



# Construction Made Faster

Version 1.0  
English

- when it has to be **right**

**Leica**  
Geosystems

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

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Builder T is an electronic theodolite used to measure angles both in horizontal and vertical directions. Therefore, it can be used for alignment, plumbing, defining angles and measuring slopes.

In addition to all that Builder T offers, Builder R also measures distances with a red laser. The laser can measure to a surface such as a wall, a corner of a building, a pillar, and much more. The reflectivity of the surface determines the maximum range. When the red laser cannot be used, like when laying out an object not physically built yet, a reflector prism to measure to is needed. The reflector prism represents the future position of the object to be laid out. A new component especially designed for Builder is the Flat Prism. The Flat Prism is an inexpensive reflector that features high reflectivity, high accuracy, and low weight. Other laser measurement systems in the market require expensive glass prisms to achieve distance measurements above 100 meters (approx. 328 feet). An additional advantage of the flat prism versus glass prisms is NO prism offsets to deal with! With Builder R and the flat prism, the operator can simply measure.

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## 2

## Package Contents



### Instrument

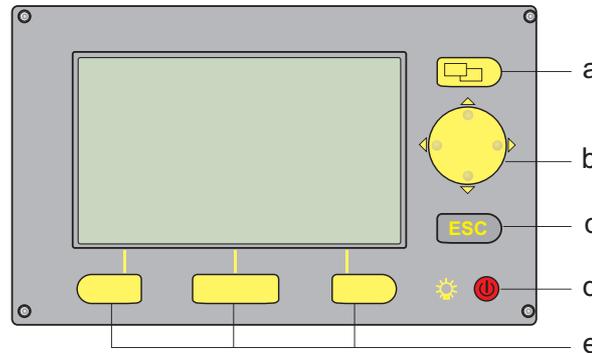
Model (Pos. 1)	Description
BUILDER T	Electronic theodolite.
BUILDER R	Electronic theodolite with distance measurement capability and construction software.
BUILDER RM	Same as BUILDER R, additionally with RS232 interface and internal memory to store and manage data.

## Accessories

Pos.	Description
<b>For all Builder types</b>	
2	Tribrach
3	Transport container
4	Alkaline batteries 3xTwin Pack, Size AA in battery adapter
5	Tool set
6	Rain cover
7	Sun shade
<b>For all Builder R and RM types</b>	
8	Mini reflector pole set with point
9	Clip-on bubble for mini reflector pole
10	Flat prism
<b>For all Builder RM types</b>	
11	USB Data transfer cable

### 3

## Keyboard and Display



- a) Page key
- b) Navigation keys
- c) ESC
- d) On/Off
- e) Function keys

Builder\_010

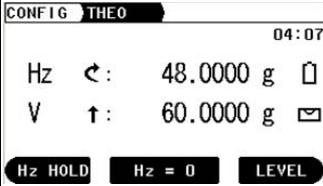
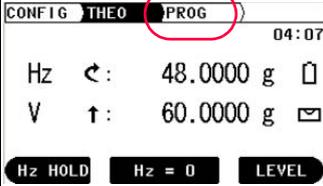
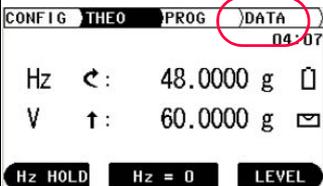
Key	Description
	Changes tab in the tab bar.
	<ul style="list-style-type: none"> <li>• Move the focus on the screen</li> <li>• Start the edit mode for edit fields</li> <li>• Control the input bar in edit and input mode</li> </ul>
	<ul style="list-style-type: none"> <li>• Leaves the current menu or dialog without storing changes made.</li> <li>• If THEO mode is active: press approx. 5 seconds to access System Info.</li> </ul>

Key	Description
	<ul style="list-style-type: none"><li>• If the instrument is off: to turn instrument on</li><li>• If the instrument is on:</li><li>• press at any time to turn on and off the display light incl. reticle illumination</li><li>• and press approx. 5 seconds to turn off the instrument</li></ul>
	Correspond to the three softkeys that appear on the bottom of the screen when the screen is activated.

# 4

## Software Concept

All instruments types use the same software concept. The software has different modes depending on the instrument type.

Model	Screen	Available Modes
BUILDER T		<ul style="list-style-type: none"> <li>• Configuration Mode</li> <li>• Theodolite Mode</li> </ul>
BUILDER R		<ul style="list-style-type: none"> <li>• Configuration Mode</li> <li>• Theodolite Mode</li> <li>• Programs Mode</li> </ul>
BUILDER RM		<ul style="list-style-type: none"> <li>• Configuration Mode</li> <li>• Theodolite Mode</li> <li>• Programs Mode</li> <li>• Data Management Mode</li> </ul>

# 5

## Measurement Preparation

### Instrument set up anywhere



Extend the legs of the tripod so that they allow working in a comfortable posture. Position the tripod over the marked ground point, centering it as good as possible.



Fasten the tribrach and the instrument on to the tripod.

