software Version 3.0 or higher must be used for error free operation.

Not using the correct upload Software can permanently damage the instrument.

☞ Before the Software Upload, always insert a charged battery into the product.

- **Format Manager**
  For creating of own, special formatted data output files.
- **Configuration Manager**
  Import/Export as well as creating of product configuration.

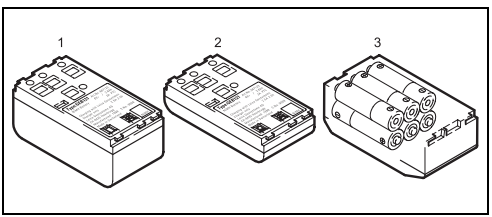
☞ For more informationen about LGO-Tools refer to the comprehensive Online Help.

Power Supply

Use the Leica Geosystems batteries, chargers and accessories or accessories recommended by Leica Geosystems to ensure the correct functionality of the product.

Power for the product can be supplied either internally or externally. An external battery is connected to the product using a LEMO cable.

- **Internal battery**:
  One GEB111 or 121 battery fit in the battery compartment.
- **External battery**:
  One GEB171 battery connected via cable.



1 GEB121
2 GEB111
3 Single cells in the battery adapter GAD39

Your Leica Geosystems product is powered by rechargeable plug-in batteries. For this product, we recommend the basic battery (GEB111) or the Pro battery (GEB121). Optionally six single cells can be used with the GAD39 battery adapter.

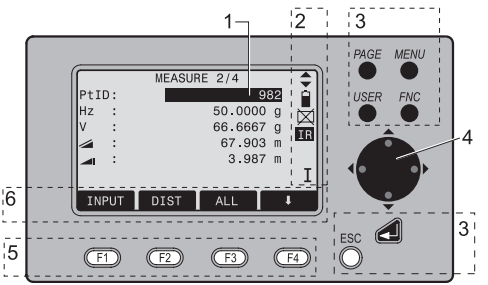
Six single cell batteries (1.5 V each) supply 9 Volts. The voltmeter on the product is designed for a voltage of 6 Volts (GEB111/ GEB121).

☞ The battery charge is not displayed correctly when using single cells. Use the single cells with the battery adapter as emergency power supply. The advantage of the single cells is in a lower rate of discharge even over long periods.

The on / off key is located on the side cover of the TPS400.

☞ All shown displays are examples. It is possible that local software versions are different to the basic version.

Keypad



TC400Z5

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

Fixed keys

[PAGE]	Scrolls to next page when a dialogue-consists of several pages.
[MENU]	Accesses programs, settings, the data manager, adjustments, communica-tions parameters,system information and data transfer.
[USER]	Key, programmable with function from the FNC menu.
[FNC]	Quick-access to measurement-supporting functions.
[ESC]	Quit a dialog or the edit mode with acti-vation of the "previous" value. Return to next heigher level.
	Confirm an input; continue to the next field.

Trigger key

The measurement trigger has three settings (ALL, DIST, OFF).

The key can be activated in the configuration menu.

Selection of Language

After switching on the instrument the user is able to choose his preferred language.

The dialog to choose the language is only shown if two languages are loaded onto the instrument and **Lang.choice: On** is set in Settings dialog.

To load an additional language connect the instru-ment to LGO Tools Version 4.0 or higher via the serial interface and load using "LGO Tools - Soft-ware Upload".

Distance measurement

A laser distancer (EDM) is incorporated into the products of the TPS400 series.

In all versions, the distance can be determined by using a laser beam which emerges coaxially from the telescope objective.

☞ **Measurements to strongly reflecting targets such as to traffic lights in** Reflector EDM **mode without prism should be avoided. The measured distances may be wrong or inaccurate.**

For applications without reflector, a special arrangement of the EDM, and appropriate arrangement of the beam paths, enable ranges of over five kilometres to be attained with standard prisms.

Miniprisms, 360° reflectors and reflector tapes can also be used, and measurement is also possible without a reflector.

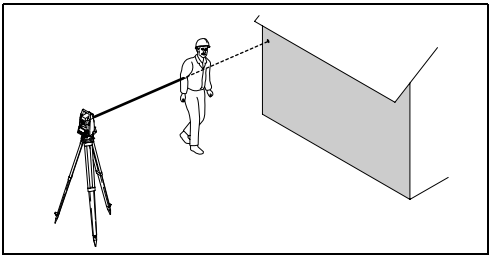
☞ **When a distance measurement is triggered, the EDM measures to the object which is in the beam path at that moment.**

If e.g. people, cars, animals, swaying branches, etc. cross the laser beam while a measurement is being taken, a fraction of the laser beam is reflected and may lead to incorrect distance values.

Avoid interrupting the measuring beam while taking reflectorless measurements or measurements using reflective foils. Measurements to prism reflectors are only critical if an object crosses the measuring beam at a distance of 0 to 30m and the distance to be measured is more than 300m.

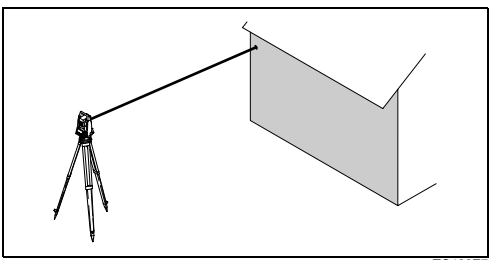
In practice, because the measuring time is very short, the user can always find a way of avoiding these critical situations.

☞ Very short distances may be measured reflectorless in IR mode to well reflecting targets. Note that the distances are corrected with the additive constant defined for the active reflector.



TC400Z6

Incorrect result



TC400Z7

Correct result

Reflectorless

Be sure that the laser beam is not reflected by anything close to the line of sight (e.g. highly reflective objects).

When a distance measurement is triggered, the EDM measures to the object which is in the beam path at that moment. In case of temporary obstruction (e.g. a passing vehicle, heavy rain, fog or snow) the EDM may measure to the obstruction.

When measuring longer distances, any divergence of the red laser beam from the line of sight might lead to less accurate measurements. This is because the laser beam might not be reflected from the point at which the crosshairs are pointing.
Therefore, it is recommended to verify that the R-laser is well collimated with the telescope line of sight (refer to the chapter "Checking and adjusting").

Do not measure with two products to the same target simultaneously.

Red laser to prisms

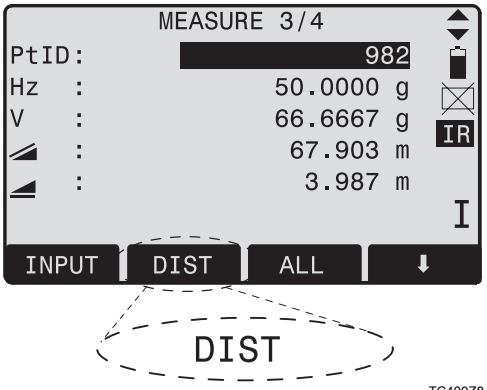
☞ Accurate measurements to prisms should be made with the standard program (Reflector EDM mode).

Red laser to reflector tape

The visible red laser beam can be used to measure to reflective foils, also. To guarantee the accuracy the red laser beam must be perpendicular to the reflector tape and it must be well adjusted (refer to the chapter "Checking and adjusting").

☞ Make sure the additive constant belongs to the selected target (reflector).

Softkeys



TC400Z8

Under softkeys, a selection of commands and functions is listed at the bottom of the screen. They can be activated with the corresponding function keys. The available scope of each function depends on the applications / functions currently active.

General softkeys:

[ALL]	Starts distance and angle measurements and saves measured values.
[DIST]	Starts distance and angle measurements without saving measured values.
[REC]	Saves displayed values.
[ENTER]	Deletes current value in the display and is ready for the input of a new value.
[ENH]	Opens the coordinate input mode.
[LIST]	Displays the list of available points.
[FIND]	Starts the search for the point entered.
[EDM]	Displays EDM settings.
[IR/RL]	Toggles between reflector and reflectorless measurement modes.
[PREV]	Back to last active dialog.
[NEXT]	Continue to next dialog.
⬅	Returns to highest softkey level.
⬇	To next softkey level.
[OK]	Set displayed message or dialog and quit dialog.

☞ Find further information about menu/applicationspecific buttons in the relevant sections.

Symbols

Depending on software version different symbols are displayed indicating a particular operating status.

◀ ▶ A double arrow indicates choice fields.

 Using the navigation keys the desired parameter can be selected.

 Quits a selection with the enter key or the navigation keys.

 Indicates that several pages are available which can be selected with [PAGE].

I, II Indicates telescope position I or II.

 Indicates that Hz is set to "left side angle measurement" (anti-clockwise).

Status symbol "EDM type"

IR Reflector EDM mode for measuring to prisms and reflective targets.

RL Reflectorless EDM for measuring to all targets.

Status symbol "Battery capacity"

 The battery symbol indicates the level of the remaining battery capacity (75% full shown in the example).

Status symbol "Compensator"

 Compensator is on.

 Compensator is off.

Status symbol "Offset"

! Offset is active.

Menu tree

[MENU] > F1 - F4 Confirm menu selection.
[PAGE] Scroll to next page.

Depending on user interface sequence and arrangement of menu items may be different.

Menu (page 1)

Programs
- Surveying
- Setting out
- Free Station
- Reference line
- Tie Distance
- Area (plan)
- Remote Height
- Construction

Settings
- Contrast, Trigger Key, USER key, V-Setting, Tilt Correction
- Sector Beep, Beep, Hz Incrementation, Reticle Illumin., DSP Heater
- Data Output, GSI 8/16, Mask 1/2, Hz Collimation, Auto-Off, Language
- Min. Reading, Angle Unit, Distance Unit, Temperature, Pressure

EDM Settings
- EDM-Mode
- Prism Type
- Prism Constant
- Laser Pointer
- Guide Light

TC400Z9

File Management
- Job
- Fixpoints
- Measurements
- Codes
- Initialize Memory
- Memory Statistic

Menu (page 2)

Calibrations
- Hz-Collimation
- V-Index
- View Calibration Data

Communication Parameters
- Baudrate
- Databits
- Parity
- Endmark
- Stopbits

Data Transfer
- Job
- Data
- Format

System Info
- Battery
- Instrument temperature
- Date
- Time

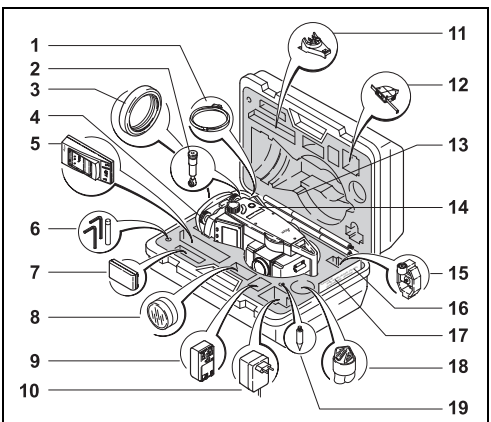
Start-up sequence

PIN Protection

TC400Z10

Unpacking

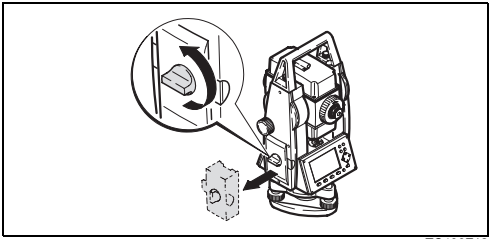
Remove TPS400 from transport case and check for completeness:



TC400Z11

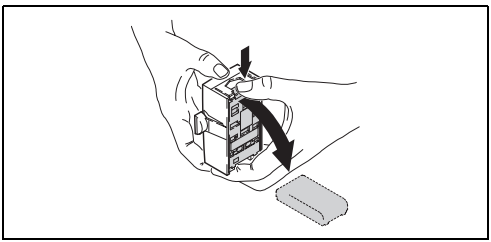
1) Data cable (optional)
2) Zenith eyepiece or eyepiece for steep angles (optional)
3) Counterweight for eyepiece for steep angles (optional)
4) Removable tribrach (optional)
5) Battery charger and accessories (optional)
6) Two Allen keys each, Adjusting pins
7) Battery GEB111 (optional)
8) Sun filter (optional)
9) Battery GEB121 (optional)
10) Mains adapter for battery charger (optional)
11) Spacing bracket GHT 196 for product height meter (optional)
12) product height meter GHM 007 (optional)
13) Mini prism rod (optional)
14) Total station
15) Mini prism + holder (optional)
16) Mini target plate (only for TCR products)
17) User Manual
18) Protective cover / Lens hood
19) Tip for mini prism (optional)

Inserting / Replacing Battery



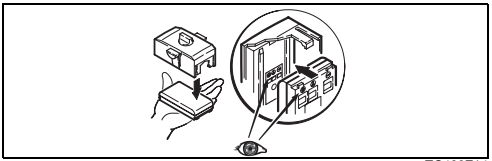
TC400Z12

1. Remove battery holder.



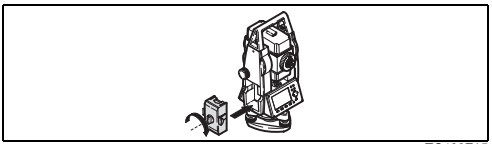
TC400Z13

2. Remove battery.



TC400Z14

3. Insert battery into battery holder.



TC400Z15

4. Insert battery holder into product.

☞ Insert battery correctly (note pole markings on the inside of the battery holder). Check and insert battery holder true to side into the housing.

- To charge the battery refer to chapter "Charging the batteries".
- For the type of battery refer to chapter "Technical data".

☞ When using the GEB121 battery, remove the spacer for the GEB111 from the battery compartment.

Primary use/charging

- The batteries must be charged prior to using for the first time because it is delivered with an energy content as low as possible.
- For new batteries or batteries that have been stored for a long time (> three months), it is effectual to make 2 - 5 charge/discharge cycles.
- The permissible temperature range for charging is between 0°C to +35°C / +32°F to +95°F. For optimal charging we recommend a low ambient temperature of +10°C to +20°C / +50°F to +68°F.

Operation/Discharging

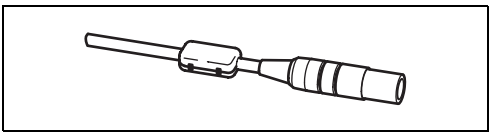
The batteries can be operated from -20°C to +55°C/-4°F to +131°F.

Low operating temperatures reduce the capacity that can be drawn; very high operating temperatures reduce the service life of the battery.

External power supply for total station

To meet the conditions stipulated for electromagnetic acceptability when powering the TPS400 from an external source, the supply cable used must be equipped with a ferrite core.

The Lemo plug with the ferrite core always has to be attached at the product side.

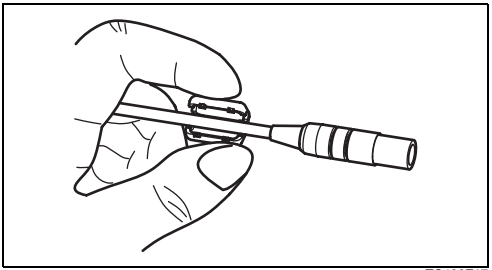


TC400Z16

The cables supplied along with your product include a ferrite core as standard.

If you are using older cables without ferrite core, it's necessary to attach ferrite cores to the cable.

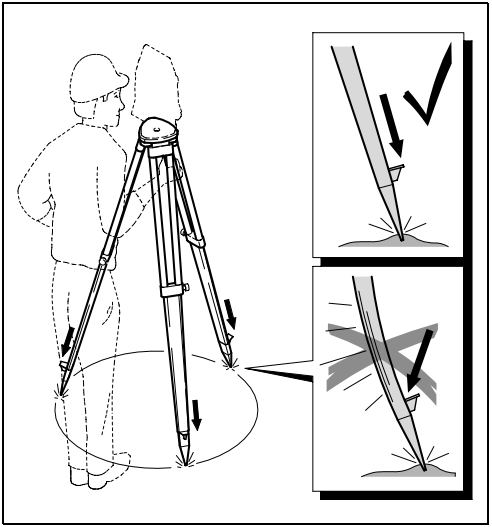
If you need additional ferrite cores, please contact your local Leica Geosystems agency. The spare-part number of the ferrite core is 703 707.



TC400Z17

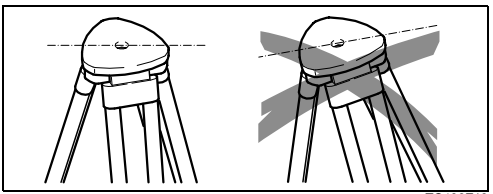
For assembling open up one ferrite core and clip it around the supply cable, about 2cm away from the Lemo plug, before using the supply cable for the first time together with a TPS400 product.

