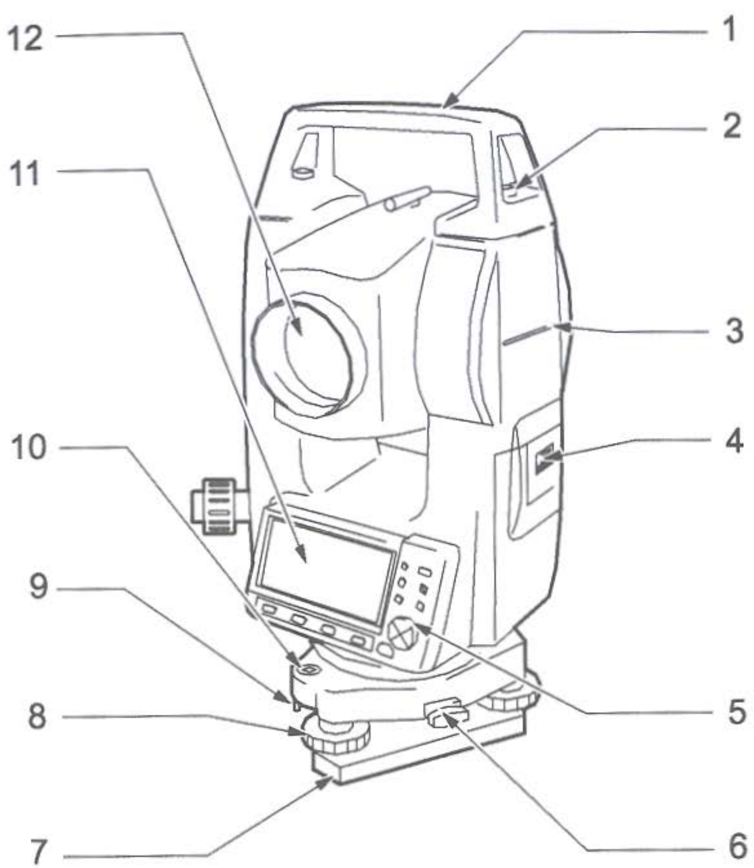
Total Station Setup and Operation

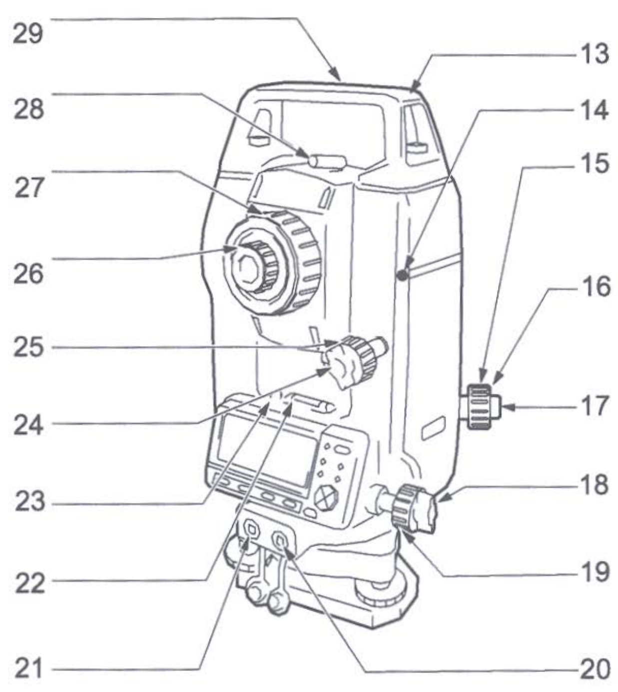
Sokkia SET Total Station

Parts of the SET Total Station



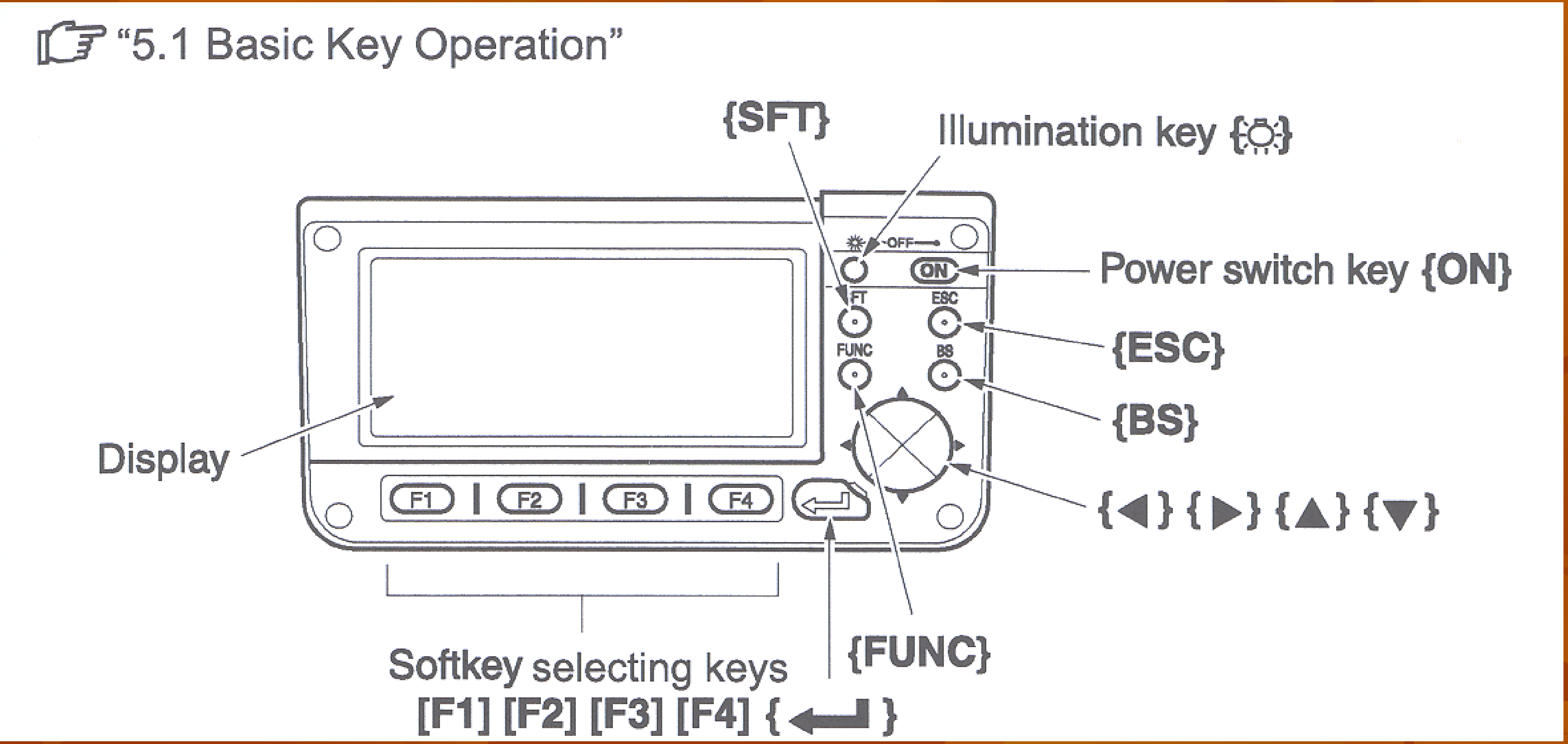
1 Handle
2 Handle securing screw
3 Instrument height mark
4 Battery cover
5 Operation panel
6 Tribrach clamp (SET310S/510S/610S: Shifting clamp)
7 Base plate
8 Levelling foot screw
9 Circular level adjusting screws
10 Circular level
11 Display
12 Objective lens