**3** 

Turn on the instrument by pressing this button. The electronic level and laser plummet are activated automatically after switching on the instrument, if compensator is set to on.

**4**

Turn the foot screws of the tribrach to precisely level up the instrument using the electronic level. Refer to "Leveling Up with the Electronic Level" for more information.

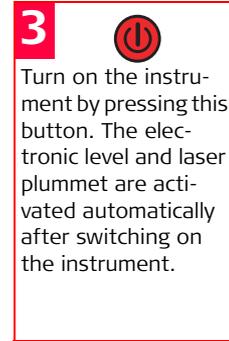
## Instrument set up over a ground point



Extend the legs of the tripod so that they allow working in a comfortable posture. Position the tripod over the marked ground point, centring it as well as possible



Fasten the tribrach and the instrument on to the tripod.



Turn on the instrument by pressing this button. The electronic level and laser plummet are activated automatically after switching on the instrument.



Use this button to adjust the brightness of laser plummet.



Use the foot screws of the tribrach to centre the plummet on the ground point. Ignore that the instrument is not yet levelled precisely.



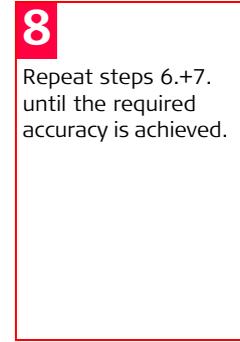
Adjust the legs of the tripod to level the circular level



Turn the foot screws of the tribrach to precisely level up the instrument using the electronic level. Refer to "Levelling up with the electronic level" for more information.



Centre the instrument precisely over the ground point by shifting the tribrach on the tripod plate.



Repeat steps 6.+7. until the required accuracy is achieved.

## Levelling up with the electronic level



Turn on the instrument by pressing the key.



Center the electronic level of this axis by turning the two footscrews. Arrows show the direction for rotating the footscrews.



When the electronic level is centered the arrows are replaced by checkmarks.



Center the electronic level for the second axis by turning the last footscrew. Arrows show the direction for rotating the footscrew.



When the electronic level is centered and three checkmarks are shown, the instrument has been perfectly leveled up. Accept with OK.



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When using Builder R or Builder RM, it is not necessary to level the instrument directly over a known point every time. Instead, it might be more efficient to level the instrument anywhere that allows complete visibility of the site or project. For this, choose the program "Control Line - Anywhere" or "Coordinates - Anywhere" described in chapter 8 in this book. With this greater flexibility to set up anywhere, the working time and inconvenience that comes with multiple setups, is significantly reduced.

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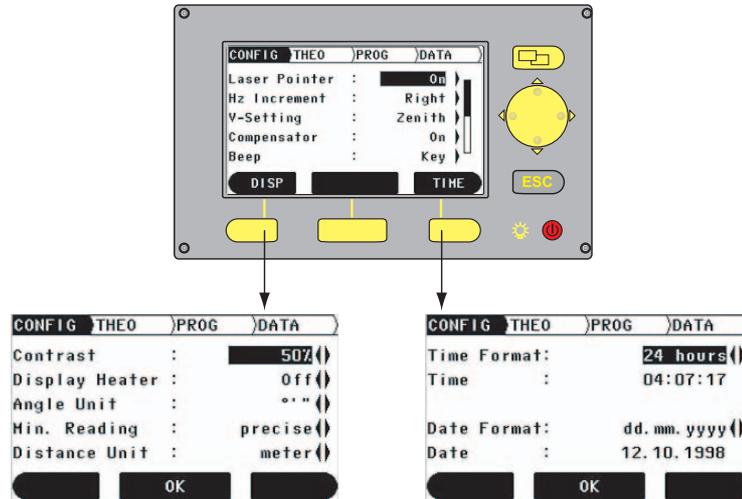
## 6

# Configuration

### Description

First, make the configuration of your Builder instrument to

- Reflect your own requirements,
- Set date and time,
- Set units.



To set configurations regarding display. To set date and time

## How to change a setting

Step	Description
1.	 Press this button to activate CONFIG Mode.
2.	 Press this button to set focus on desired field.
3.	 Press this button to access the choicelist.
4.	 Press this button to toggle through the list and set focus on desired field.
5.	Accept with OK.



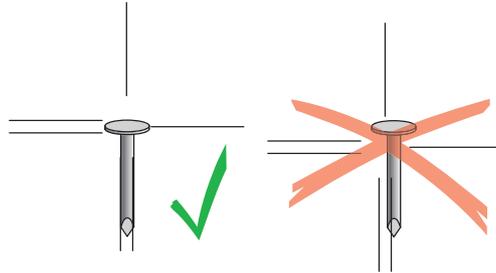
You have to make the configuration only once because the settings remain active even after switching off the instrument.

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# 7

## Measuring with the Builder T

Aiming correctly with the crosshair, e.g. on a nail



How to extend a straight line



Setup and level the instrument over point B.