Setting up the tripod



TC400Z18

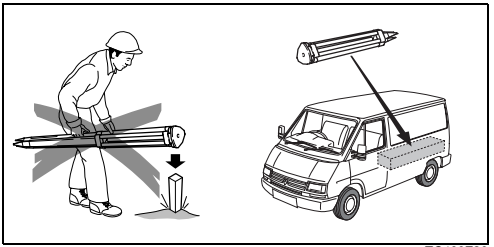
1. Loosen the clamping screws on the tripod legs, pull out to the required length and tighten the clamps.
2. In order to guarantee a firm foothold sufficiently press the tripod legs into the ground. When pressing the legs into the ground note that the force must be applied along the legs.



TC400Z19

When setting up the tripod pay attention to 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.

When using a tribrach with an optical plummet, the laser plummet cannot be used.



TC400Z20

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.

Instrument Setup

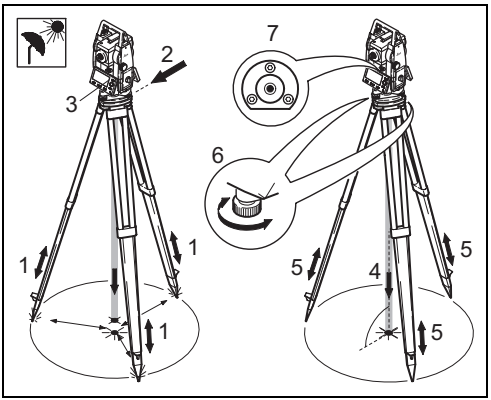
Description

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 centre the instrument.
- The laser plummet cannot be used in conjunction with a tribrach equipped with an optical plummet.

Setup step-by-step



TC400Z21

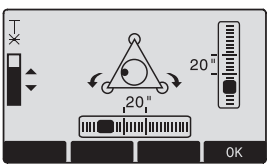
1. Extend the tripod legs to allow for a comfortable working posture. Position the tripod over the marked ground point, centring it as well as possible.
2. Fasten the tribrach and instrument onto the tripod.
3. Turn on the instrument and switch on the laser plummet and electronic level by pressing [FNC] > [Level/Plummet].
4. Move the tripod legs (1) and use the tribrach footscrews (6) to centre the plummet (4) over the ground point.
5. Adjust the tripod legs to level the circular level (7).
6. By using the electronic level turn the tribrach footscrews (6) to precisely level the instrument.
   Refer to "Levelling up with the electronic level step-by-step" for more information.
7. Centre the instrument precisely over the ground point (4) by shifting the tribrach on the tripod plate (2).
8. Repeat steps 6. and 7. until the required accuracy is achieved.

Levelling up with the electronic level step-by-step

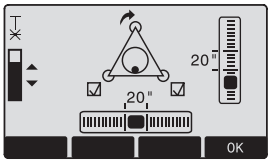
The electronic level can be used to precisely level up the instrument using the footscrews of the tribrach.

1. Turn on the instrument and switch on the electronic level by pressing [FNC] > [Level/ Plummet].
2. Centre the circular level approximately by turning the footscrews of the tribrach.

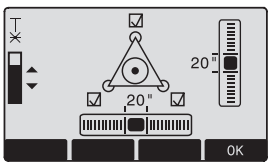
   The bubble of the electronic level and the arrows for the rotating direction of the footscrews only appear if the instrument tilt is inside a certain levelling range.
3. Turn the instrument until it is parallel to two footscrews.
4. Centre the electronic level of this axis by turning the two footscrews. Arrows show the direction for rotating the footscrews. When the electronic level is centred the arrows are replaced by checkmarks.



5. Centre the electronic level for the second axis by turning the last footscrew. An arrow shows the direction for rotating the footscrew. When the electronic level is centred the arrow is replaced by a checkmark.



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

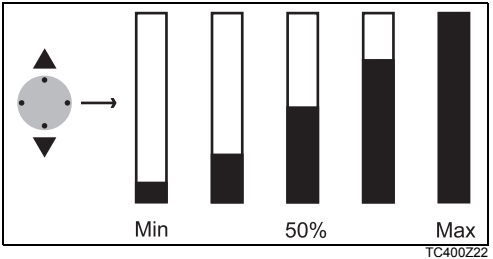


6. Accept with **OK**.

Laser intensity

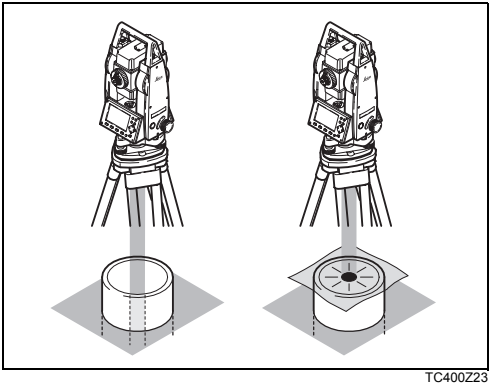
Changing the laser intensity

External influences and the surface conditions may require the adjustment of the intensity of the laser. The laser can be adjusted in 25% steps as required.



TC400Z22

Hints for positioning



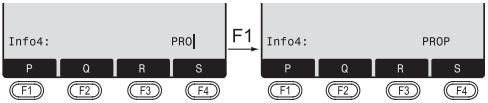
TC400Z23

Positioning over pipes or depressions

Under some circumstances the laser spot is not visible (e.g. over pipes). In this case, the laser spot can be made visible by using a transparent plate so the the laser spot can be easily aligned to the centre of the pipe.

Input mode - method 1

In entry mode, enter text or numeric values.



TC400Z24

[INPUT] 1. Delete entry, display numeric/ alpha-numeric softkey bar. The cursor indicates that the product is ready for input.

F1 - F3 2. Selection of range of characters/ range of numbers.

[>>>] Additional characters/ numbers.

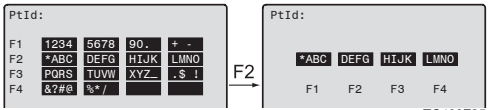
F1 - F4 3. Select the desired character. Character shifts to the left.

4. Confirm entry.

[ESC] Deletes input and restores previous value.

Input mode - method 2

In entry mode, enter text or numeric values.



TC400Z25

[INPUT] 1. The full range of available characters are displayed on the screen.

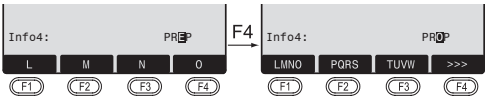
F1 - F4 2. Selection of range of characters/ range of numbers.

Proceed with steps 3 and 4 from method 1.

The method you like to use can be set in the settings.

Edit mode

Existing characters are changed in the edit mode.



TC400Z26

1. Start edit mode. Vertical edit bar is positioned flush right.
   Edit bar is positioned flush left.
2. F1 - F3 Select range of characters/ range of numbers.
   [>>>] Addional characters / numbers.
3. F1 - F4 Overwrite existing characters.
4. Confirm input.
   [ESC] Deletes change and restores previous value.

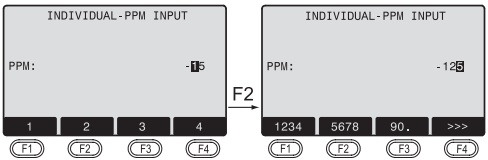
Erasing characters

1. Place cursor on character to be deleted.
2. Pressing the navigation key deletes the relevant character.
3. Confirm input.

[ESC] Deletes the change and restores the previous value.

Inserting characters

If a character was skipped (e.g. -15 instead of -125) you can insert it later.



TC400Z27

1. Place cursor on "1".

2. Inserts an empty character on the right of "1".

F1 - F3 3. Select range of characters /range of numbers.

F1 - F4 4. Select relevant character.

5. Confirm input.

Numerical and Alphanumerical input

Input is made with the softkey bar and the assigned function keys.

Position the marker in the relevant field.

[INPUT] 1. Calls up the input dialogue.

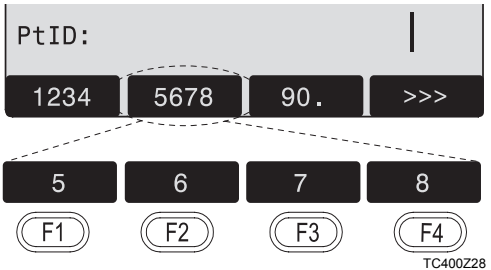
F1 - F4 2. Select range of characters /range of numbers.

[>>>] Additional characters / numbers.

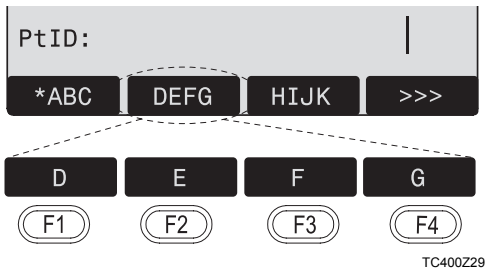
3. Confirm input.

Selection is limited to valid digits for entries, that due to their display characteristics, fall into a certain range (e.g. angles in degrees).

Numerical input



Alphanumerical input



Character set

Entry mode contains the following characters for numeric and alphanumeric input.

Numerical		Alphanumerical	
" + "	(ASCII 43)	" "	(ASCII 32) [space]
" - "	(ASCII 45)	" ! "	(ASCII 33)
" . "	(ASCII 46)	" # "	(ASCII 35)
" 0 - 9 "	(ASCII 48 - 57)	" $ "	(ASCII 36)
		" % "	(ASCII 37)
		" & "	(ASCII 38)
		" ("	(ASCII 40)
		") "	(ASCII 41)
		" * "	(ASCII 42)
		" + "	(ASCII 43)
		" , "	(ASCII 44)
		" - "	(ASCII 45)
		" . "	(ASCII 46)
		" / "	(ASCII 47)
		" : "	(ASCII 58)
		" < "	(ASCII 60)
		" = "	(ASCII 61)
		" > "	(ASCII 62)
		" ? "	(ASCII 63)
		" @ "	(ASCII 64)
		" A - Z"	(ASCII 65 .. 90)
		" _ "	(ASCII 95) [Underscore]
		" ‘ "	(ASCII 96)

The character entry "*" can be used in data fields where point numbers or codes can be searched for.

Signs

+/- In the alphanumeric character set "+" and "-" are treated as normal alphanumeric characters with no mathematical function.

Additional characters

* Place holder during Wildcard point search (see chapter "Wildcard search").

☞ "+" / "-" appears only in the front position of an input.

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

Pointsearch

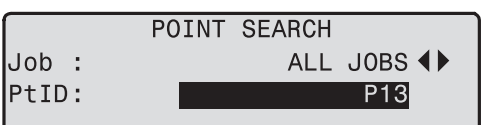
Pointsearch is a global function used by applications to e.g. find internally saved measured or fixed points.

It is possible for the user to limit the point search to a particular job or to search the whole storage.

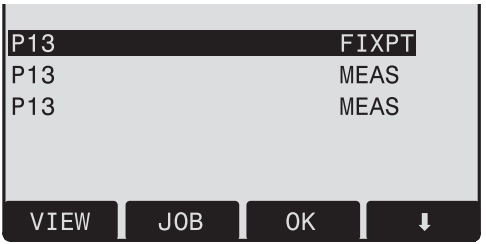
The search procedure always finds fixed points before measured points that fulfill the same search criteria. If several points meet the search criteria, then the points are listed according to their age. The product finds the most current (youngest) fixed point first.

Direct search

By entering an actual point number (e.g. "P13") all points with the corresponding point number are found.



TC400Z30

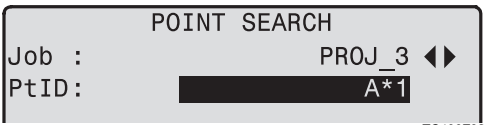


TC400Z31

[VIEW]	Displays the coordinates of the selected point.
[ENH]	For manual input of coordinates.
[OK]	Confirm selected point.
[JOB]	To select a different job.

Wildcard search

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



TC400Z32

Starts point search.

Examples:

* All points of any length are found.

A All points with exactly the point number "A" are found.

A* All points of any length starting with "A" are found (e.g.: A9, A15, ABCD).

*1 All points of any length with a "1" as the second character are found (e.g.: A1, B12, A1C).

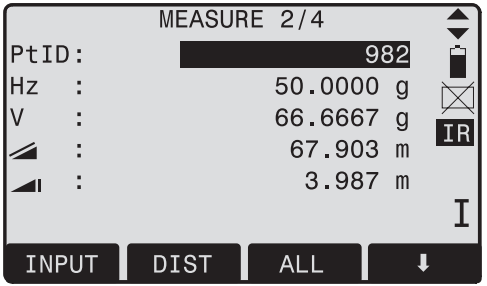
A*1 All points of any length with an "A" as the first character and a "1" as the third character are found.
(e.g.: AB1, AA100, AS15).

Measuring

After switching on and setting up correctly, the total station is immediately ready for measuring.
In the measurement display it is possible to call up fixed keys and function keys, as well as trigger keys and their functions

☞ All shown displays are examples. It is possible that local software versions are different to the basic version.

Example of a possible measuring display:



TC400Z33

F1 - F4 Calling up the assigned function.

FNC Key

Under [FNC] several functions can be called up.

Their applications are described below.

☞ Functions can also be started directly from the different applications.

☞ Each function from the FNC menu can be assigned to the [USER]-key (see chapter "Settings").

Light On /Off

Switches display light on / off.

Level/Plummet

This function enables the electronic bubble and the range of intensity settings of the laser plummet.

IR/ RL Toggle

Change between the two EDM types IR (on Reflectors) and RL (Reflectorless). New setting is displayed for about one second.

IR: Distance measurements with prisms.

RL: Distance measurements without prisms.

Find more information in chapter "EDM Settings".

Laser Pointer

Switches on or off the visible laser beam for illuminating the target point. The new settings are displayed for about one second and then saved.

Free-Coding

Starts "Coding" to select a code from a codelist or enter a new code. Some functionality like softkey button [CODE].

Units

Displays the current distance and angle unit and gives the possibility to change these.

Delete Last Record

This function 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 can be deleted which were recorded in "Surveying" or in "Measuring".

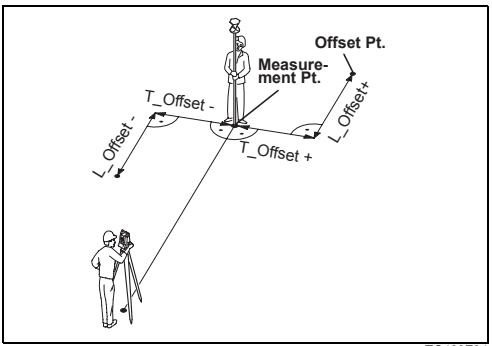
Lock with PIN

This function is used to prevent **unauthorized use** of the instrument. It enables you to lock the instrument from any application by pressing [FNC] > [Lock with PIN] without switching off the instrument. After that the instrument will prompt for a PIN code entry.

☞ The function is available when the PIN protection is activated under [MENU] > [PIN].

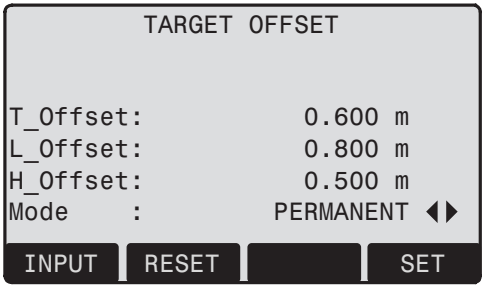
Target Offset

If it is not possible to set up the reflector directly, or it is not possible to aim the target point directly, the offset values (length, cross and/or height offset) can be entered. The values for the angle and distances are calculated directly for the target point.



TC400Z34

H_Offset +: Offset point is higher than measurement



TC400Z35

Procedure:

1. Enter the offset values (length, cross and/or height) as per the sketch.
2. Define the period for which the offset is to apply. [RESET]: Sets eccentricity to zero.
3. [SET]: calculates the corrected values and jumps 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.

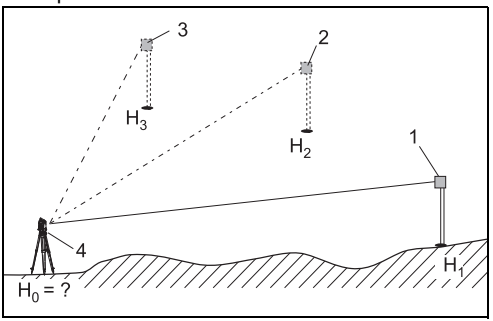
The period of applicability can be set as follows:

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.

