Leica TPS400/TPS410C Series

User Manual TC(R)403/405/407/410C

Version 2.0
English

Leica Geosystems

Electronical Total Station

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

This manual contains important safety directions (refer to chapter "Safety directions") as well as instructions for setting up the product and operating it.

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

Product identification

The type and the serial number of your product is indicated on the label in the battery compartment. Write the type and serial number of your product in the space provided below, and always quote this information when you need to contact your agency or 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.

Contents - Overview

Contents

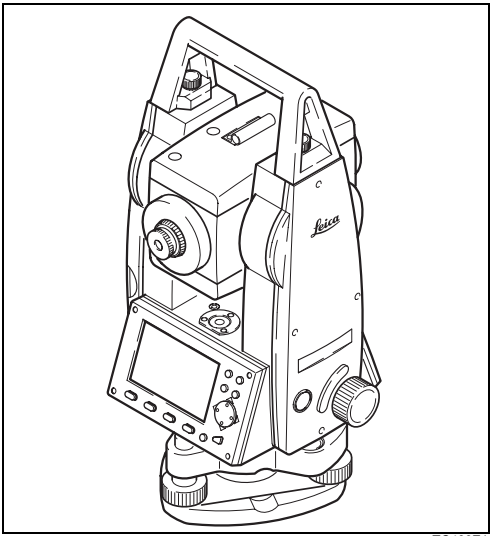
Introduction

The Leica Geosystems TC(R)403/405/407/410© is a high-quality electronic total station designed for the construction site.

Its innovative technology makes the daily surveying jobs easier.

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

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

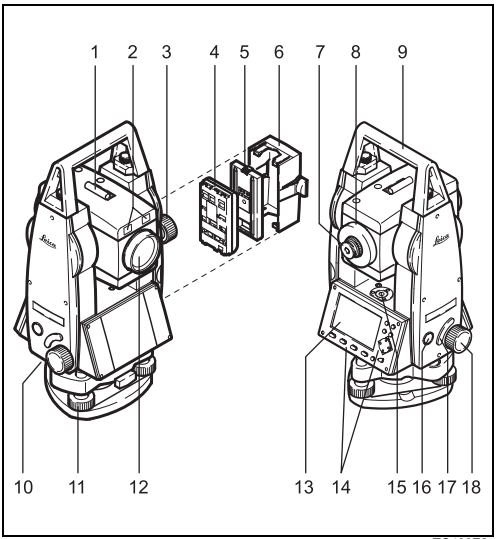


TC400Z1

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 instruments).
- Additional trigger key on side cover.
- Continuous drives for horizontal and vertical angles (tangent screws).
- With laser plummet as standard.

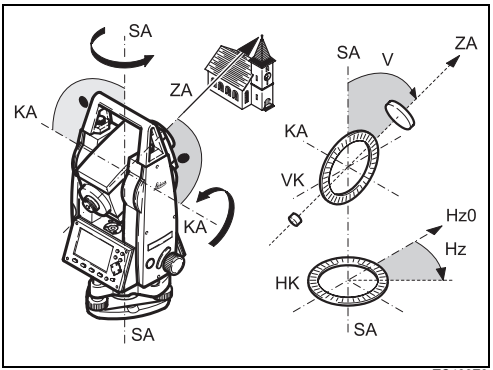
Important parts



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



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.

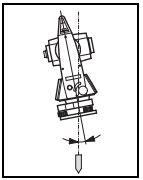
KA = Tilting axis
Horizontal rotation axis of the telescope (Trunion axis).

V = Vertical angle / zenith angle

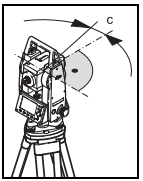
VK = Vertical circle
With coded circular division for reading the V-angle.

Hz = Horizontal direction

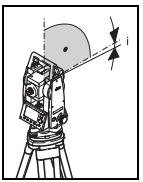
HK = Horizontal circle
With coded circular division for reading the Hz-angle.



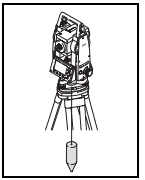
Standing axis inclination
Angle between plumb line and standing axis. Standing axis tilt is not an instrument error and is not eliminated by measuring in both faces. Any possible influence it may have on the Hz-direction resp. V-angle is elliminated by the dual axis compensator.



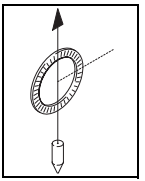
Line-of-sight error (Hz-collimation)
The line-of-sight error is the deviation from the perpendicular between tilting axis and line-of-sight. This could be eleminated by measuring in both faces.



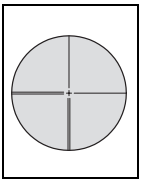
V-Index (Vertical index error)
With horizontal line-of-sight the V-circle reading should be exactly 90°(100gon). The deviation from this values is termed V-index (i).



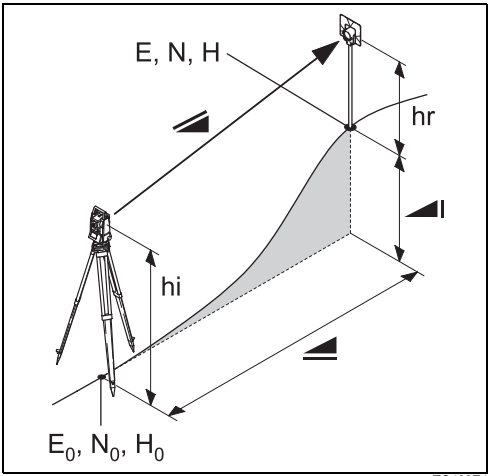
Plumb line / Compensator
Direction of gravity. The compensator defines the plumb line within the instrument.



Zenith
Point on the plumb line above the observer.



Reticle
Glass plate within the telescope with reticle.



TC400Z4

	Indicated meteorological corrected slope distance between instrument 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	Instrument 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 instruments of the TPS400 Series.

TC Instruments are equipped with an invisible infrared EDM and TCR Instruments with a visible red laser for reflectorless measuring.

Sections only valid for TCR instruments are marked accordingly.

PC Program Package Leica Survey Office

The program package Leica Survey Office is used for the data exchange between the TPS400 and the PC. It contains several auxiliary programs in order to support your use of the Instrument.

Installation on the PC

The installation program for the Leica Survey Office can be found on the CD-ROM supplied. Please note that Survey Office can only be installed on computers with MS Windows 95/ 98, ME and Windows NT 4.0/ 2000/ XP operating systems.

☞ Any previous versions of Survey Office on your computer must be uninstalled first before installing the new version.

For the installation call program "**setup.exe**" in the directory **\SurveyOffice\"Language"\Disk1** on the CD-ROM and follow the input instructions of the installation program.

Program content

After successful installation the following programs appear:

Settings (menu bar)

- General settings for all applications of Survey Office (settings for communication).
- User's own software can be configured and integrated (User configurations). These are displayed in the Tool directory under "Additional applications".

Main-Tools

- **Data Exchange Manager**
  For data exchange of coordinates, measurements, codelists and output formats between instrument 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/deleting system software, application programs and EDM-software as well as system/application texts.

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

TPS300-700 & DNA-Tools

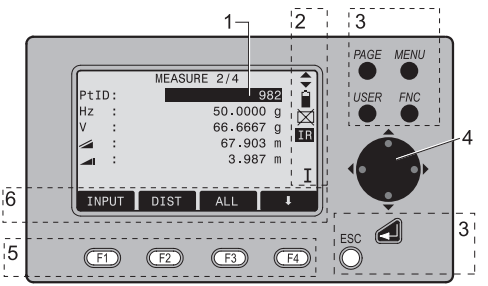
Accesses the format manager (user defined output format) and configuration manager (user defined instrument settings).

☞ For more informationen about Leica Survey Office refer to the comprehensive Online Help.

The on / off key is located on the side cover of the TC(R)403/405/407/410ℂ.

☞ 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, communications 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 activation of the "previous" value. Return to next heigher level.
	Confirm an input; continue to the next field.

Trigger key

The measurement trigger (see "Most important elements"; index 17) has three settings (ALL,DIST, OFF).

The key can be activated in the configuration menu.

Distance measurement

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

In all versions, the distance can be determined by using an invisible infrared beam which emerges coaxially from the telescope objective.

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

For applications without reflector, the TCR-version also use a **visible red laser beam** which emerges in the same manner. 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.

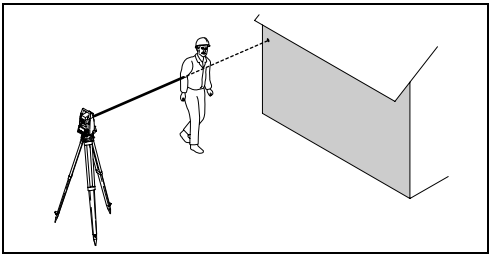
Miniprisms, 360° reflectors and reflector tapes can also be used, and measurement is also possible without a reflector.

☞ **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.

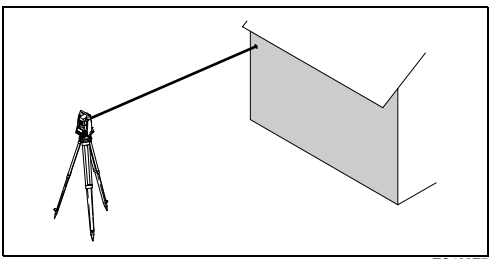
Avoid interrupting the measuring beam while taking reflectorless measurements or measurements using reflective foils. Measurements to prism reflectors are only critical if an object crosses the measuring beam at a distance of 0 to 30m and the distance to be measured is more than 300m.

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



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 instruments to the same target simultaneously.

Red laser to prisms

WARNING:
Due to laser safety regulations and measuring accuracy, using the visible red laser (RL) is only allowed to prisms that are more than 1000 m (3300 ft) away.

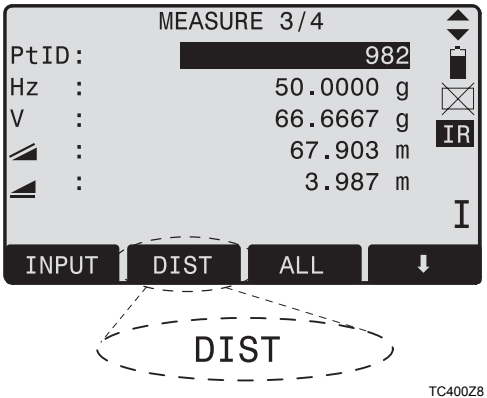
Accurate measurements to prisms should be made with the standard program (Infrared mode).

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 infrared 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"

CP **Infrared EDM** (invisible) for measuring to prisms and reflective targets.

SP **Reflectorless EDM** (visible) 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.

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
  - 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

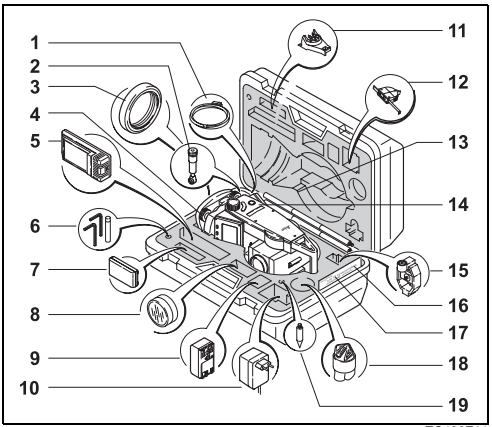
Menu (page 2)

- **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**

TC400Z10

Unpacking

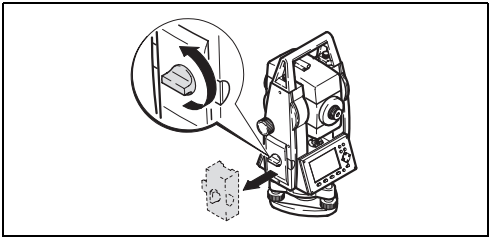
Remove TC(R)403/405/407/410© from transport case and check for completeness:



TC400Z11

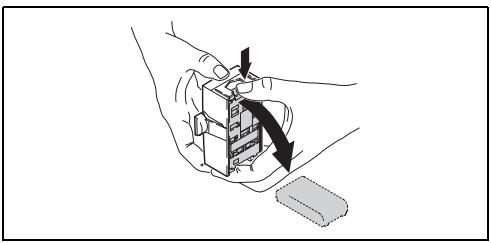
1) Data cable (optional)
2) Zenith eyepiece or eyepiece for steep angles (optional)
3) Counterweight for eyepiece for steep angles (optional)
4) Removable tribrach (optional)
5) Battery charger and accessories (optional)
6) Two Allen keys each, Adjusting pins
7) Battery GEB111 (optional)
8) Sun filter (optional)
9) Battery GEB121 (optional)
10) Mains adapter for battery charger (optional)
11) Spacing bracket GHT 196 for instrument height meter (optional)
12) Instrument 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 instruments)
17) User Manual
18) Protective cover / Lens hood
19) Tip for mini prism (optional)

Inserting / Replacing Battery



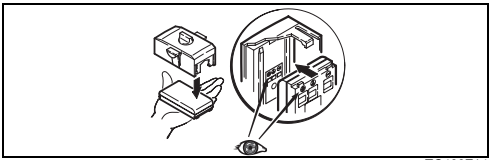
TC400Z12

1. Remove battery holder.



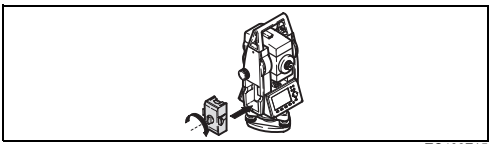
TC400Z13

2. Remove battery.



TC400Z14

3. Insert battery into battery holder.



TC400Z15

4. Insert battery holder into instrument.

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

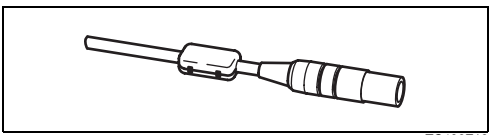
- To charge the battery refer to chapter "Charging the batteries".
- For the type of battery refer to chapter "Technical data".