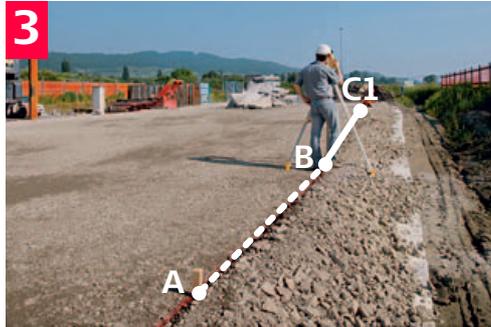
### 2



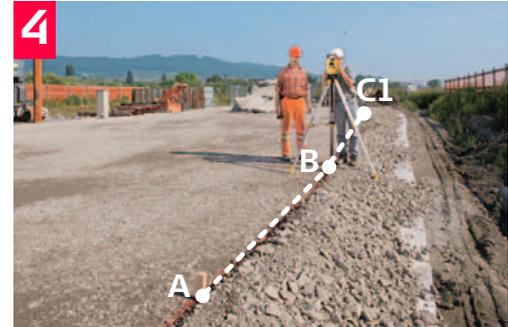
Press this button to activate **THEO** Mode.

Aim at point A.

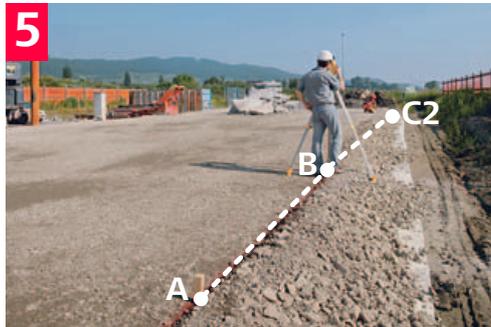
- Press Hz = 0 to set the horizontal angle to zero.
- Accept with OK.



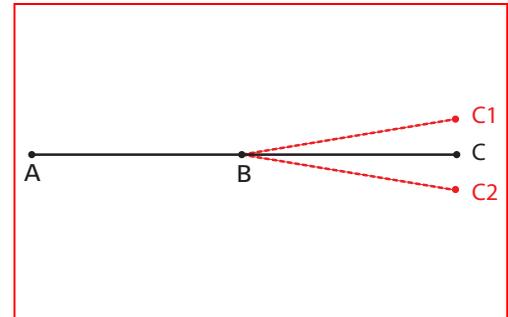
Flip the telescope (i.e. reverse it) and mark point C1.



Turn the instrument  $180^\circ$  (200 gon) and target point A again.



Flip the telescope again and mark point C2.

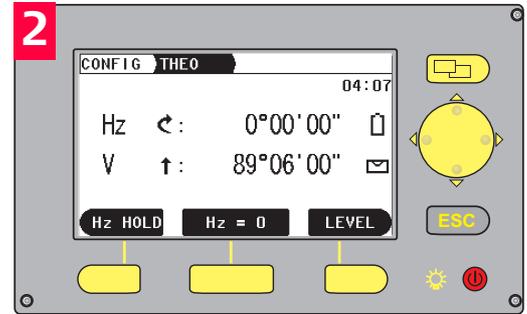


Point C the mid-point between C1 and C2, corresponds exactly to the extrapolation of the line AB.

## How to set out 90° angles

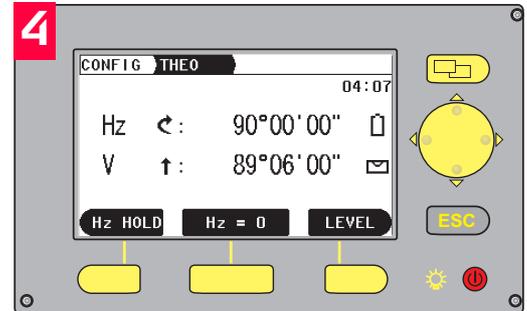


Setup and level the instrument over point B.



 Press this button to activate THEO Mode.

- 3**
- Aim at point A.
  - Press Hz = 0 to set the horizontal angle to zero.
  - Accept with OK.



Rotate the instrument until the horizontal angle 90°(100 gon) appears in the display.



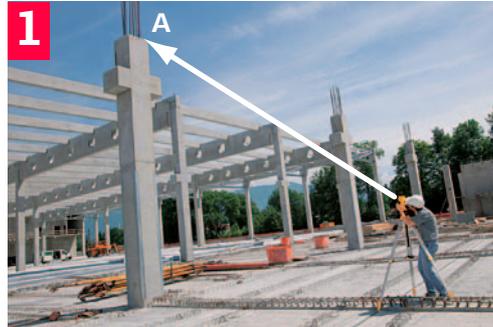
Guide the reflector carrier into and along the line of sight of the telescope.