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

Height Transfer

Example:



TC400Z36

1) Reflector 1
2) Reflector 2
3) Reflector 3
4) Instrument

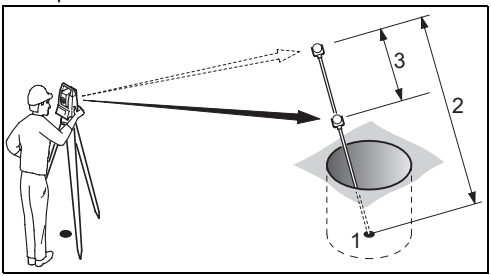
This function determines the height of the product from measurements to a maximum of 5 target points, with known heights, in two faces.
With measurements to several targets, the improvement is indicated in the "delta" value.

Procedure:

1. Select known point and input reflector height.
2. After triggering the measurement with [ALL], the calculated height H_0 is displayed.
   - [AddPt] Add another height of a known point.
   - [FACE] Measure to the same target in second face.
3. [SET] Save the changes and set the station.

Hidden Point

Example:



1 E, N, H of Hidden Point
2 Rod Length
3 Distance R1-R2

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

Procedure:

1. Measure to first prism (P1).

[All]	Starts measurement and proceeds to step 2.
[ROD]	Allows you to define the rod and the EDM-Settings.

Rod Length
Total length of hidden-point rod.

Dist. R1-R2
Spacing between the centers of reflector R1 and prism R2.

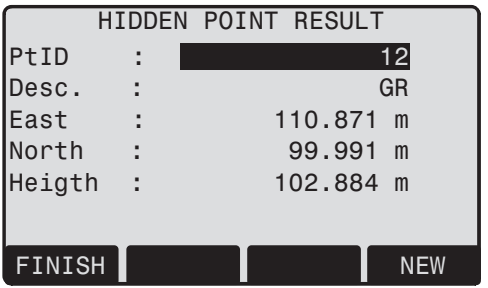
Meas. Tol
Limit for the difference between the given and measured spacing of the reflectors. If the tolerance value is exceeded, the program will issue a warning.

EDM-Mode
Changes the EDM-Mode.

Prism type
Changes the prism type.

Prism Const
Displays the prism constant.

2. [All] Starts measurement and proceeds to the Result dialog.
3. Result is displayed.

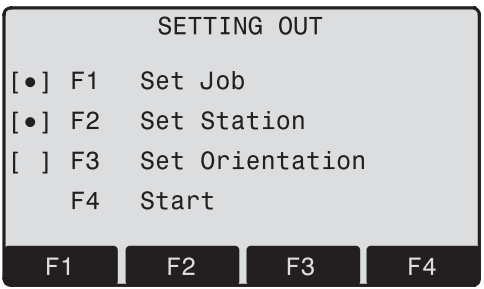


TC400Z37

[NEW] Returns to step 1.
[FINISH] Returns to calling application.

Application pre-settings

These are programs that precede the application programs and are used to set up and organize data collection. They are displayed after selecting an application. The user can select the start programs individually.



TC400Z38

[•] Settings made.
[ ] Settings not made.

☞ Find further information about individual start-up programs on the subsequent pages !

Setting job

All data is saved in JOBS, like directories. Jobs contain measurement data of different types (e.g. measurements, codes, fixed points, stations,...) and are individually manageable and can be readout, edited or deleted separately.

[NEW] Creating a new job.

[SET] Setting the job and back to start-up programs.

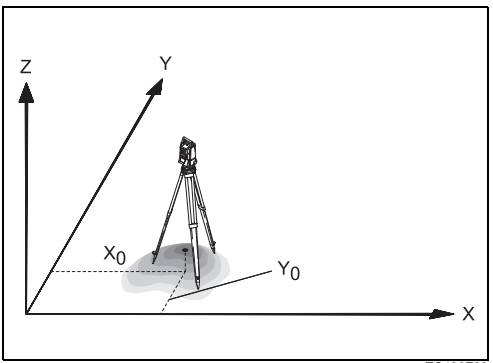
☞ All subsequent recorded data is stored in this job/directory.

☞ If no job was defined and an application was started or if in "Meas & Rec" [ALL] or [REC] was triggered, then the system automatically creates a new job and names it "DEFAULT".

Setting Station

Each coordinate computation relates to the currently set station.

At least plan coordinates (E, N) are required for the station. The station height can be entered if required. The coordinates can be entered either manually or read from the internal memory.



TC400Z39

Known Point

1. Select a ptID stored in internal memory.
2. Input product height.
   [OK] Sets the station.

Set manually

1. [ENH] Calls up manual point input dialogue.
2. Input PtID and coordinates.
3. [SAVE] Saves station coordinates. Continues to the input of the product height.
4. [OK] Sets the station.

☞ If no station was set and no application started and if in "Meas & Rec " [ALL] or [REC] was activated, then the last station is set as the current station.

Orientation

With the orientation, Hz-direction can be input manually or points with known coordinates can be set.

Method 1: Manual input

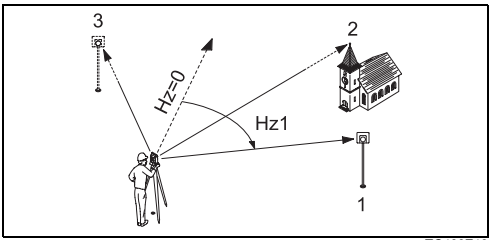
1. F1 To input a random Hz-orientation.
2. Input of Hz-direction, reflector height and PtID.
3. [ALL] Triggers measurement and sets orientation.
   [REC] Records Hz-direction and sets orientation.

Method 2: with coordinates

To determine the orientation, a target with known coordinates can also be used.

1. F2 As orientation with coordinates.
2. Input of the orientation point number and to determine the point found.
3. To input and confirm the reflector height.

For determining the orientation a maximum of 5 target points with known coordinates can be used.



TC400Z40

1) 1. Target point
2) 2. Target point
3) 3. Target point

Orientation coordinates can be either obtained from the internal memory or entered manually.

The workflow is similar to Free Station workflow.

After each measurement you are asked wether to proceed or not. Answering with yes brings you back to the Measurement dialog, to take an additional measurement. Answering with no brings you to the Result dialog.

[COMPUTE] Calculates and displays the orientation results.

[NextPt] Input another backsight point.

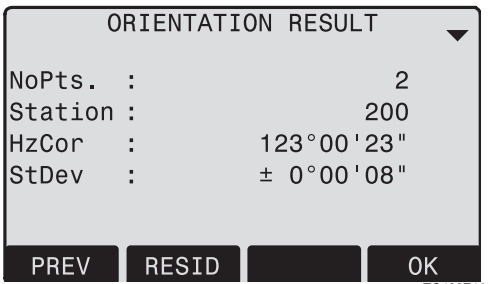
1/I Status indication; shows that first point was measured in telescope position I.

1/I II First point measured in telescope pos. I and II.

▲Hz: After the first measurement the finding of other target points (or the same point when changing the telescope position) is easier by setting the indicated angle difference near to 0°00'00" by turning the product.

▲  : Difference between horizontal distance to target point computed from coordinates and the measured distance.

Display of computed orientation



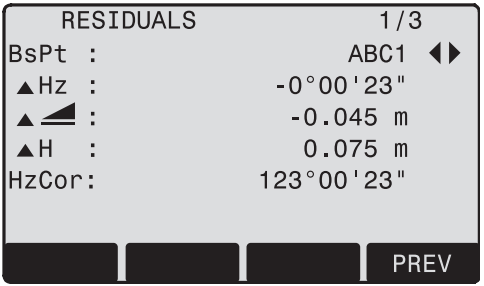
TC400Z41

[OK] Set computed Hz-orientation.

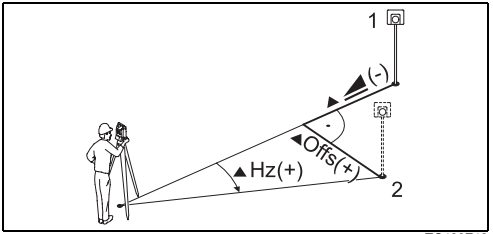
If more than one target point is measured then the orientation is computed using the "least squares method".

Displaying residuals

[RESID] Display of residuals.



TC400Z42



TC400Z43

1) Actual
2) Design

▲H: Height correction

▲ : correction of the horizontal distance

▲Hz: Correction of Hz-angle.

Useful information

- If the orientation is only measured in telescope position II the Hz-orientation is based on telesope position II. If measured only in telescope position I or mixed the Hz-orientation is based on telescope position I.
- The prism height may not be changed during measurements in the first and second telescope position.
- If a target point is measured several times in the same telescope position the last valid measurement is used for the computation.

☞ If no orientation was set and an application was started resp. if in "Meas & Rec" [ALL] or [REC] was triggered, then the current Hz-direction and V-angle are set as orientation.

Applications

Introduction

Applications are predefined programs, that cover a wide spectrum of surveying duties and facilitate daily work in the field.

The following applications are available:

- Surveying
- Setting Out
- Tie Distance
- Area & Volume
- Free Station
- Reference Line
- Remote Height
- Construction

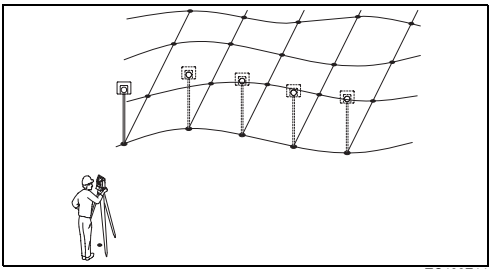
[MENU] 1. Press the [MENU] fixed key.

F1 2. Selecting the "Program" option.

F1 - F4 3. Calling up applications and activating start programs.
[PAGE] Scroll to next page.

Surveying

With the program Surveying the measurement of an unlimited number of points is supported. It is comparable to "Meas & Rec", but includes stationing, orientation and coding.



TC400Z44

Procedure:

1. Input PtID, codes and the reflector height if desired.
2. [ALL] Triggers and records measurements.
   [IndivPt] Switches between individual and current point number.

Two coding methods are available:

1. Simple coding = remark:
   Input a code/remark in the relevant field. These text is stored with the corresponding measurement with [ALL]. 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 the [CODE] softkey. The code that was input is searched for within the code list and it is possible to add attributes to the code.

☞ Codes are always stored as free codes (Wi41-49), that means that codes are not directly linked to a point. Point codes (Wi71-79) are not available.

Stake out

This program calculates the required elements to stakeout points from coordinates or manualy entered angles, horizontal distances and heights. Setting out differences can be displayed continuously.

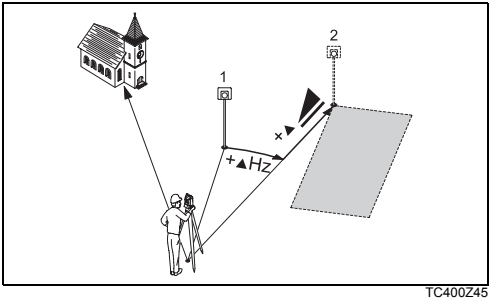
Setting out coordinates from memory

Procedure:

◀▶	Select the point.
[DIST]	Starts measurement and calculation of the stake-out elements.
[REC]	Saves the displayed values.
[B&D]	Input direction and Hz-distance of stake out point.
[MANUAL]	Enables simplified input of a point without ptID and without the possibility of storing the data of the point.

Polar Stake out

Normal indication of polar stake out offsets ▲Hz, ▲ ⟋, ▲ ◢.



TC400Z45

1) Actual
2) Point to be stake out

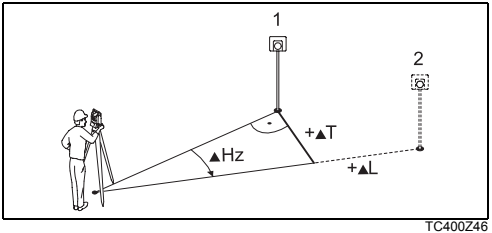
▲Hz: Angle offset: positive if point to be set-out is to the right of the actual direction.

▲ ⟋: Longitudinal offset: positive if point to be stake out is further away.

▲ ◢: Height offset: positive if point to be stake out is higher than measured point.

Orthogonal Stake out

The position offset between measured point and stake out point is indicated in a longitudinal and transversal element.



TC400Z46

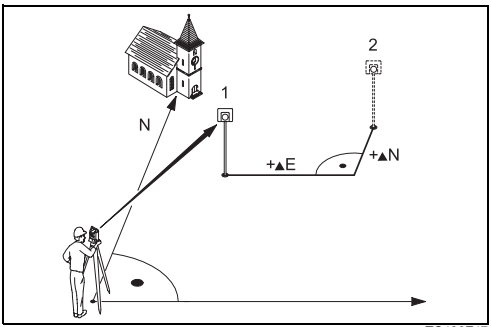
1) Actual
2) Point to be stake out

▲L: Longitudinal offset: positive if nominal point further away.

▲T: Transversal offset, perpendicular to line-of-sight: positive if nominal point is to the right of measured point.

Cartesian Stake out

Setting out is based on a coordinate system and the offset is divided into a north and east element.



TC400Z47

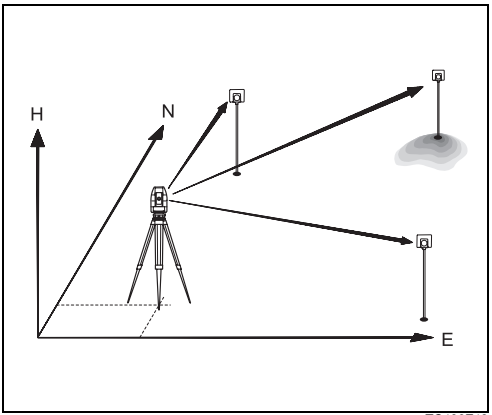
1) Actual
2) Point to be stake out

▲E Easting offset between stake out and actual point.

▲N Northing offset between stake out and actual point.

Free Station

The application "Free Station" is used to determine the product position from measurements to a minimum of two known points and a maximum of five known points.



TC400Z48

The following measurements sequences to target points are possible:

1. Hz- and V-angles only (resection)
2. Distance and Hz- and V-angle (3 point resection)
3. Hz- and V-angles to some point(s) and Hz- and V-angle plus distance to other point(s).

The final computed results are Easting, Northing and Height of the present product station, including the products Hz-circle orientation.

Standard deviations and residuals for accuracy assessments are provided.

Measuring facilities

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

Gross errors checks are made for dual face measurements to ensure the same point(s) are sighted with the other face.

☞ If a target point is measured several times in the same telescope position the **last valid measurement** is used for computation.

Measurement restrictions:

- **2 face measurements**
  When measuring the same target in both faces, the reflector height may not be altered when changing the telescope position.
- **Target points with 0.000 height**
  Target points with 0.000 height are discarded for height processing. If target points have a valid height of 0.000 m, use 0.001 m to enable it for height processing.

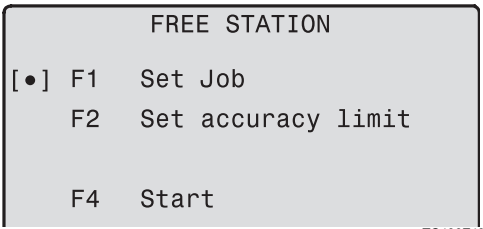
Computation procedure

The measuring procedure automatically determines the mothod of evaluation, e.g. resection, 3 point resection, etc.

If more than the minimum required measurements are performed, the processing routine uses a least squares adjustment to determine the plan position and averages orientation and heights.

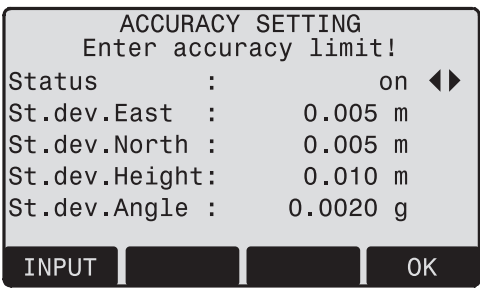
1. The original averaged face I and face II measurements enter the computation process.
2. All measurements are treated with the same accuracy, whether these are measured in single or dual face.
3. Easting and northing is determined by the method of least squares, including standard deviation and improvements for Hz-direction and horizontal distances.
4. The final height (H) is computed from averaged height differences based on the original measurements.
5. The Hz-circle orientation is computed with the original averaged face I and face II measurements and the final computed plan position.

Procedure:



TC400Z49

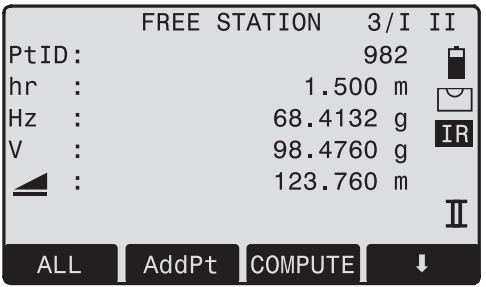
F2 Enables you to define an accuracy limit.