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

External power supply for total station

To meet the conditions stipulated for electromagnetic acceptability when powering the TPS400/410© 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 instrument side.

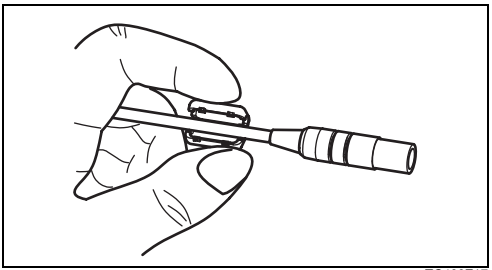


TC400Z16

The cables supplied along with your instrument 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.

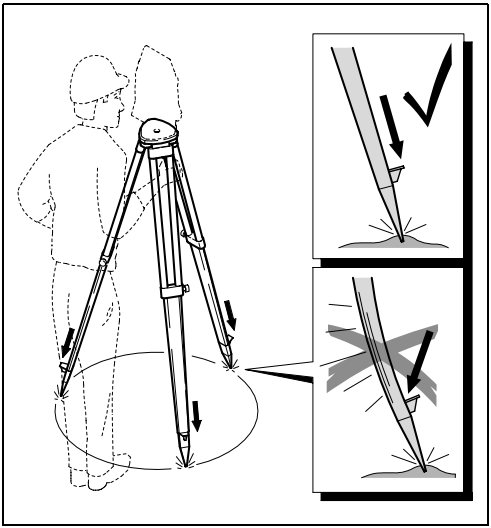
If you need additional ferrite cores, please contact your local Leica Geosystems agency. The spare-part number of the ferrite core is 703 707.



TC400Z17

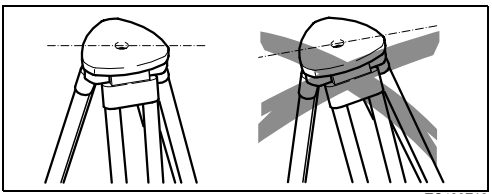
For assembling open up one ferrite core and clip it around the supply cable, about 2cm away from the Lemo plug, before using the supply cable for the first time together with a TPS400/410© instrument.

Setting up the tripod



TC400Z18

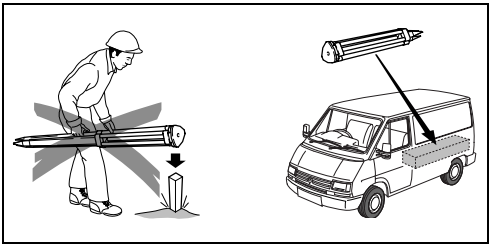
1. Loosen the clamping screws on the tripod legs, pull out to the required length and tighten the clamps.
2. In order to guarantee a firm foothold sufficiently press the tripod legs into the ground. When pressing the legs into the ground note that the force must be applied along the legs.



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.

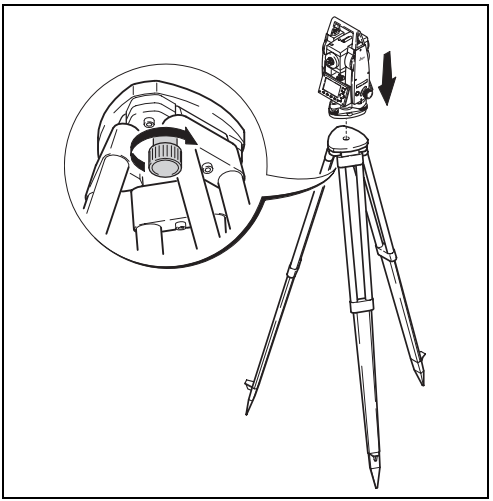


TC400Z20

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.

Centring with laser plummet, coarse level-up

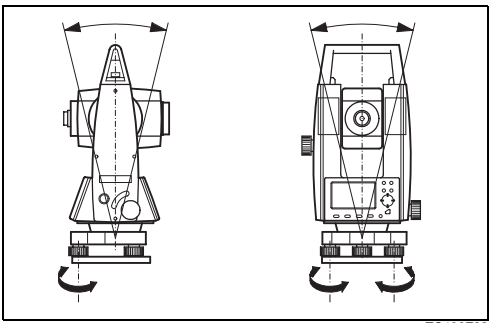


TC400Z21

1. Place the instrument onto the tripod head. Tighten central fixing screw of tripod slightly.
2. Turn footscrews of tribrach into its centre position.
3. Switch on the laser plummet with [FNC] > [Level/Plummet]. The electronic bubble is displayed.
4. Position tripod legs so that the laser beam is aimed to the ground point.
5. Firmly press in tripod legs.
6. Turn the footscrews of the tribrach to centre the laser beam exactly over the ground point.
7. Move the tripod legs to centre the circular level. The instrument is now roughly levelled-up.

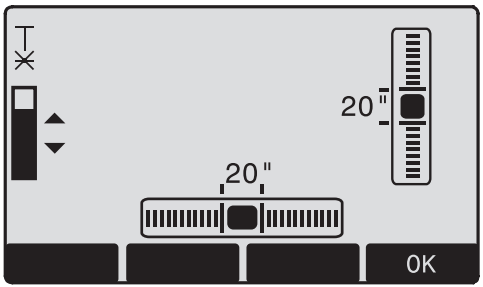
Fine tuning in the horizontal with the electronic bubble

1. Switch on the electronic bubble with [FNC] > [Level/Plummet]. In case of insuffient levelling-up an inclined level symbol appears.
2. Center the electronic bubble by turning the foot screws.



TC400Z22

When the electrical bubble is centered, the instrument is leveled.



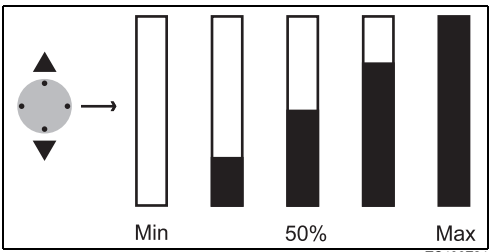
TC400Z23

3. Check centring with the laser plummet and re-centre if necessary.
4. Switch off the electronic bubble and the laser plummet by pressing [OK] .

Laser intensity

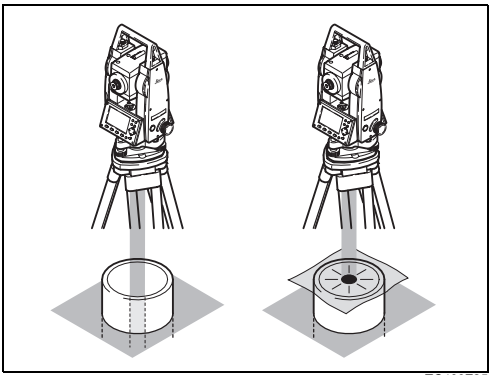
Changing the laser intensity

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.



TC400Z24

Hints for positioning



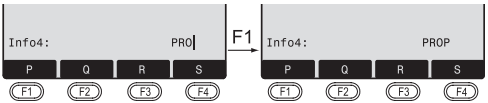
TC400Z25

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.



TC400Z26

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

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

[>>>] Additional characters/ numbers.

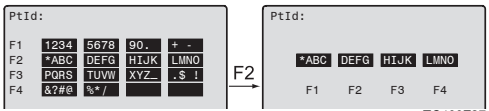
F1 - F4 3. Select the desired character. Character shifts to the left.

4. Confirm entry.

[ESC] Deletes input and restores previous value.

Input mode - method 2

In entry mode, enter text or numeric values.



TC400Z27

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

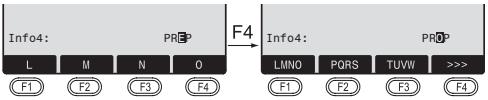
F1 - F4 2. Selection of range of characters/ range of numbers.

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.



TC400Z28

1. Start edit mode. Vertical edit bar is positioned flush right.
   Edit bar is positioned flush left.

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

[>>>] Addional characters / numbers.

F1 - F4 3. Overwrite existing characters.

4. Confirm input.

[ESC] Deletes change and restores previous value.

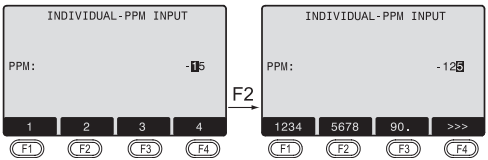
Erasing characters

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.



TC400Z29

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.

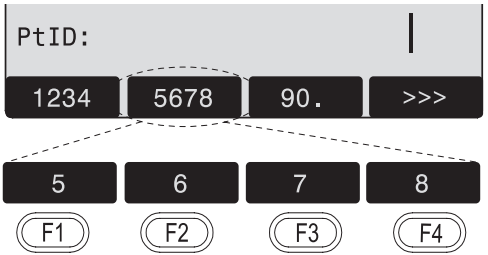
F1 - F4 2. Select range of characters /range of numbers.

[>>>] Additional characters / numbers.

3. Confirm input.

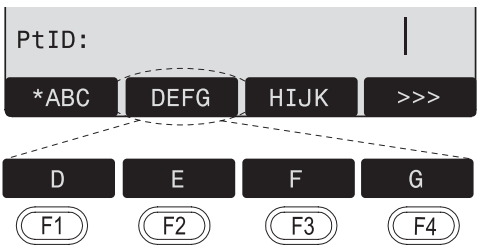
Selection is limited to valid digits for entries, that due to their display characteristics, fall into a certain range (e.g. angles in degrees).

Numerical input



TC400Z30

Alphanumerical input



TC400Z31

Character set

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

Numerical		Alphanumerical	
" + " " - " " . " " 0 - 9 "	(ASCII 43) (ASCII 45) (ASCII 46) (ASCII 48 - 57)	" " " ! " " # " " $ " " % " " & " " (" ") " " * " " + " " , " " - " " . " " / " " : " " < " " = " " > " " ? " " @ " " A - Z" " _ " " ` "	(ASCII 32) [space] (ASCII 33) (ASCII 35) (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) (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.

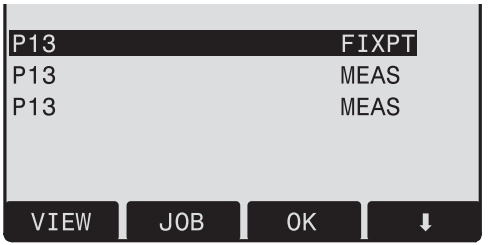
It is possible for the user to limit the point search to a particular job or to search the whole storage.

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 instrument 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.

TC400Z32

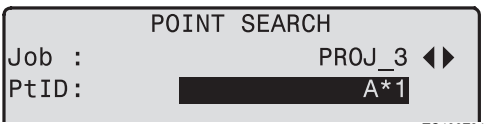


TC400Z33

[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.



TC400Z34

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).

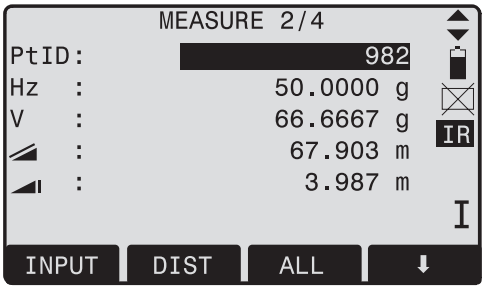
Measuring

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:



TC400Z35

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 (Infrared) and RL (Reflectorless). New setting is displayed for about one second.