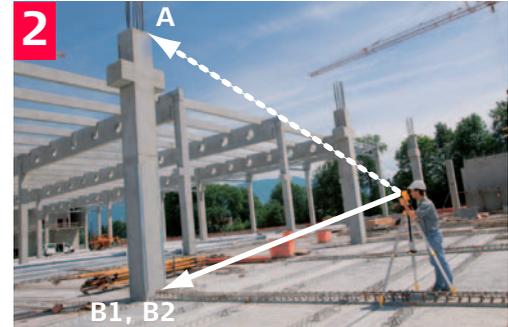
Hint: In CONFIG Mode turn on Sector Beep to have an acoustic signal which sounds if horizontal angle is  $0^\circ$ ,  $90^\circ$ ,  $180^\circ$ ,  $270^\circ$  or 0, 100, 200, 300 gon.

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## How to plumb vertically



Setup and level the instrument.  
Target high point A



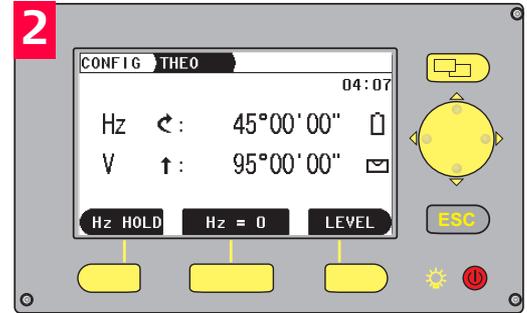
Tilt the telescope downwards and mark  
ground point B1.

- 3**
- Transit the telescope, and repeat the procedure. Mark point B2.
  - The mid-point between the points B1 and B2 is the exact plumbing point.

## How to measure slopes



1 Setup and level the instrument on a point along the straight line the slope of which is to be determined. Position a staff at a second point along that line.



2 Press this button to activate THEO Mode.

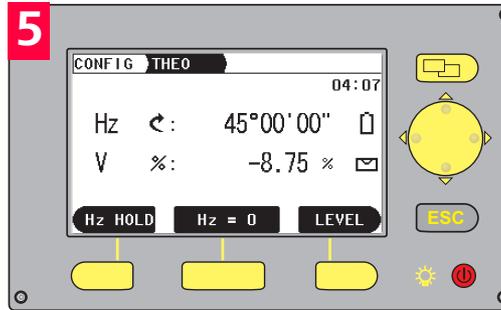
3



Press this button to change the vertical circle reading to V%

4

- Measure the instrument height.
- Using the telescope, determine the instrument height at the staff.
- Note that you should target the flat prism or a level staff at the same height  $i$  of the instrument's telescope tilt axis.



The slope can be read off directly in %.  
Vertical angles are expressed in % with positive above the horizon and negative below it.  
100% corresponds to a vertical angle of 45° (50 gon)



A reflector pole fitted with a flat prism can be used instead of the staff. Extend the reflector pole to the instrument height and use the telescope to target the centre of the flat prism.

## How to measure differences in height

If you turn the telescope until V% is zero, you can use the Builder like a level. Note: Changing V% by 0.01 results in a height reading error of 1mm on a reading distance of 10m.

Computation of a height difference might be necessary because e.g. the target is too high to be reached with a level staff or a pole.

- Measure the distance between the object and the center point under the theodolite (laser plummet mark) with a Leica DISTO or with a tape horizontally adjusted (!).
- Target object with telescope, read V% value, as described previously.
- Height Difference = distance measured x V% / 100
- Now you have computed the Height Difference in relation to the tilting axis of the telescope. If you want to get the Height Difference between two objects, repeat the above procedure with the second object and add both values to get the final result.



Determination of height differences is much faster with Builder R using laser distance measurement and the application 'tie distance'.

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## 8

# Measuring with the Builder R

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### How to use Instrument Setup

Three Setup options (Simple, Advanced, Height Setup) with different Setup methods are available.

After setting up the instrument on the construction site, typically you must define the zero direction of the theodolite. Builder R allows the combination of angle and distance measurements to provide a maximum of efficiency. Therefore, the flexibility of Builder setup options enables you to personalize your working environment defined by your construction site and/or your blueprint.

**Scenario One:** Align a row of columns by setting up over first column point.

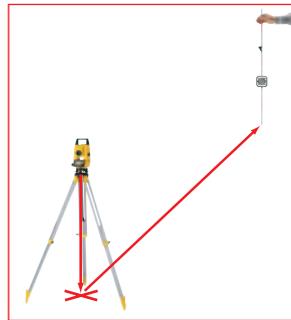
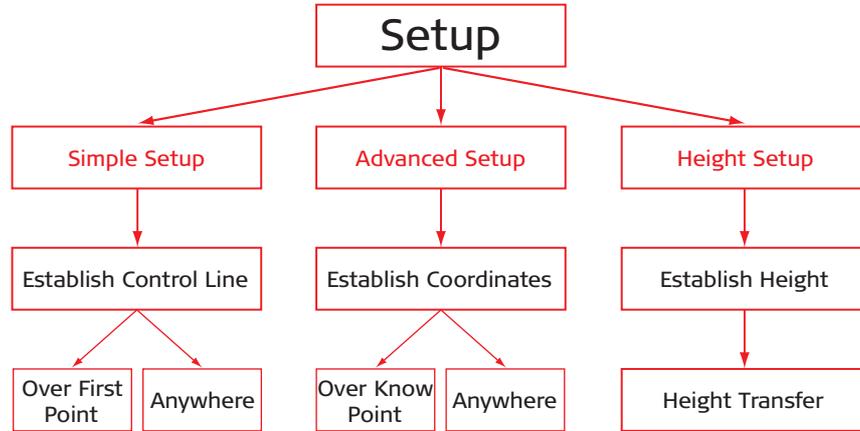
For this scenario, choose "Establish control line - Over 1st point." This can only be done provided there is a clear line of sight up the entire row of columns. If obstructions are in line of sight, choose scenario two.

