STANDARD OPERATING PROCEDURE

for

Field Operation of

Electronic Total Station

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Course Name	500 (Surveying Engineer)			
Training Module Name	**Field Operation of Electronic Total Station**			
Description	**Use of Electronic Total Station in Traverse, Detail survey, Stake-out and Its Utilities**			
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Date Created	09.09.2025			
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1	Anurag Misra, Surveyor			

Note: **This SoP is prepared using Topcon ETS model no. 7501(7500 series).**

1 Objective

The primary objectives of using the Electronic Total Station (Topcon 7500 Series) are:

a. Extension of Control – to extend the horizontal and vertical control from known geodetic/control stations to the survey area.

b. Detail Survey – to collect precise measurements of land parcel vertices and topographic features.

c. Establishment/Stakeout of known coordinate/point on ground– to re-establish and mark missing boundary pillars or survey monuments using control points and ETS observations.

d. Utility of ETS Program Modes (REM, MLM, etc.) – to utilize inbuilt ETS functions such as Remote Elevation Measurement (REM), Missing Line Measurement (MLM), Repetition Angle Measurement (REP), and other advanced modes for specialized survey requirements.

2 Hardware & Software

2.1 Hardware:

a. 01 number Electronic Total Station (ETS) with carrying case.

b. 03 number Tripod Stands (wooden or aluminium).

c. 02 Tribrach Prism.

d. 01 No. Rod with Prism pole with bubble level.

e. Measuring Tape (5 Meter)

f. Rechargeable battery with charger.

g. USB Cable/ Compact Flash memory card (For data downloading)

h. Barometer and Thermometer for atmospheric corrections.

2.2 Software:

a. ETS native/Inbuilt software. (Topsurv for Topcon-Latest Version 8.2.3)

3 Pre-requisites

The following are required before commencing ETS Survey.

a. Surveyor should have basic theoretical knowledge of working principle of ETS, Traverse and Detail Survey.

b. 02 inter visible known control points near the Survey location.

c. If the control points are not available, then the Surveyor should know how to establish control points near the location using GNSS static or NRTK method.

4 Roles & Responsibilities

The surveyor will have the following roles and responsibilities.

a. The surveyor will use 2 known coordinates and carry out a Traverse to establish new control points.

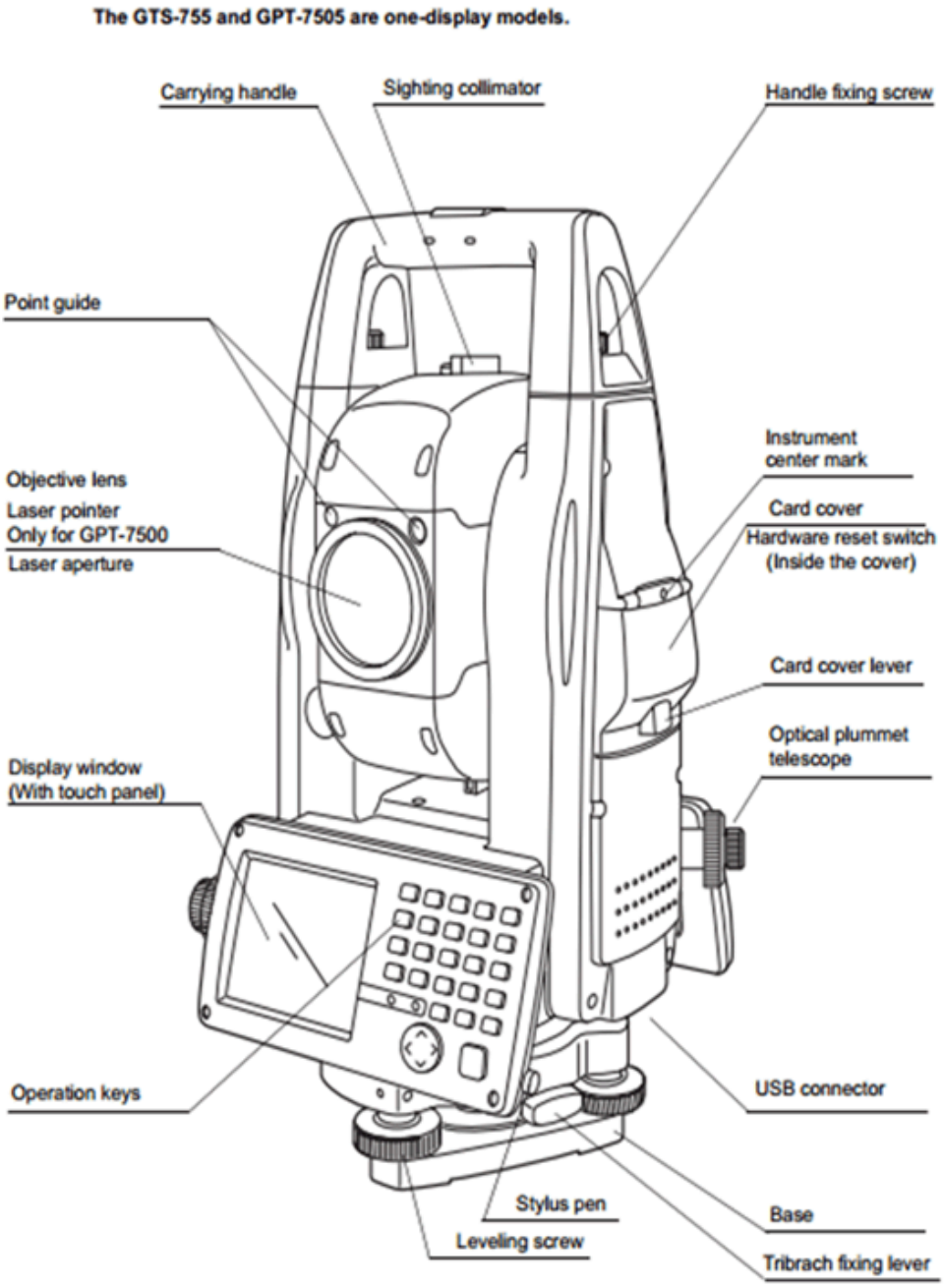
b. Using the newly established control points the Surveyor will carry out a detail survey of the AOI (Area Of Interest).

c. The Surveyor will locate the missing pillar/ points on ground whose co-ordinates are provided using Offset method.

d. The Surveyor will explore the utilities like MLM, REM etc of the ETS.

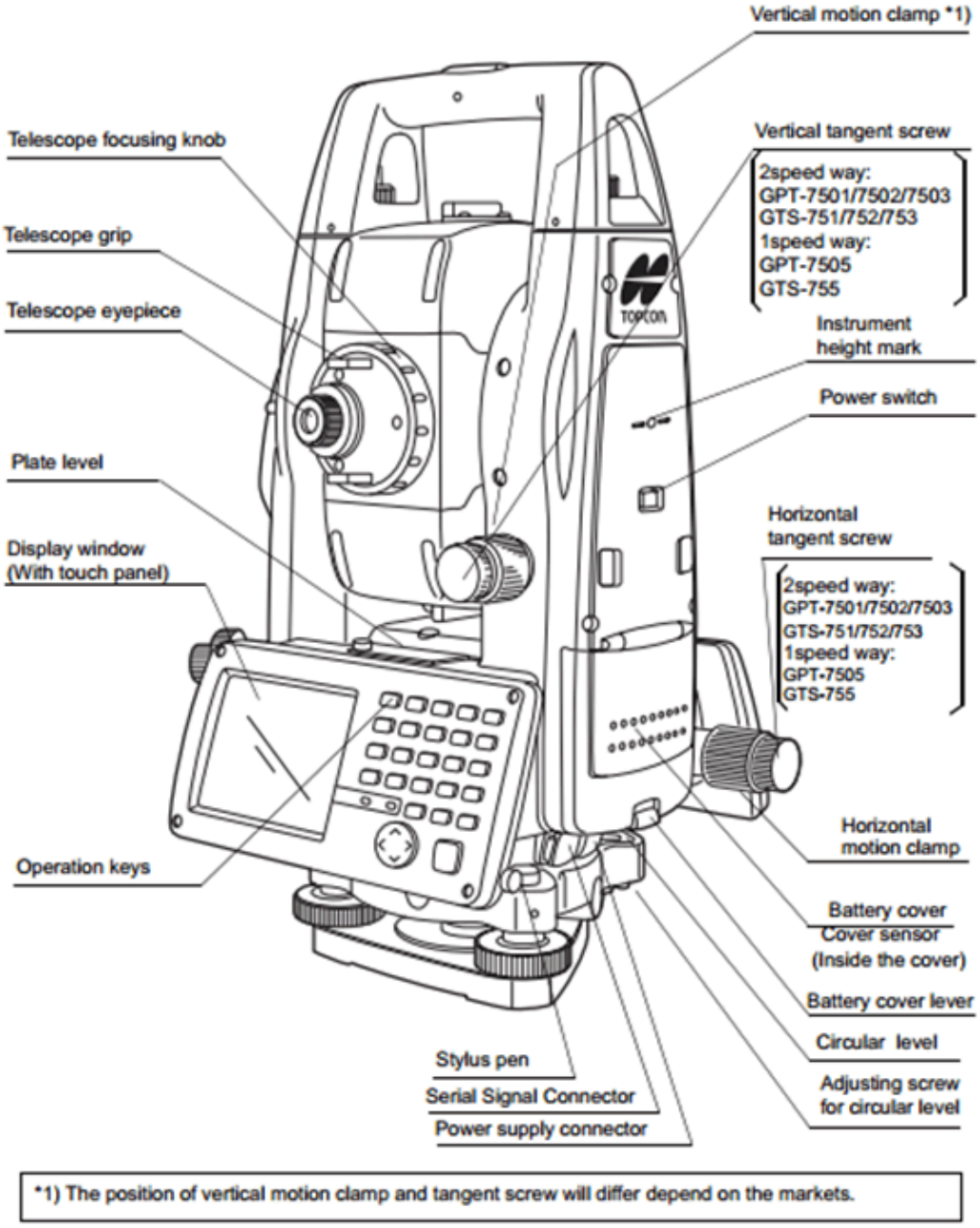
5 Specifications of ETS

Parts of a Total Station (Model - Topcon 7500 Series)