IR: Infrared: Distance measurements with prisms.

RL: Visible laser: Distance measurements without prisms up to 80m; with prisms from 1 km.

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

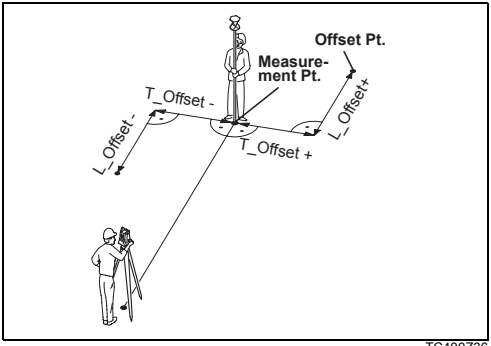
Select code from the codelist or enter a new code.

Units

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

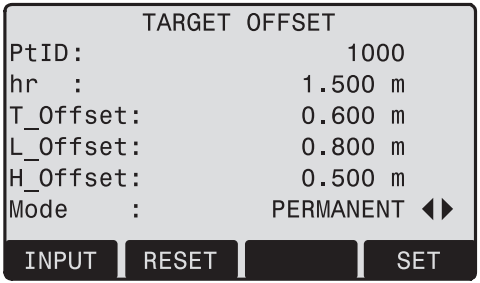
Target Offset

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.



TC400Z36

H_Offset +: Offset point is higher than measurement



TC400Z37

Procedure:

1. Enter the point ID and the reflector height.
2. Enter the offset values (length, cross and/or height) as per the sketch.
3. Define the period for which the offset is to apply. [RESET]: Sets eccentricity to zero.
4. [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.

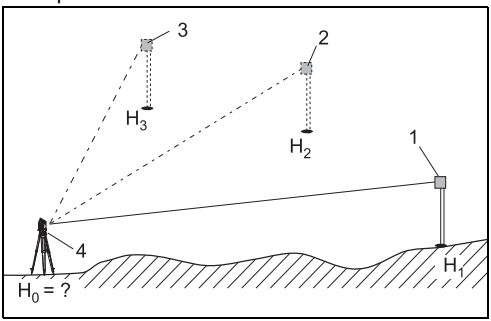
The period of applicability can be set as follows:

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:



TC400Z38

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

This function determines the height of the instrument 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.

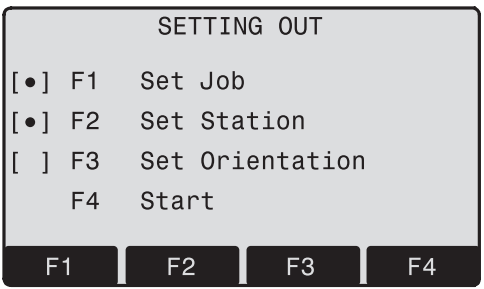
*) TPS410©: 1 Target point

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.

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.



TC400Z39

[•] 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.

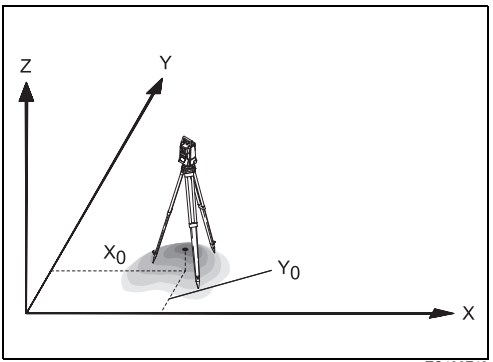
☞ All subsequent recorded data is stored in this job/directory.

☞ 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.



TC400Z40

Known Point

1. Select a ptID stored in internal memory.
2. Input instrument 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 instrument 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.

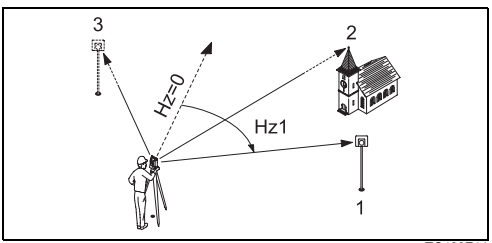
Method 2: with coordinates

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.

*) TPS410C: 1 Target point

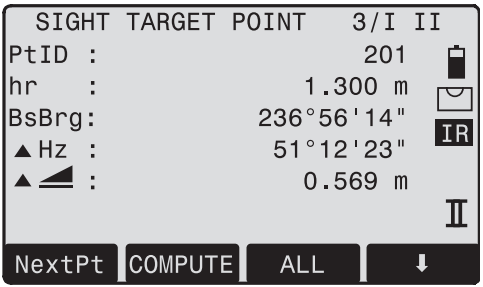


TC400Z41

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.



TC400Z42

[COMPUTE] Calculates and displays the orientation results.

[NextPt] Input another backsight point.

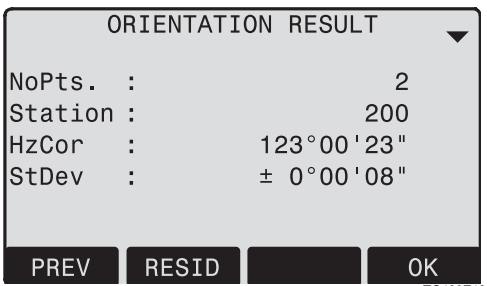
1/I Status indication; shows that first point was measured in telescope position I.

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 instrument.

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

Display of computed orientation



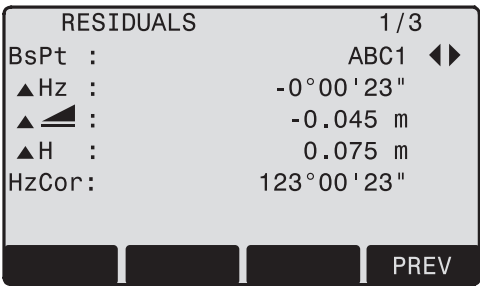
TC400Z43

[OK] Set computed Hz-orientation.

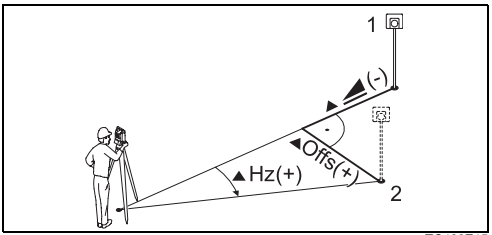
If more than one target point is measured then the orientation is computed using the "least squares method".

Displaying residuals

[RESID] Display of residuals.



TC400Z44



TC400Z45

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 (plan)
- Free Station
- Reference Line
- Remote Height

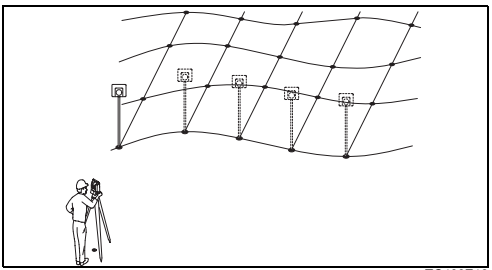
[MENU] 1. Press the [MENU] fixed key.

F1 2. Selecting the "Program" option.

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

Surveying (only TPS403/405/407)

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.



TC400Z46

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:
   Input a code into the relevant box. The code is stored along with the corresponding measurement.
2. Expanded coding:
   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.

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.

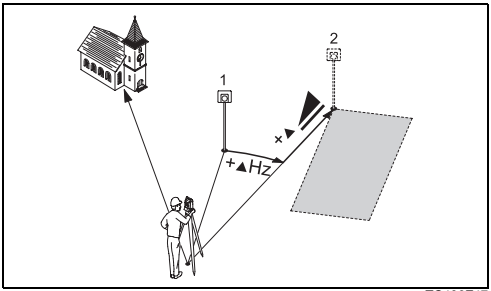
Setting out coordinates from memory

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, ▲ ⟋, ▲ ◢.



TC400Z47

1) Actual
2) Point to be stake out

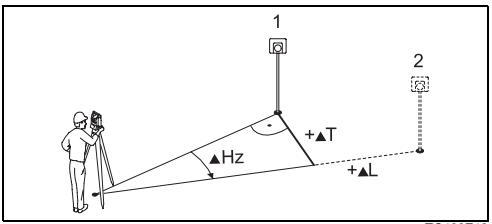
▲Hz: Angle offset: positive if point to be set-out is to the right of the actual direction.

▲ ⟋: 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.



TC400Z48

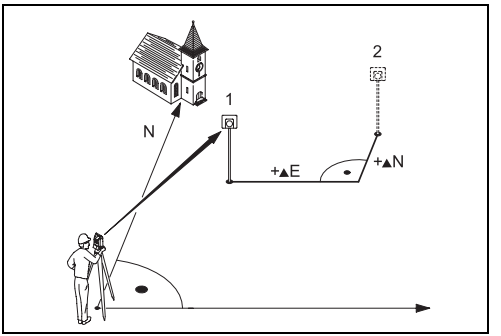
1) Actual
2) Point to be stake out

▲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 (only TPS403/405/407)

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



TC400Z49

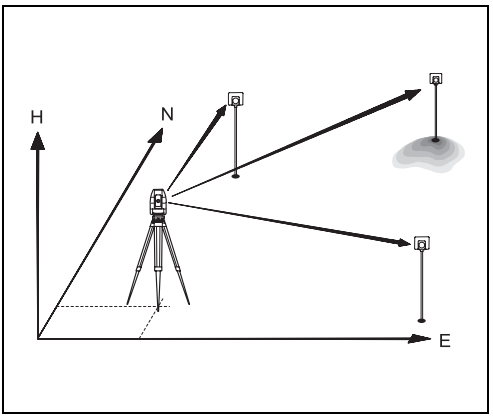
1) Actual
2) Point to be stake out

▲E Easting offset between stake out and actual point.

▲N Northing offset between stake out and actual point.

Free Station (only TPS403/405/407)

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



TC400Z50

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 instrument station, including the instruments 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.

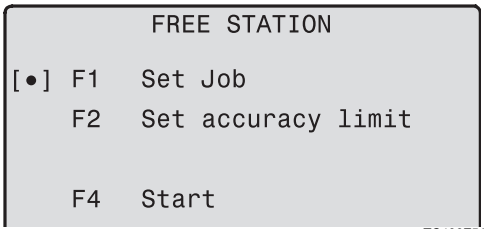
Computation procedure

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.

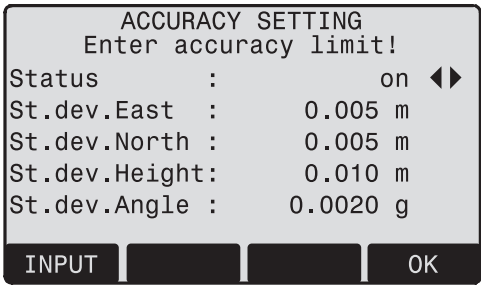
1. The original averaged face I and face II measurements enter the computation process.
2. All measurements are treated with the same accuracy, whether these are measured in single or dual face.
3. Easting and northing is determined by the method of least squares, including standard deviation and improvements 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:



TC400Z51

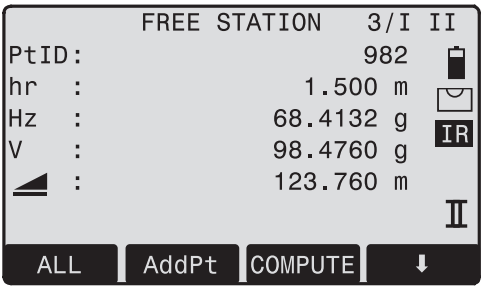
F2 Enables you to define an accuracy limit.



TC400Z52

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 instrument.
2. Input of the target ptID and the reflector height.



TC400Z53

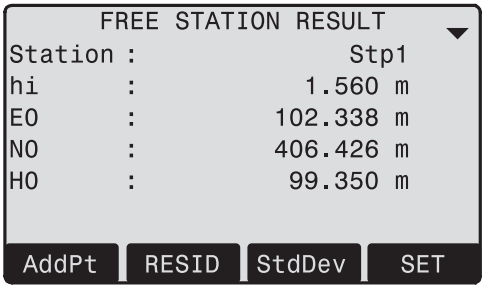
[ALL] Triggers angle and distance measurement (3 point resection).