**Scenario Two:** Align a row of columns by setting up anywhere.

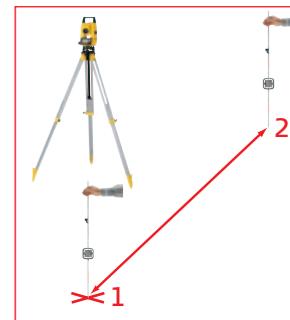
For this scenario, choose "Establish control line - Anywhere." This allows you to setup anywhere that provides clear line of sight for two points on the row of columns (e.g. first and last column points) as well as all column points in between.

**Scenario Three:** Align a row of columns from a list of coordinates.

For this scenario, choose "Establish Coordinates."



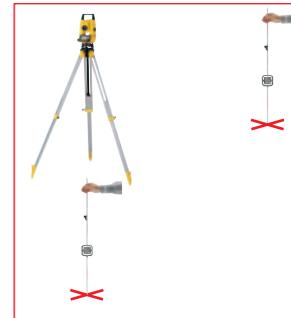
- Setup and center over line start point
- Aim a second point on the line



- Setup anywhere
- Measure startpoint and second point on the line



- Setup and center over a known point
- Measure second point for orientation



- Setup anywhere
- Measure two known points



- Enter instrument and rod height
- Measure a known point

## How to use Electronic Distance Measurement (EDM)

All Builder R and Builder RM types are equipped with electronic distance measurement to measure reflectorless to any surface or to the included flat prism



Reflectorless to any surface



To flat prism



Do not measure to regular glass prism.



Holding the reflector pole correctly





Tilt the moving part of the flat prism correctly.

The flat prism reflector should always be aimed faceforward towards the telescope. That can be achieved by tilting the moving part of the flat prism up or down.

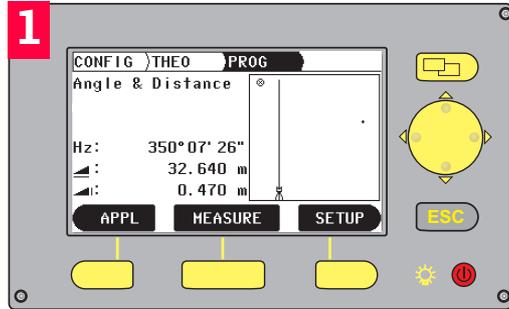


Target Point roughly using the notch.

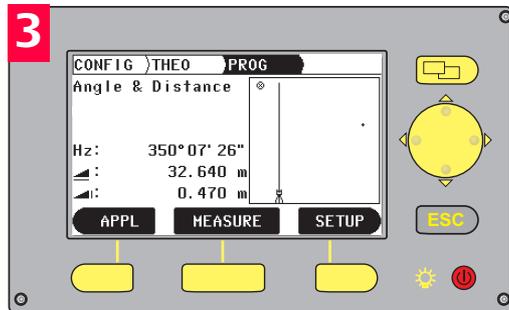
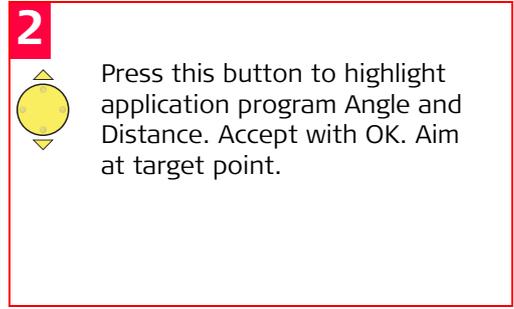


Using the telescope, overlay crosshair and prism center.

## How to measure angle and distance



Press this button to activate PROG Mode. Press APPL.



Press MEASURE to measure point.