Magnification of the Telescope	30 X
Optical Plummet Telescope	3X
Laser Plummet (Optional)	LD (Visible laser)
Distance measurement with single prism	3 Km to 3.5 Km (Depend on the atmospheric conditions)
Measuring Accuracy	+ or – (2mm + 2ppm X D)m.s.e. D is Measuring distance (mm).
Electronic Angle measurement	absolute reading on both faces.
Minimum Reading Accuracy	5”/1” reading. 2”
Diameter of circle	71 mm
Tilt correction	Automatic vertical and Horizontal
Computer Processor	PXA255 with 177 MHz
Operation System (OS)	Microsoft Windows CE.NET 4.2
Memory	64MB / RAM and 64MB Flash disk (Internal)
External Memory	Compact Flash Card Slot Based on Compact Flash (Type 1 /II)
Display	3.5 inch TFT color LCD
Input device	Touch Screen / Stylus
Rechargeable Battery BT-61Q	Out put voltage : DC 7.4 V Current rating : 4400mAh Working hours 7.5h to 10h. Charging hours max 04 hours. Charging signal: Red lamp glows Finishing signal: Red lamp go out.

Parts of a Total Station (Model - Topcon 7500 Series)



Note:

1. The Instrument has an in-built back up battery and also a main battery.

2. Memory back up:The back-up battery built in the instrument needs to be charged approximately 24 hrs before using it for the first time after purchase. Connect the fully charged battery to the instrument in order to charge the back-up-battery.

6 Setting up the ETS Instrument

6.1 Setting up of the Tripod

Setting up a wooden/aluminium tripod is the first step in preparing for a Total Station survey. It provides a stable platform for the instrument, ensuring accuracy and reliability in measurements.Provides a stable base for accurate angle and distance measurements.

- Prevents instrument vibration or movement during use.
- Essential for precise levelling and centering of the Electronic Total Station.
- Proper setup of a wooden tripod is critical to the success of a Total Station survey. It ensures measurement accuracy and supports the reliable operation of the instrument throughout the survey.

Step by Step Procedure for setting up of tripod

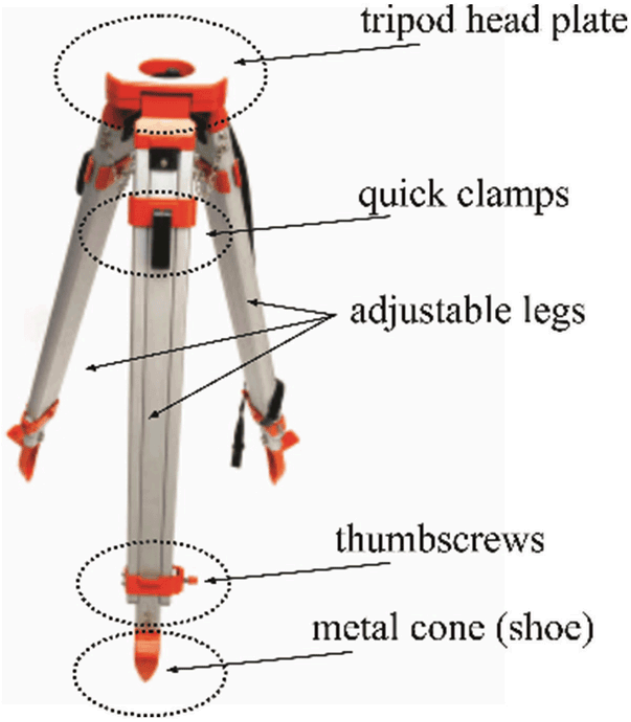
a. Loosen the thumb screws and extend the tripod legs as required (will depend on the height of the surveyor), tighten the thumb screws after extension of tripod legs.

   Note: care should be taken to tighten the thumb screws properly to ensure that the legs do not sink or slide upon mounting the ETS on tripod.

b. Check and adjust the tripod height so that the instrument is at a comfortable working level. Generally the tripod should be around sternum level of the Surveyor.

c. Firmly place the tripod on the ground by pushing the Metal cones (Shoes) of tripod legs in the ground and ensure its stability. It should be placed vertically above the control point marked on ground.Approximate centering can be achieved using a Plumb Bob.

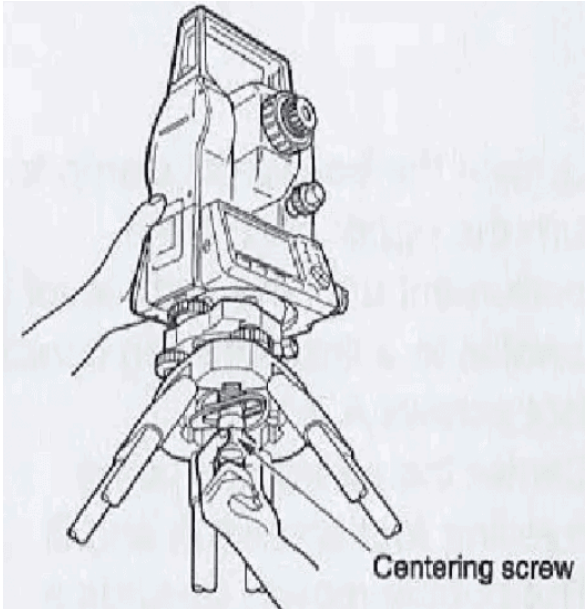
d. The tripod head plate of the tripod should be horizontal.



6.2 Mounting the ETS on Tripod

a. Carefully place the Total Station onto the tripod.

b. Secure it using the central fixing screw. The instrument



6.3 Levelling the Electronic Total Station

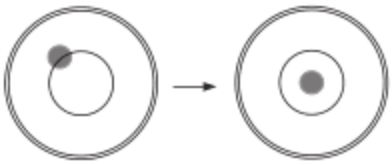
Levelling of a ElectronicTotal Station is the process of adjusting the instrument so that its vertical axis is truly perpendicular to the horizontal plane. This is done using the instrument's foot screws and electronic or optical level indicators.

Accurate levelling of the ETS is necessary for the following reasons:

- **Accuracy of Measurements:**
  Proper levelling ensures accurate angle and distance measurements. An unlevelled instrument can lead to significant errors in surveying data.
- **Instrument Functionality:**
  Many functions of the Total Station, such as horizontal angle zeroing and vertical angle referencing, depend on the instrument being level.
- **Reliable Data Collection:**
  Levelling is essential for reliable and repeatable measurements in topographic surveys, construction layout, and alignment tasks.

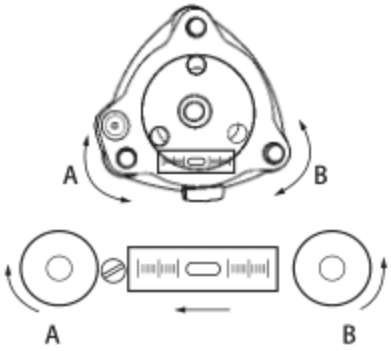
Step by Step Procedure for levelling the ETS

a. Use the circular bubble level to level the instrument.

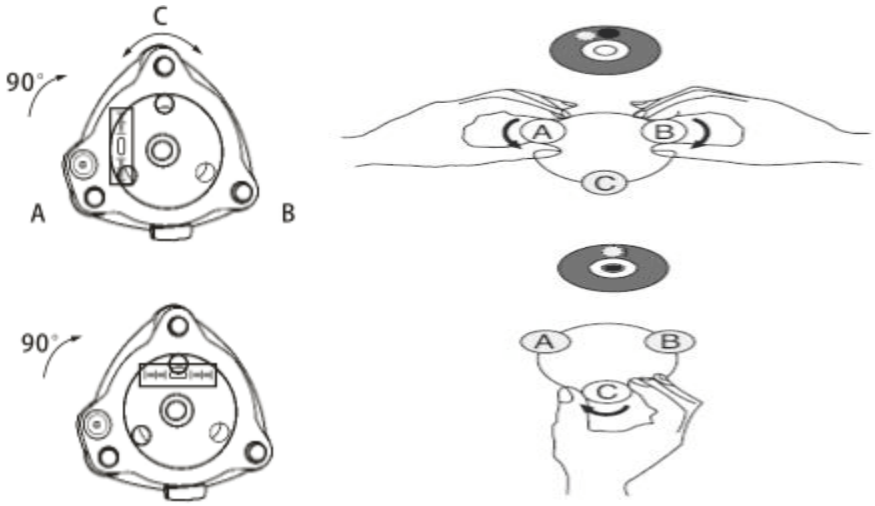


b. Adjust the tripod legs if necessary.

c. Use the three levelling screws to fine-tune the level until the bubble is centered in the circular vial.