[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:

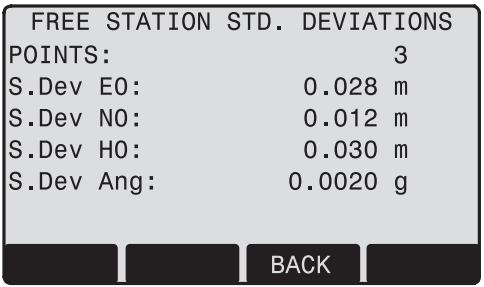


TC400Z54

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

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

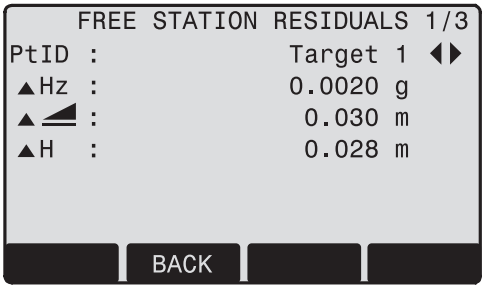
Displays standard deviations:



TC400Z55

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



TC400Z56

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 (only TPS403/405/407)

This program facilitates the easy setting out or checking of lines for buildings, straight 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 or in parallel to the base line, or be rotated around the first base point as required.

Definition of the Base line

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

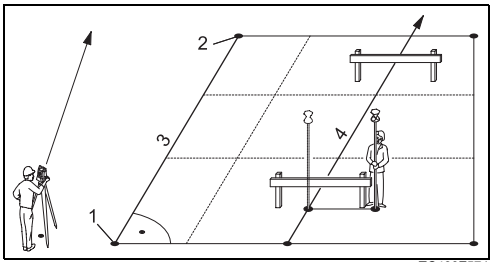
- Measured points
- Enter co-ordinates using keypad
- Select point from memory.

Definition of the base points

Procedure:

1. **Measuring base points:**
   Input ptID and measure base points with [ALL] or [DIST] / [REC].
2. **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.

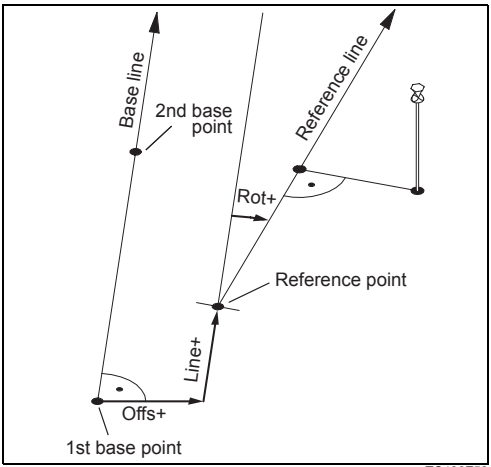


TC400Z571

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

Base line

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



TC400Z58

Input of the parameters:

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

BASELINE SHIFTS		
Point 1	:	1000
Point 2	:	1001
Offset	:	1.000 m
Line	:	0.500 m
H-Offset	:	0.900 m
Rotate	:	25.0000 g
NewBL	SHIFT=0	L&O	RefLine

TC400Z59

The following entries are possible:

Offset+: Parallel offset of the reference line to the right, referred to the direction of the base line (1-2).

Line+: Longitudinal offset of the start point (=reference point) of the reference line in the direction of base point 2.

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

H-Offset+: Height offset; the reference line is higher than the first base point.

Meaning of the softkeys:

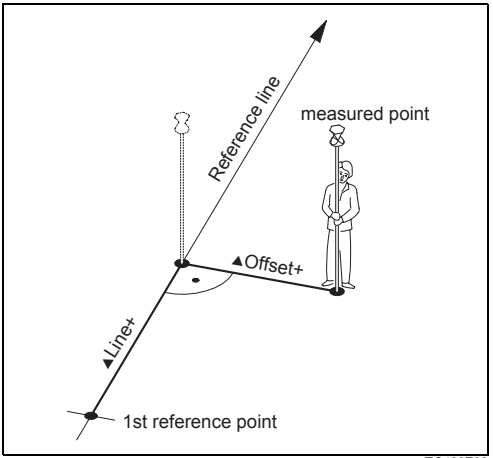
[NewBL] Return to the definition of a new base line.

[StOut] Opens the "Orthogonal Stake out" application.

[L&O] Opens the "Reference Line" application.

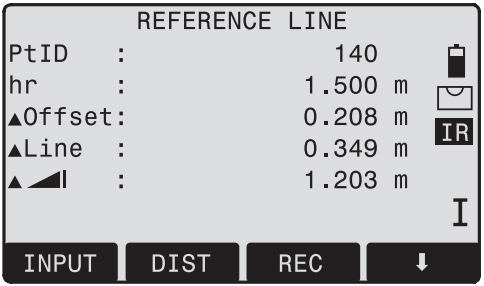
[SHIFT=0] Sets offset / rotation to zero.

Reference Line



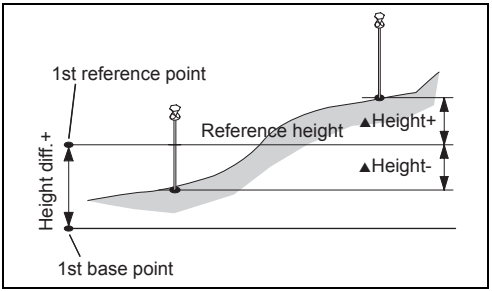
TC400Z60

The [L&O] function calculates from measurements or coordinates longitudinal, cross and height differences of the target point relative to the reference line.



TC400Z61

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



TC400Z62

☞ If tracking mode is activated (see "EDM Settings section"), correction values for the position of the reflector are displayed continuously.

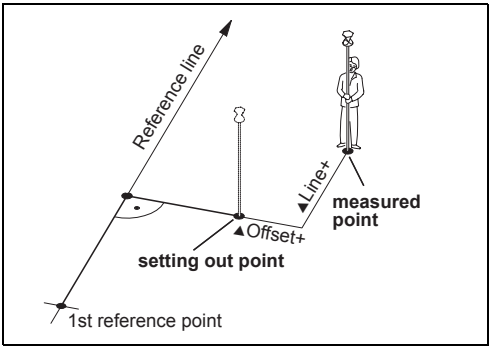
Orthogonal Stake out

You can enter longitudinal, transverse 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 (▲Line, ▲Offset, ▲ ◢▌) and the polar (▲Hz, ▲ ◢, ▲ ◢▌) differences.

Procedure:

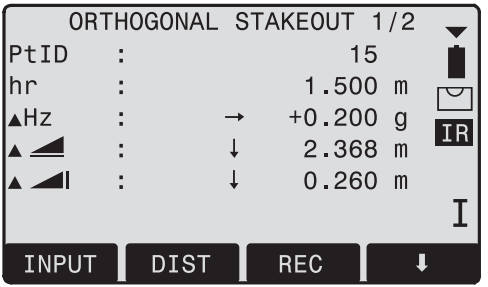
1. Input the orthogonal stake out elements or call up of a point from internal memory.
2. [SET] Confirm entry and start calculation.

Example "orthogonal methods"

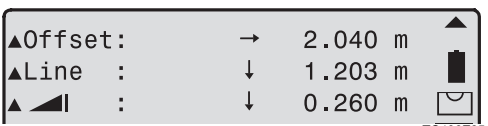


TC400Z63

Display in measure mode:



TC400Z64



TC400Z65

The signs for the distance and angle differences are exactly the same as for the "Stake out" application. These are correction values (required minus actual).

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

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

+▲ The setting 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 successfully 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.
Co-ordinates invalid !	No co-ordinates or invalid co-ordinates for a point. Ensure that a point used has at least one Easting and one Northing co-ordinate.

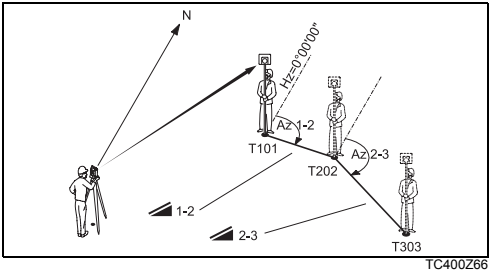
Tie Distance

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:

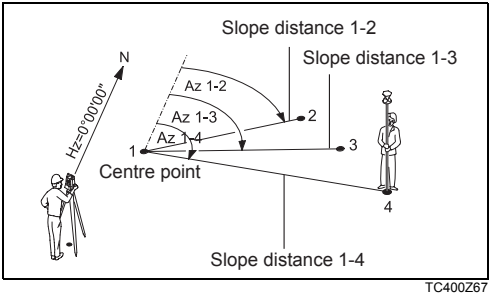
- F1 Polygonal (A-B, B-C)
- F2 Radial (A-B, A-C)

Polygonal Method:



TC400Z66

Radial Method:



TC400Z67

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:

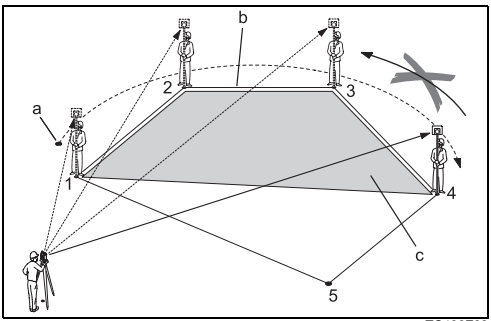
[NewPt 1]	An additional missing line is computed. Program starts again (at point 1).
[NewPt 2]	Point 2 is set as starting point of a new missing line. New point (Pt 2) must be measured.
[RADIAL]	Switches to radial method.

Softkeys - radial method:

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

Area (plan)

The application areas (plane) computes online areas from an unlimited number of points connected by straights. The points can be measured, selected from memory or input with the keyboard.



TC400Z68

a) Start
b) Polygonal length, from starting point to the actual measured point.
c) Actual area, always closed to the starting point (1).

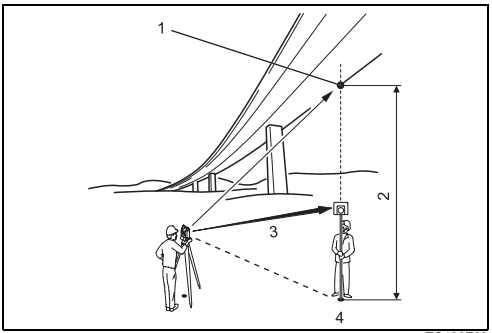
Procedure:

1. **Determine the first area point**
   [ALL] Starts the measurement to the point.
   [FIND] Searches internal memory for point entered.
   [XYZ] For manual input of the coordinates.
2. **Determine additional area points**
   Proceed as with first area point.
   [RESULT] Displays additional results (Circumference).

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

Remote Height (only TPS403/405/407)

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



TC400Z69

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.
   - 1.1 [ALL] Starts measurement to base point.
   - 1.2 Aim at top of reflector and confirm with [Set_V].
2. **Aim at inaccessible height point**
   - [SAVE] Saves the measured data.
   - [BasePt] Input and measurement of a new base point.

Construction

This application allows to define a construction site by combining set-up of the instrument 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:

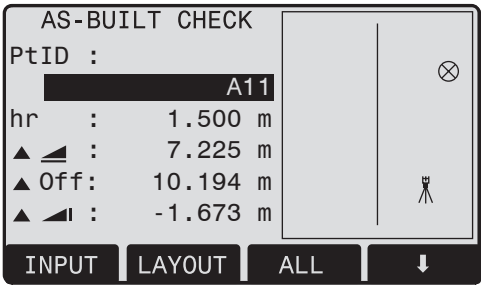
Defining new site:

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.



TC400Z70

[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.

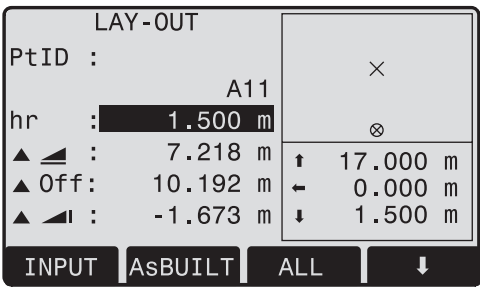
▲Height is positive:

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.



TC400Z71

[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.

Coding

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

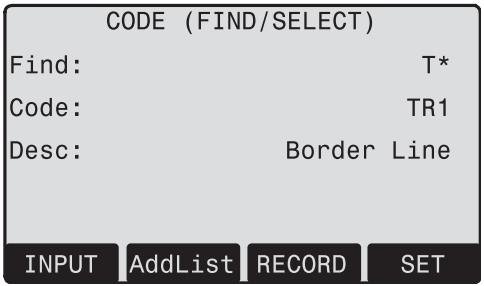
More information on coding can be found under "Data management".