TC400Z50

Here you can enter a limit for the standard deviation values. If your computed deviation exceeds the limit a warning dialog appears, where you can decide wether to proceed or not.

1. Input of the name of the station and the height of the product.
2. Input of the target ptID and the reflector height.



TC400Z51

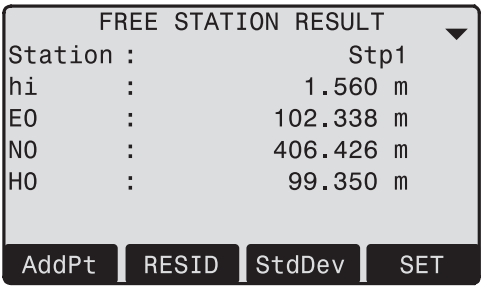
[ALL] Triggers angle and distance measurement (3 point resection).

[REC] Saves Hz-direction and V-angle (resection).

[AddPt]	Input another backsight point.
[COMPUTE]	Calculates and displays the station coordinates, if at least 2 points and a distance were measured.
`3/I`	Indicates that the third point in telescope position I was measured.
`3/I II`	Indicates that the third point in telescope positions I and II.

Results

Displays calculated station coordinates:

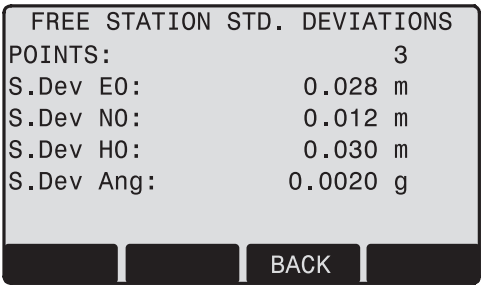


TC400Z52

[AddPt]	Switches to measurement display, to measure additional points.
[RESID]	Displays residuals.
[STDEV]	Displays standard deviation.
[SET]	Sets the displayed coordinates and product height as new station.

☞ If the product height was set to 0.000 in the setup screen, then the station height refers to height of trunnion axis.

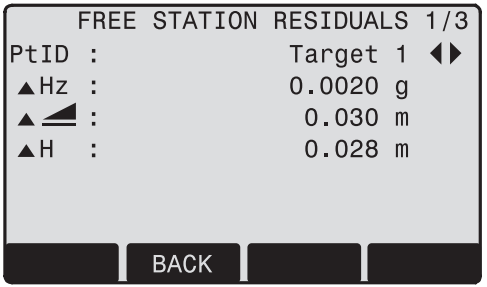
Displays standard deviations:



TC400Z53

S.Dev E0, N0, H0	Standard deviation of the station coordinates
S.Dev Ang	Standard deviation of the orientation

This dialog shows the computed residuals:
Residual = Calculated value - Measured value



TC400Z54

With the function keys, scroll between the residuals of the individual backsight points.

Warnings / Messages

Important messages	Meaning
Selected point has no valid data !	This message occurs if the selected target point has no easting or northing coordinate.
Max 5 points supported !	If 5 points have already been measured and another point is selected. The system supports a maximum of 5 points.
Invalid data - no position computed !	The measurements may not allow final station coordinates (Eastings, Northings) to be computed.
Invalid data - no height computed !	Either the target height are invalid or insufficient measurements are available to compute a final station height.
Insufficient space in job !	The present selected job is full and does not allow further storage.
Hz (I - II) > 0.9 deg, measure point again !	This error occurs if a point was measured in one face and the measurement in the other face differs by more than 180° ±0.9° for the horizontal angle.
V (I - II) > 0.9 deg, measure point again !	This error occurs if a point was measured in one face and the measurement in the other face differs by more than 360° - V ±0.9° for the vertical angle.
More points or distance required !	There is insufficient data measured to be able to compute a position. Either there are not enough points used or not enough distances measured.

Reference Line

This program facilitates the easy stake out or checking of lines for buildings, sections of road, simple excavations, etc.

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.

Procedure:

1. Definition of the Base line:

The base line is fixed by two base points that can be defined in three ways:

- Measured points
- Enter coordinates using keypad
- Select point from memory.

a) Measuring base points:
Input PtID and measure base points with [ALL] or [DIST] / [REC].

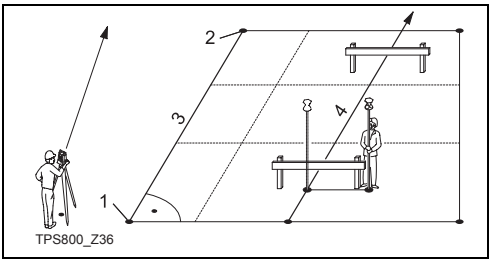
b) Base points with coordinates:

[FIND] Starts to search for the PtID entered.

[ENH] Manually input coordinates.

[LIST] Displays the list of available points.

Analogue procedure for the second base point.

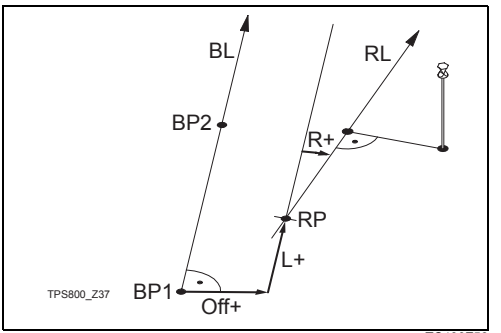


TC400Z55

1) 1st base point
2) 2nd base point
3) Base line
4) Reference line

2. Shifting/Rotating the Base line

The base line can be offset longitudinally, parallel and vertically or rotated. This new line is called the reference line. All measured data refers to the reference line.



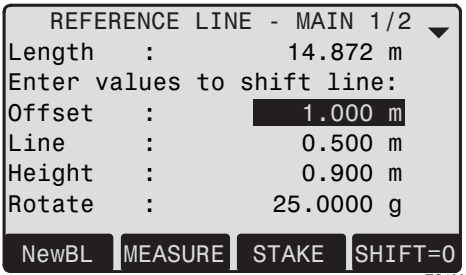
TC400Z56

BP: Base point
BL: Base line
RP: Reference point
RL: Reference line

Off: Parallel offset
L: Longitudinal offset
R: Rotation parameter

Input of the parameters:

Use the navigation keys to select the shifting and rotation parameters of the reference line.



TC400Z57

The following entries are possible:

Offset+: Parallel offset of the reference line to the right, referred to the direction of the base line (BP1-BP2).

Line+: Longitudinal offset of the start point (=reference point) of the reference line in the direction of base point BP2.

Rotate+: Rotation of the reference line clockwise around the reference point.

Height+: Height offset; the reference line is higher than the selected reference height.

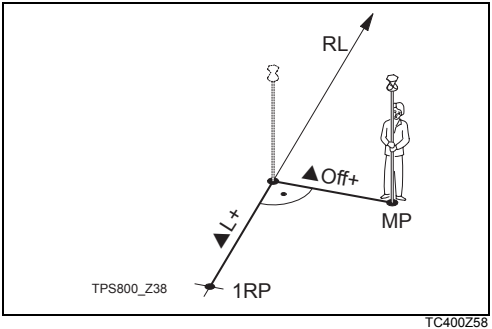
3. Decide to measure or to stake out

[MEASURE] Starts the subapplication to measure Line & Offset (see issue 4).

[STAKE] Starts the subapplication to stake out (see issue 5).

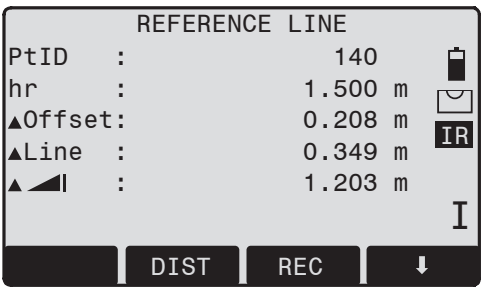
4. "Line & Offset" subapplication

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



TC400Z58

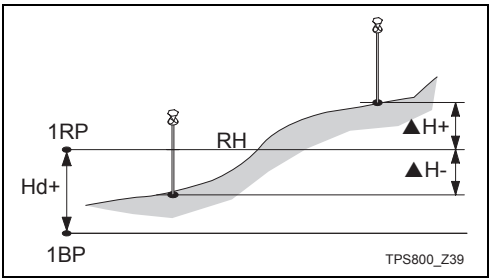
1RP: 1st reference point
MP: Measured point
RL: Reference line
▲L: Longitudinal offset
▲Off: Parallel offset



TC400Z59

The height of the first reference point is always used as the reference height for the calculation of the height differences (▲).

Example "relative to first reference point"



TC400Z60

1RP: 1st reference point
1BP: 1st base point
RH: Reference height
Hd: Height difference between reference and base point
▲H: Height difference from reference height

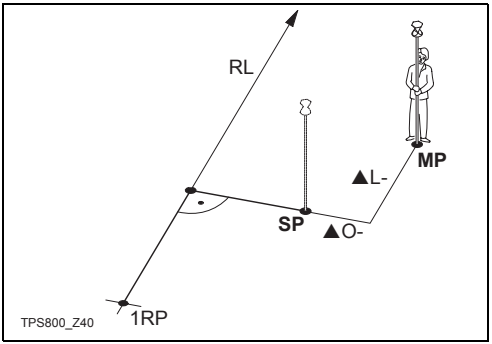
5. "Stake out" subapplication

You can enter longitudinal, parallel and height offsets for the target points to be set-out relative to the reference line. The program calculates the difference between a measured point and the calculated point. The program displays the orthogonal (pLine, ▲Offset, ▲ ◢I) and the polar (▲Hz, ▲ ◢, ▲ ◢I) differences.

Procedure:

1. Input the orthogonal stake out elements.
2. [OK] Confirm entry and start calculation.

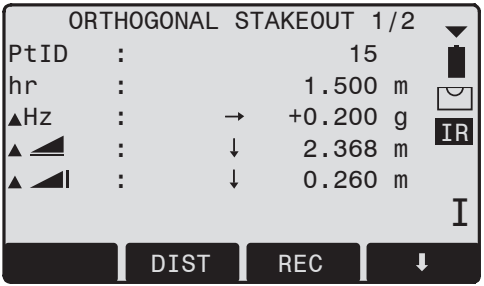
Example "orthogonal stake out"



TC400Z61

1RP: 1st reference point
RL: Reference line
MP: Measured point
SP: Stake out point
▲L: Longitudinal offset
▲Off: Parallel offset

Display in "Stake out" measure mode:



The signs for the distance and angle differences are correction values (required minus actual).

+▲Hz Turn telescope clockwise to the stake out point.

+▲ The stake out point is further away than the point measured.

+▲ The stake out point is higher than the measured point.

Warnings / Messages

Important Messages	Meaning
Save via RS232 !	Data output (system setting menu) via RS232 interface is activated. To be able to succesfully start reference line, the "INTERN" setting must be enabled.
Base line too short !	Base line is shorter than 1 cm. Choose base points such that the horizontal separation of both points is at least 1 cm.
Coordinates invalid !	No coordinates or invalid coordinates for a point. Ensure that a point used has at least one Easting and one Northing co-ordinate.

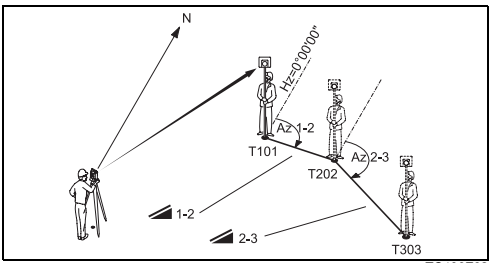
Tie Distance

The application **Tie Distance** computes slope distance, horizontal distance, height difference and azimuth of two target points measured **online**, selected from the **Memory** or entered using the **Keypad**.

The user can choose between two different methods:

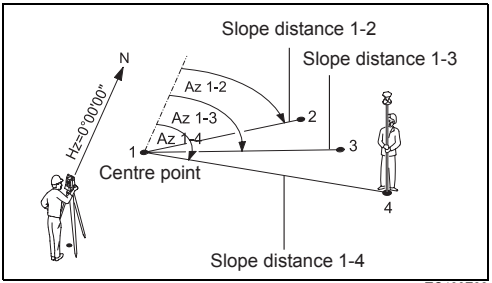
- F1 Polygonal (A-B, B-C)
- F2 Radial (A-B, A-C)

Polygonal Method:



TC400Z62

Radial Method:



TC400Z63

In principal both methods are the same.
Any differences will be described.

Procedure:

1. **Determine first target point.**
   - [ALL] Starts measurement to the target point.
   - [FIND] Searches internal memory for point entered.
2. **Determine second target point.**
   Proceed as with first target point.

3. Result is displayed.

Brg	Azimuth between point1 and point2.
▲ 	Slope distance between point1 and point2.
▲ 	Horizontal distance between point1 and point2.
▲ 	Height difference between point1 and point2.
Grade	Grade [%] between point1 and point2.

Softkeys - polygonal method:

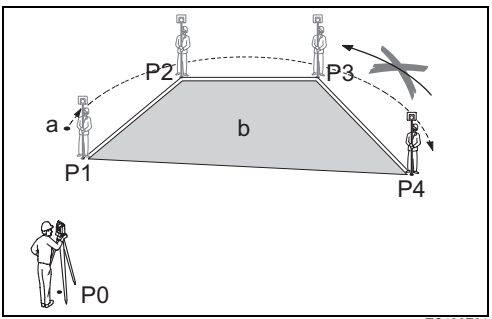
[NewPt 1]	An additional missing line is computed. Program starts again (at point 1).
[NewPt 2]	Point 2 is set as starting point of a new missing line. New point (Pt 2) must be measured.
[RADIAL]	Switches to radial method.

Softkeys - radial method:

[NewPt 1]	Determine new central point.
[NewPt 2]	Determine new radial point.
[POLY]	Switch to polygonal method.

Area & Volume

The application program Area is used to compute online areas of max. 50 points connected by straights. The target points have to be measured, selected from memory or entered via keyboard in clockwise direction. The calculated area is projected onto the horizontal plane (2D). Furthermore a volume with constant height can be calculated.



TC400Z64

P0 Station
P1 Start point
P2 Target point
P3 Target point
P4 Target point

a Perimeter, polygonal length from start point to the current measured point.

b Calculated area always closed to the start point P1, projected onto the horizontal plane.

1. Determine area points

[ALL]	Starts the measurement to the point.
[FIND] / [LIST]	Searches for point in internal memory.
[ENH]	For manual input of the coordinates.
[1PtBACK]	Undo measurement or selection of last point.

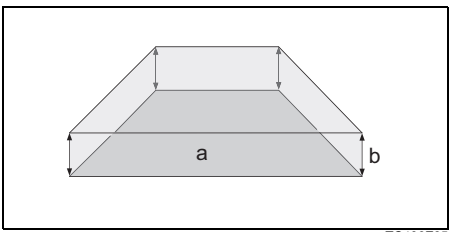
☞ The area is calculated and displayed once three points have been measured or selected.

2. Results

[VOLUME] To calculate a volume with constant height. The height have to be entered or measured.

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

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



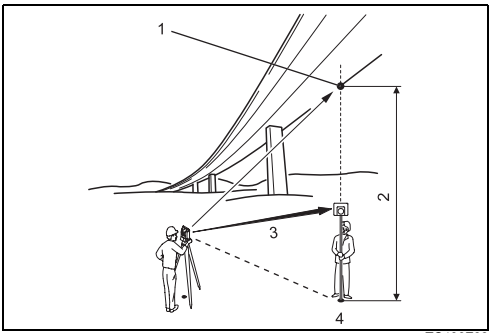
TC400Z65

a Calculated area always closed to the start point P1, projected onto the horizontal plane.

b Constant height.

Remote Height

Points directly above the base prism can be determined without a prism at the target point.



TC400Z66

1) Remote point
2) Height diff.
3) Slope distance
4) Base point

Procedure:

1. **Input PtID and reflector height**
   - [ALL] Starts measurement to base point and continues to 2.
   - [hr?] Starts the program that determines an unknown reflector height.
2. **Aim at inaccessible height point**
   - [OK] Saves the measured data.
   - [BASE] Input and measurement of a new base point.

Construction

This application allows to define a construction site by combining set-up of the product along a construction line, measuring and setting out points in relation to the line.