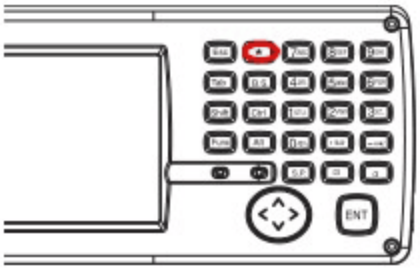
d. Turn each screw in opposite directions in pairs to maintain an even balance and prevent unnecessary tilting.

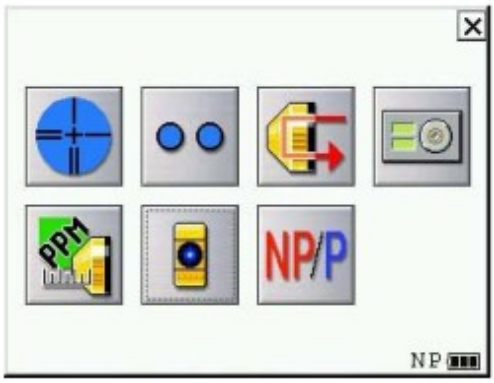


e. Make gradual adjustments to avoid overshooting the correct level position.

f. Check the electronic level in the Total Station's settings and make further adjustments as needed. The X & Y values should be less than 10"

Note: press * key on the keypad to invoke the Digital circular level settings of the instrument.





g. Reconfirm the level status after all adjustments to ensure accuracy before proceeding.

6.4 Centering over a Known Control Point

Centering the Total Station involves positioning the instrument exactly over a known control point (also called a station point) using a plumb bob or optical/laser plummet. This ensures that all horizontal and vertical measurements originate from the correct location.

Importance of Centering is as follows:

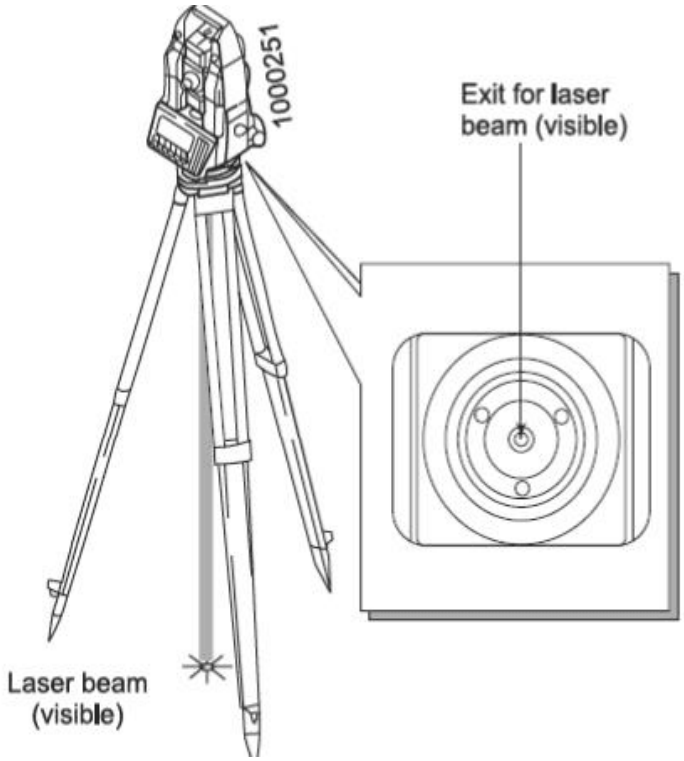
- Ensures that all measurements (angles, distances, coordinates) are referenced to the correct geographic location.
- Prevents positioning errors, especially over large distances.
- Critical for control surveys, traversing, and layout work where accuracy is essential.
- Poor centering can cause horizontal and vertical errors in the survey data.

Step by Step Procedure for centering of ETS

a. Use the optical plummet or laser plummet to align the instrument over the control point.

b. Adjust the tripod legs slightly to position the instrument correctly.

c. Recheck the levelling after final adjustments.



6.5 Setting up of Prism at Backsight Station

Setup of the prism at the backsight point is essential for establishing the Total Station's orientation and ensuring precise measurements. It forms the foundation for accurate surveying work in an occupied backsight setup.

Importance of Prism Setup:

- Provides a known direction (backsight) to orient the Total Station.
- Ensures accuracy in horizontal angle measurements and instrument orientation.
- Crucial for traversing, resection, and layout surveys.
- Poor prism setup can result in errors in angle and distance readings.

Step by Step Procedure for Setting up of Prism at Backsight Station

a. Assemble the Prism Pole

b. Attach the prism to the prism pole securely.

c. Ensure the prism is clean and free of obstructions.

d. Place the prism pole precisely over the designated survey point.

e. Use the built-in bubble level on the prism pole to ensure that it is placed upright.

f. If using a tripod-mounted prism, securely attach the pole to the tripod.

g. Adjust the height of the prism according to the required specifications.

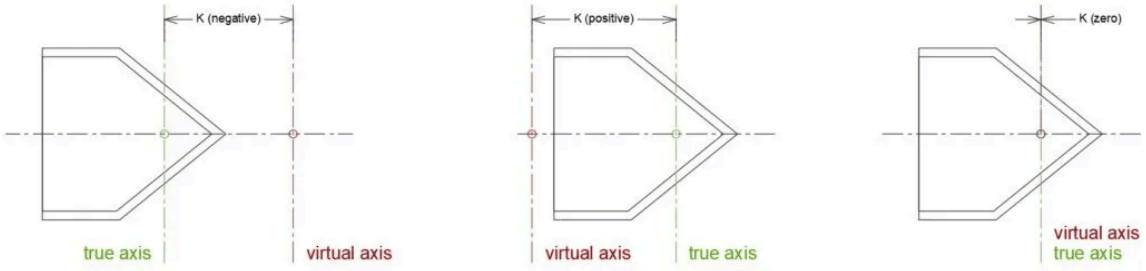
h. Align the prism pole with the Total Station's line of sight.

i. Double-check the height settings and ensure accurate placement before proceeding with measurements.

6.6 Prism Constant and Prism Offset

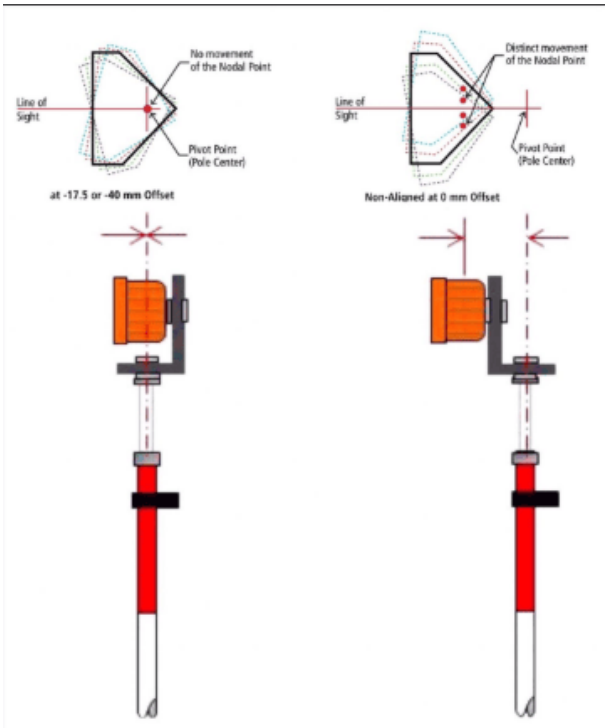
6.6.1 Definitions

Prism Constant: A fixed EDM correction value representing the difference between the physical centre of the prism and the optical reflection point.



K - negative K - positive K = 0

Prism Offset: The physical distance between the prism's optical centre and the actual survey point on the ground, usually represented by prism pole height.



Prism Constant is an instrumental correction automatically applied by the Total Station EDM. Each prism has a manufacturer-defined constant that must be correctly set in the instrument before observations.

6.6.2 Typical Prism Constant Values

- Leica Standard Prism: +34.4 mm
- Trimble Standard Prism: −30 mm
- Mini Prism: −17.5 mm
- Topcon:--30 mm or 0 mm
- 360° Prism: 0 mm (or manufacturer specific)

6.6.3 Comparison table

Aspect	Prism Constant	Prism Offset
Related to	Prism optics	Physical setup
Entered where	Prism settings	Prism/Target height
Nature	EDM correction	Geometric offset
Error effect	Same error in all distances	Height & coordinate error
Controlled by	Manufacturer	Surveyor/Operator

Prism Constant corrects the measurement path, Prism Offset corrects the survey point

6.6.4 How Prism Constant Affects Observations

Effect on Distance Measurement

- Wrong prism constant causes a **systematic error** in all measured distances.
  Example:

    - Error of **+30 mm** prism constant
    - Every measured distance will be **30 mm longer** than the actual.

Practical Impact

- Traverse mis-closure
- Coordinate errors
- Poor stake-out accuracy
- Discrepancies between GNSS and ETS results

6.6.5 How Prism Offset Affects Observations

Effect on Positioning

- If prism offset (pole height or target height) is incorrect:
    - Elevation will be wrong
    - Horizontal position may also shift for inclined sights

Example

- Actual prism pole height: **2.000 m**
- Entered height: **1.950 m**
- Error in elevation: **50 mm**

6.6.6 Field Best Practices

- Always verify prism constant before starting work
- Use **the same prism type throughout a traverse**
- Clearly label prisms with their constants
- Measure and recheck prism pole height frequently
- Never mix mini prism and standard prism without changing settings
- Include prism constant details in field book / observation log

7 Creating a Job in ETS.

TopSURV is the field software used with Topcon Total Stations for managing survey data and operations. One of the first steps before starting a survey is creating a job, which acts as a container for all collected data such as points, measurements, and settings.