GSI-coding

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

Procedure:

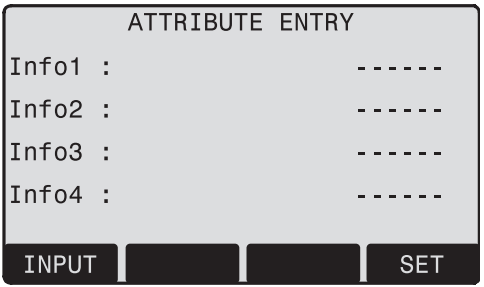
1. Move cursor to field "Code".
2. Input code.
3. [ALL] Starts the distance measurement and saves the values including the entered code.
   [CODE] Searches for the entered code and offers the option of adding attributes.



TC400Z72

[SET] Sets the code block.
[AddList] Adds an entered code into codelist.
[RECORD] Closes the code entry or code selection and saves the code block.

Manual code input
Individual code blocks can be entered directly via keypad.



TC400Z73

1. [INPUT] Enter desired code.
2. Confirm with ENTER.
3. Enter the attributes 1-4.
4. [SET] Sets the code block.

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

Exceptions:
With the codelist editor of Survey Office a status can be assigned to the attributes.

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

Recording code block
[SET] Sets the code block temporarily in the system after ending the code functions. Recording only with measurement and always with reference to the actual point number.

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 Survey Office

Codelists can be easily created and uploaded to the instrument using the supplied "Leica Survey Office" Software.

This menu enables extensive user-specific settings in order to adapt the instrument 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 instrument 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.

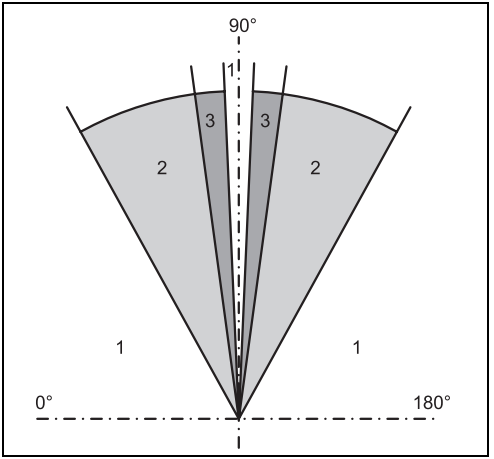
☞ The compensator setting remains active even after the instrument is switched off.

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.



TC400Z74

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 instrument temperature is ≤ 5°C.

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 instrument is switched off after 20 minutes without any acticn (= no key pressed; V and Hz angle deviation ≤ ±3' / ±600cc).
Disable	The instrument is switched on permanently. Battery discharges quicker.
Sleep	Economy mode. Instrument 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°:**
  0.0005° / 0.001° / 0.005°
- **For gon:**
  0.0005 gon / 0.001 gon / 0.005 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-in1/8	US-feet-Inch-1/8 inch
US-ft	US-feet
INT-ft	International feet

Temperature

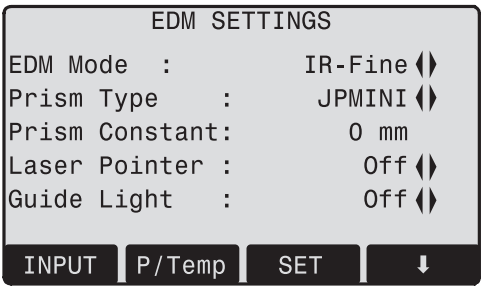
°C	Degree Celsius
°F	Degree Fahrenheit

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.



TC400Z75

EDM Mode

With TCR instruments different settings for measurements with visible (RL) and invisible (IR) EDM type are available.

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

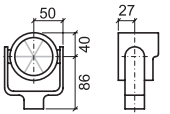
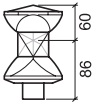
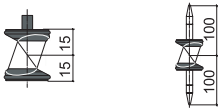
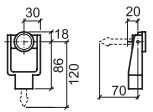
IR-Fine	Fine measuring mode for high precision measurements with prisms (2mm + 2 ppm)
IR-Fast	Quick measuring mode with higher measuring speed and reduced accuracy (5mm + 2 ppm)
IR-Track	Continuous distance measuring (5mm + 2 ppm)
IR-Tape	Distance measurement using Retro targets (5mm + 2 ppm)

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 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 mm to +999 mm

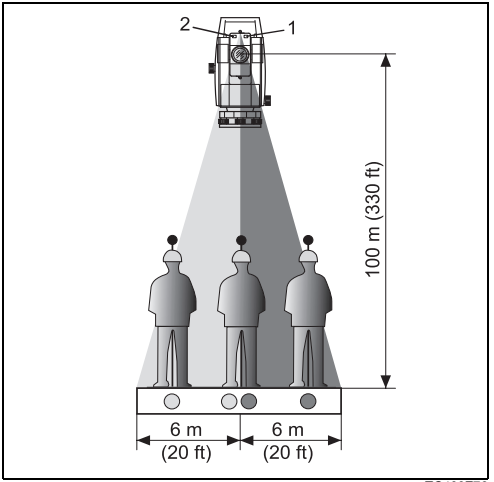
Laser Pointer

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.



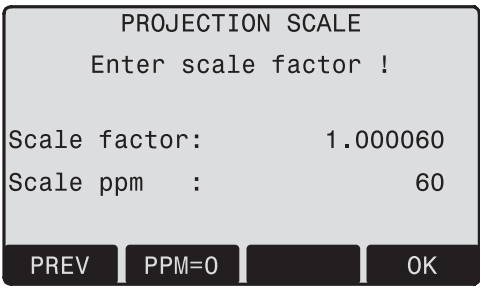
TC400Z76

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.



TC400Z77

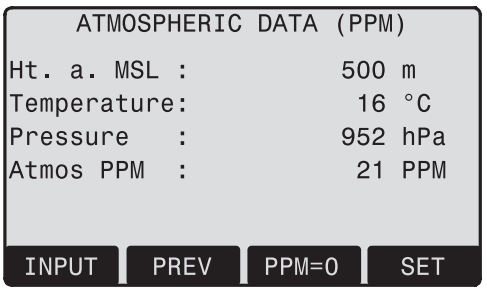
Scale factor:
Entering the scale of projection. Measured values and coordinates are corrected with the PPM parameter.

[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.



TC400Z78

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

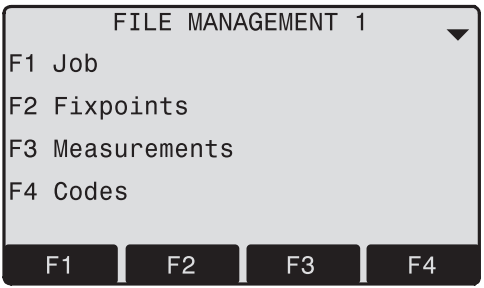
- Ht. a. MSL
  Height above sea level at instrument location.
- Temperature
  Air temperature at instrument location.
- Pressure
  Air pressure at instrument location.
- Atmos PPM:
  Calculated and indicated atmospheric PPM.

Signal

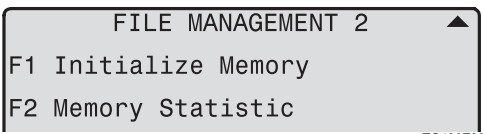
[SIGNAL] Displays EDM signal strength (reflection strength) in steps of 1%. Permits optimal aiming at distant barely visible targets.

File Management

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



TC400Z79



TC400Z80

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.

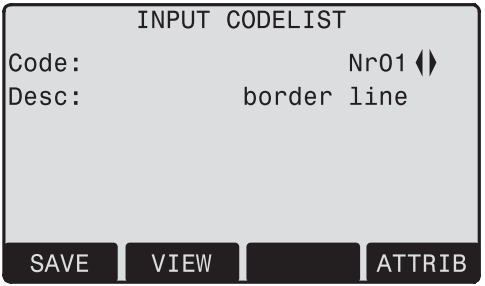
Measurements

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

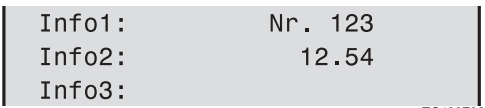
[FIND]	Starts point search dialogue.
[VIEW]	Displays all measurements.

Codes

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



TC400Z81



TC400Z82

[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.

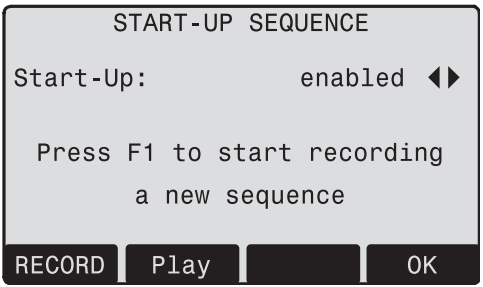
Memory Statistic

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



TC400Z83

[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 instrument is switched on.

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

Determining Line-of-sight error and V-Index

The calibration contains the determination of the following instrument 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 instrument error is thus eliminated.

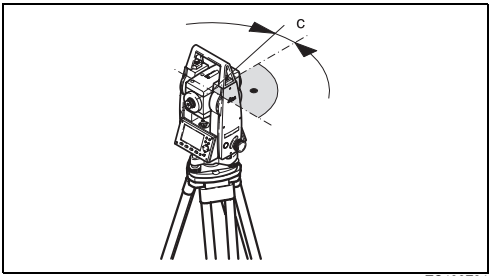
The instruments are adjusted in the factory prior to shipping.

Instrument errors can change with time and temperature.

☞ These errors should be determined before the instrument 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 instrument errors, level-up the instrument using the electronic bubble. The instrument 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)



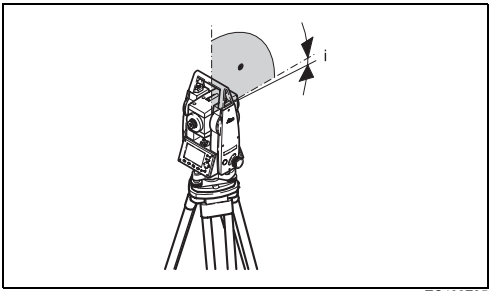
TC400Z84

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)



TC400Z85

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).

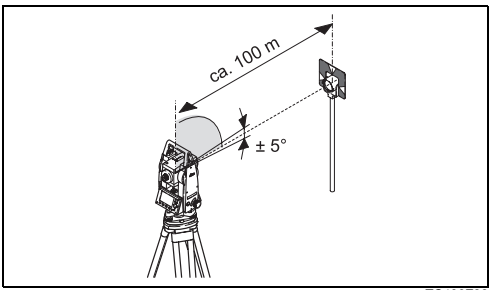
By determining the vertical index error the electronic level is adjusted automatically.

☞ 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:

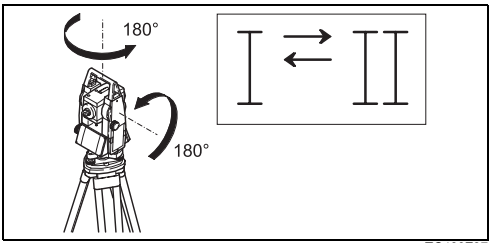
1. Level instrument with electronic bubble.
2. Aim at a point approximately 100m from the instrument which is within 5° of the horizontal.



TC400Z86

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

For checking the horiontal aiming Hz and V are displayed.



TC400Z87

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 instrument 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

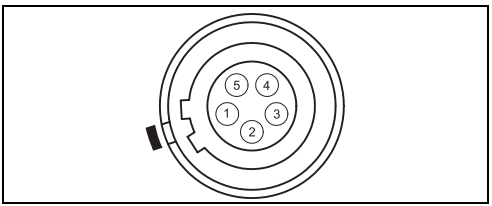
Even	Even parity
Odd	Odd parity
None	No parity (if data bit is set to 8)

Endmark

CRLF	Carriage return; line feed
CR	Carriage return

Stopbits
Fixed setting 1.

Interface plug connections:



TC400Z88

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 Survey Office.

[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 instrument 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	≙	Instrument height

System Info

Displays helpful information and date / time are set.

- **Battery**
  Remaining battery power (e.g. 40%).
- **Instr.Temp.**
  Measured instrument 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 instrument is composed of different software packages. Depending on the package, different versions are possible.