Parts of the SET Total Station

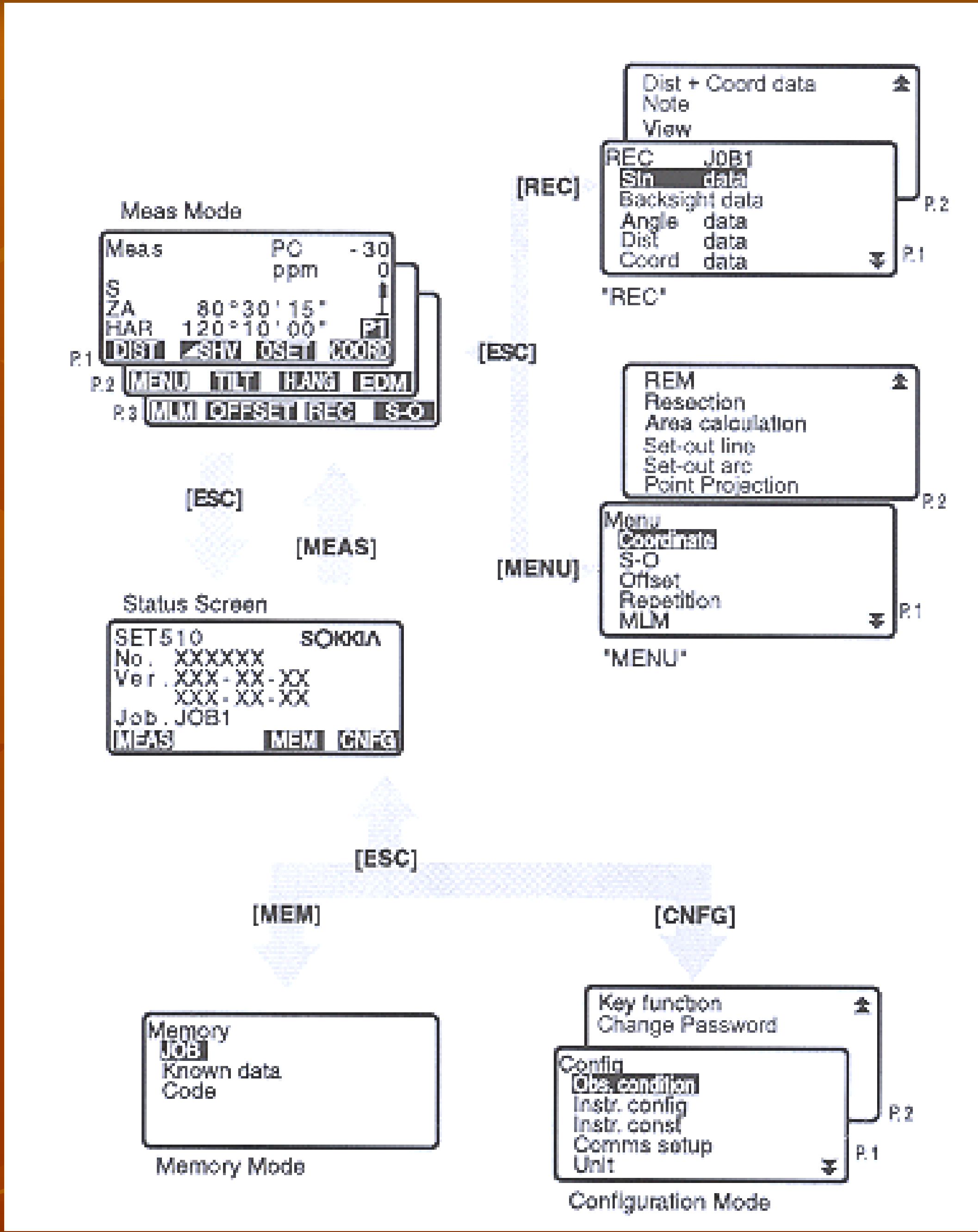


13 Tubular compass slot
14 Beam detector for wireless keyboard (Not included on SET610/610S)
15 Optical plummet focussing ring
16 Optical plummet reticle cover
17 Optical plummet eyepiece
18 Horizontal clamp
19 Horizontal fine motion screw
20 Data input/output connector (Beside the operation panel on SET610/610S)
21 External power source connector (Not included on SET610/610S)
22 Plate level
23 Plate level adjusting screw
24 Vertical clamp
25 Vertical fine motion screw
26 Telescope eyepiece
27 Telescope focussing ring
28 Peep sight
29 Instrument center mark