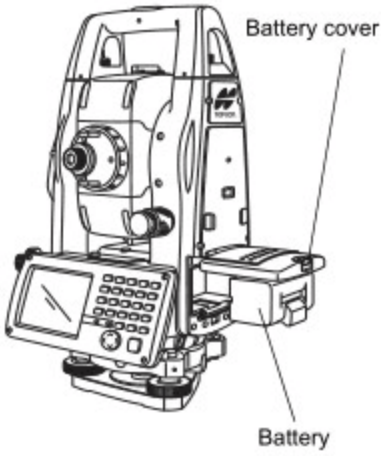
Importance of Job Creation:

- Organizes all survey data under one project.
- Ensures correct coordinate system and measurement units are used.
- Prevents data mixing or loss between different projects.
- Allows for easy data export and management after the fieldwork.

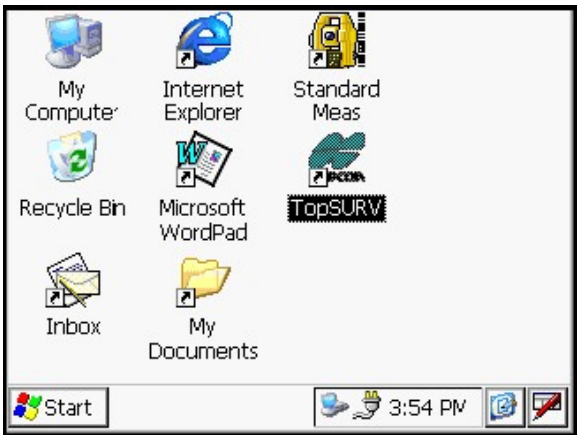
7.1 Creating a New job in TopSurv

Step by Step Procedure for Creating a New job in TopSurv

➤ Place the battery in the ETS, Switch on the ETS.

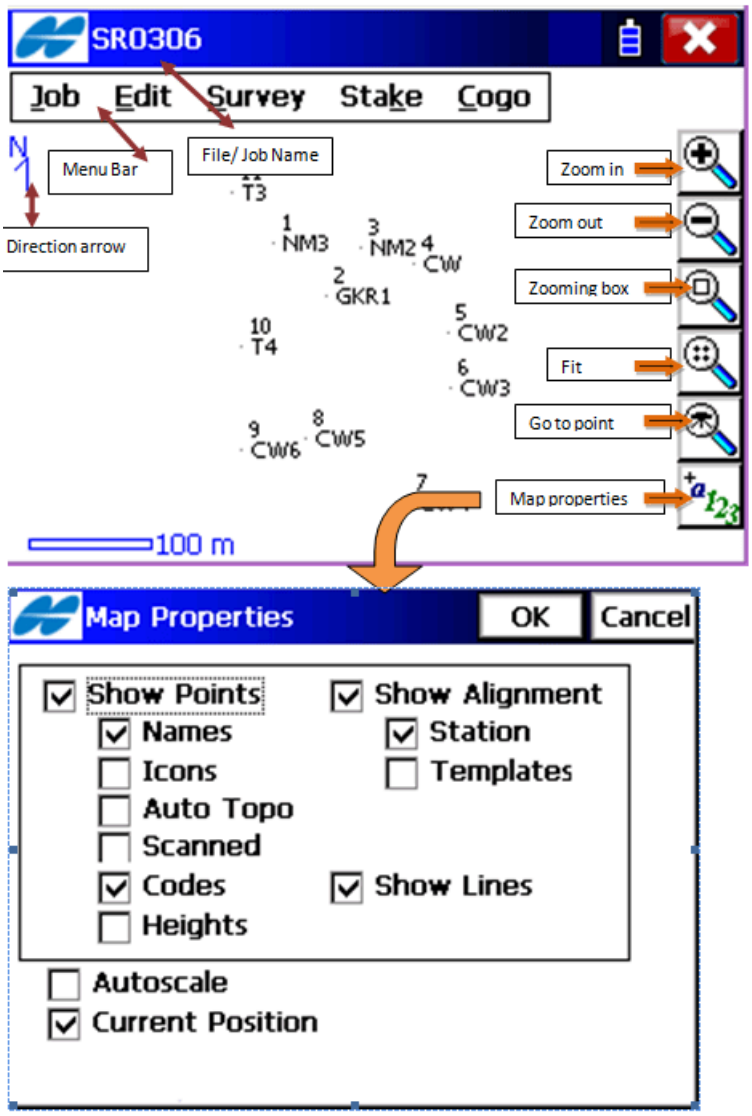


➤ Double-Click on the Topsurv Icon visible on the screen.

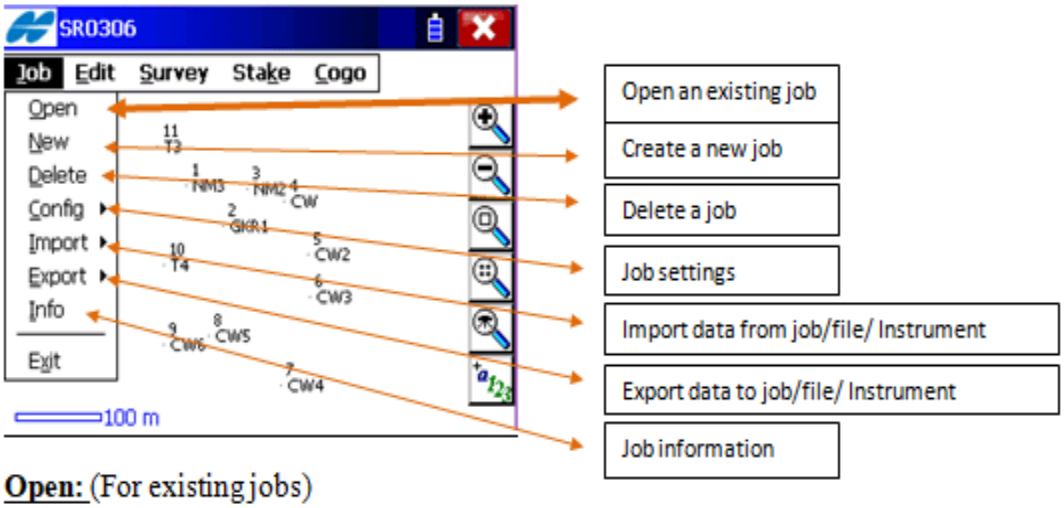


- The Topsurv application will open. (*Note*: previous job will open by default) The screen and its options are as below.

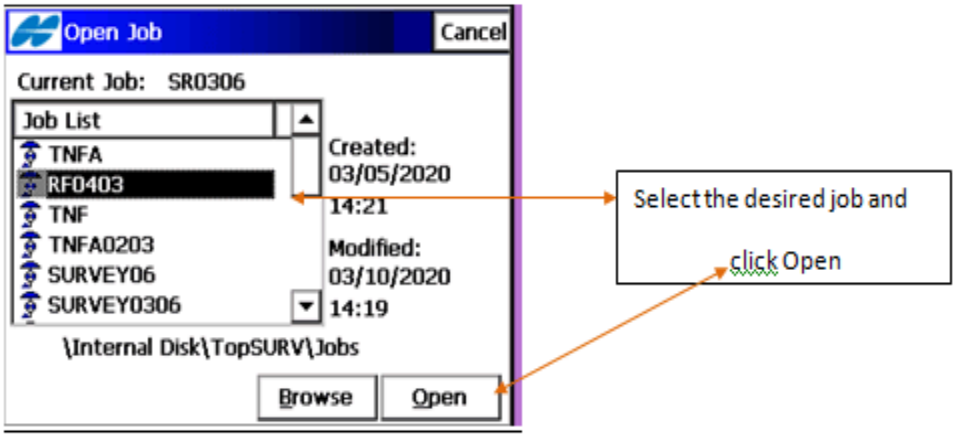
- The Topsurv main window details as under


SR0306
Job
Edit
Survey
Stake
Cogo
N
Menu Bar
File/ Job Name
Direction arrow
Zoom in
Zoom out
Zooming box
Fit
Go to point
Map properties
T3
1 NM3
3 NM2
4 CW
2 GKR1
5 CW2
10 T4
6 CW3
9 CW6
8 CW5
7
100 m
Map Properties
OK
Cancel
Show Points
Names
Icons
Auto Topo
Scanned
Codes
Heights
Show Alignment
Station
Templates
Show Lines
Autoscale
Current Position

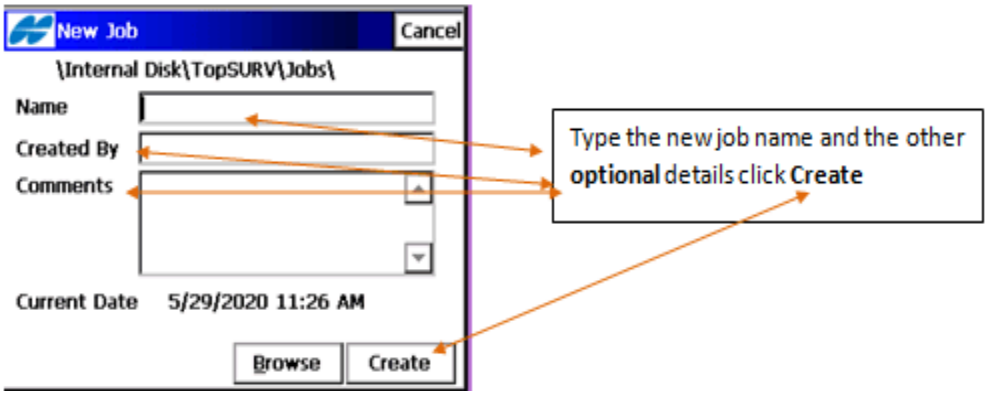
➤ The job options will be as below.