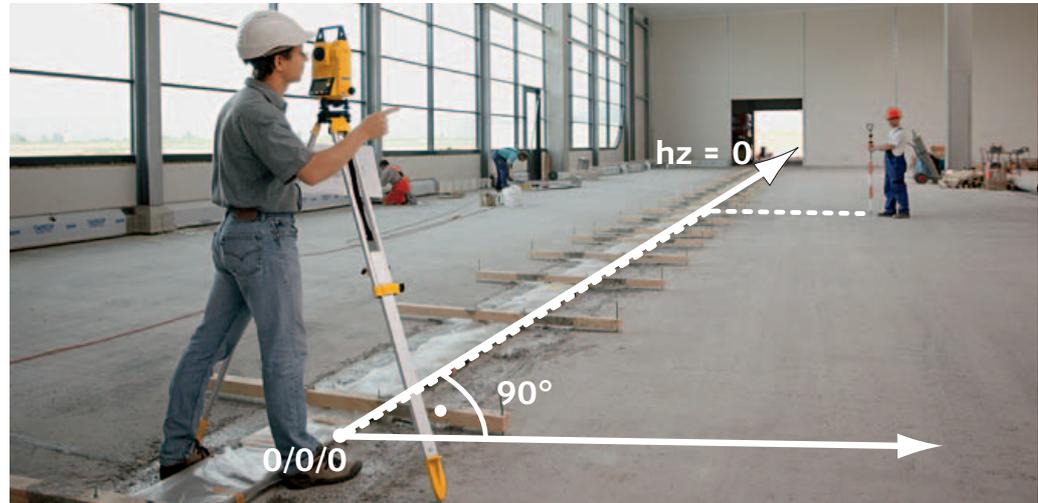
Press MEASURE for at least "5" seconds to turn on the red laser pointer.

**The measured horizontal distance is displayed.**

## How to use Layout

Often, you lay out an object in relation to a given line. No matter which setup you have chosen, the layout always works in the same way. Enter two values into the Layout programm, which might be given as line and offset or northing and easting, and the instrument tells you where to target and how far to move the rod.

On Builder R100M/R200M models, you can enter all data in the office, and you just need to pick a point from the memory without the need to define them in the field.

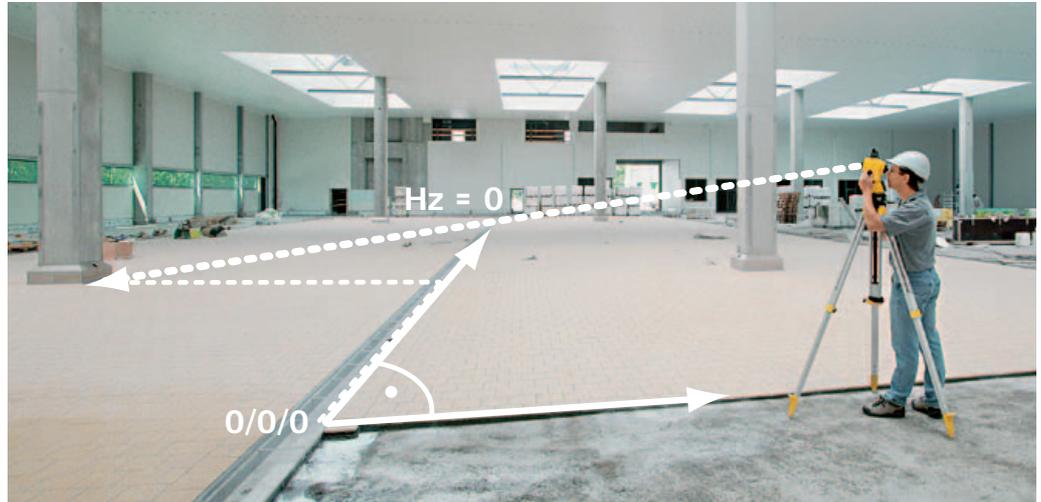


Press MEASURE for at least "5" seconds to turn on Tracking Mode. If Tracking Mode is activated the stake out differences are displayed continuously.

## How to use As-built

The Builder R displays values as line and offset or northing and easting, depending if you have chosen setup control line or setup coordinates. A graphic always visualizes the current setup, it even draws the last measured points in the graphic that allows a quick overview.

On Builder R100M/R200M models, you can save all data in the field memory, and then just connect to the PC later to read all measurements.



Press MEASURE for at least "5" seconds to turn on the red laser pointer.

## How to find remote heights with Tie Distance

Remote heights can be calculated with the application program Tie Distance.

As an addition to the plumbing method shown in chapter 7, with tie distance you can precisely determine the height difference between two points. The next chapter tells more about the tie distance program for position differences.



Press MEASURE for at least "5" seconds to turn on the red laser pointer.

## How to find missing line and radius measurements with Tie Distances

Two different methods are available:



 Polygonal

With Polygonal method, the tie distance is always computed between subsequent points. If all distances should be measured from the same startpoint always, then choose the radial method below:



 Radial

With Radial method, the tie distance is always computed starting from the first point. Distances are measured from a center. Radial tie distance also allows the layout of circles.



Press MEASURE for at least "5" seconds to turn on the red laser pointer.

## How to use Area and Block Height to calculate Volume

The area program measures the plan area size and the perimeter of a structure. To compute the volume of a block, measure the ground shape of the block first and then enter the height of the block to compute the volume. The volume is the result of the plan area multiplied with the block height given.