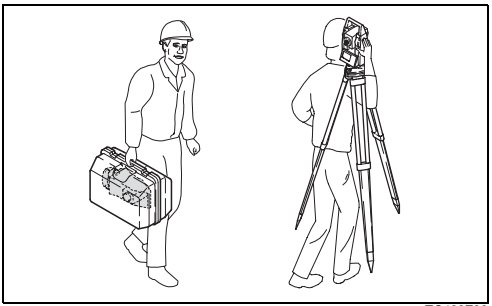
Op-System:	Operating System
App.-SW:	Applications, functions and menu
Layout:	User displays

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 instrument always check the field ajustment parameters indicated in this manual before using the instrument.

In the field



TC400Z89

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

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

Inside vehicle

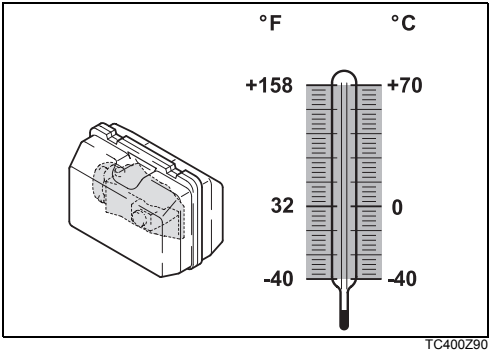
Never transport the instrument loose **inside the vehicle.**

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

Shipping

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

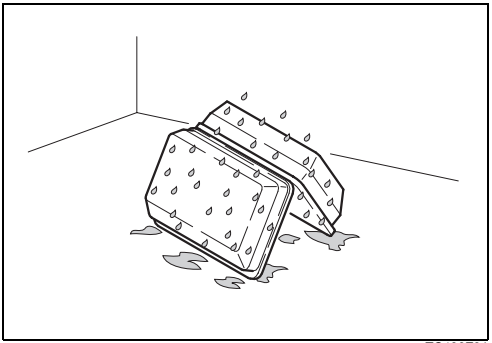
Storage



TC400Z90

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

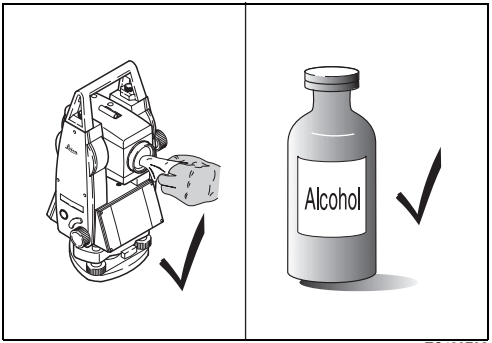
When storing the intrument inside a building also use the transport case (if possible, in a safe place).



TC400Z91

If the instrument becomes wet, leave it unpacked. Wipe down, clean, and dry the instrument (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 instrument in the field always close the transport case.

Cleaning



TC400Z92

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.

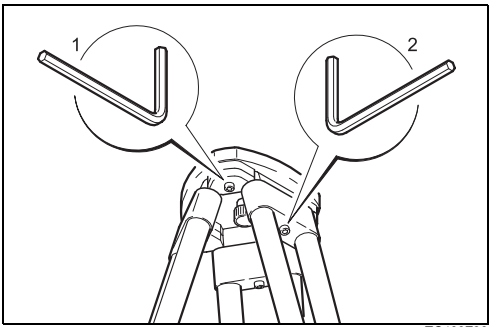
Use no other liquids; these may attack polymer components.

☞ **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

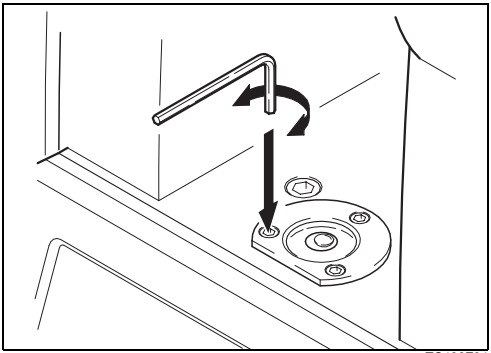


TC400Z93

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.

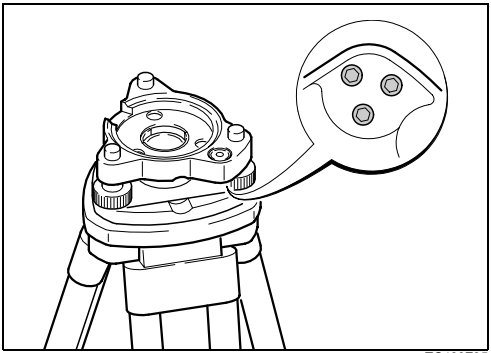
Circular level



Level-up the instrument 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



Level the instrument 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

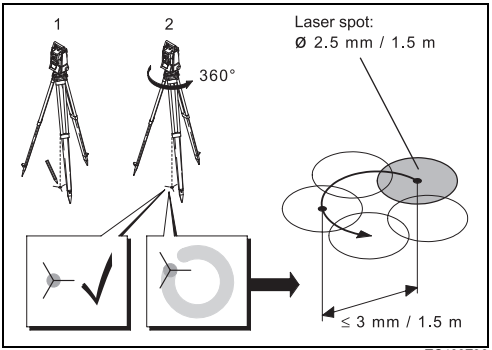
The laser plummet is integrated into the vertical axis of the instrument. Under normal circumstances setting of the laser plummet is not necessary. If an adjustment is necessary due to external influences the instrument has to be returned to any Leica service department.

Checking by turning the instrument by 360°:

1. Install the instrument 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 instrument 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.



TC400Z96

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.

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 instrument 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.

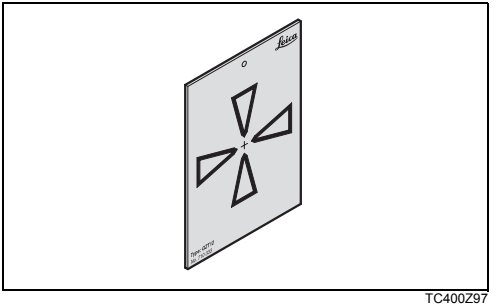
☞ The direction of the beam should be inspected before precise measurement of distances is attempted, because an excessive deviation of the laser beam from the line of sight can result in imprecise distance measurements.

Inspection

A target plate is provided. Set it up between five and 20 metres away with the grey reflective side facing the instrument. 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 instrument 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.



TC400Z97

Adjusting the direction of the beam

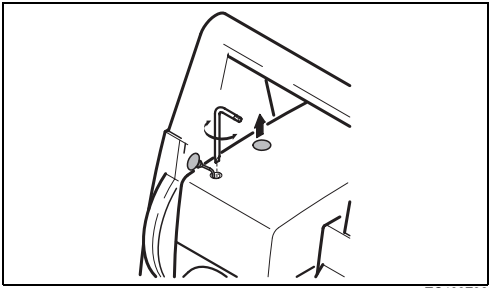
Pull the two plugs out from the adjustment ports on the top side of the telescope housing.

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).

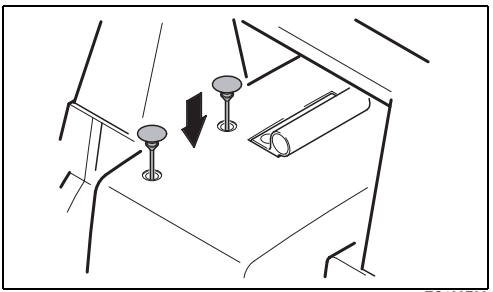
To correct the beam laterally, insert the screwdriver into the front adjustment port and turn it clockwise (spot moves to the right) or anticlockwise (spot moves to the left).

☞ 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.



TC400Z98



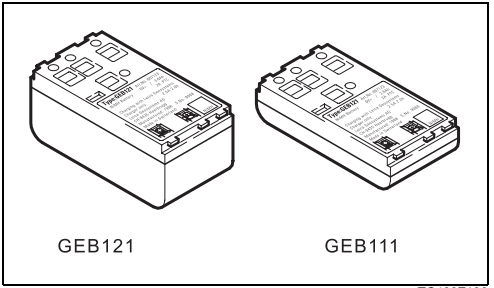
TC400Z99

Battery charging

WARNING:
Use a battery charger in a dry room only, never outdoors. Charge the batteries under ambient temperatures of 0°C to +35°C (32°F to 95°F). We recommend a temperature of 0°C to +20°C (32°F to 68°F) for storing the batteries.

☞ Only use batteries, charging sets and accessories recommended by Leica Geosystems.

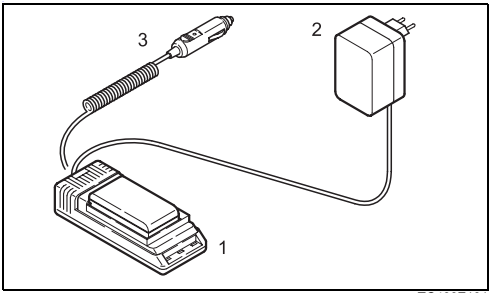
☞ In order to fully extend battery capacity it is absolutely necessary, with the new GEB111/121 batteries, to carry out 3 to 5 complete charging/ discharging cycles.



TC400Z100

Your Leica Geosystems instrument is operated with rechargable plug-in batteries. For the TC(R)403/ 405/407/410℃ instruments the GEB111 or GEB121 batteries are recommended.

GKL111 charger:

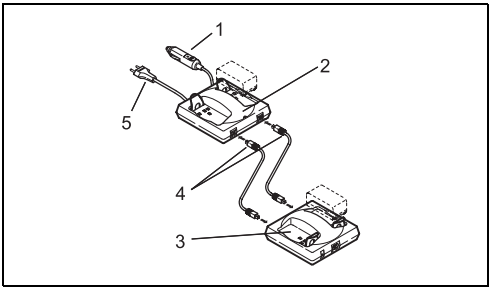


TC400Z101

1) Battery charger GKL111
2) Mains connection cable
3) Vehicle connection cable

The GKL111 charges GEB111 and GEB121 batteries. It can be connected to a mains or with a adapter cable to a vehicle (12V).

GKL122 charger:



TC400Z102

1) Vehicle connection cable
2) Battery charger GKL122
3) Adapter plate GDI121
4) Battery charger cable
5) Power cable

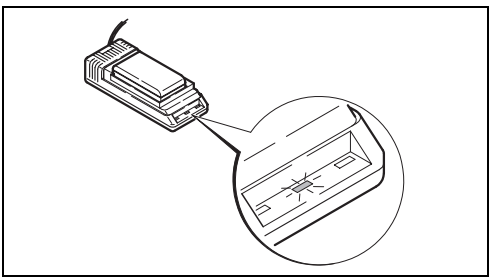
The GKL122 will charge up to four batteries, either from a 230V or 115V mains using the mains plug or from the 12V or 24V source provided by the cigarette lighter in a vehicle. At any one time, either two GEB111/121 batteries and two batteries with 5-pin

sockets can be charged or, by using the adapter plate (GDI121), four batteries. For instructions on how to use the charger, refer to the User Manual of the charger.

Connect battery charger GKL111/121 to mains or inside the vehicle.

Insert battery GEB111/121 into the charger so that the metal contacts of the charger and of the battery connect and the battery is locked in place.

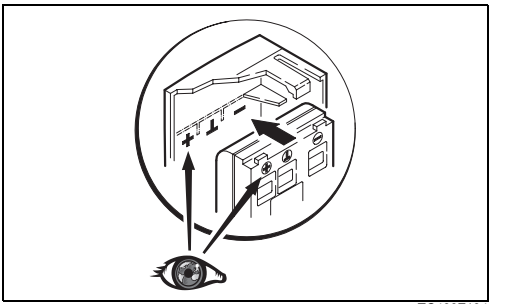
The continuously lit green lamp indicates the charging process.



TC400Z103

When the lamp turns green, the battery is charged and can be removed from the charger.

Insert charged battery into the battery holder of your instrument. Pay attention to the correct polarity (corresponding with indication in the battery cover).



TC400Z104

Pull battery holder with inserted battery into the instrument. Now the instrument is ready for measuring and can be switched on.

Safety Directions

The following directions should enable the person responsible for the TC(R)403/405/407/410©, and the person who actually uses the instrument, to anticipate and avoid operational hazards.

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

Intended use of instrument

Permitted uses

The electronic total stations are intended to the following applications:

- 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 uses

- 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 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 instrument to inform the user about hazards and how to counteract them. The electronic total stations are not to be used until the user has been properly instructed how to use them.

Limits of use

Environment:
Suitable for use in an atmosphere appropriate for permanent human habitation: not suitable for use in aggressive or explosive environments. Use in rain is permissible for limited periods.

Refer to chapter "Technical Data".