Open: (For existing jobs)



Create a new job:



- Click job>> New. Enter the new job name. (A valid job name comprises of alpha/numeric characters).
- Enter the job description, surveyor name, and comments (Optional).
- Press >> Create
- The created job will be stored in IE files in internal disk of the ETS and its extension will be .tsj.

7.2 Setting up of the Job Parameters

After creating a new job in TopSURV, the next crucial step is setting up parameters. These parameters define how the Total Station will collect, process, and store data, ensuring the job runs smoothly and accurately according to project requirements.

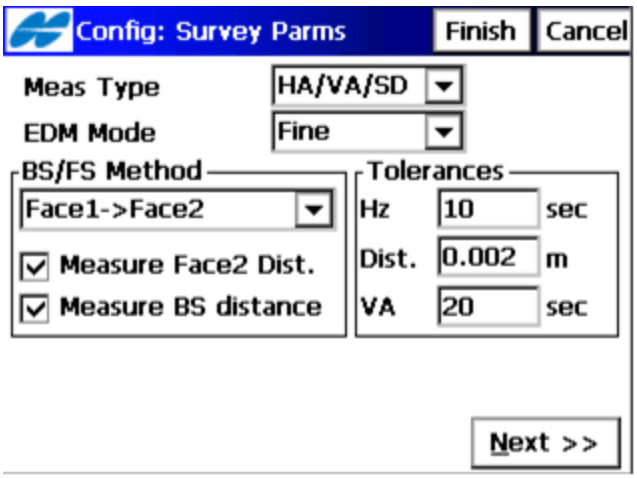
Importance of Setting Parameters:

- Ensures measurement accuracy and consistency throughout the survey.
- Tailors the system to specific project needs (e.g., construction, topographic survey).
- Prevents data errors caused by incorrect units or instrument configurations.
- Saves time by automating defaults for repeated use in the same project.

Step by Step Procedure for setting up of Job Parameters

Press: Job >> Config (Configuration)

1. Select>> Survey (set parameters as shown)>>Next>>Finish

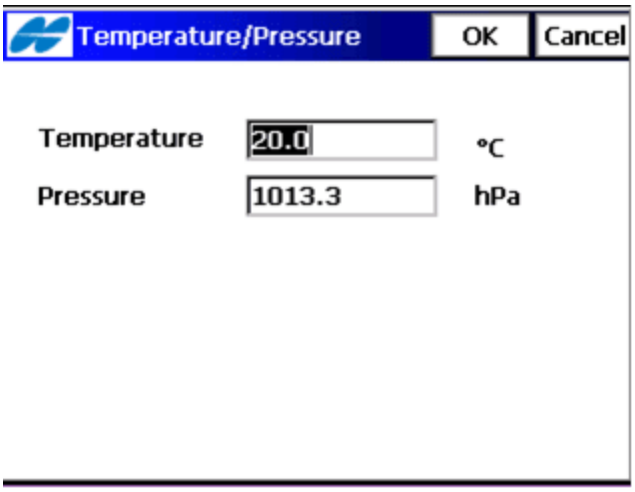


Traverse can be done by using only one prism or by using multiple prism.

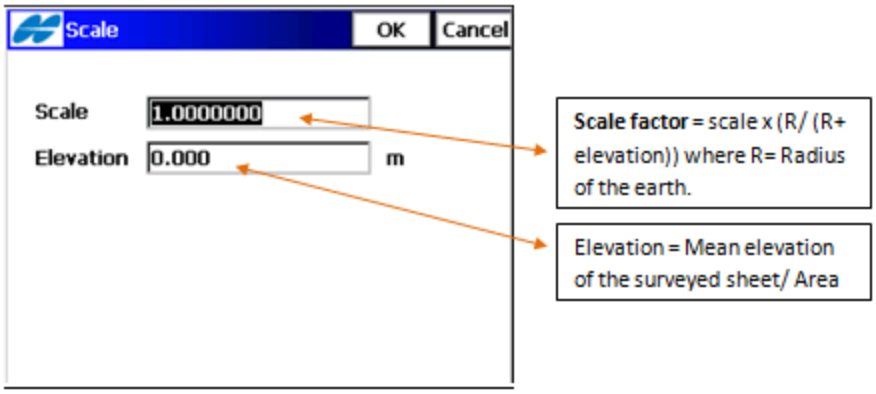
i. One Prism: If only one prism is used you have to select the option of“Face1&Face2”(means to measure one Foresight in both face1 and face2 before measuring the next Foresight.) in Config: Survey Parms. First Screen BS/FS Method (Parms-Parameters)

ii. Two Prism:If the user has more than one prism set we can survey using“Face1->Face2”(means to measure all Foresights in face1 before measuring them in face2.) in Config: Survey Parms. First Screen BS/FS Method

2. Select >> Temperature (fill as per present values) >> OK



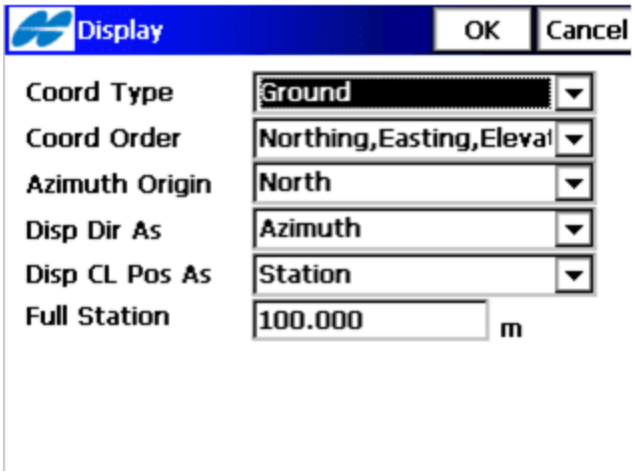
3. Select >> Scale Factor (choose as below) >> OK



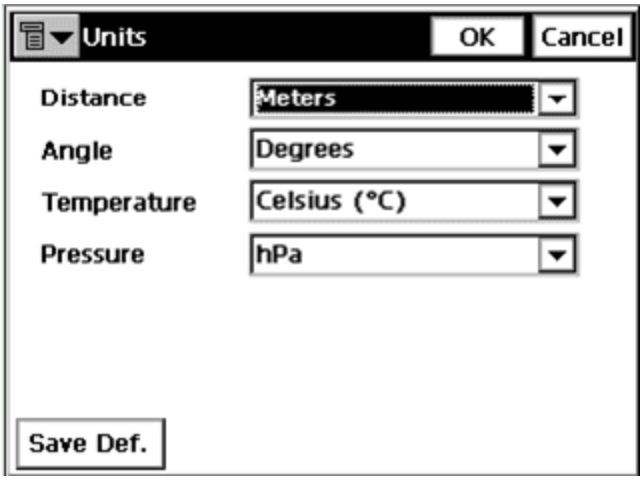
- The Scale Factor converts the ground distances to the grid distances and scales the average mapping factor.

- Scale: the value of projection scale. Range from 0.9 to 1.1.for Everest ellipsoid, and for UTM Grid it is 1.0004 for Hyderabad

4. Select >> Display (Enter as shown) >> OK



5. Config>>units (set units as below)



7.3 Adding Coordinates of Known Control Points

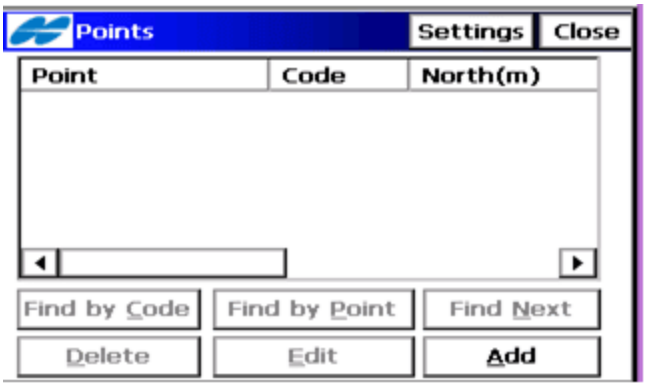
When working on a job, it's often necessary to add known station coordinates (e.g., control points) to properly orient the instrument and start surveying accurately.

Adding coordinates of known stations is a fundamental step in ensuring survey accuracy, orientation, and data consistency. In TopSURV, this is done through the Station Setup process by entering the known coordinates and completing a proper backsight.

Step by Step Procedure for adding coordinates of known control points in TopSurv

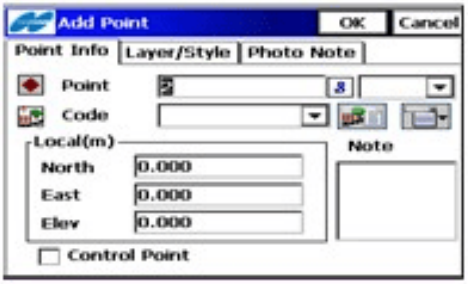
➤ Menu: Edit >> Point >> Add

1. Enter the Easting, Northing and Elevation of both the known points. Control Point A to be saved as Point 1, Control Point B to be saved as Point 2
2. Check on the box for Control point.