Sokkia SET 550 Total Station Keys/Screen



SET 550 Menu Pages

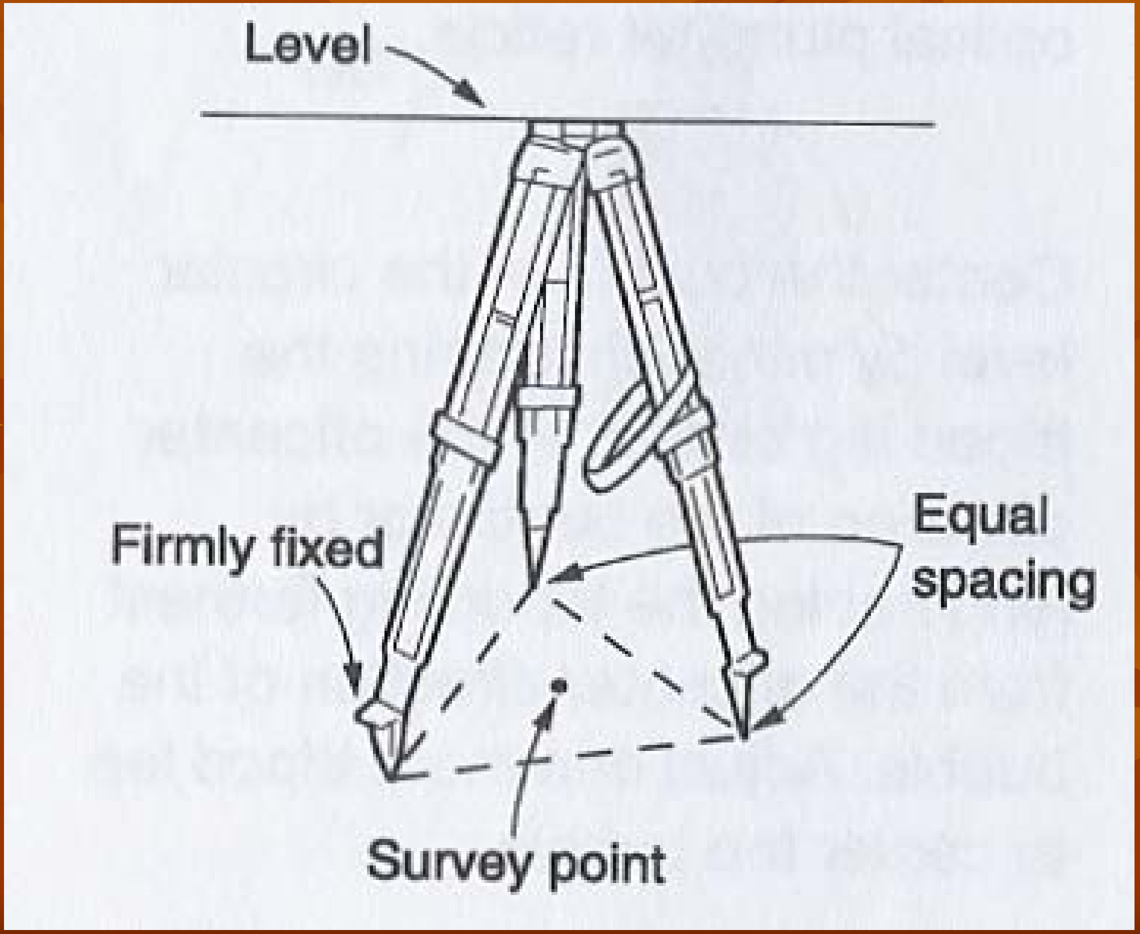


Leveling the Total Station

- Leveling the Total Station must be accomplished to sufficient accuracy otherwise the instrument will not report results
- Leveling the instrument takes 30 to 45 minutes – make sure you can see all targets from the instrument station before going through the process

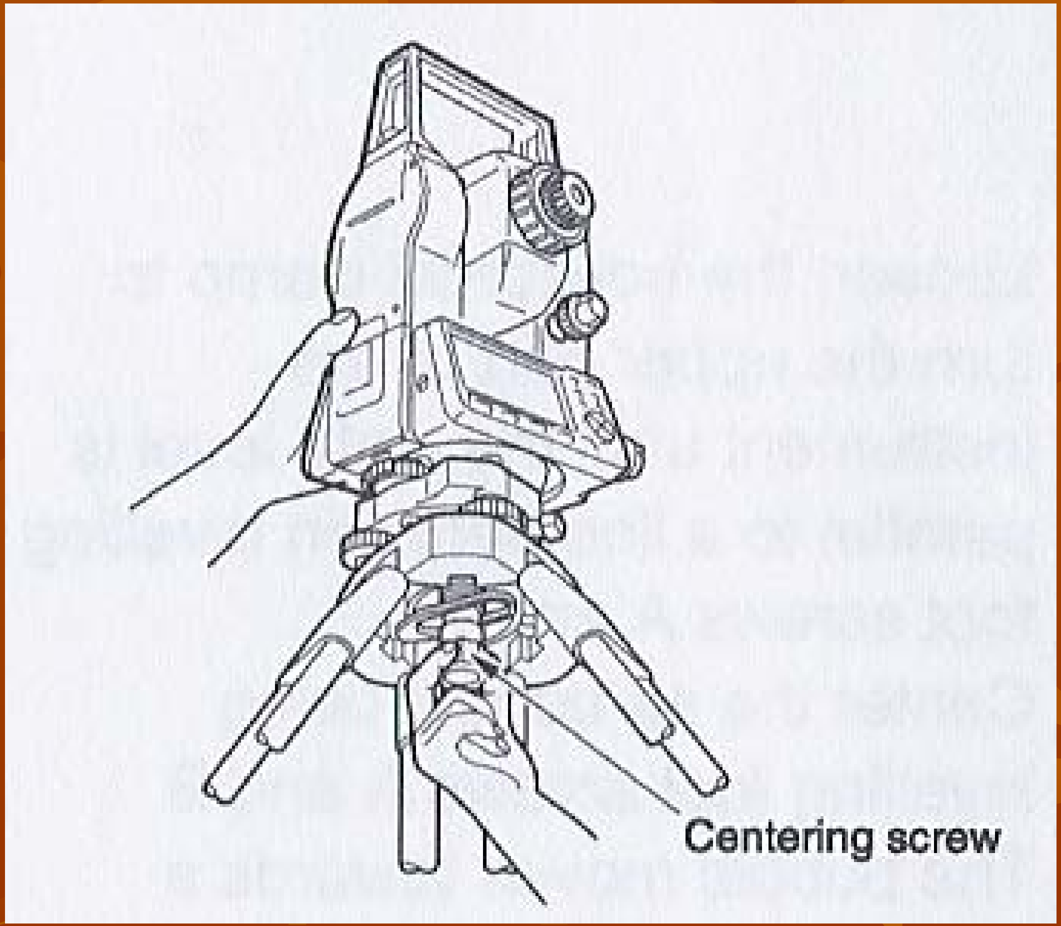
Step 1: Tripod Setup

- Tripod legs should be equally spaced
- Tripod head should be approximately level
- Head should be directly over survey point



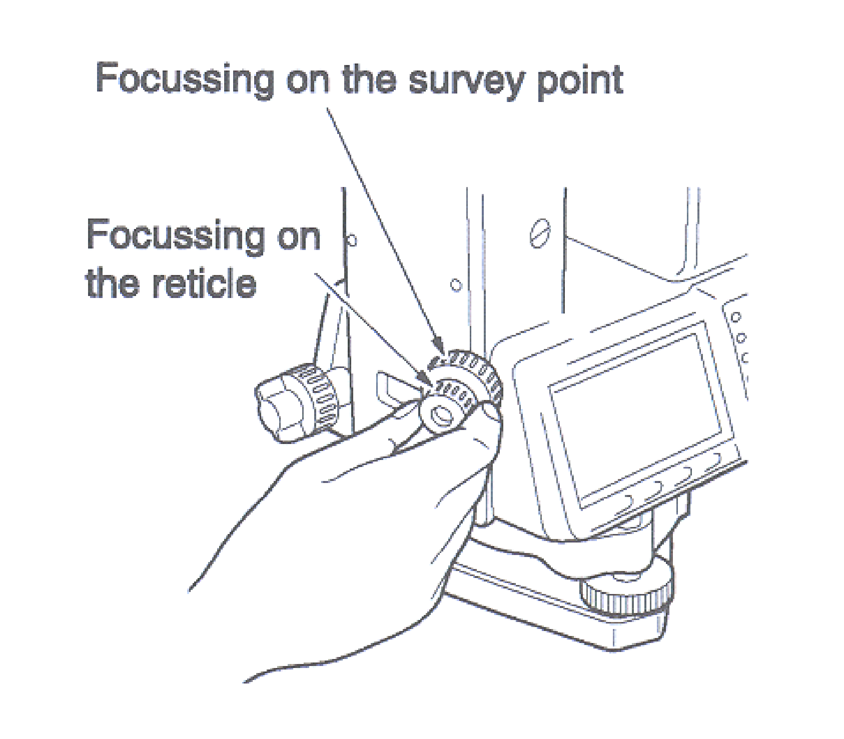
Step 2: Mount Instrument on Tripod

- Place Instrument on Tripod
- Secure with centering screw while bracing the instrument with the other hand
- Insert battery in instrument before leveling