DANGER:
Local safety authorities and safety experts must be contacted before working in hazardous explosive areas or in extreme environment conditions by the person in charge of the instrument. This includes the use of a lockable battery holder to prevent accidental opening of the compartment.

Responsibilities

Area of responsibility for the manufacturer of the original equipment Leica Geosystems AG, CH-9435 Heerbrugg (hereinafter referred to as Leica Geosystems):

Leica Geosystems is responsible for supplying the product, including the User Manual and original accessories, in a completely safe condition.

☞ **Responsibilities of the manufacturers of non-Leica Geosystems accessories:**

The manufacturers of non-Leica Geosystems accessories for the TC(R)403/405/407/410© electronic total stations 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.

Responsibilities of the person in charge of the instrument:

WARNING:

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

The person in charge of the instrument 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 accident prevention.
- To inform Leica Geosystems immediately if the equipment becomes unsafe.

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 instrument.

WARNING:
The battery charger is not designed for use under wet and severe conditions. If instrument becomes wet it may cause you to receive an electric shock.

Precautions:
Use charger only in dry rooms and protect instrument from humidity. Do not use instruments becoming wet.

WARNING:
If you open the charger, either of the following actions may cause you to receive an electric shock:

- Touching live components
- Using the charger after incorrect attempts to carry out repairs

Precautions:
Do not open the charger. Only a Leica Geosystems-approved service technician is entitled to repair it.

DANGER:
Because of the risk of electrocution, it is very dangerous to use reflector 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 lens and can injure your eyes or damage the distance measuring device and the Guide Light EGL.

Precautions:
Do not point the telescope directly at the sun.

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 local regulations governing accident prevention and road traffic.

CAUTION:
If a target lamp accessory is used with the instrument the lamp's surface temperature may be extreme after a long working period. It may cause pain if touched. Replacing the halogen bulb before the lamp has been allowed to cool down may cause burning to the skin or fingers.

Precautions:
Use appropriate heat protection such as gloves or woollen cloth before touching the lamp, or allow the lamp to cool down first.

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 instruments.

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

Precautions:
Before transporting or disposing of equipment, discharge the battery (e.g. by running the instrument in tracking mode until the batteries are exhausted).

WARNING:
If the equipment 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 equipment 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.

- Leakage of silicone oil from the compensator can damage the optical and electronic subassemblies.

Precautions:
Dispose of the equipment appropriately in accordance with the regulations in force in your country. Always prevent access to the equipment by unauthorized personnel.

CAUTION:
If the accessories used with the instrument are not properly secured, and the equipment is subjected to mechanical shock (e.g. blows, falling etc.), the equipment may be damaged, safety devices may be ineffective or people may sustain injury.

Precautions:
When setting-up the instrument, make sure that the accessories (e.g. tripod, tribrach, etc.) are correctly adapted, fitted, secured and locked in position.
Avoid subjecting the equipment to mechanical shock.

Never position the instrument on the tripod baseplate without securely tightening the central fixing screw. If the screw is loosened always remove the instrument immediately from the tripod.

CAUTION:
Watch out for erroneous measurements if the instrument is defective or if it has been dropped or has been misused or modified.

Precautions:
Periodically carry out test measurements and perform the field adjustments indicated in the User Manual particularly after the instrument has been subjected to abnormal use and before and after important measurements.

Laser classification

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

Integrated distancer (infrared laser)

The EDM module built into the total stations produces an invisible infra-red laser beam which emerges from the telescope objective.

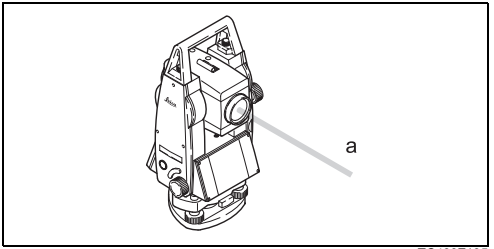
The product is a Class 1 laser product in accordance with:

- IEC 60825-1: 1993 "Radiation safety of laser products".
- EN 60825-1 : 1994 + A11: 1996 "Radiation safety of laser products".

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

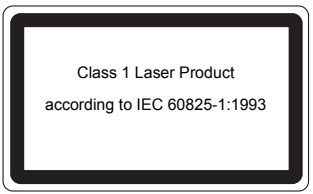
- FDA 21CFR Ch.I §1040: 1988 (US Department of Health and Human Service, Code of Federal Regulations).

Class 1/I 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.

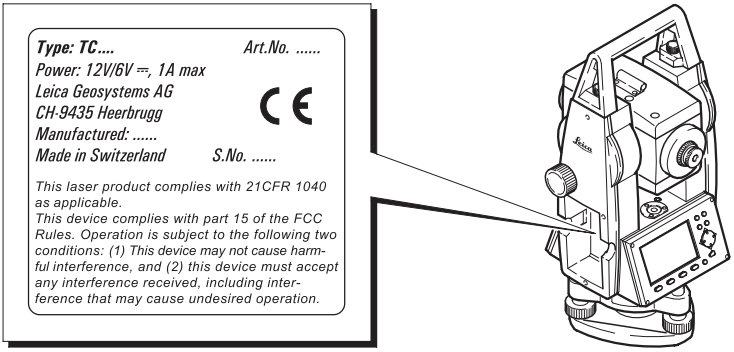


TC400Z105

a) Infrared laser beam exit (invisible)



Labelling



TC400Z106

Beam divergence:	1.8 mrad
Pulse duration:	800 ps
Maximum radiant power:	0.33 mW
Maximum radiant power per pulse:	4.12 mW
Measurement uncertainty:	± 5%

Integrated distancer (visible laser)

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

WARNING:
Two types of distancers with visible laser are available:

1. Total stations with distancers of **laser class 3R resp. IIIa** - identifiable by:
   - the type plate in the battery compartment **with** note to "+Reflectorless Ext. Range",
   - a laser emission indicator lamp on the eyepiece side of the telescope cover,
   - a warning label below the memory card compartment: "Laser class 3R" and "Class IIIa LASER PRODUCT".
2. Total stations with distancers of **laser class 2 resp. II** - identifiable by:
   - the type plate in the battery compartment **without** note to "+Reflectorless Ext. Range",
   - a warning label below the memory card compartment: "Laser class 2" and "Class II LASER PRODUCT".

Products with an integrated distancer of laser class 3R resp. IIIa

The product is a Class 3R laser product in accordance with:

- IEC 60825-1 (2001-08) : "Radiation safety of laser products"

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

- FDA 21CFR Ch.I §1040 : 1988 (US Department of Health and Human Service, Code of Federal Regulations).

Class 3R / IIIa laser products:
Direct intrabeam viewing is always hazardous. Avoid direct eye exposure. The accessible emission limit is within five times the accessible emission limits of Class 2 / II in the wavelength range from 400nm to 700nm.

WARNING:
Direct intrabeam viewing is always 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 (e.g. prisms, mirrors, metallic surfaces, 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 / IIIa 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), within the hazard distance *). Pay particular attention to Section Three "User's Guide".

There follows here below an interpretation of the main points in the relevant section of the standard quoted.
Class 3R laser products used on construction sites and outdoors (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 instrument, 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.

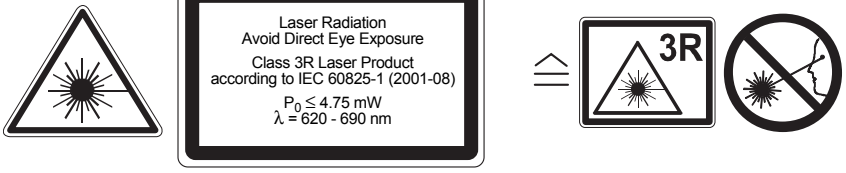
f) When not in use the laser product should be stored in a location where unauthorized personnel cannot gain access.

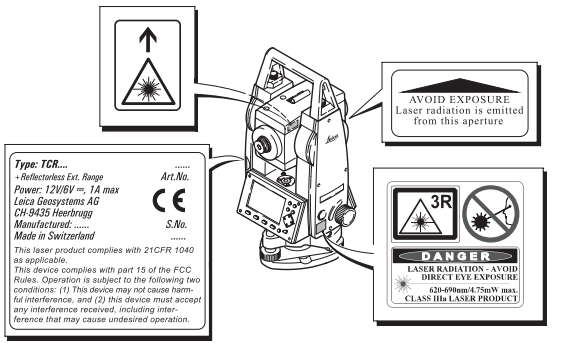
g) Precautions should be taken to ensure that the laser beam is not unintentionally directed at mirror-like (specular) surfaces (e.g. mirrors, metal surfaces, windows). But, more importantly, at flat or concave mirror-like surfaces.

*) 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.

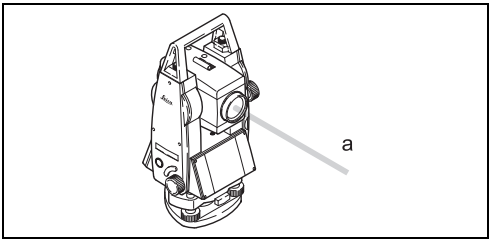
Products with an integrated distancer of laser class 3R resp. IIIa this hazard distance is 1000m (3300ft). At this distance, the laser beam rates as Class 1 (= direct intrabeam viewing is not hazardous).

Labelling





TC400Z107



TC400Z108

a) Exit for laser beam (visible)

Beam divergence:	0.15 x 0.35 mrad
Pulse duration:	800 ps
Maximum radiant power:	4.75 mW
Maximum radiant power per pulse:	59.4 mW
Measurement uncertainty:	± 5%

Products with an integrated distancer of laser class 2 resp. II

The product is a Class 2 laser product in accordance with:

- IEC 60825-1:1993 "Radiation safety of laser products"
- EN 60825-1:1994 + A11:1996 "Radiation safety of laser products"

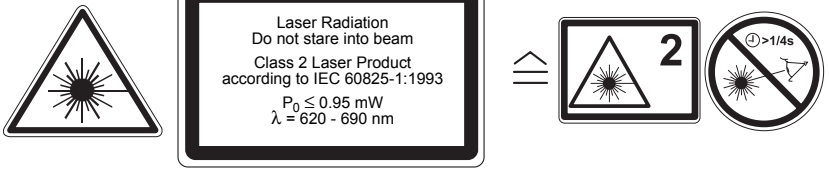
The product is a Class II laser product in accordance with:

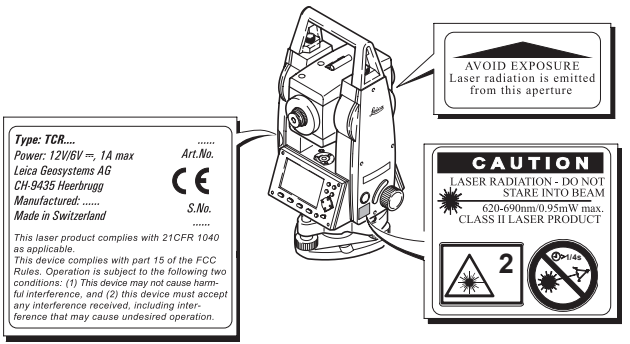
- FDA 21CFR Ch.I §1040: 1988 (US Department of Health and Human Service, Code of Federal Regulations)

Class 2/II 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.

WARNING:
It can be dangerous to look into the beam with optical equipment (e.g. binoculars, telescopes)
Precautions:
Do not look directly into the beam with optical equipment.

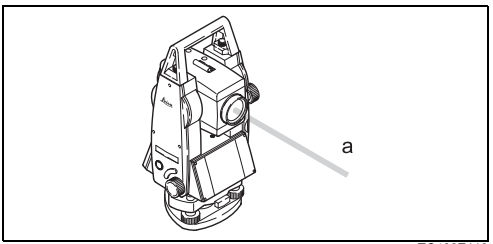
Labelling





TC400Z109

Beam divergence:	0.15 x 0.35 mrad
Pulse duration:	800 ps
Maximum radiant power:	0.95 mW
Maximum radiant power per pulse:	12 mW
Measurement uncertainty:	± 5%



TC400Z110

a) Exit for laser beam (visible)

Guide Light EGL

The integrated Guide Light produces a visible LED beam from the upper front side of the telescope.

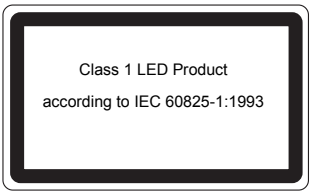
The product is a Class 1 LED product *) in accordance with:

- IEC 60825-1: 1993 "Radiation safety of laser products"
- EN 60825-1: 1994 + A11: 1996 "Radiation safety of laser products"

*) Within the specified working range of > 5 m (> 16 ft).