➤ Enter point serial no., code, easting, northing and elevation. If this is a control point, check the box on.

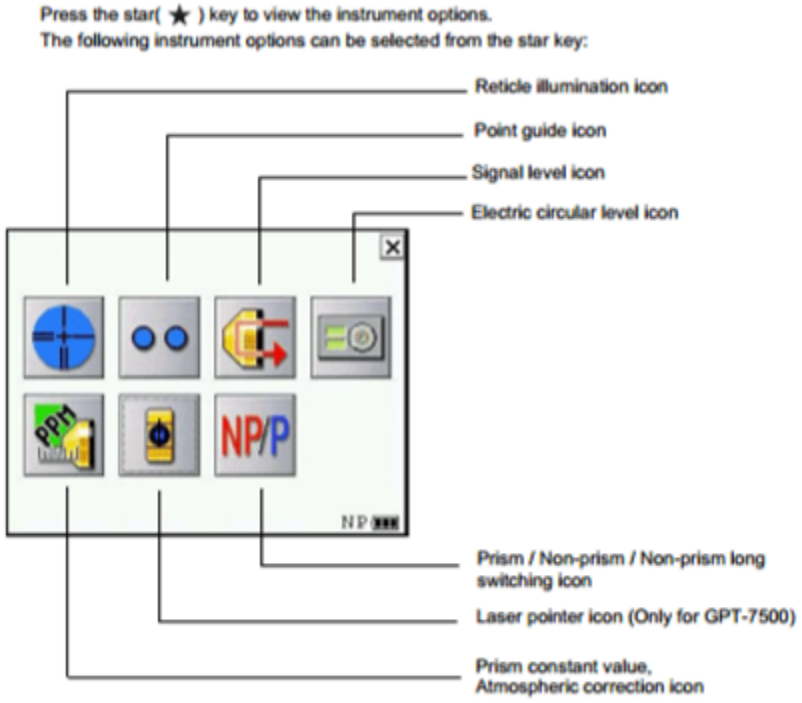
➤ Any No. of control points can be added here. All the control points should be added before starting the work.



8 Work at First station (Start of Traverse)

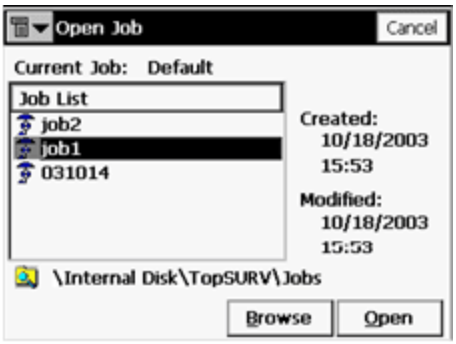
8.1 Selection of job

1. Centering and levelling of the Topcon – 7501 as per serial no. 6.3 & 6.4
2. Press the Star (*) key to view the instrument options.



3. Select Electric circular level icon and see that on both scales the levelling error should be within 10”.

4. Select the Laser icon and see that the red laser beam is falling exactly on the point on which the instrument is erected truly vertical.
5. Press ESC key to view the Windows CE desktop.
6. Now select the and open
7. Now select the JOB and open
8. The following box opens.



8. Check up in the CURRENT JOB status is it your job? if yes>> Open
9. If the current job is not your opted job then select the appropriate job by browsing. Once the job is opened.

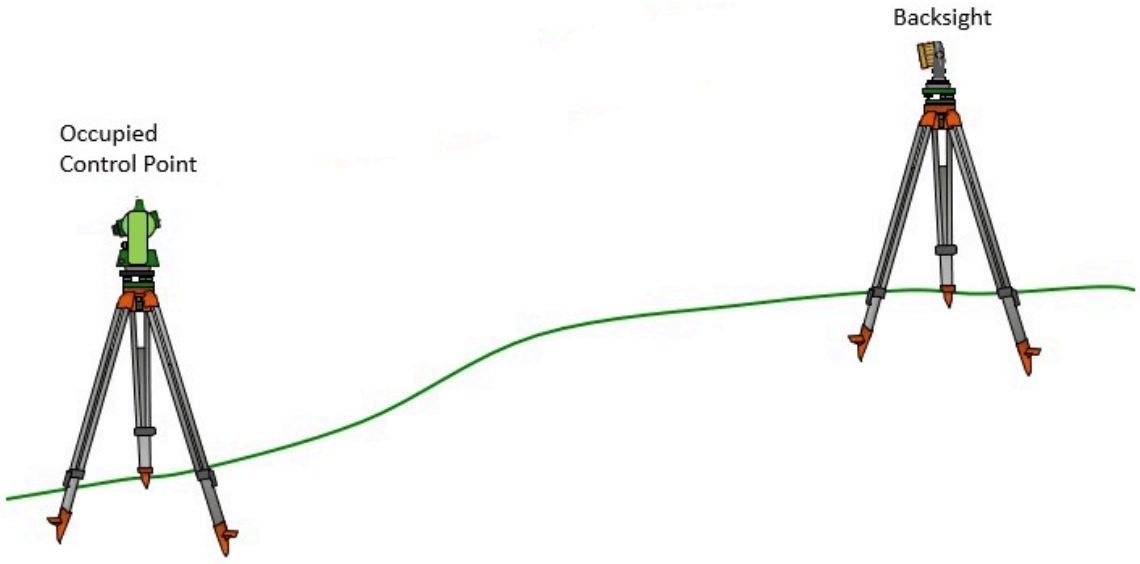
8.2 Orientation of ETS

Orientation of a total station refers to the process of setting up and aligning the instrument at a known point (station) with respect to a reference direction (usually true north or a backsight point). This involves establishing the instrument's position and angular reference so that all subsequent measurements are accurate and consistent within the coordinate system.

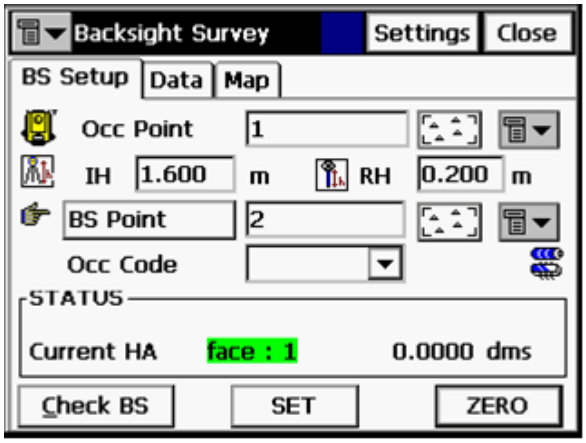
Importance of Orientation:

1. **Accurate Angular Measurements:** Ensures horizontal angles are measured relative to a true reference, avoiding directional errors.
2. **Correct Coordinate Calculation:** Enables the total station to calculate precise coordinates of new points relative to the job coordinate system.
3. **Efficient Layout and Design:** Critical for setting out structures and boundaries exactly as planned.

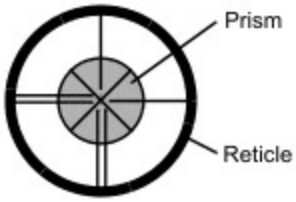
Step by Step Procedure for Orientation of ETS using 2 known points



a. Menu: Survey >> Occ/BS Setup



- Sight and focus the ETS to the prism placed at Control point B
- While focussing on the target prism the cross wire must be clearly visible and must intersect the centre of prism.



- Measure the Height of the ETS (IH) and Prism (RH) using a measuring tape
- Enter the Occupation point No. as 1 , In this case it is (Control Point A) from List
- Select Back sight point, in this case point no 2 (Control Point B) from list.
- Instrument Height (IH) and Reflector Height (RH=00) are to be entered.
- Sight the Back sight prism after proper intersection (Cross hair) on Face 1-Set
- A beep sound will come. Press check BS. The error in Easting, Northing and Elevation will be displayed. This error should be within the permissible limit (preferably in mm).

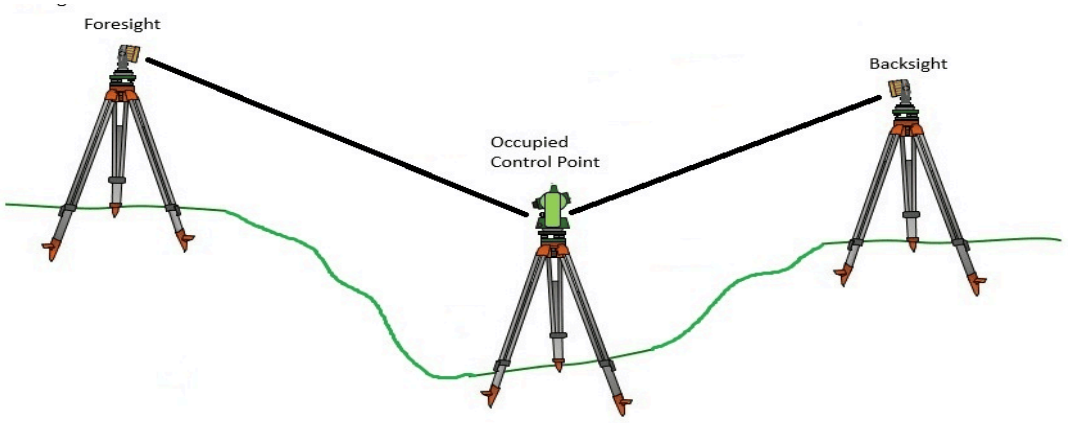
8.3 Traverse using Two Prisms

Traverse is a surveying method used to establish control points by measuring distances and angles from known stations. When using an Electronic Total Station (ETS), a traverse can be set up by occupying one known station and using another known station as a backsight to orient the instrument.