After selecting the application you have two options:

a) Defining a new construction site
   or
b) Continue with previous site (skips set-up)

Procedure:

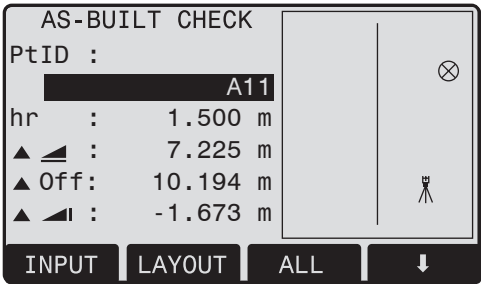
Defining new site:

1. Measure line Start point [ALL], [DIST]+[REC]
2. Measure second line point [ALL], [DIST]+[REC]

☞ In case, you have entered coordinates by ENH and measured to known points a plausibility check informs you about the calculated line length, the actual length and the difference.

As built check:

This dialog shows you the ▲Line, ▲Offset and ▲Height of a measured point in relation to the line.



TC400Z67

[ShiftLn]	Allows you to enter values for shifting the line.
[LAYOUT]	Switches to Layout-mode.

▲Line is positive:

Measured point is in direction from line start - to line end point.

▲Offset is positive:

Measured point is right of line.

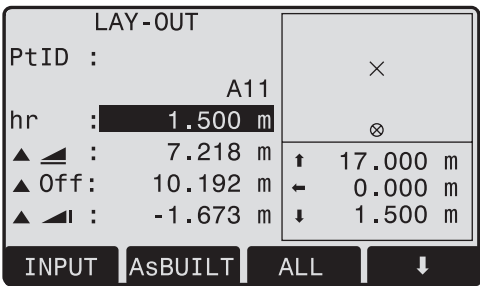
▲Height is positive:

Measured point height is above line start point's height.

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

Layout

Here you can search or enter points for staking out related to the measured line.



TC400Z68

[ShiftLn] Allows you to enter values for shifting the line.

[AsBUILT] Switches to AsBuilt-mode.

The graphics show you the position of the prism related to the stake out point. Below, the exact values are displayed, combined with arrows to show the direction.

▲Line is positive (arrow up):
Target point is further away than the measured point.

▲Offset is positive (arrow right):
Target point is right of the measured point.

▲Height is positive (arrow up):
Target point is higher than the measured point.

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

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

☞ Be aware that the line start point and the line end point are measured in the previous coordinate system. When staking out this 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.

Coding

Codes contain information about recorded points. With the help of coding, points can be assigned to a particular group simplifying later processing.
More information on coding can be found under "Data management".

GSI-coding

Code: Code name
Desc.: Additional remark
Info1: more, freely editable
... information
Info8: lines

☞ 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.

Procedure:

Select code from a codelist or enter a new code:

[RECORD] The code is directly recorded without a measurement with [ALL].
[OK] The code is set. After a measurement with [ALL] the code is recorded.
[AddList] Adds the entered code to the codelist.

Extending / editing code

1. Call available code from code list.
2. Attributes can be overwritten freely.

Exceptions:

With the codelist editor of LGO/LGO-Tools a status can be assigned to the attributes.

- Attributes with "fixed status" (see LGO/LGO-Tools) are write-protected. They cannot be over-written or edited.
- For attributes with status "Mandatory" an input or a confirmation is required.
- Attributes with status "Normal" can be edited freely.

Warnings / Messages

Important Messages	Meaning
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.
Entry required !	Code missing. Extend input.

☞ Individually entered code blocks are not added to the code list.

Leica Geo Office Tools (LGO-Tools)

Codelists can be easily created and uploaded to the product using the supplied "LGO-Tools" Software.

Settings

This menu enables extensive user-specific settings in order to adapt the product to their own requirements.

Contrast
Setting the display contrast in 10% steps.

Trigger key
Configuration of the trigger key on side cover.

Off	Trigger key deactivated.
ALL	Trigger key with same function as the [ALL]-key.
DIST	Trigger key with same function as the [DIST]-key.

USER Key
Configure the USER Key with a function from the FNC-menu.

V-Setting
The "0"- orientation of the vertical circle can be either selected for the zenith, the horizontal plane or in %.

- Zenith: Zenith=0°; Horizon=90°
- Horizon: Zenith=90°; Horizon=0°
- V-(%): 45°=100%; Horizon=0°

☞ The % value increases rapidly. "--.--%" appears on the display above 300%".

Tilt Correction

Off	Tilting compensation switched off.
1-axis	V-angles relate to the plumb line.
2-axis	V-angle refer to the plummet line and the Hz-directions are corrected by the standing axis tilt.

If the product is used on an unstable base (e.g. shaking platform, ship, etc.) the compensator should be switched off.
This avoids the compensator drifting out of it's measuring range and interupting the measuring process by indicating an error.

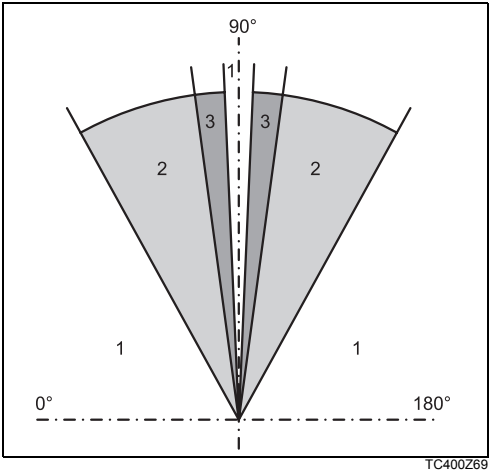
☞ The compensator setting remains active even after the product is switched off.

Sector Beep

Off	Sector Beep switched off
On	Sector Beep sounds at right angles (0°, 90°, 180°, 270° or 0, 100, 200, 300 gon)

Example Sector Beep:

From 95.0 to 99.5 gon (or from 105.0 to 100.5 gon) a "Fast beep" sounds whilest from 99.5 to 99.995 gon (or from 100.5 to 100.005 gon) a "Permanent beep" sounds.



1) No beep
2) Fast beep (interrupted)
3) Permanent beep

Beep

The beep is an acoustic signal after each key stroke.

Off	Beep switched off
Normal	Normal volume
Loud	Increased volume

Hz Incrementation

Right	Set right Hz for "Clockwise direction measurement".
Left	Set left Hz for "Counter-clockwise direction measurement". "Counter-clockwise" directions are only displayed but saved as "Clockwise direction".

Reticle Illumination

The reticle illumination is only switched on if the display illumination is on.

Low	Low illuminaton
Medium	Medium illuminaton
High	High illuminaton

DSP Heater

On	Is automatically activated when the display illumination is on and the product temperature is ≤ 5°C.

Language

The current loaded languages are shown.

Language choice

If two languages are loaded onto the instrument a dialog to choose the language can be shown directly after switching on the instrument.

On	The language dialog is shown as startup dialog.
Off	The language dialog is not shown as startup dialog.

Data Output

RS232	Data is recorded via the serial interface. For this purpose, a data storage device must be connected.
Intern	All data is recorded in the internal memory.

GSI 8/16

Select GSI output format.

GSI 8: 81..00+12345678

GSI 16: 81..00+1234567890123456

Mask 1/2

Select GSI output mask.

Mask 1: PtID, Hz, V, SD, ppm+mm, hr, hi

Mask 2: PtID, Hz, V, SD, E, N, H, hr

Hz Collimation

On Hz Collimation is switched ON.

Off Hz Collimation is switched OFF.

If option "Hz Collimation ON" is active, each measured Hz-angle is corrected (depending on V-angle).

For normal operation the Hz-collimation remains switched on.

☞ More information on Hz-collimation can be found under "Adjusments".

Auto-OFF

Enable The product is switched off after 20 minutes without any action (= no key pressed; V and Hz angle deviation ≤ ±3' / ±600cc).

Disable The product is switched on permanently. Battery discharges quicker.

Sleep Economy mode. product is recovered by any key stroke.

Min. Reading

The displayed angle format can be selected in three steps.

- **For 360°'":**
  0° 00' 01" / 0° 00' 05" / 0° 00' 10"
  Always " are indicated.
- **For 360°:**
  0.0001° / 0.0005° / 0.001°
- **For gon:**
  0.0001 gon / 0.0005 gon / 0.001 gon
- **For mil:**
  0.01 mil / 0.05 mil / 0.10 mil

Input method

Here you can select the method to input alphanumeric characters.

- Method 1
  Standard method
- Method 2
  Advanced method

Angle Unit

° ' "	(degree sexagesimal) possible angle values: 0° to 359°59'59"
DD	(degree decimal) possible angle values: 0° to 359.999°
gon	possible angle values: 0 gon to 399.999 gon
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.

Distance Unit

meter	Meter
ft-in1/16	US-feet-Inch-1/16 inch
US-ft	US-feet
INT-ft	International feet

Temperature

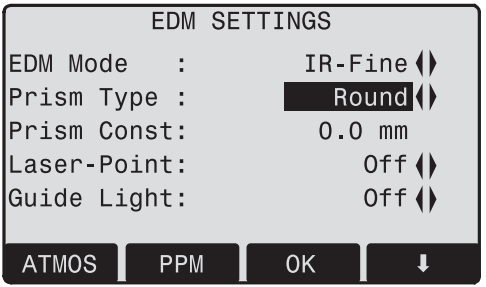
°C	Degree Celsius
°F	Degree Fahrenheit

Pressure

mbar	Millibar
hPa	Hecto Pascal
mmHg	Millimeter mercury column
inHg	Inch mercury column

EDM Settings

The EDM-settings contain a detailed menu with selection boxes.



TC400Z70

EDM Mode

With TCR products different settings for measurements with reflectorless (RL) and reflector (IR) EDM mode are available.

Depending on selected measuring mode the selection prism types are different.

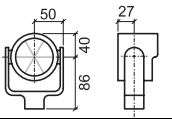
IR-Fine	Fine measuring mode for high precision measurements with prisms (2mm + 2 ppm)
IR-Fast	Quick measuring mode with higher measuring speed and reduced accuracy (5mm + 2 ppm)
IR-Track	Continuous distance measuring (5mm + 2 ppm)
IR-Tape	Distance measurement using Retro targets (5mm + 2 ppm)

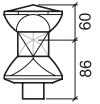
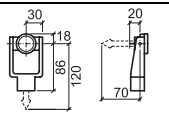
RL-Short	Short range. For distance measurements without prisms with a target distance up to 80 m (3mm + 2 ppm)
RL-Track	Continuous distance measurement without prisms (5mm + 2 ppm)
RL-Prism	Long range. For distance measurements with prisms (5mm + 2 ppm)

☞ With the RL-EDM each object in the beam is measured (possibly also branches, cars, etc.).

Prism type

Calling the function in the EDM settings.

Leica Prisms	Constants [mm]	
Standard prism (Round) GPH1 + GPR1	0.0	

360° prism GRZ4	+23.1	
360° Mini prism GRZ101	+30.0	
Miniprism GMP101/102	+17.5	
JPMINI	+34.4	Mini prism
Reflective targets	+34.4	
USER	--	is set at "Prismconst" (-mm + 34.4; e.g.: mm = 14 -> input = -14 + 34.4 = 20.4)
RL	+34.4	Reflectorless

Prism Constant

Calling the function in the EDM settings.

Entry of a user specific prism constant. Input can only be made in [mm].

Limit value: -999,9 mm to +999,9 mm

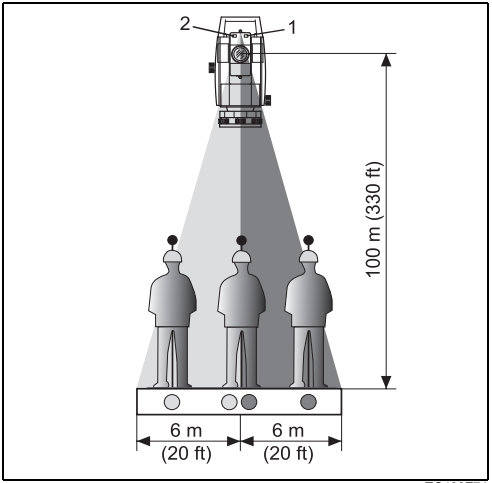
Laser Pointer

Off: Visible laser beam is switched off.

On: Visible laser beam for visualising the target point is switched on.

Guide Light

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 setting out points.



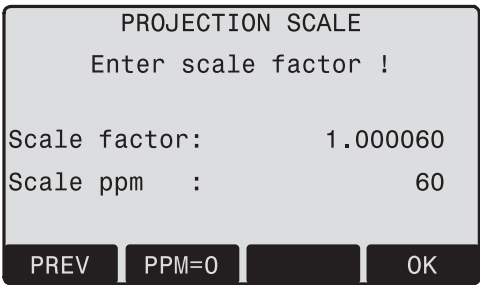
TC400Z71

1) Flashing red diode
2) Flashing yellow diode

Operat. range: 5 - 150 m (15 -500 ft)

Divergence: 12 m (40 ft) at 100 m (330 ft)

[SCALE]
Scale of projection.



TC400Z72

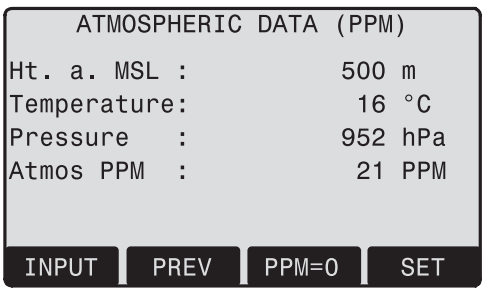
Scale factor:
Entering the scale of projection. Measured values and coordinates are corrected with the PPM parameter.

[PPM=0] Sets default parameters.

[PPM]
Input of individual scaling parameters.

[P/Temp]
Input of atmospheric parameters.

Atmospheric Parameters (ppm):
Distance measurement is influenced directly by the atmospheric conditions of the air in which distance measurement are taken.



TC400Z73

In order to take into consideration these influences distance measurements are corrected using atmospheric correction parameters.

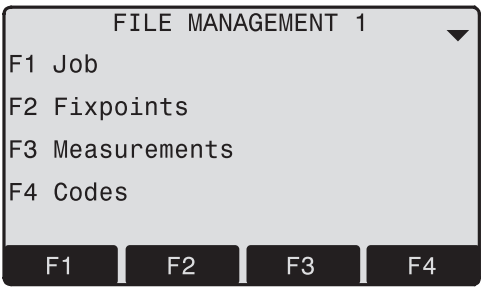
- Ht. a. MSL
  Height above sea level at product location.
- Temperature
  Air temperature at product location.
- Pressure
  Air pressure at product location.
- Atmos PPM:
  Calculated and indicated atmospheric PPM.

Signal

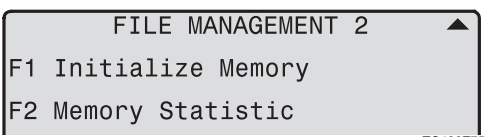
[SIGNAL] Displays EDM signal strength (reflection strength) in steps of 1%. Permits optimal aiming at distant barely visible targets.

File Management

The File Manager contains all functions for entering, editing and for checking data in the field.



TC400Z74



TC400Z75

Job

Jobs are a summary of data of different types, e.g. fixed points, measurements, codes, results, etc.

The job definition consists of the input of job name and user.

Additionally, the system generates time and date at the time or creation.

Job search:

◀ ● ▶	Scrolling through jobs.
[DELETE]	Deletes selected job.
[SET]	Sets the selected job.
[NEW]	Starts new job.

Fixpoints

Valid fixed points contain at least the ptID and the coordinates (E, N) or (H).

[DELETE]	Deletes selected fixed point.
[FIND]	Starts point search. Exact ptIDs can be entered or the * wildcard-criteria used.
[NEW]	Opens input for ptID and coordinates.

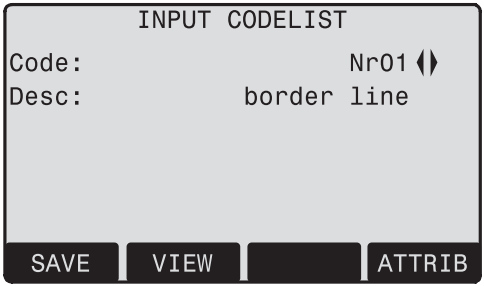
Measurements

Measurement data available in the internal memory can be searched and displayed or erased.

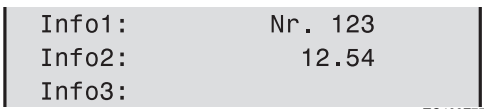
[FIND]	Starts point search dialogue.
[VIEW]	Displays all measurements.

Codes

To each code a description and a maximun of 8 attributes with up to 16 characters can be assigned.



TC400Z76



TC400Z77

[SAVE]	Save data.
[VIEW]	Starts search dialogue.
[ATTRIB]	Input of attributes.

Initialize Memory

Deletes jobs, single data areas of a job or all data.

[DELETE] Starts deleting process within the selected area.