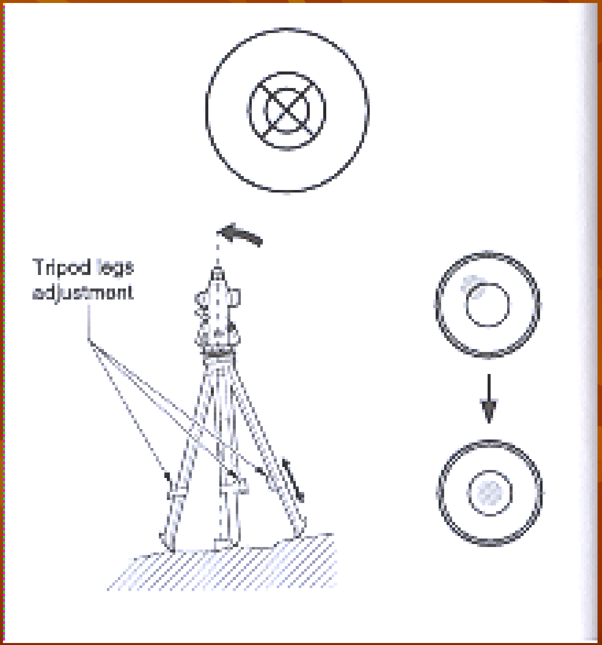
Step 3: Focus on Survey Point

- Focus the optical plummet on the survey point



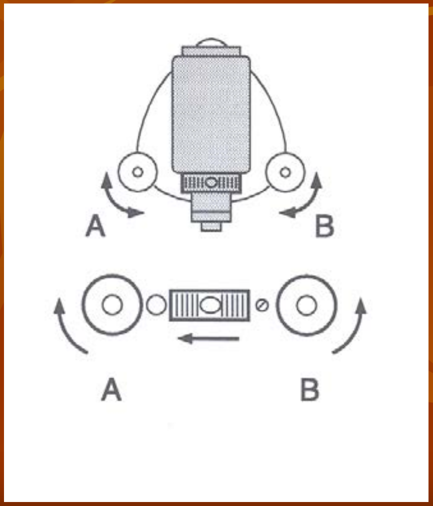
Step 4: Leveling the Instrument

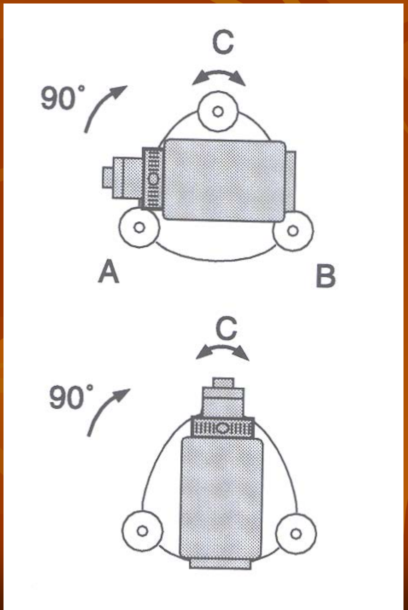
- Adjust the leveling foot screws to center the survey point in the optical plummet reticle
- Center the bubble in the circular level by adjusting the tripod legs



Step 4: Leveling …

- Loosen the horizontal clamp and turn instrument until plate level is parallel to 2 of the leveling foot screws
- Center the bubble using the leveling screws- the bubble moves toward the screw that is turned clockwise
- Rotate the instrument 90 degrees and level using the 3rd leveling screw



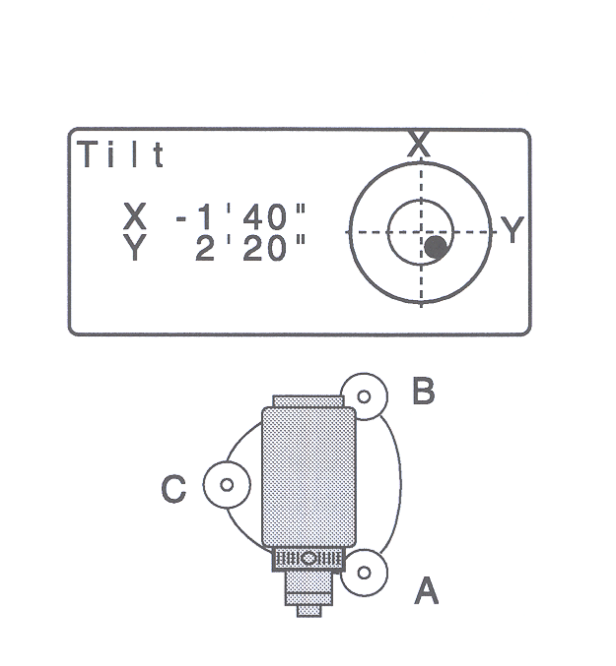


Step 4: Leveling …

- Observe the survey point in the optical plummet and center the point by loosening the centering screw and sliding the entire instrument
- After re-tightening the centering screw check to make sure the plate level bubble is level in several directions

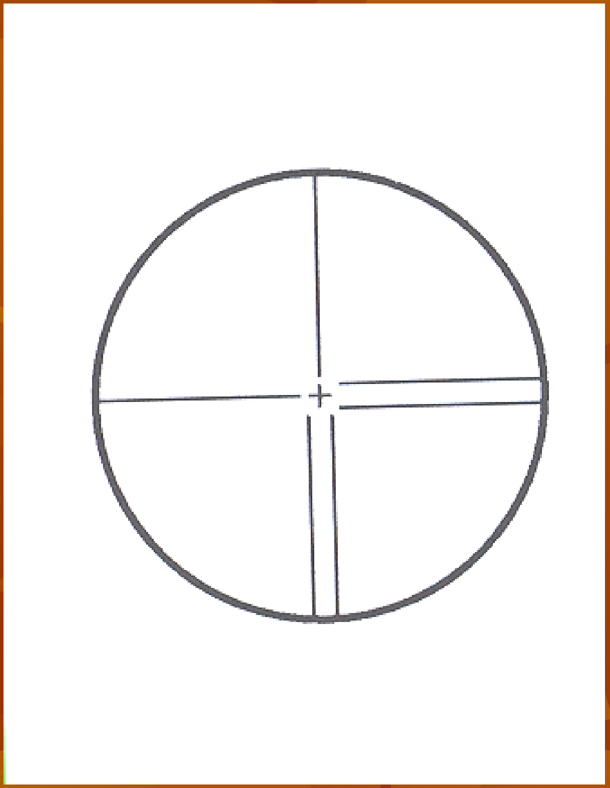
Step 5: Electronically Verify Leveling

- Turn on the instrument by pressing and holding the "on" button (you should hear an audible beep)
- The opening screen will be the "MEAS" screen. Select the [Tilt] function
- Adjust the foot level screws to exactly center the electronic "bubble"
- Rotate the instrument 90 degrees and repeat