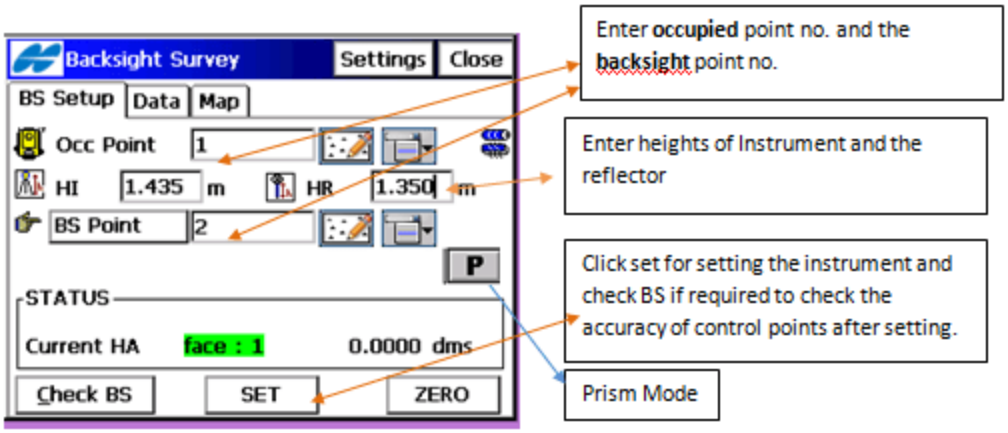
Importance of Traverse Using Two Known Points:

1. Improved Accuracy and Control: Using two known points to orient the instrument minimizes angular errors and enhances positional accuracy.
2. Reliable Orientation: Ensures the total station is correctly aligned within the coordinate system, providing a stable reference for all subsequent measurements.
3. Flexibility in Fieldwork: Allows setting up the instrument at multiple stations with reliable orientation, useful for covering large or irregular sites.
4. Data Consistency: Coordinates of new points are directly related to the known control network, ensuring uniformity.
5. Error Detection: Comparing measurements between two known points helps detect and correct mistakes early in the survey.

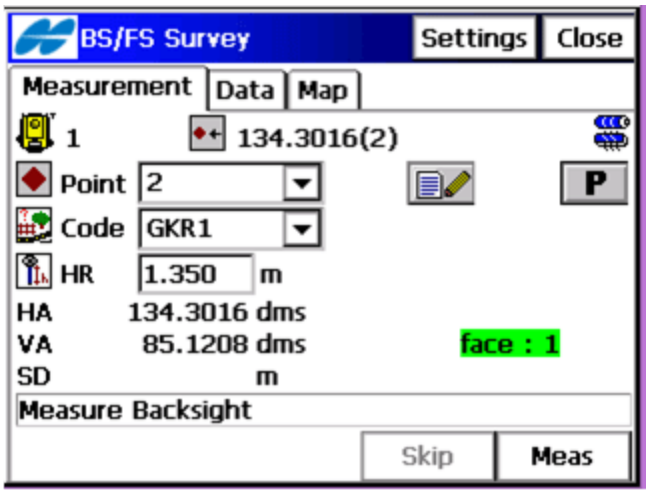
Step by Step Procedure for conducting a Traverse using 2 known points



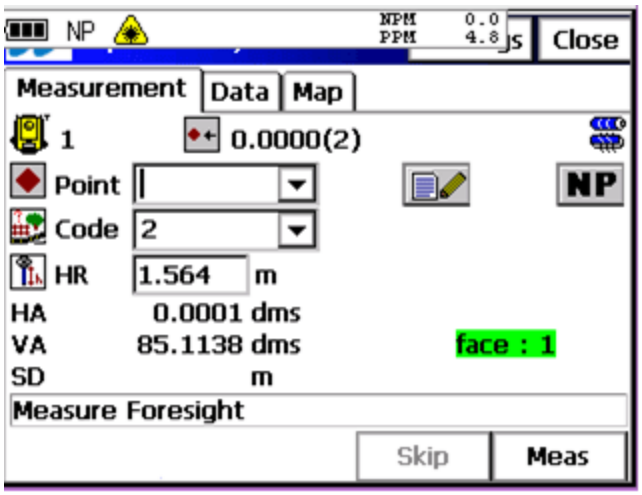
- Now, Select Survey and select BS/FS Survey (care should be taken to not disturb the focussing and orientation of the instrument)
- The Instrument is focussed at Backsight.(To avoid instrumental error one particular leg of the Instrument tripod should face the backsight always)
- The instrument is in Face:1 (This will be indicated by the message"Face:1" in green colour on the screen.



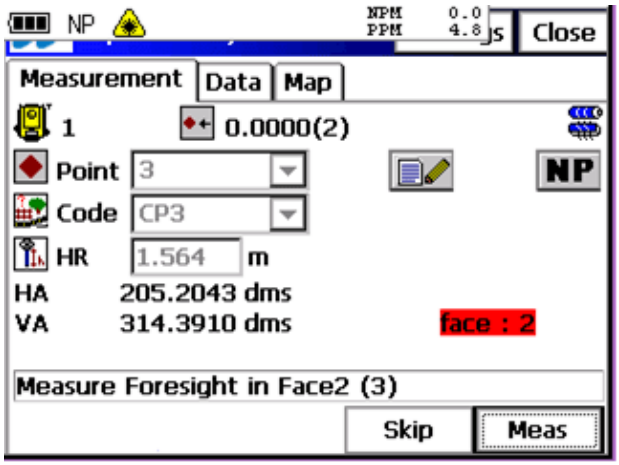
- The BS/FS screen will show the instrument point as well as the backsight point.



- Now Measure the backsight. A beep sound will come.



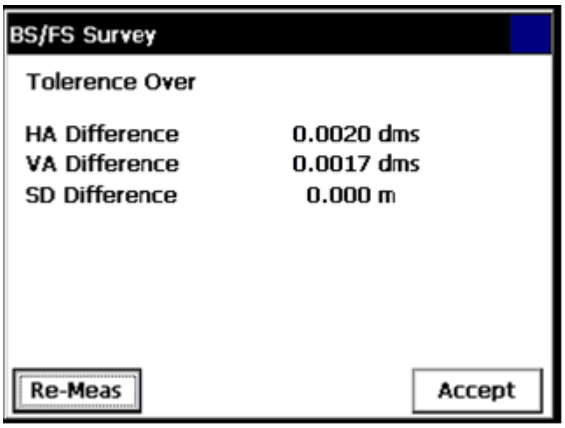
- The message" Measure Foresight" will appear
- Now aim and focus on the forward point/ Foresight. (Unknown).
- Enter its Point number. eg 2 and its code eg T2
- Focus and measure the Foresight point.
- Now Transit the telescope to start measurement in Face:2
- Measure backsight on Face 2 (Message appears)
- A message"Face:2" will appear in **red colou**r on the screen. Note: The horizontal and Vertical adjustment screws will now be on your left hand side.



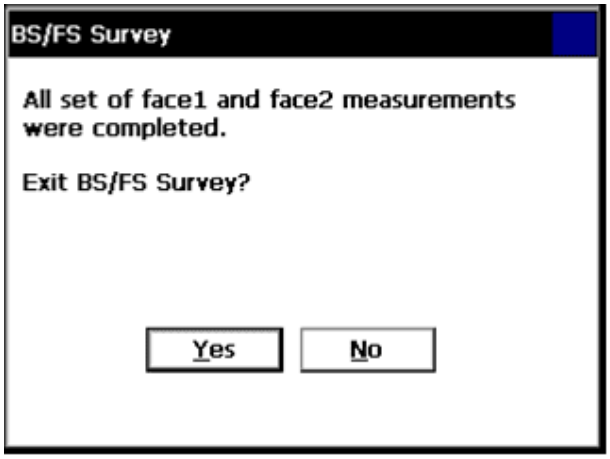
- Now measure the Foresight.Note: the measurement mode should be
- Rotate the instrument to face the Backsight. Focus and measure the Backsight in Face:2 After taking a double face measurement, if the differences between face1 and face2 measurements are over than the tolerance value defined in Con-fig settings, warning message will be displayed.(This box will appear only when the measurements are out of tolerance otherwise it wont appear. The measurements are recorded directly indication

for this is the point no changes to next observation point number.)

- A dialog box will appear showing the tolerance parameters of this observation.



- Accept if measurement is within tolerance limits else Re measure.
- After completion of observation a dialog box will appear informing that the BS/FS measurements were completed.



- Press Yes.
- On main Menu goto Edit>>Points check if coordinates of Foresight have been recorded. if Yes shift the instrument. If no then repeat the observation.
- Shift the Backsight to the present Instrument position. Shift the Instrument to the Foresight position & Shift the Foresight to the 4th unknown point.Carry on similarly and close on 2 known points.
- Note: Before any measurement check the levelling and centering of the Instrument to avoid any angular and distance errors.