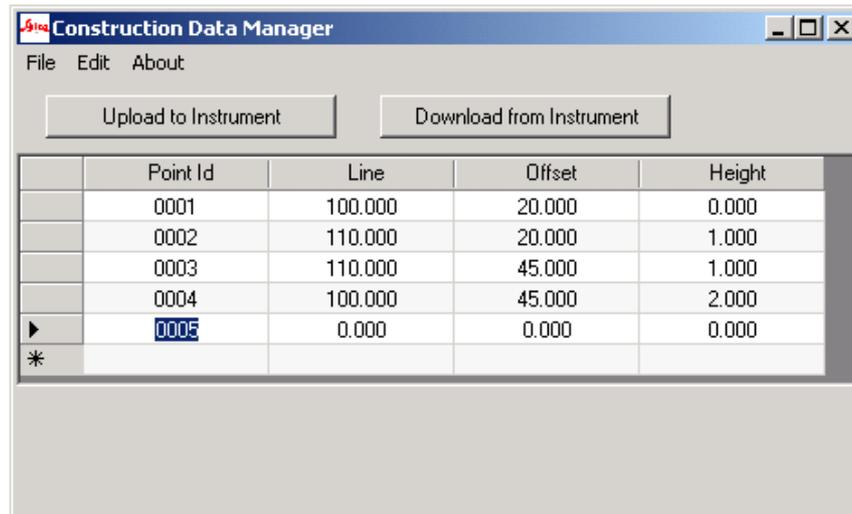


Press MEASURE for at least "5" seconds to turn on the red laser pointer.

## Data Transfer with the Builder RM

To load point in the Builder R100M or R200M, simply use the 'construction data manager' program that is provided on the Builder CD. Connect the instrument with the cable to the PC, then simply type data in the spreadsheet and press 'upload'.

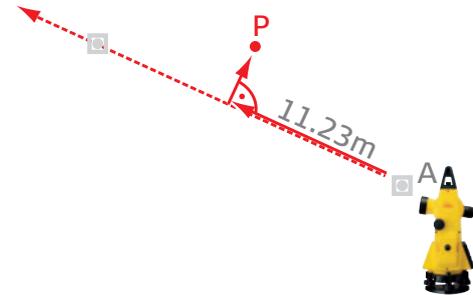
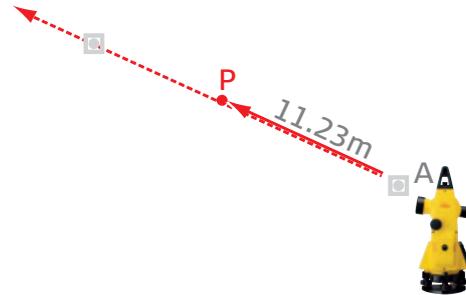
With the same program, you can also download measured data from Builder to your PC.



# 10

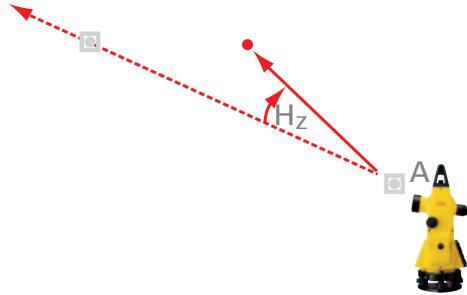
## Theory

### Working in a Construction Grid



Working along a control line requires the distance between the defining point A and the target P. Further, to orientate the theodolite, a second point is needed to orientate the telescope before measuring the distance. The given line and the distance between P and A define the point P.

In case that P is not on the line, in addition to the above, the perpendicularly measured offset between the line and P is needed. Distance along the line and offset are both needed to define P, both values are often referred as "line and offset", sometimes as "chainage and offset". The line starting in A and its perpendicular line given the direction to P define a so called grid.



Instead line and offset, P can be defined with the angle  $H_z$  between the line and in what direction (left or right of control line), plus the distance between instrument and P. These are so called “polar coordinates”, often used by surveyors.



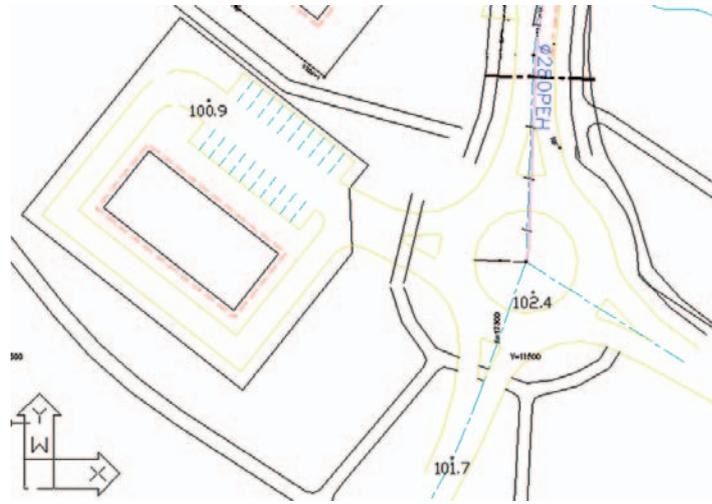
If you work with a level, theodolite, or transit, very often you work only along one line to define points. Then you reposition the instrument to work on a parallel line or on a line perpendicular to the first line. Working with Builder R simplifies the process because in most cases it is sufficient to position the instrument once and then use the software to compute line and offset. With one measurement of Builder R it is possible to replace two traditional line and offset measurements. Therefore, the efficiency increases significantly if you work with Builder R, compared to Builder T and of course compared to traditional instruments.