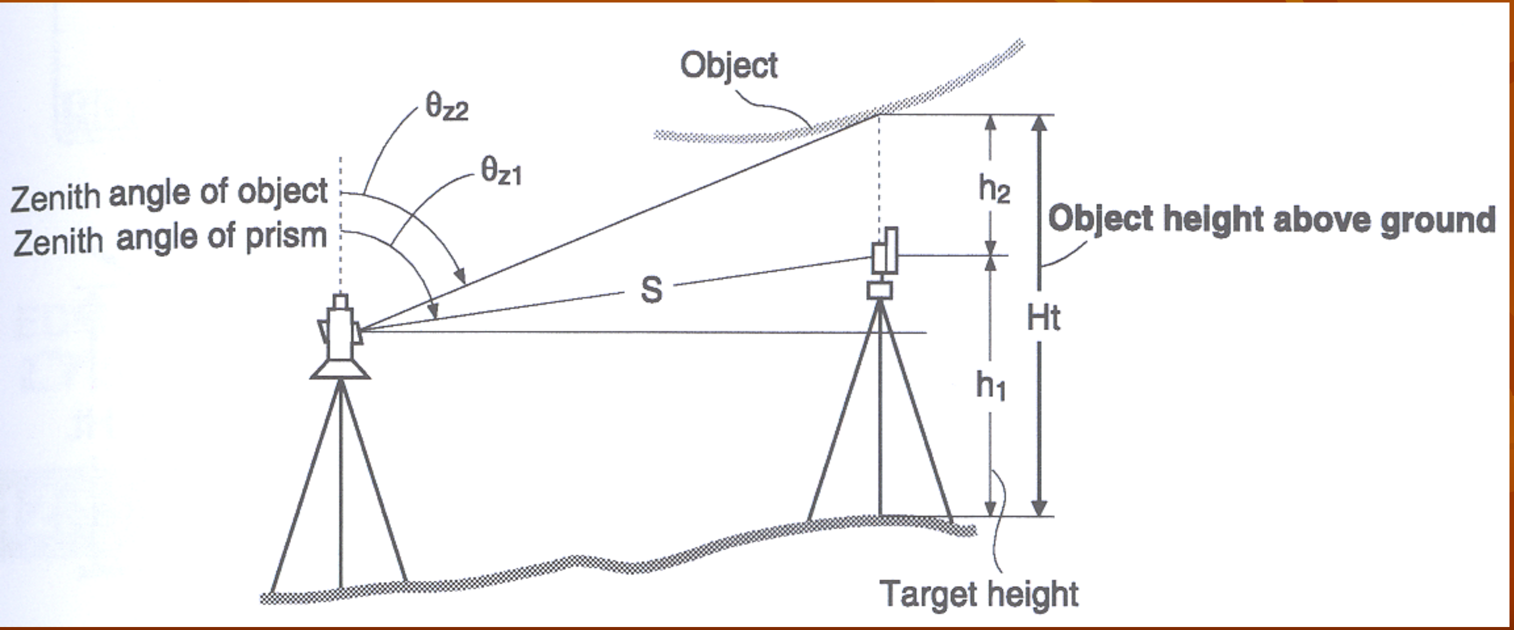
Step 5: Adjust Image & Reticle Focus

- Release the horizontal & vertical clamps and point telescope to a featureless light background
- Adjust the reticle (i.e. cross-hair) focus adjustment until reticle image is sharply focused
- Point telescope to target and adjust the focus ring until target is focused
- Move your head from side-to-side to test for image shift (i.e. parallax). Repeat the reticle focus step if parallax is significant
- NOTE: When the instrument operator changes the reticle focus may need to be adjusted



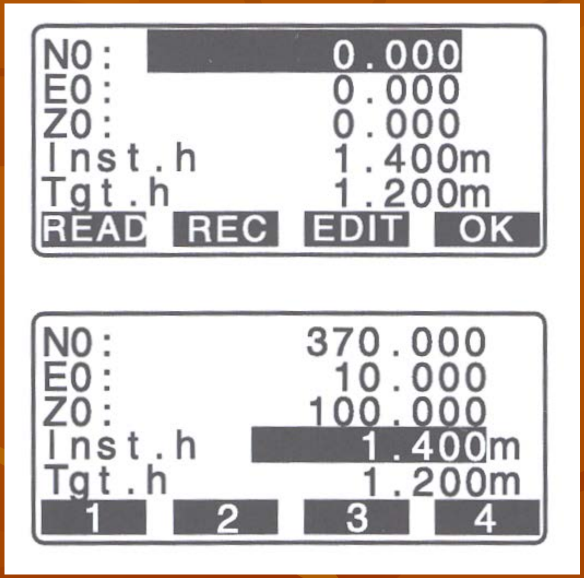
Measuring the Height of An Object

- Level the instrument at a site where the target can be viewed through the telescope and the mirror target can be setup directly below the target
- After powering on the instrument select “REM” from “MEAS” > “Menu”
- Ht = h1 + h2
- $h2 = S(\sin\theta_{z1})(\cot\theta_{z2}) - S(\cos\theta_{z1})$
- NOTE: Instrument height does not affect this calculation