[ALL] Deletes all data in memory. All data will be lost !

☞ Deleting the memory cannot be undone. After confirming the message all data is deleted permanently.

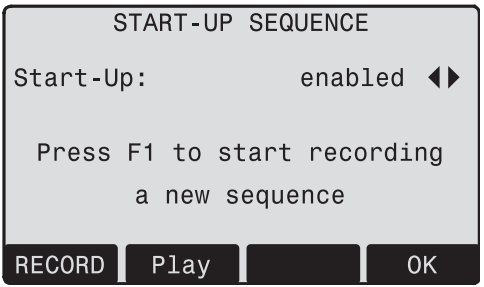
Memory Statistic

Displays job specific memory information such as:

- Number of stored fixpoints.
- Number of recorded data blocks (measured points, codes, etc.).
- Number of free or not defined jobs.

Start-up sequence

Sets the screen the product starts in when switched on. E.g. the electronic bubble can be displayed at every start.



TC400Z78

[OK] Stores current settings.

[RECORD] Defines the key presses that are executed automatically upon start up.

[Play] Starts to run the recorded sequence.

Procedure:

After confirming the dialogue of notification, the "Meas & Rec" screen is displayed. A maximum of 16 of the next key presses are stored. The sequence is ended with [ESC]. If the start sequence is activated, the stored key presses are executed automatically when the product is switched on.

☞ The automatic start sequence has the same effect as pressing the keys manually. Certain product settings can not be made in this way. "Relative entries" such as automatically setting "IR-FINE" upon switching on the product, are not possible.

Determining Line-of-sight error and V-Index

The calibration contains the determination of the following product errors:

- Hz-collimation
- V-index (simultaneously electronic level)

For determining the Hz-collimation or the V-index it is necessary to measure in both telescope positions. The procedure can be started in any telescope position.

The user is guided clearly through the procedure. A wrong determination of product error is thus eliminated.

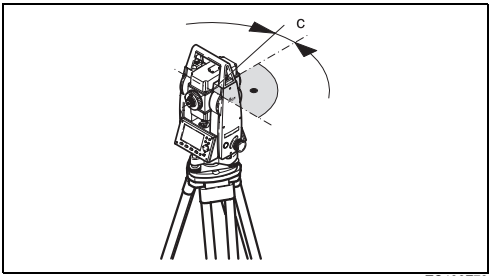
The products are adjusted in the factory prior to shipping.

product errors can change with time and temperature.

These errors should be determined before the product is used for the first time, before precision surveys, after long periods of transport, before and after long periods of work, and if the temperature changes by more than 10°C (18°F).

Before determining the product errors, level-up the product using the electronic bubble. The product should be secure and firm, and should be protected from direct sunlight in order to avoid thermal expansion on one side only.

Line-of-sight error (Hz-collimation)



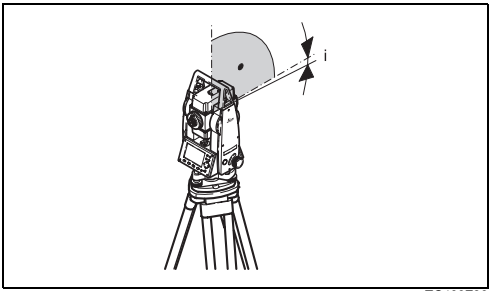
TC400Z79

The line-of-sight error or collimation error (C) 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 Hz-angle increases with the vertical angle.

For horizontal aimings the error of Hz equals the line-of-sight error.

V-Index (Vertical index error)



TC400Z80

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 (i).

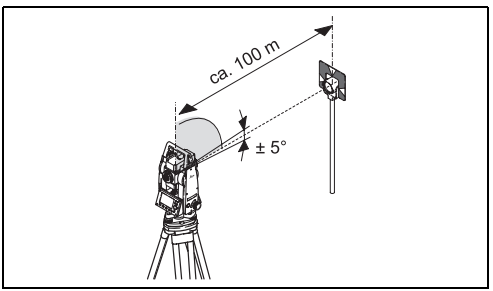
By determining the vertical index error the electronic level is adjusted automatically.

☞ Procedures and conditions required to correct line-of-sight and height index errors are the same. Thus the procedure will only be described once.

F1 Hz-collimation
F2 V-index
F3 Display adjustment value:
Summarizes saved values.

Procedure:

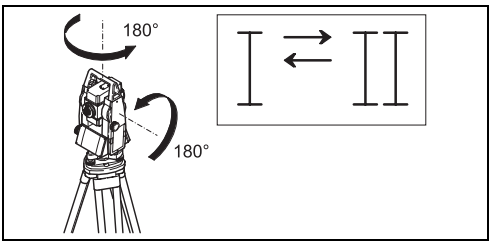
1. Level product with electronic bubble.
2. Aim at a point approximately 100m from the product which is within 5° of the horizontal.



TC400Z81

3. [ALL]: Trigger measurement.
4. Change telescope position and aim to the point again.

For checking the horiontal aiming Hz and V are displayed.



TC400Z82

5. [ALL]: Starts measurement
6. Displays the old and new calculated values.
   [SET] Sets new calibration data.
   [ESC] Quits program without setting new calibration data.

Warnings / Messages

Important Messages	Meaning	Measures
V-Angle not suitable for calibration (Check V-angle or face) !	Aiming tolerance not met or telescope position/face not changed.	Aim on the target point with an accuracy of min. 5 gon. The target point must be approximately in the horizontal plane. Confirmation of the message required.
Calibration result out of tolerance. Previous values retained !	Computed values out of tolerance. Previous values retained.	Repeat measurements. Confirmation of the message required.
Hz-Angle out of limit !	Hz-angle in second face/telescope pos. deviates more than 5 gon from the target point.	Aim on the target point with an accuracy of min. 5 gon. Confirmation of the message required.
Measurement Error. Try again.	Measurement error appeared (e.g. instable set up or period between measuring in telescope position I and II too long).	Repeat the process. Confirmation of the message required.

COMM Parameters

For data transfer between PC and product the communication parameters of the serial interface RS232 must be set.

Leica Standard setting
19200 Baud, 8 Databit, No Parity, 1 Stopbit, CR/LF

Baudrate
Data transfer speed 2400, 4800, 9600, 19200 [bits / second]

Databits
7 Data transfer is realized with 7 databits. Is set automatically if parity is "Even" or "Odd".
8 Data transfer is realized with 8 databits. Is set automatically if parity is "None".

Parity

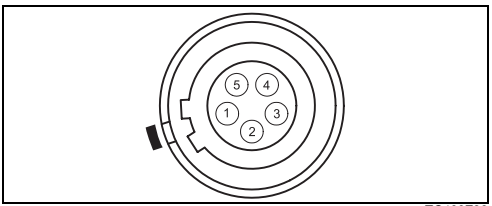
Even	Even parity
Odd	Odd parity
None	No parity (if data bit is set to 8)

Endmark

CRLF	Carriage return; line feed
CR	Carriage return

Stopbits
Fixed setting 1.

Interface plug connections:



TC400Z83

1) External battery
2) Not connected / inactive
3) GND
4) Data reception (TH_RXD)
5) Data transfer (TH_TXD)

TH ... Theodolite

Data Transfer

With this special function measured data can be transfered via the serial interface to a receiver (e.g. a Laptop). Using this type of transfer the success of the transfer is **not** checked.

Job: Selection of job from which data should be transfered.

Data: Select the data range to be transferred (measurements, fixed points)

Format: Select output format. Select Leica-GSI-format, or your own format created in the "Format Manager" and transfer to the LGO/LGO-Tools.

[SEND] Starts the transmission.

Example:

Within the "data" 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

☞ If the receiver is to slow in processing data the data could be lost. With this type of data transfer the product is not informed about the performance of the receiver (no protocol).

GSI-ID's		
11	≙	PtID
21	≙	Horizontal direction
22	≙	Vertical angle
31	≙	Slope distance
32	≙	Horizontal distance
33	≙	Height difference
41-49	≙	Codes and attributes
51	≙	ppm [mm]
58	≙	Prism constants
81-83	≙	(E, N, H) Target point
84-86	≙	(E, N, H) Stand point
87	≙	Reflector height
88	≙	product height

System Info

Displays helpful information and date / time are set.

- **Battery**
  Remaining battery power (e.g. 40%).
- **Instr.Temp.**
  Measured product temperature.
- **Date**
  Displays the current date.
- **Time**
  Displays current time.

[DATE] Change date and format.

Format: There are three display formats:

- DD.MM.YYYY
- MM.DD.YYYY
- YYYY.MM.DDT

Date: Input date

[TIME] Set time.

[SW-Info] The software of the product is composed of different software packages. Depending on the package, different versions are possible.

Op-System:	Operating System
App.-SW:	Applications, functions and menu
Layout:	User displays

Instrument Protection with PIN

The instrument can be protected by a **P**ersonal **I**dentification **N**umber. If the PIN protection is activated, the instrument will always prompt for a PIN code entry after starting up. If a wrong PIN has been typed in five times, a **P**ersonal **U**nbloc**K**ing code is required which can be found on the instrument delivery papers. If the PUK code entered is correct then the old PIN code is set to default value "0" and the PIN protection is deactivated.

Procedure:

1. [MENU] > [PIN]
2. Activate PIN by setting <Use PIN Code>: On.
3. Enter your desired personal PIN Code (max. 6 character numeric) and accept with [OK].

☞ Now the instrument is protected against unauthorized use. After switching on the instrument the PIN Code entry is necessary.

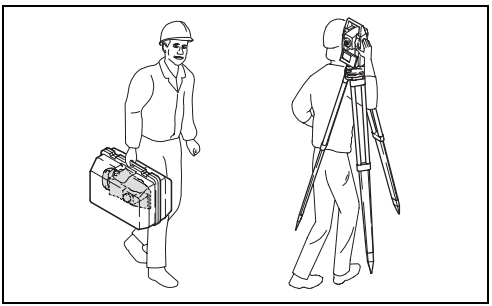
☞ If the PIN protection is activated you can furthermore lock the instrument from any application by pressing [FNC] > Lock with PIN without switching off the instrument

Transport

When transporting or shipping the equipment always use the original Leica Geosystems packaging (transport case and shipping cardboard).

☞ After a longer period of storage or transport of your product always check the field ajustment parameters indicated in this manual before using the product.

In the field



TC400Z84

When transporting the equipment **in the field**, always make sure to

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

Inside vehicle

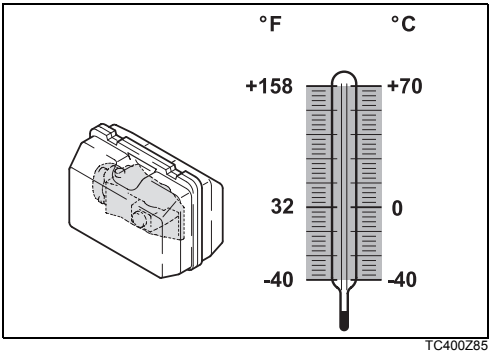
Never transport the product loose **inside the vehicle.**

The product can be damaged by blows and vibrations. It must always be transported in its case and be properly secured.

Shipping

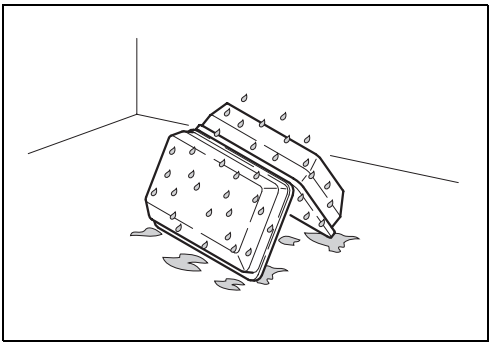
For shipping the product by rail, aircraft or ship use the Leica Geosystems original packaging (transport case or shipping cardboard) or another suitable packaging securing the product against blows and vibrations.

Storage



When storing the equipment, particularly in summer and inside a vehicle, take the **temperature limits** into account.

When storing the intrument inside a building also use the transport case (if possible, in a safe place).



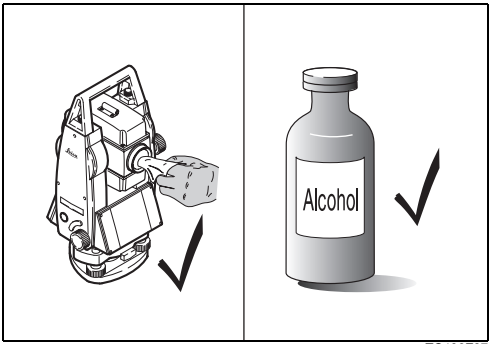
TC400Z86

☞ **If the product becomes wet, leave it unpacked**. Wipe down, clean, and dry the product (at not more than 40 °C/ 104°F), transport case, foam inserts, and accessories. Pack up the equipment only when it is perfectly dry.
When using the product in the field always close the transport case.

Batteries

- The permissible temperature range for storing is -40°C to +55°C / -40°F to +131°F. A storage temperature range of 0°C to +20°C / +32°F to 68°F in dry environment is recommended to minimize 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 (NiMH) before using.
- Protect batteries from damp and wetness. Wet or damp batteries must be dried before storing or use.

Cleaning



TC400Z87

Objective, eyepiece and prisms:

- Blow dust off lenses and prisms.
- Never touch the glass with fingers.
- Use only a clean, soft and lint-free cloth for cleaning. If necessary, moisten the cloth with pure alcohol.

Use no other liquids; these may attack polymer components.

Fogging of prisms:

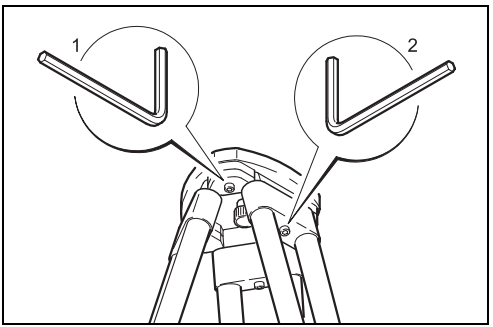
Reflector prisms that are cooler than the ambient temperature tend to fog. It is not enough simply to wipe them. Keep them for some time inside your jacket or in the vehicle to allow them to adjust to the ambient temperature.

Cables and plugs:

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

Checking and adjusting

Tripod

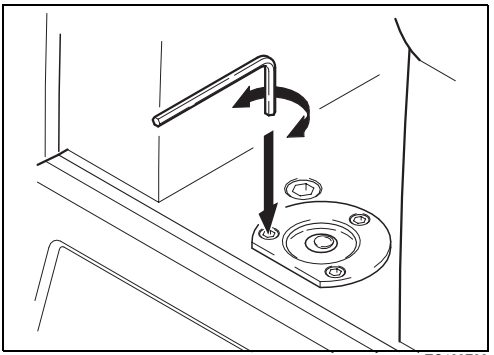


TC400Z88

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

- Tighten the Allen screws (2) moderately.
- Tighten the articulated joints on the tripod head (1) just enough to keep the tripod legs open when you lift it off the ground.

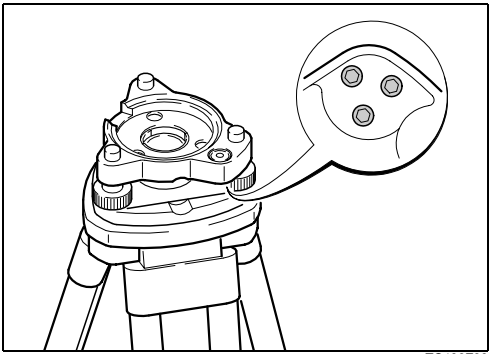
Circular level


TC400Z89

Level-up the product in advance with the electronic level. The bubble must be centered. If it extends beyond the circle, use the Allen key supplied to center it by turning the adjustment screws.

After adjustment no screw must be loose.

Circular level on the tribrach



TC400Z90

Level the product and then remove it from the tribrach. If the bubble is not centred, adjust it using the adjusting pin.

Turning the adjustment screws:

- to the left: the bubble approaches the screw
- to the right: the bubble goes away from the screw.

After adjustment no screw must be loose.

Laser plummet

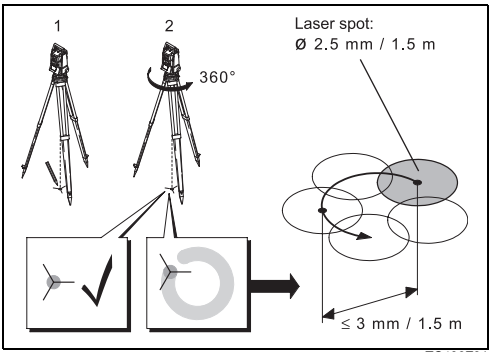
The laser plummet is integrated into the vertical axis of the product. Under normal circumstances setting of the laser plummet is not necessary. If an adjustment is necessary due to external influences the product has to be returned to any Leica service department.