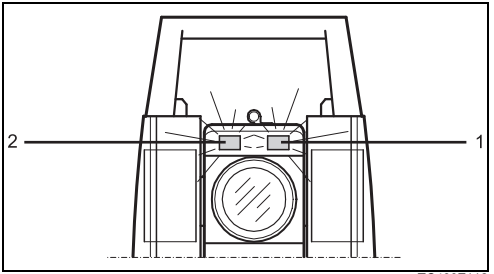
Class 1 LED products are safe under reasonably foreseeable conditions of operation and are not harmful to the eyes provided that the products are used and maintained in accordance with the instructions.

CAUTION:
Use the Guide Light only within the specified working range of > 5 m (> 16 ft) from the telescope.



TC400Z111

Flashing LED	yellow	red
Beam divergence:	2.4 °	2.4 °
Pulse duration:	2 x 105 ms	105 ms
Maximum radiant power:	0.28 mW	0.47 mW
Maximum radiant power per pulse:	0.75 mW	2.5 mW
Measurement uncertainty:	± 5%	± 5%



TC400Z112

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

Laser plummet

The integrated laser plummet produces a visible laser beam which emerges from the base of the instrument.

The product is a Class 2 laser product in accordance with:

- IEC 60825-1: 1993 "Radiation safety of laser products".
- EN 60825-1 : 1994 + A11: 1996 "Radiation safety of laser products".

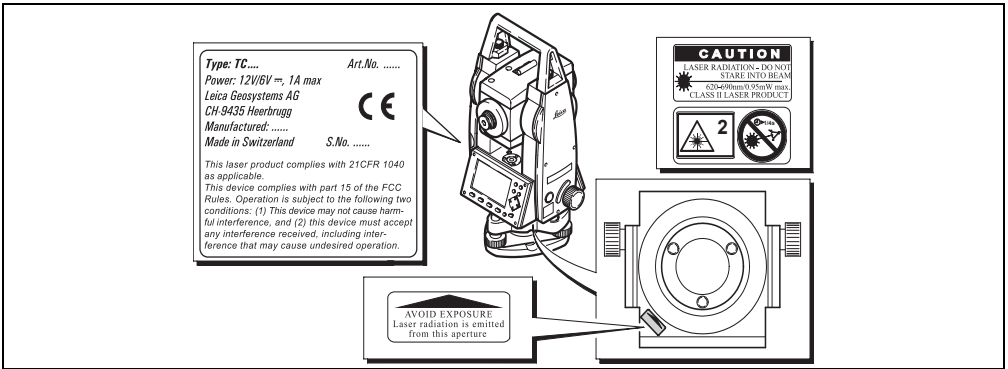
The product is a Class II laser product in accordance with:

- FDA 21CFR Ch.I §1040: 1988 (US Department of Health and Human Service, Code of Federal Regulations).

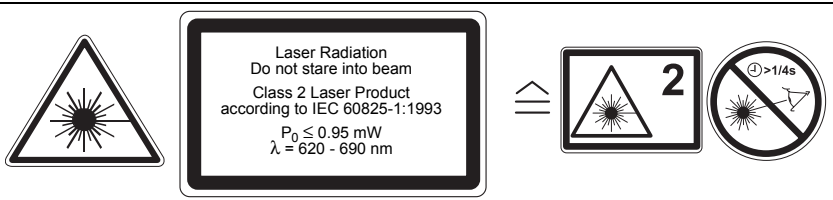
Class 2/II laser products:

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.

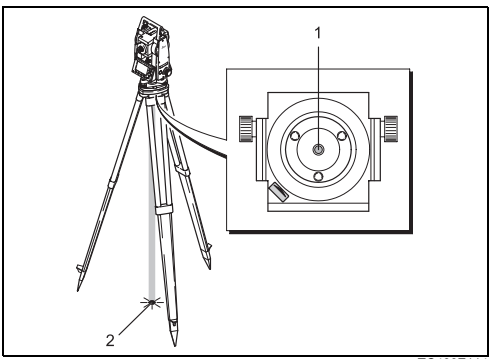
Labelling



TC400Z113



Beam divergence:	0.16 x 0.6 mrad
Pulse duration:	c.w.
Maximum radiant power:	0.95 mW
Maximum radiant power per pulse:	n/a
Measurement uncertainty:	± 5%



TC400Z114

1) Exit for laser beam (visible)
2) Laser beam (visible)

Electromagnetic acceptability

The term "electromagnetic acceptability" is taken to mean the capability of the instrument to function correctly in an environment where electromagnetic radiation and electrostatic discharges are present, and without causing electromagnetic disturbances in other equipment.

WARNING:
Electromagnetic radiation can cause disturbances in other equipment.

Although electronic total stations 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 total station is used in conjunction with accessories from other manufacturers, e.g. field computers, personal computers, walkie-talkies, non-standard cables, external batteries.

Precautions:
Use only the equipment and accessories recommended by Leica Geosystems. When combined with total stations, they meet the strict requirements stipulated by the guidelines and standards. When using computers and walkie-talkies, pay attention to the information about electromagnetic acceptability provided by the manufacturer.

CAUTION:
Disturbances caused by electromagnetic radiation can result in the tolerance limits for measurements being exceeded.

Although the total stations meet the strict regulations and standards which are in force in this connection, Leica Geosystems cannot completely exclude the possibility that the total station may be disturbed by very intense electromagnetic radiation, e.g. near radio transmitters, walkie-talkies, diesel generators, power cables.
Check the plausibility of results obtained under these conditions.

WARNING:
If the total station is operated with connecting cables attached at only one of their two ends (e.g. external supply cables, interface cables), the permitted level of electromagnetic radiation may be exceeded and the correct functioning of other instruments may be impaired.

Precautions:
While the total station is in use, connecting cables (e.g. instrument to external battery, instrument 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.

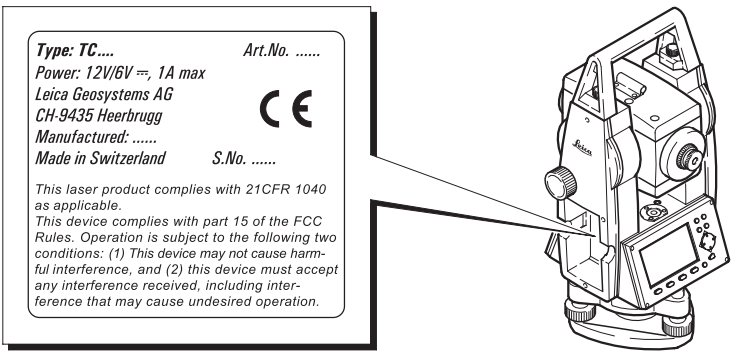
If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- 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:

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.



TC400Z115

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)
  TC(R)410© ..... 10" (3 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)410© ..... 3" (1.0 mgon)
  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 instrument
- Accuracy: .....Deviation from .....plumbline 1.5 mm ..... (2 sigma) at 1.5 m ..... instrument 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:

- Instrument:.....
  Height (including tribrach and carrying handle):
  - with tribrach GDF111.....
  ..... 360 mm ± 5 mm
  Width:..... 150 mm
  Length:..... 145 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:
- Storage: .....-40°C to +70°C
  ..... -40°F to +158°F
- Operating: .....-20°C to +50°C
  ..... -4°F to +122°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
  TPS410℃ ..... ≈ 5000 data blocks or
  ..... ≈ 8000 fixpoints

Distance measurement (IR: infrared):

- Type ..... infrared
- Carrier wavelength ..... 0.780 µm
- Measuring system .... special frequency system ..... basis 100 MHz ≙ 1.5 m
- 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)	250 m (800 ft)
3	3500 m (12000 ft)	5400 m (17700 ft)	2000 m (7000 ft)	250 m (800 ft)	2000 m (7000 ft)	250 m (800 ft)

TPS410© Range: (normal and rapid measurement)						
	Standard prism	3 prisms (GPH3)	360° reflector	Tape 60mm x 60mm	Mini prism	360° Mini prism
1	1000 m (3500 ft)	1000 m (3500 ft)	800 m (2600 ft)	150 m (500 ft)	800 m (2600 ft)	450 m (1500 ft)
2	1000 m (3500 ft)	1000 m (3500 ft)	1000 m (3500 ft)	250 m (800 ft)	1000 m (3500 ft)	250 m (800 ft)
3	1000 m (3500 ft)	1000 m (3500 ft)	1000 m (3500 ft)	250 m (800 ft)	1000 m (3500 ft)	250 m (800 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: visible)

- Type ..... visible red laser
- Carrier wavelength ..... 0.670 µm
- Measuring system .... special frequency system ..... basis 100 MHz ≙ 1.5 m
- EDM type ..... coaxial
- Display (least count) ..... 1 mm
- Laser spot size: ..... approx. 7x 14 mm / 20 m ..... approx. 10 x 20 mm / 50 m

Distance measurement (reflectorless)

- Range of measurement:
  Standard ..... 1.5 m to 80 m
  Power ..... 1.5 m to 300 m
  .....(to target plate 710 333)
- Display unambiguous: ..... to 760 m
- Prism constant (additive constant): . + 34.4 mm

Standard: Range (without reflector)		
Atmospheric conditions	No reflector (white target)*	No reflector (grey, albedo 0.25)
4	60 m (200 ft)	30 m (100 ft)
5	80 m (260 ft)	50 m (160 ft)
6	80 m (260 ft)	50 m (160 ft)

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)

* 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 measure-ment
Short	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 (with reflector)

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

Standard: Range (with reflector)		
Atmospheric conditions	Standard-prism	3 prisms (GPH3)
1	1500 m (5000 ft)	2000 m (7000 ft)
2	5000 m (16000 ft)	7000 m (23000 ft)
3	> 5000 m (16000 ft)	> 9000 m (30000 ft)

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)

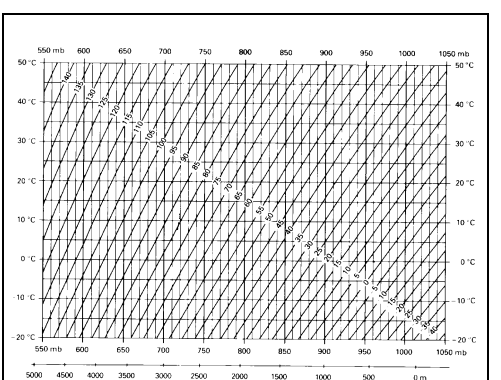
1) Strong haze, visibility 5km; or strong sunlight, severe heat shimmer
2) Light haze, visibility about 20km; or moderate sunlight, slight heat shimmer
3) Overcast, no haze, visibility about 40km; no heat shimmer

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.

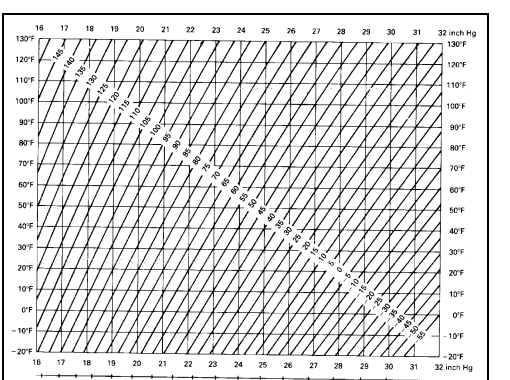
The atmospheric correction takes air pressure and air temperature into account.
For utmost precision in distance measurements, atmospheric correction must be determined with 1 ppm accuracy, air temperature to 1°C and air pressure to 3mb accuracy.

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



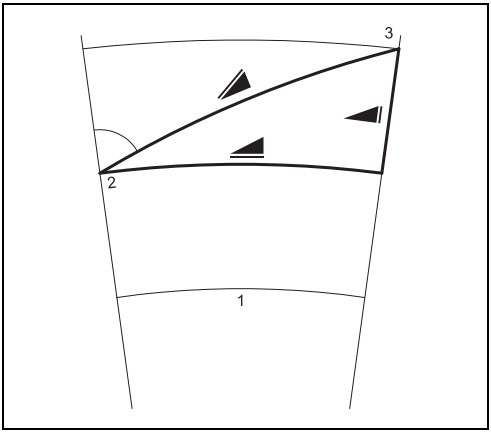
TC400Z116

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



TC400Z117

Reduction formulae



TC400Z118

Height measurement

1) Mean sea level
2) Instrument
3) Reflector

The instrument 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.

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

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]

$Y = \text{  } \cdot |\sin \zeta|$

$X = \text{  } \cdot \cos \zeta$

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

Index

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

Total Quality Management-
Our commitment to total customer satisfaction.

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

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