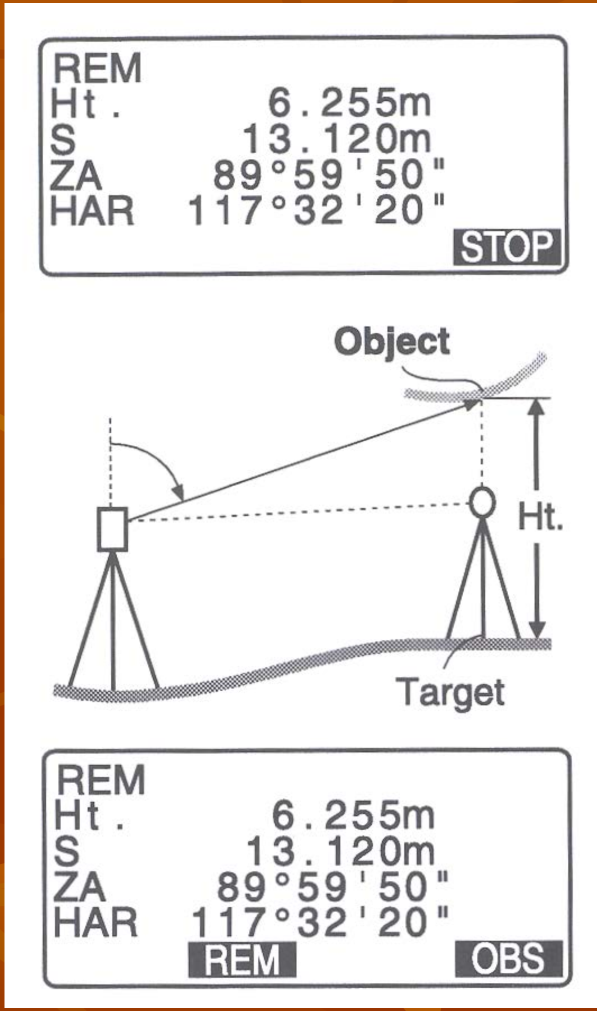
Measurement of Target Height

- Set the Target Height from "MEAS" > "Menu" > "Coordinate" > "Station Orientation" > "Station Coordinate"
- Set the target height to the measured height of the mirror target. Make sure you use the metric side of the tape measure if working with metric units. You do not have to fill out the other fields for a REM measurement, however, it is good practice to measure and enter the instrument height. After entering the TH and IH make sure you press "OK" (F4) to accept new values.
- Press "ESC" to return to the "MEAS" menu
- Select the "MEAS" > "Menu" > "REM", sight the mirror target, press [OBS] to measure "S", then [STOP]
- Sight the object above the target for height measurement
- Select [REM] after sighting the top of the height target, and then [STOP] to stop the calculations.



REM Screen Results

- To re-shoot the mirror target use the [OBS] on the REM screen.
- Note that after selecting REM the instrument continues to make calculations in case you need to adjust the vertical angle on the height target.
- Select “STOP” to terminate calculations on the REM command.



Trouble-Shooting the REM Measurement

- The only numerical input is the target height so make sure that is entered correctly. When TH is changed make sure you hit the “OK” function key.
- If the instrument is reset (zeroed) TH will be 0.0 so if you make a REM measurement with TH=0 the answer will be underestimated by the actual TH.
- A quick check can be made by using REM on the mirror target – the answer should be the TH.

Calibrating the Instrument

- Calibration must be completed before coordinates can be obtained
- 3 possible calibrations:
  - Backsight by angle: must know instrument coordinates and have a landmark/target at a known azimuth
  - Backsight by coordinate: must know instrument coordinates and have mirror target set on a position of known coordinates
  - Resection (triangulation): must have 3 or more mirror targets established at known 3D coordinates

3D Coordinates

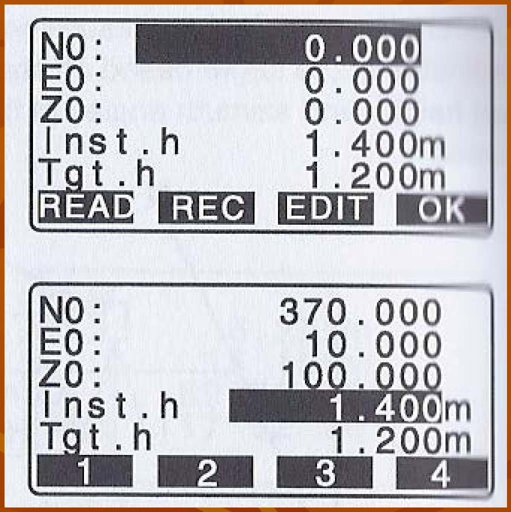
- Coordinates may be absolute or relative depending on survey requirements
- Surveying the area of a mining site would require relative coordinates, therefore, the initial instrument X,Y,Z coordinates may be 5000, 5000, 100
- Surveys that have to match a downloaded aerial photo from the USGS would have to match UTM NAD83 coordinates so the starting point would have to be determined by an accurate GPS receiver

Calibrate by Backsight by Angle

- Remember that when the instrument is powered on it has a random X,Y coordinate system: you must align the instrument with your working coordinate system.
- Level the instrument on the desired starting survey marker. Make sure that on the last leveling step the optical plummet is centered on the survey point

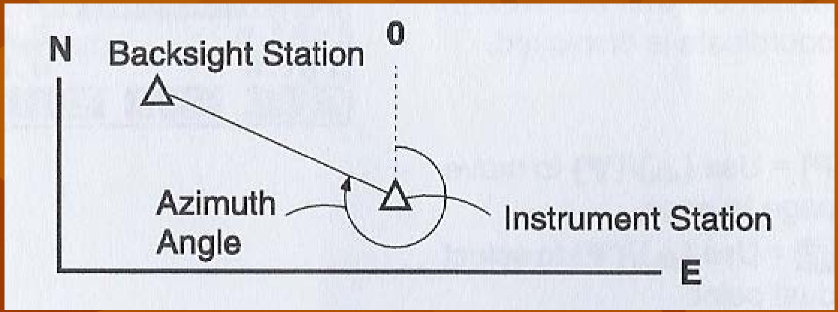
Backsight by Angle continued..

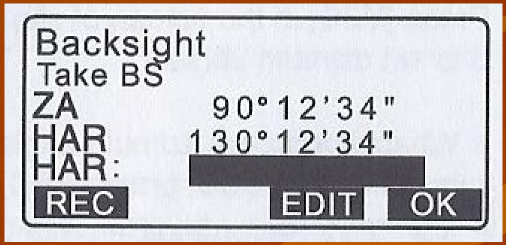
- Measure the target height and instrument height
- Select [COORD] from the MEAS menu
- Select "Stn. Orientation" and then "Stn. Coordinate"
- Edit the "N0", "E0", and "Z0" fields to appropriate values (i.e. northing, easting, elevation of instrument)
- Enter the instrument and target height if necessary
- Select [OK] when done



Backsight by Angle continued…

- Select “Backsight” and then “Angle” from the menu
- Sight the landmark/target of known azimuth relative to instrument with telescope
- Select “Angle” from menu. Note that the menu displays the zenith angle (ZA) and current horizontal angle (HAR) and is waiting for you to enter the known angle with [EDIT]
- Note: if you enter an azimuth angle as “85.4514” this will be interpreted as 85 degrees, 45 minutes, 14 seconds
- IMPORTANT! You must select [OK] to accept the angle. **<Esc> to leave this screen!** **Never use**