Checking by turning the product by 360°:

1. Install the product on the tripod approx. 1.5 m above ground and level up.
2. Switch on laser plummet and mark the centre of the red spot.
3. Turn product slowly by 360° and observe the red laser spot.

Inspecting the laser plummet should be carried out on a bright, smooth and horizonal surface (e.g. a sheet of paper).

If the centre of the laser spot makes a clearly circular movement or if the centre of the point is moving away more than 3 mm from the first marked point an adjustment is possibly necessary. Call your nearest Leica service department.



TC400Z91

Depending on brightness and surface the size of the laser spot can vary. At a distance of 1.5 m an average value of 2.5 mm diameter must be estimated.

The maximum diameter of the circular movement described by the centre of the laser point should not exceed 3 mm at a distance of 1.5m.

Chapter validity

This chapter is relevant for Telescope Type 1 only.

Reflectorless EDM

The red laser beam used for measuring without reflector is arranged coaxially with the line of sight of the telescope, and emerges from the objective port. If the product is well adjusted, the red measuring beam will coincide with the visual line of sight. External influences such as shock or large temperature fluctuations can displace the red measuring beam relative to the line of sight.

The direction of the beam should be inspected before precise measurement of distances is attempted, because an excessive deviation of the laser beam from the line of sight can result in imprecise distance measurements.

WARNING

For safety aspects direct intrabeam viewing should be considered always as hazardous.

Precautions:

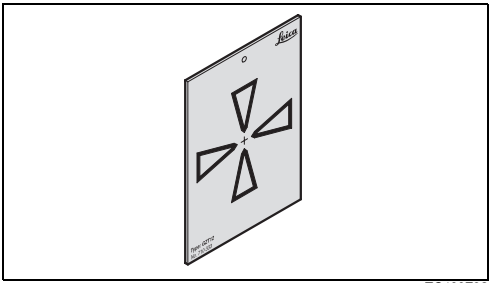
Do not stare into the beam or direct it towards other people unnecessarily. These measures are also valid for the reflected beam.

Inspection

A target plate is provided. Set it up between five and 20 metres away with the grey reflective side facing the product. Move the telescope to face II. Switch on the red laser beam by activating the laser-point function. Use the telescope crosshair to align the product with the centre of the target plate, and then inspect the position of the red laser spot on the target plate. Generally speaking the red spot cannot be seen through the telescope, so look at the target plate from just above the telescope or from just to the side of it.

If the spot illuminates the cross, the achievable adjustment precision has been reached; if it lies outside the limits of the cross, the direction of the beam needs to be adjusted.

If the spot on the more reflective side of the plate is too bright (dazzling), use the white side instead to carry out the inspection.



TC400Z92

Adjusting the direction of the beam

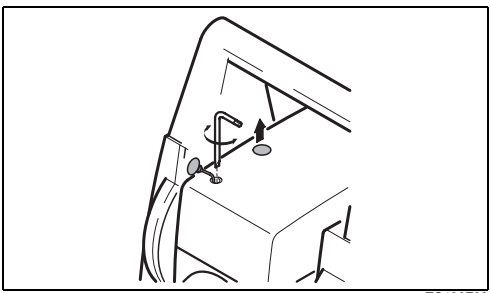
Pull the two plugs out from the adjustment ports on the top side of the telescope housing.

To correct the height of the beam, insert the screwdriver into the rear adjustment port and turn it clockwise (spot on target plate moves obliquely upwards) or anticlockwise (spot moves obliquely downwards).

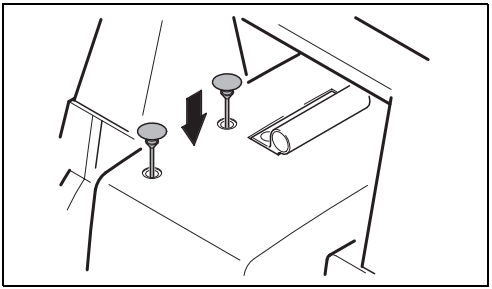
To correct the beam laterally, insert the screwdriver into the front adjustment port and turn it clockwise (spot moves to the right) or anticlockwise (spot moves to the left).

☞ Throughout the adjustment procedure, keep the telescope pointing to the target plate.

☞ After each field adjustment, replace the plugs in the adjustment ports to keep out damp and dirt.



TC400Z93



TC400Z94

Safety Directions

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.

Intended Use

Permitted use

- Measuring horizontal and vertical angles.
- Measuring distances.
- Recording measurements.
- Computing by means of application software.
- Visualising the standing axis (with laser plummet).
- Visualizing the aiming direction (with guide light EGL)

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 (screwdriver, etc.), unless this is specifically permitted for certain functions.
- Modification or conversion of the product.

- Use after misappropriation.
- Use of products with obviously recognizable damages or defects.
- Use with accessories from other manufacturers without the prior express approval of Leica Geosystems.
- Aiming directly into the sun.
- Inadequate safeguards at the surveying site (e.g. when measuring on roads, etc.).
- Controlling machines, or controlling moving objects or similar, with the integrated distancer (visible laser).
- Deliberate dazzling of third parties.

WARNING

Adverse use can lead to injury, malfunction, and material damage. It is the task of the person responsible for the product 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.

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 explosive areas, or in close proximity to electrical installations or similar situations by the person in charge of the product.

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.

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.

International Waranty, Software Licence Agreement

International Waranty

The International Warranty can be downloaded from the Leica Geosystems AG home page at http://www.leica-geosystems.com/internationalwarranty or received from your Leica Geosystems dealer.

Software Licence Agreement

This product contains software that is preinstalled on the product, or that is supplied to you on a data carrier medium, or that can be downloaded by you online pursuant to prior authorization from Leica Geosystems. Such software is protected by copyright and other laws and its use is defined and regulated by the Leica Geosystems Software Licence Agreement, which covers aspects such as, but not limited to, Scope of the Licence, Warranty, Intellectual Property Rights, Limitation of Liability, Exclusion of other Assurances, Governing Law and Place of Jurisdiction. Please make sure, that at any time you fully comply with the terms and conditions of the Leica Geosystems Software Licence Agreement.

Such agreement is provided together with all products and can also be found at the Leica Geosystems home page at http://www.leica-geosystems.com/swlicense or your Leica Geosystems dealer.

You must not install or use the software unless you have read and accepted the terms and conditions of the Leica Geosystems Software Licence 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 licence agreement. If you do not agree to all or some of the terms of such licence 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.

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.

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.

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

By surveying during a thunderstorm you are at risk from lightening.

Precautions:

Do not carry out field surveys during thunderstorms.

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 surveying site can lead to dangerous situations, for example in traffic, on building sites and at industrial installations.

Precautions:

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

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

WARNING
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 unauthorized 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 unauthorized 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.

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, for example tripod, tribrach, connecting cables, are correctly adapted, fitted, secured, and locked in position.

Avoid subjecting the product to mechanical stress.

CAUTION

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

Laser classification

Integrated Distancer, Measurements with Reflectors (IR mode)

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

The product is a Class 1 laser product in accordance with:

- IEC 60825-1 (2001-08): "Safety of Laser Products"
- EN 60825-1:1994 + A11:1996 + A2:2001: "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 the instructions.

Description	Value
Maximum average radiant power	0.33 mW ± 5%
Maximum peak radiant power	4.12 mW ± 5%
Pulse duration	800 ps
Pulse repetition frequency	100 MHz
Beam divergence	1.5 mrad x 3 mrad

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

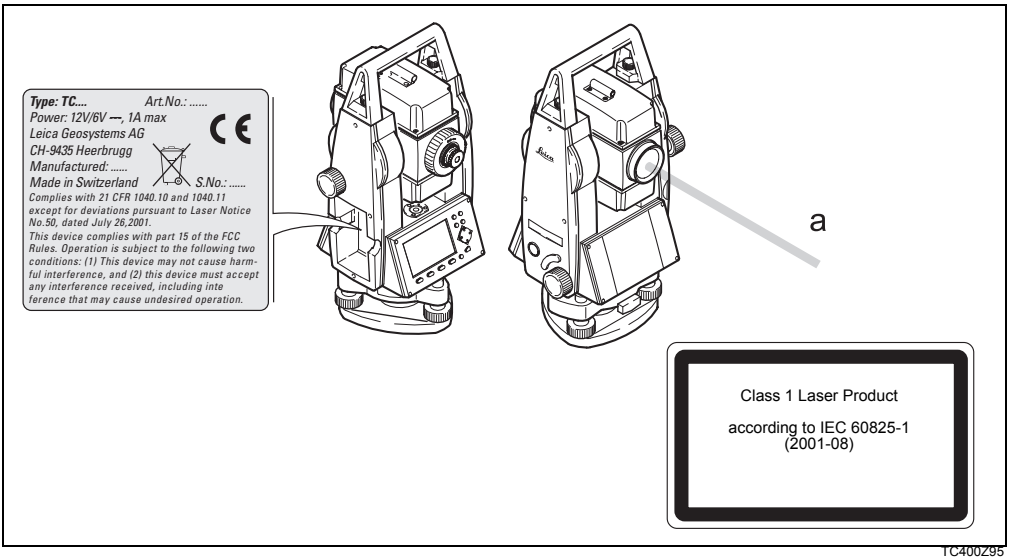
The product is a Class 1 Laser Product in accordance with:

- IEC 60825-1 (2001-08): "Safety of Laser Products"
- EN 60825-1:1994 + A11:1996 + A2:2001: "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 the instructions.

Description	Value
Maximum average radiant power	0.33 mW ± 5%
Maximum peak radiant power	4.12 mW ± 5%
Pulse duration	800 ps
Pulse repetition frequency	100 MHz - 150 MHz
Beam divergence	1.5 mrad x 3 mrad

Labelling



a) Laser beam exit

Integrated Distancer, Measurements without Reflectors (RL mode)

As an alternative to the invisible laser, the EDM incorporated into the product produces a visible red laser beam which emerges from the telescope objective.

The products are Class 3R Laser Products in accordance with:

- IEC 60825-1 (2001-08): "Safety of Laser Products"
- EN 60825-1:1994 + A11:1996 + A2:2001: "Safety of Laser Products"

Class 3R Laser Products:

For safety aspects direct intrabeam viewing should always be considered as hazardous. Avoid direct eye exposure. The accessible emission limit is within five times the accessible emission limits of Class 2 in the wavelength range from 400 nm to 700 nm.

Description	R100	R300
Maximum average radiant power	4.75 mW ± 5%	4.75 mW ± 5%
Maximum peak radiant power	59 mW ± 5%	59 mW ± 5%
Pulse duration	800 ps	800 ps
Pulse repetition frequency	100 MHz	100 MHz - 150 MHz
Beam divergence	1.5 mrad x 0.35 mrad	1.5 mrad x 0.5 mrad

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

The products are Class 3R Laser Products in accordance with:

- IEC 60825-1 (2001-08): "Safety of Laser Products"
- EN 60825-1:1994 + A11:1996 + A2:2001: "Safety of Laser Products"

Class 3R Laser Products:

For safety aspects direct intrabeam viewing should always be considered as hazardous. Avoid direct eye exposure. The accessible emission limit is within five times the accessible emission limits of Class 2 in the wavelength range from 400 nm to 700 nm.

Description	Value
Maximum average radiant power	4.75 mW ± 5%
Maximum peak radiant power	59 mW ± 5%
Pulse duration	800 ps
Pulse repetition frequency	100 MHz - 150 MHz
Beam divergence	0.2 mrad x 0.3 mrad

WARNING

For safety aspects direct intrabeam viewing should be considered always as hazardous.

Precautions:

Do not stare into the beam or direct it towards other people unnecessarily. These measures are also valid for the reflected beam.

WARNING

Looking directly into the reflected laser beam could be dangerous to the eyes when the laser beam is aimed at areas that reflect like a mirror or emit reflections unexpectedly, for example prisms, mirrors, metallic surfaces or windows.

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 Laserpointer or distance measurement mode. Aiming at prisms is only permitted when looking through the telescope.

WARNING
The use of Laser Class 3R equipment can be dangerous.

Precautions:
To counteract hazards, it is essential for every user to respect the safety precautions and control measures specified in the standard IEC 60825-1 (2001-08) resp. EN 60825-1:1994 + A11:1996 + A2:2001, within the hazard distance *); pay particular attention to Section Three "User's Guide".

Following an interpretation of the main points in the relevant section of the standard quoted.

Class 3R Laser Products used on construction sites and outdoors, for example surveying, alignment, levelling:

a) Only qualified and trained persons should be assigned to install, adjust and operate the laser equipment.
b) Areas in which these lasers are used should be posted with an appropriate laser warning sign.
c) Precautions should be taken to ensure that persons do not look directly, with or without an optical product, into the beam.
d) The laser beam should be terminated at the end of its useful beam path and should in all cases be terminated if the hazardous beam path extends beyond the limit (hazard distance *) of the area in which the presence and activities of personnel are monitored for reasons of protection from laser radiation.
e) The laser beam path should be located well above or below eye level wherever practicable.

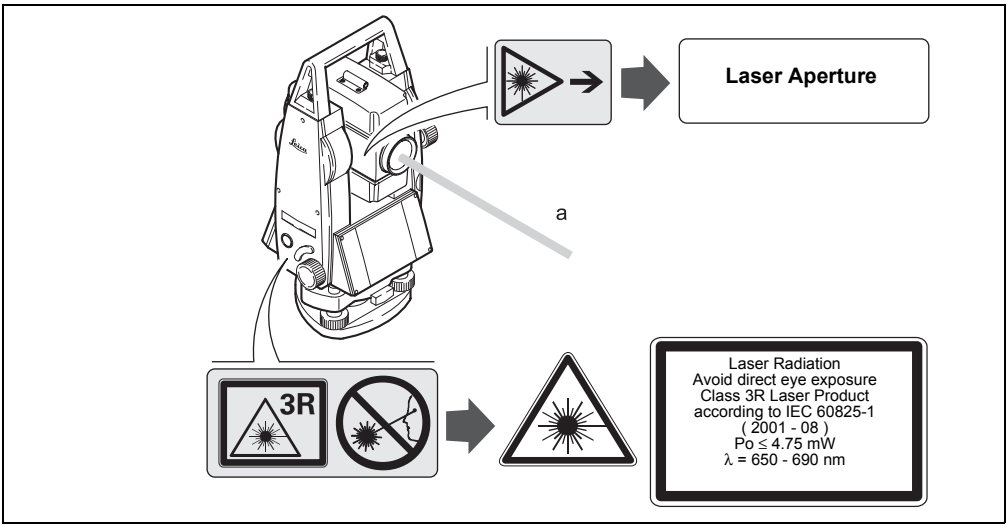
f) When not in use the Laser Product should be stored in a location where unauthorized personnel cannot gain access.

g) Precautions should be taken to ensure that the laser beam is not unintentionally directed at mirror-like, specular surfaces, for example mirrors, metal surfaces or windows. But, more importantly, at flat or concave mirror-like surfaces.

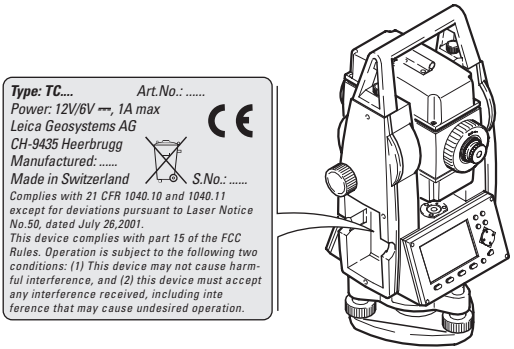
*) The hazard distance is the distance from the laser at which beam irradiance or radiant exposure equals the maximum permissible value to which personnel may be exposed without being exposed to a health risk.

For products with an integrated distancer of laser class 3R the hazard distance is 96 m / 315 ft. At this distance, the laser beam rates as Class 1M, that means direct intrabeam viewing is not hazardous.

Labelling



a)Laser beam


Type: TC.... Art.No.: .....
Power: 12V/6V ⎓, 1A max
Leica Geosystems AG
CH-9435 Heerbrugg
Manufactured: .....
Made in Switzerland S.No.: .....
Complies with 21 CFR 1040.10 and 1040.11 except for deviations pursuant to Laser Notice No.50, dated July 26,2001.
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 inte ference that may cause undesired operation.