## Working with northing and easting

If there is no preferred control line available, a situation you might often find it in road construction, often easting and northing values are used to define a point. Surveyors call these 'local coordinates'. Similar to the line and offset used in the grid above, you need two values to define a point position.

In special cases, the northing and easting values are equal with the official country mapping datum.

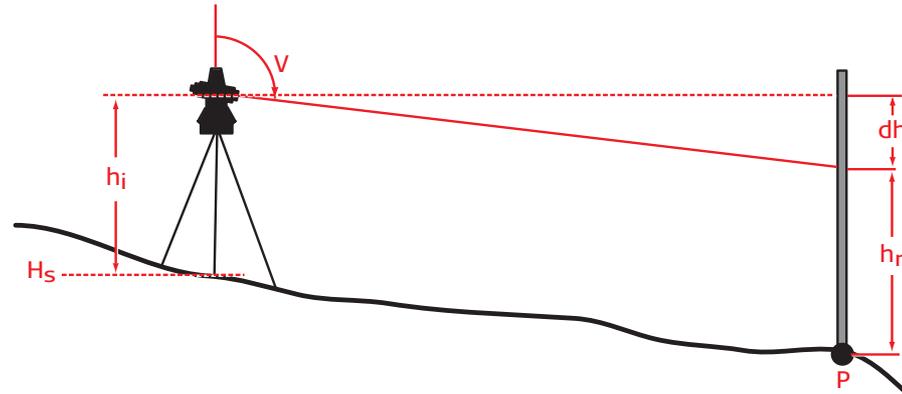
If you have to work with northing and easting coordinates, then you can choose the setup 'Establish Coordinates'. All other Builder functions, such as Asbuilt and Layout, work exactly the same way as the well known grid of control lines.



## Calculating point elevation

To measure the absolute height of a point P, the height of the tilting axis of the telescope must be known. The height of the tilting axis is the elevation of the station point  $H_s$  plus the height of the instrument set up ( $=h_i$ ). Next, to compute the elevation of P the height of the reflector (typically denoted as  $h_r$ ) must be known as well. The instrument further determines the height difference  $dh$  between reflector and tilting axis of instrument out of the measured zenith angle and the distance measured. Finally, height of point P will be computed as

$$\text{Height of P} = H_s + h_i - h_r + dh$$



If you want to measure point elevation it is recommended to enter first the instrument height  $h_i$  in the 'Set-Up height' menu, before doing any further set-up. If you do not yet know the height  $H_s$  of the station, you can use the 'height transfer' method in the 'Set-Up Height' menu after entering instrument height  $h_i$  and reflector height  $h_r$ .

## Quality checks for measurements

There are many influences on a result of a measurement. Some of them, even with best instrument can never be measured or compensate for. If you work with any theodolite, you should always try to watch out for the following issues:



- Always read the manual before starting to measure.
- Quality of the set up is important. Beside automatic corrections, e.g. a bad tripod can significantly diminish the quality of the measurement. Do not save money buying only the cheapest accessories. Even good accessories account typically for less than 10% of the overall purchasing value, that money is always worth spending.
- Never underestimate effects caused by temperature changes or direct sunlight. Even the best material works unpredictable in case of rapidly changing environmental conditions. Allow the material to settle to the external temperature conditions before you start working. Under any sunlight, offer a sunshade to the instrument and the tripod.
- If you look through the telescope and see the air shimmering because of sunlight heating the ground, always watch out! Rather measure twice and compare the result. If both results do not match, consider changing your setup in a way that it allows shorter distances between target and instrument.
- Always check the orientation of your horizontal angle. Like mentioned above, the effects can never be fully excluded, even if working procedure is cautious. Sight a known point and remember the Hz value, which is the easiest if you are able to sight the zero direction precisely. After a certain period of time, e.g. 30 minutes, check if targeting the known direction still gives you the same angle reading. In case that there are significant differences, first setup correctly again and then check your already measured points in reverse order; e.g. measure the last point again, and then the second to last point and compare the result. Continue with task only if you're sure that the undesired change of orientation didn't influence the measurements.

- Do overlapping checks; e.g. measure a couple of points again, setting up the instrument on a different location. Do the results match within the specified accuracy of the instrument?
  - You should definitely NOT try to check a measurement using a less accurate tool. It makes no sense to check an electronic distance measurement shot over 40m using a steel tape. But it does make sense to check a distance 2m or less with a folding ruler or a tape. You can also use the 'tie distance' method for control measurements, see chapter 8.
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**Total Quality Management - Our commitment to total customer satisfaction.**



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

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

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- when it has to be **right**

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