Backsight by Angle Continued…

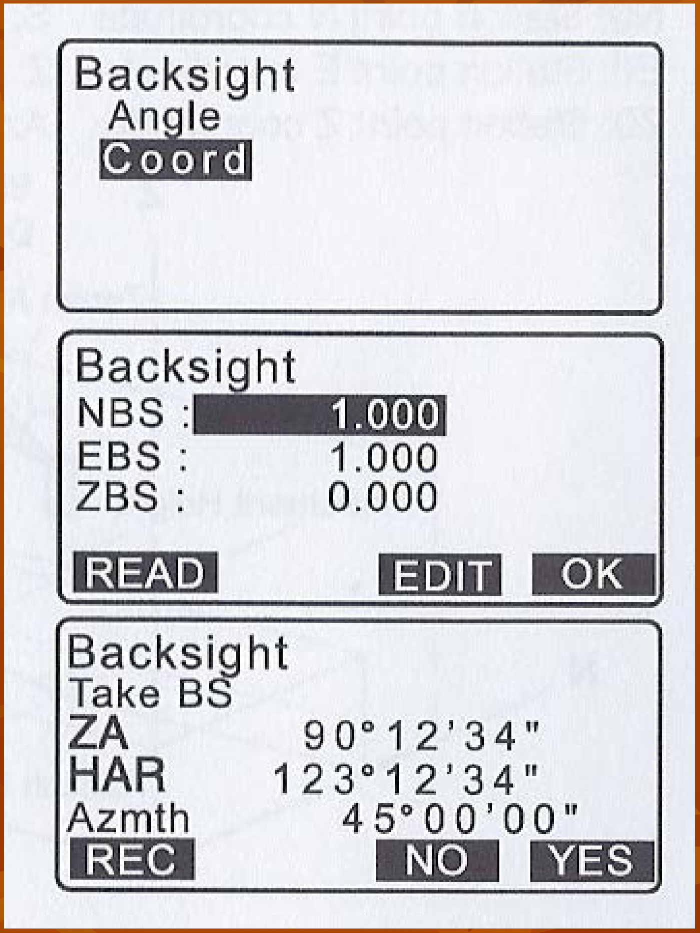
- NOTE: because the backsight by angle simply sets the instrument horizontal angle encoder to match your desired coordinate system the mirror target is never "shot" by the beam. If you can accurately sight on an object or landmark such as a building corner the mirror target is not needed. Make sure the instrument is "locked" and accurately sighted with telescope before entering the backsight angle.

Backsight by Angle cont…

- Because there is no internal statistical measure of how well the backsight angle has been set it is imperative to check the backsight independently:
  - Known point: shoot the target at a position of known X,Y,Z such as a GPS point. The result should be within the resolution of the GPS.
  - Known angle: shoot to a landmark at a known azimuth from the instrument location- the angle should be within the resolution of the instrument

Backsight by Coordinate

- Use this method when you have 2 known survey points with the instrument established on one and the mirror target on the other survey point
- From the "MEAS" menu select [COORD] and then "Stn. Orientation". Set the instrument coordinates with "Stn. Coordinate" and then select [OK] and return to "Backsight"
- Select "Coord" and then enter the backsight target coordinates (NBS, EBS, ZBS) and select [OK]
- Sight in the target and inspect the "Azmth" (it should be reasonable for your coordinate system).
- Select [YES] to calibrate. If you don't select [YES] the coordinate system is still random

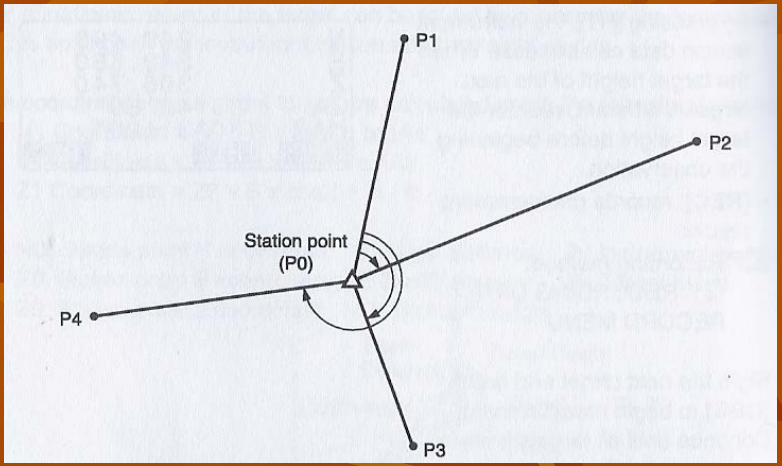


Backsight by coordinate …

- Always check the calibration of the instrument by shooting the target used for the backsight.
- The resulting X,Y,Z should be within the several cm resolution typical for a TS instrument.
- It is a very good idea to shoot other benchmarks within range to make sure accuracy is within acceptable limits

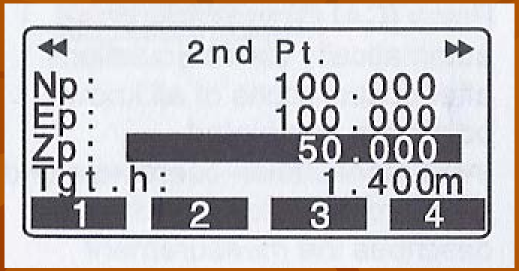
Resection

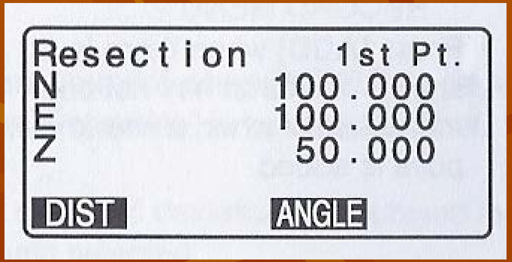
- Resection uses 3 or more known target survey points to automatically determine the X,Y,Z coordinates of the instrument
- This has the significant advantage of not requiring the instrument to be leveled exactly on a survey point- any convenient location where you can sight the targets is OK
- The ideal geometry is displayed to the right



Resection continued…

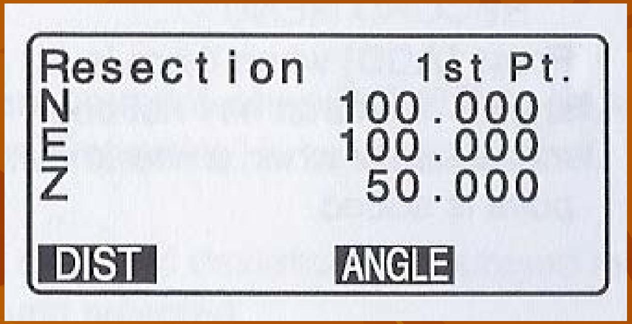
- Prior to resection enter survey markers as known points through the “MEM” menu
- From the “MEAS” menu select “[MENU]” > [RESEC]
- The resection procedure requires that the known coordinates be defined first, and in the order that they will be shot
- In the top right screen the 1st point has been defined and the 2nd point is being entered. You can use [READ] to read in previously entered or measured points
- Press the “>” or “<“ arrow to move to next or previous point
- When all points are entered select [MEAS]