TC400Z96

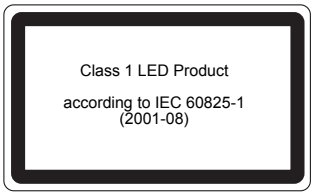
Electronic Guide Light EGL

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 is a Class 1 LED product in accordance with:

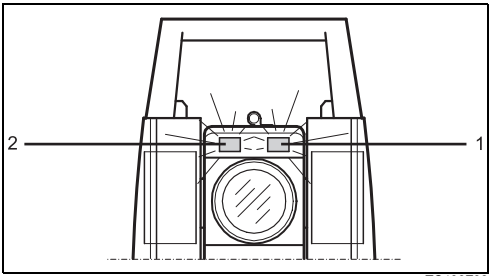
- IEC 60825-1 (2001-08): "Safety of Laser Products"
- EN 60825-1:1994 + A11:1996 + A2:2001: "Safety of Laser Products"

Class 1 LED 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 the instructions.



TC400Z97

Flashing LED	Yellow	Red
Maximum average radiant power	0.28 mW ± 5%	0.47 mW ± 5%
Maximum peak radiant power	0.75 mW ± 5%	2.5 mW ± 5%
Pulse duration	2 x 105 ms	1 x 105 ms
Pulse repetition frequency	1.786 Hz	1.786 Hz
Beam divergence	2.4 °	2.4 °



TC400Z98

1) Exit for flashing red LED
2) Exit for flashing yellow LED

Laser plummet

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

The product is a Class 2 Laser Product in accordance with:

- IEC 60825-1 (2001-08): "Safety of Laser Products"
- EN 60825-1:1994 + A11:1996 + A2:2001: "Safety of Laser Products".

Class 2 Laser Products:
Do not stare into the beam or direct it unnecessarily at other persons. Eye protection is normally afforded by aversion responses including the blink reflex.

Description	Value
Maximum average radiant power	0.95 mW ± 5%
Pulse duration	c.w.
Beam divergence	0.16 mrad x 0.6 mrad

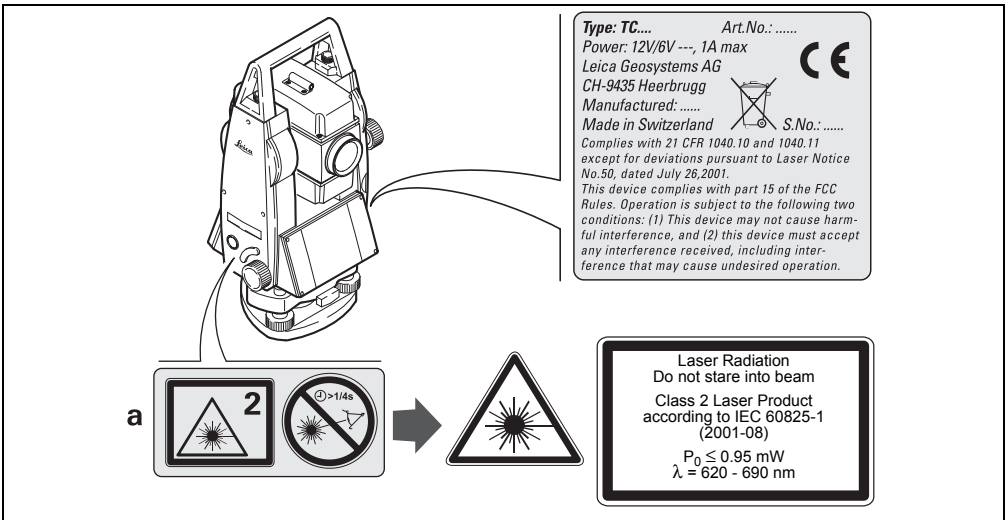
WARNING

It can be dangerous to look into the beam with optical equipment, for example binoculars or telescopes.

Precautions:

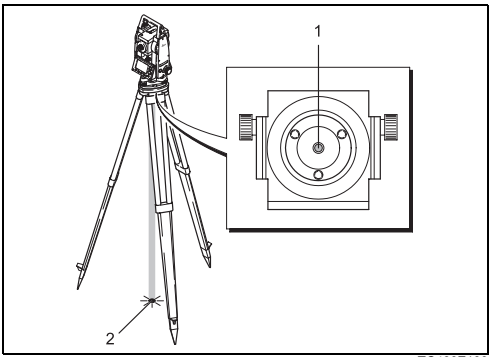
Do not look directly into the beam with optical equipment.

Labelling



TC400Z99

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



TC400Z100

1) Exit for laser beam
2) Laser beam

Electromagnetic Compatibility EMC

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

WARNING
Electromagnetic radiation can cause disturbances in other equipment.

Although the product meet 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 acceptability 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.

FCC Statement (Applicable in U.S.)

WARNING

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

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

This equipment generates, uses and can radiate 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.

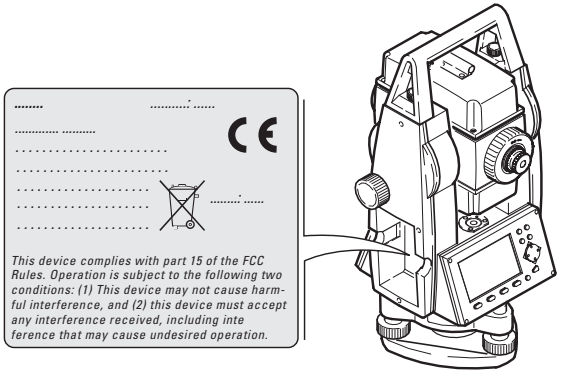
If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

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



TC400Z101

Technical Data

Telescope

- Transit fully
- Magnification: 30x
- Image: ..... upright
- Free Objective aperture: ..... 40 mm
- Shortest focussing distance: .....1.7 m (5.6 ft)
- Focusing: ..... fine
- Field of view: .....1°30' (1.7gon)
- Telescope field of view at 100m..... 2.6 m

Angle measurement

- absolute, continuous,
- Updates each 0.3 seconds
- Units selectable
  360° sexagesimal, 400gon,
  360° decimal, 6400 mil, V%, ±V
- Accuracy standard deviation Hz, V
  (acc. to ISO 17123-3)
  TC(R)403 ..... 3" (1 mgon)
  TC(R)405 ..... 5" (1.5 mgon)
  TC(R)407 ..... 7" (2 mgon)

Display resolution
gon 0.0005
360d 0.0005
360s ..... 1"
mil 0.01

Level sensitivity

- Circular level: ..... 6'/2 mm

Compensator:

- 2-axis-oil compensator
- Setting range ..... ±4' (0.07 gon)
- Setting accuracy .....
  TC(R)407 ..... 2" (0.7 mgon)
  TC(R)405 ..... 1.5" (0.5 mgon)
  TC(R)403 ..... 1" (0.3 mgon)

Laser plummet

- Location: ..... in vertical axis of product
- Accuracy: .....Deviation from .....plumbline 1.5 mm .....(2 sigma) at 1.5 m ..... product height
- Diameter of laser point..... 2.5 mm / 1.5 m

Keyboard:

- Tilt angle: .....70°
- optional 2nd keyboard

Display:

- Backlit
- Heatable..... (Temp. < -5°C)
- LCD:..... 280 x 160 Pixel
- 8 lines with 31 characters each

Type of tribrach:

- Tribrach removable GDF111
  Thread diam.:.....5/8"
  .....(DIN 18720 / BS 84)

Dimensions:

- product:.....
  Height (including tribrach and carrying handle):
  - with tribrach GDF111.....
  ..... 360 mm ± 5 mm
  Width:..... 203 mm
  Length:..... 151 mm
- Case: ..... 468x254x355mm ..... (LxBxH)

Weight:

(including battery and tribrach)

- with tribrach GDF111 ..... 5,2 kg

Tilting axis height:

- without tribrach ..... 196 mm
- with tribrach GDF111 ..... 240 mm ± 5 mm

Power supply:

- Battery GEB111:.....NiMh
  Voltage:.....6V
  Capacity:.....2100 mAh
- Battery GEB121:.....NiMh
  Voltage:.....6V
  Capacity:.....4200 mAh

- External supply
  (via serial interface)
  ..... If an external cable is used,
  .....then the voltage range must lie
  .....between 11.5V and 14V.

No. of measurements (angle + distance):

- GEB111: ..... approx. 4000
- GEB121: ..... approx. 9000

Temperature range:

Type	Operating temperature	Storage temperature
TPS400	-20°C to +50°C / -4°F to +122°F	-40°C to +70°C / -40°F to +158°F
Battery internal	-20°C to +50°C / -4°F to +131°F	-40°C to +55°C / -40°F to +131°F

Automatic corrections:

- Line-of-sight error.....Yes
- Vertical-index error.....Yes
- Earth curvature .....Yes
- Refraction.....Yes
- Tilt correction .....Yes

Recording:

- RS232 interface .....Yes
- Internal Memory .....Yes
  Total capacity..... 576 KB
  ..... ≈ 10000 data blocks or
  ..... ≈ 16000 fixpoints

Distance measurement (IR: Reflector mode):

Principle: Phase measurement
Type: Coaxial, infrared laser Class 1
Carrier wave: 780 nm
Measuring system: Special frequency system basis 100 MHz ≙ 1.5 m

Principle: Phase measurement
Type: Coaxial, visible red laser Class 1
Carrier wave: 660 nm
Measuring system: System analyser basis 100 MHz - 150 MHz

- EDM type ..... coaxial
- Display (least count) ..... 1 mm

EDM measuring program	Accuracy* (Standard deviation acc. to ISO 17123-4)	Time per measure-ment
IR_Fine	2 mm + 2 ppm	<1 sec.
IR_Fast	5 mm + 2 ppm	<0.5 sec.
Tracking	5 mm + 2 ppm	<0.3 sec.
IR Tape	5 mm + 2 ppm	<0.5 sec

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

Range: (normal and rapid measurement)						
	Standard prism	3 prisms (GPH3)	360° reflector	Tape 60mm x 60mm	Mini prism	360° Mini prism
1	1800 m (6000 ft)	2300 m (7500 ft)	800 m (2600 ft)	150 m (500 ft)	800 m (2600 ft)	450 m (1500 ft)
2	3000 m (10000 ft)	4500 m (14700 ft)	1500 m (5000 ft)	250 m (800 ft)	1200 m (4000 ft)	800 m (2600 ft)
3	3500 m (12000 ft)	5400 m (17700 ft)	2000 m (7000 ft)	250 m (800 ft)	2000 m (7000 ft)	1000 m (3500 ft)

1) Strong haze, visibility 5km; or strong sunlight, severe heat shimmer
2) Light haze, visibility about 20km; or moderate sunlight, slight heat shimmer
3) Overcast, no haze, visibility about 40km; no heat shimmer

Distance measurement (RL: Reflectorless mode)

Measuring system R100:	Special frequency system basis 100 MHz ≙ 1.5 m
Measuring system R300:	System analyser basis 100 MHz - 150 MHz
Type:	Coaxial, visible red laser Class 3R
Carrier wave:	670 nm

Measuring system:	System analyser basis 100 MHz - 150 MHz
Type:	Coaxial, visible red laser Class 3R
Carrier wave:	660 nm

Distance measurement (without reflector**)**

- Range of measurement:
  Power..... 1.5 m to 300 m
  .....(to target plate 710 333)
  Ultra ..... 1.5 m to >500 m
  .....(to target plate 710 333)
- Display unambiguous:..... to 760 m
- Prism constant (additive constant):.. + 34.4 mm

Power: Range (without reflector)		
Atmospheric conditions	No reflector (white target)*	No reflector (grey, albedo 0.25)
4	140 m (460 ft)	70 m (230 ft)
5	170 m (560 ft)	100 m (330 ft)
6	>170 m (560 ft)	>100 m (330 ft)

Ultra: Range (without reflector)		
Atmospheric conditions	No reflector (white target)*	No reflector (grey, albedo 0.25)
4	300 m (990 ft)	200 m (660 ft)
5	500 m (1640 ft)	300 m (990 ft)
6	>500 m (>1640 ft)	>300 m (>990 ft)

* Kodak Grey Card used with exposure meter for reflected light

4) Object in strong sunlight, severe heat shimmer
5) Object in shade, or sky overcast
6) Day, night and twilight

EDM measuring program	Accuracy** (Standard deviation acc. to ISO 17123-4)	Time per measurement
Standard	3 mm + 2 ppm	3.0 sec. +1.0 sec./10m > 30m
Prism	5 mm + 2 ppm	2.5 sec.
Tracking	5 mm + 2 ppm	1.0 sec. +0.3 sec./10m > 30m

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

Distance measurement RL-prism (with reflector)

- Range of measurement: .....from 1000m up
- Display unambiguous: ..... to 12 km

Ultra & Power: Range (with reflector)		
Atmospheric conditions	Standard-prism	Reflector tape 60 x 60
1	2200 m (7200 ft)	600 m (2000 ft)
2	7500 m (24600 ft)	1000 m (3300 ft)
3	> 10000 m (33000 ft)	1300 m (4200 ft)

1) Strong haze, visibility 5km; or strong sunlight, severe heat shimmer
2) Light haze, visibility about 20km; or moderate sunlight, slight heat shimmer
3) Overcast, no haze, visibility about 40km; no heat shimmer

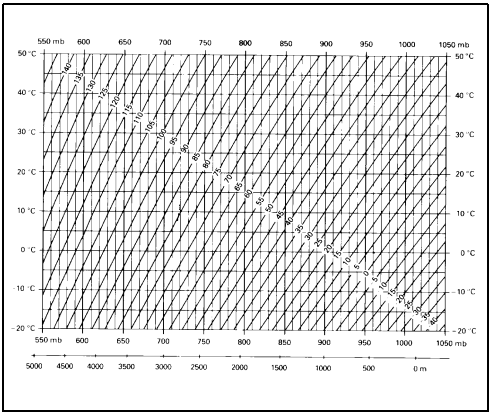
Atmospheric correction

The distance displayed is correct only 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 takes air pressure and air temperature into account.

For utmost precision in distance measurements, atmospheric correction must be determined with 1 ppm accuracy, air temperature to 1°C and air pressure to 3mb accuracy.

Atmospheric correction in ppm with °C, mb, H (metres) at 60% relative humidity



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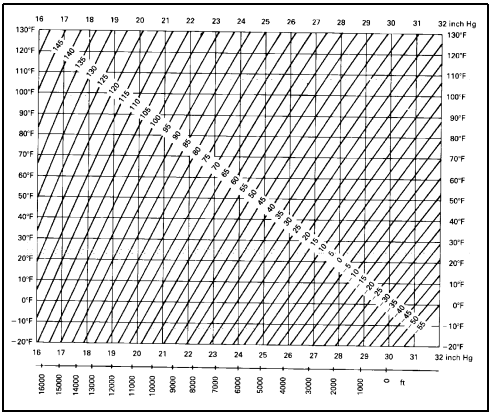
Atmospheric correction in ppm with °F, inch Hg, H (feet) at 60% relative humidity



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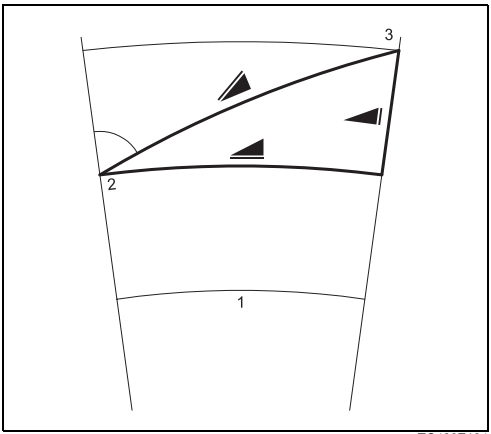
Reduction formulae



TC400Z104

Height measurement

1) Mean sea level
2) product
3) Reflector

The product calculates slope distance, horizontal distance and height difference in accordance with the following formula. Earth curvature and mean refraction coefficient (k = 0.13) are taken into account automatically. The calculated horizontal distance relates to the station height, not to the reflector height.

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

slope	=	displayed slope distance [m]
D_0	=	uncorrected distance [m]
ppm	=	scale correction [mm/km]
mm	=	prism constant [mm]

$$\text{horizontal} = Y - A \cdot X \cdot V$$

$$\text{height} = X + B \cdot Y_2$$

horizontal	=	horizontal distance [m]
height	=	height difference [m]

Y =  · |sin ζ |

X =  · cos ζ

ζ = vertical-circle reading

$$A = \frac{1 - k/2}{R} = 1.47 \cdot 10^{-7} \ [m^{-1}]$$

$$B = \frac{1 - k}{2R} = 6.83 \cdot 10^{-8} \ [m^{-1}]$$

k = 0.13

R = $6.37 \cdot 10^{6}$ m

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Total Quality Management: Our commitment to total customer satisfaction.

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

Ask your local Leica dealer for more information about our TQM program.

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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**

Leica Geosystems