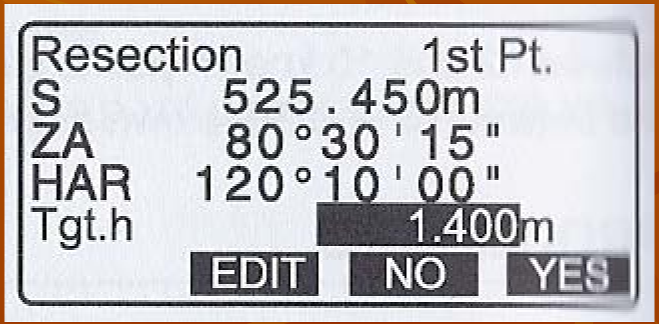


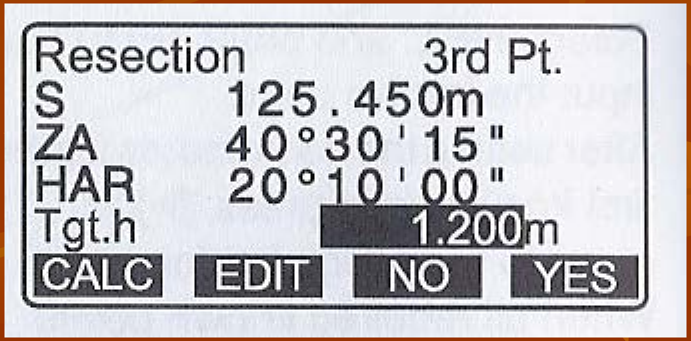


Resection continued…

- The [MEAS] screen (right) displays the point being shot – in this example the 1st point
- Choose [DIST] if you are shooting to a mirror target, [ANGLE] if not
- Select [YES] to accept measurement, [NO] to re-shoot, [EDIT] to change target height
- The [CALC] option will be displayed when the standard deviation of northing and easting can be displayed

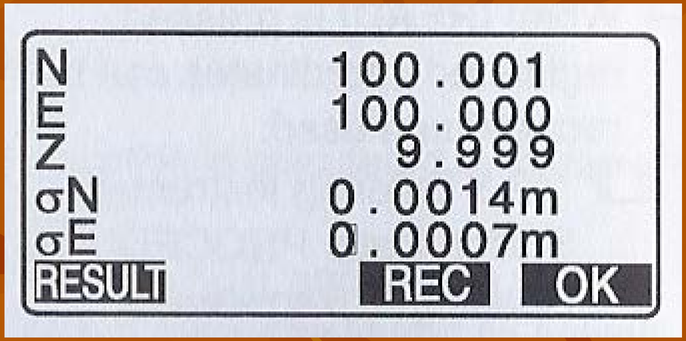


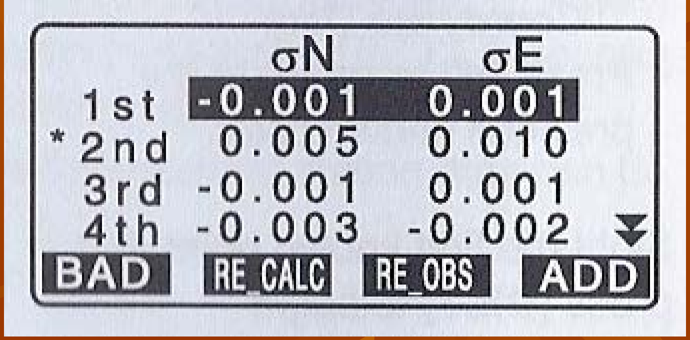




Resection continued…

- Press [CALC] or [YES] on last point to display the calculated instrument coordinates and the standard deviation of easting (σE) and northing (σN). **Press [OK] to finish Resection, and then [YES] to set the backsight azimuth to the 1st shot point**
- Press [RESULT] to display the residuals of each shot point- large deviations identify "bad" points
- If there are no problems press {Esc} to return to main resection screen
- The standard deviations are a measure of the accuracy. They should be in the range of several cm's for most surveys





Resection Notes

- Resection initializes the X,Y,Z coordinates of the instrument. Save this as a point (ex. G1S02 for group 2, instrument station #2) since it represents a surveyed coordinate
- Once the instrument is calibrated the mirror targets can be taken down and used elsewhere
- The instrument height should be entered before resection is calculated
- You can only begin shooting resection point 1 from the resection point #3 or higher coordinate entry screen

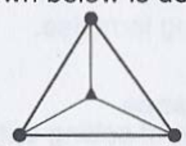
Resection Notes

- Certain Geometries should be avoided: Targets and Instrument should not be arranged on a circle

Precaution when performing resection

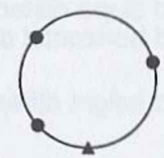
In some cases it is impossible to calculate the coordinates of an unknown point (instrument station) if the unknown point and three or more known points are arranged on the edge of a single circle.

An arrangement such as that shown below is desirable.



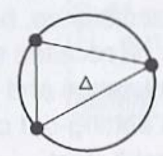
△▲ : Unknown point
○● : Known point

It is sometimes impossible to perform a correct calculation in a case such as the one below.

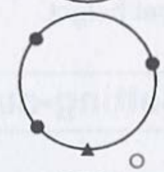


When they are on the edge of a single circle, take one of the following measures.

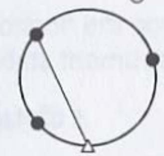
(1) Move the instrument station as close as possible to the center of the triangle.



(2) Observe one more known point which is not on the circle.



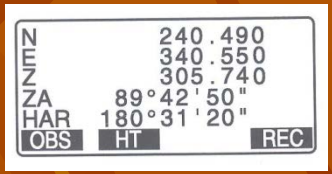
(3) Perform a distance measurement on at least one of the three points.



Caution

Coordinate Measurement

- Used to determine XYZ coordinates of target point.
- Make sure the instrument height and target height are already set.
- Make sure backsight/resection have already “locked” the instrument into a mapping coordinate system
- From MEAS select Menu > Coord > Observation

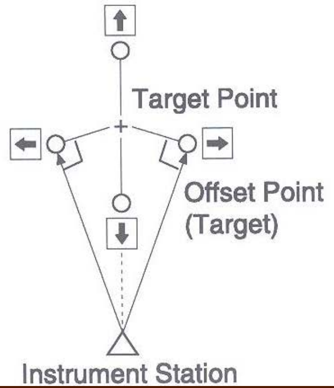


Offset: Single Distance

- Single distance offset – used to measure points that cannot be “occupied” by the target.
- Examples: (1) center of a large tree, (2) center of a fountain, (3) center of a building

18.1 Single-distance Offset Measurement

Finding it by entering the horizontal distance from the target point to the offset point.



Offset: Single Distance

- Offset point can be right or left of the target, but must be the same distance from the instrument.
- Offset point can be in front or behind target, but must be on the same azimuth line.
- In any case the person/team holding the target must have a tape to measure the exact distance (to cm accuracy at least) of the offset.
- The instrument will request an observation to the target first, and then request the offset distance and where the target point is relative to the point of interest (left, right, front, back).

Offset: Single Distance

- Note the arrow that indicates that the target is to the left of the survey point by 2 meters.