8.4 Traverse Adjustment

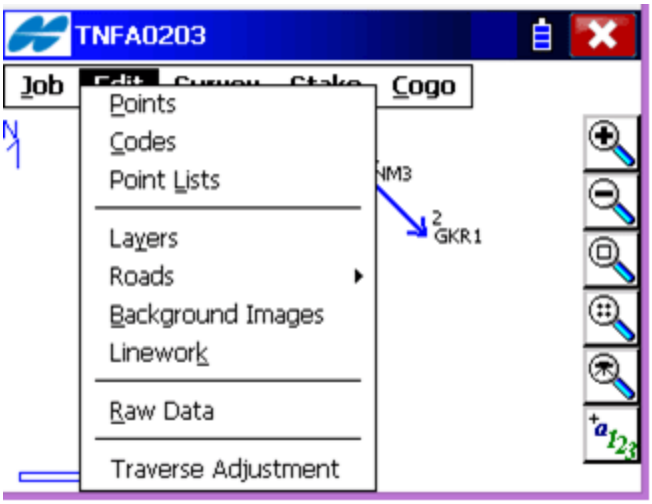
Traverse adjustment in TopSURV refers to the process of correcting and balancing a traverse network to minimize measurement errors and ensure accurate coordinate results. In Topcon Total Stations using TopSURV field software, this function is used after measuring a series of traverse legs (distances and angles between known and unknown points).

Importance of Traverse Adjustment:

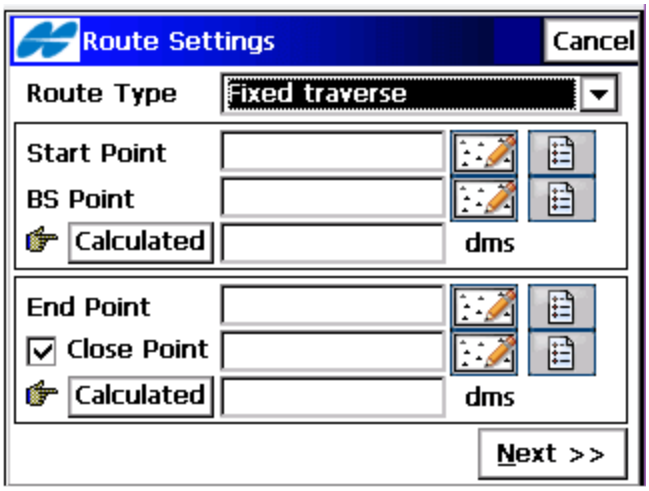
- Reduces measurement errors accumulated during traverse.
- Ensures coordinate accuracy for all points derived from the traverse.
- Provides a balanced and closed network, essential for reliable mapping, construction, or boundary work.
- Enhances the overall precision and trustworthiness of survey data.

Step by Step Procedure for Traverse Adjustment in Topsurv

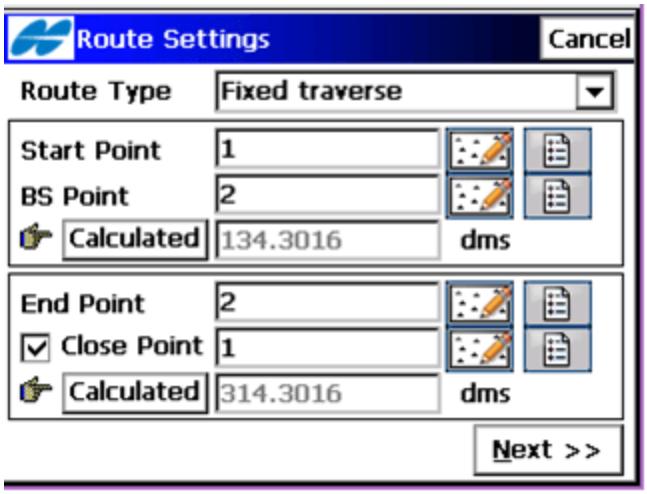
➤ Goto Main menu>> Edit>>Traverse Adjustment



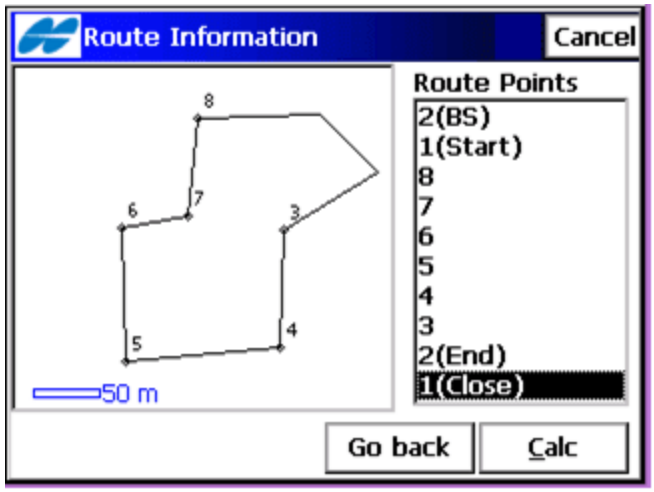
➤ Choose Open/Fixed Traverse.



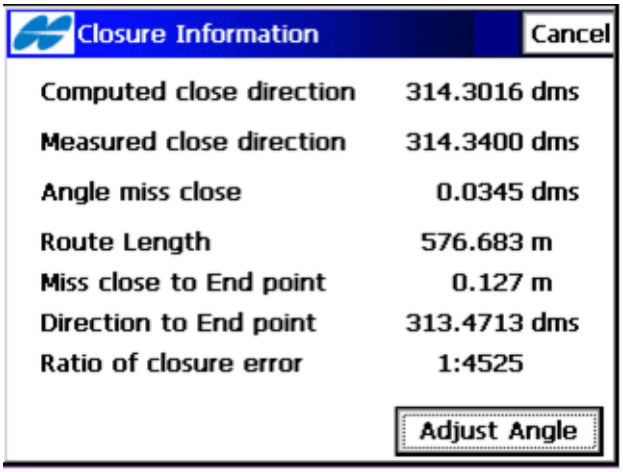
➤ Enter Start point and Close point



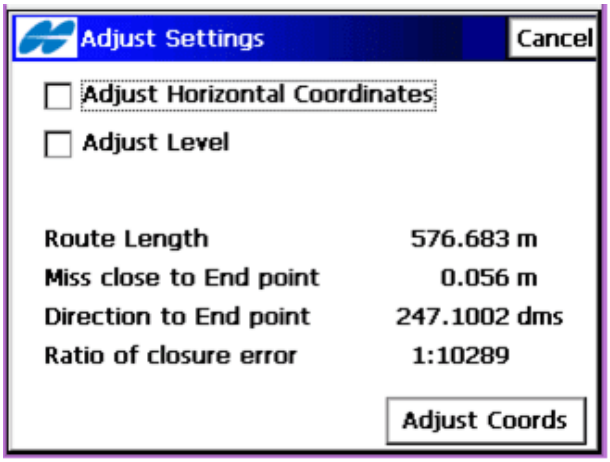
➤ Click Next



➤ Click>>Calc

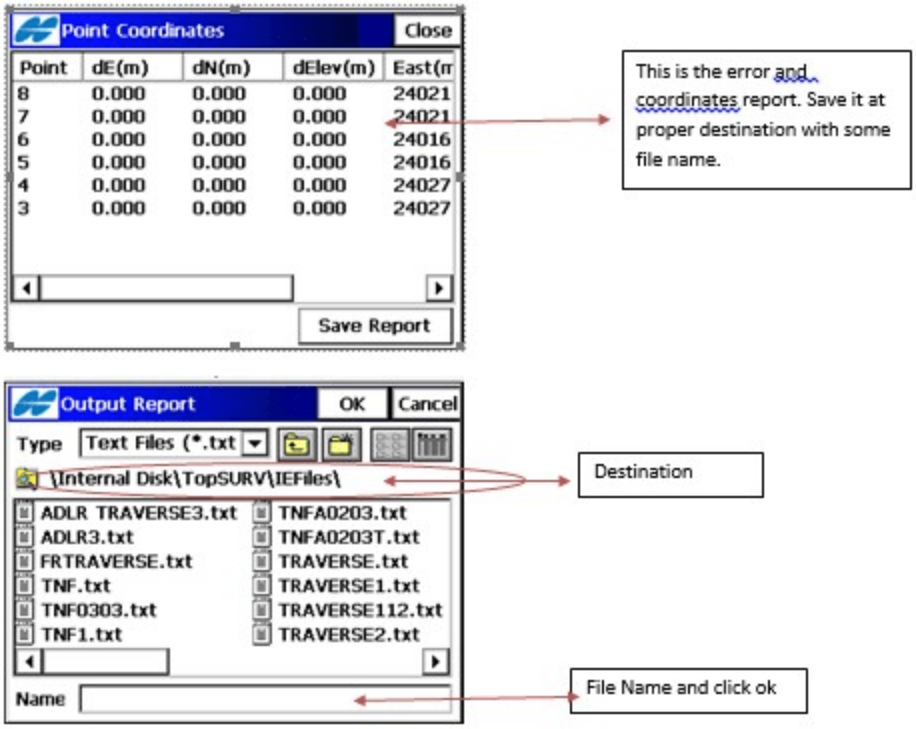


➤ Check on Adjust Horizontal Co-Ord, Adjust Level & Adjust side shots. Click on Adjust Coords.



➤ The traverse will be adjusted and adjusted coordinate △E and △N values will be displayed.

➤ The length of traverse, Angle & Distance mis-closure and Accuracy of Traverse will also be displayed.



- ➤ You can save this adjustment in a .txt file in the Internal disk of the ETS.
- ➤ Copy the .txt to an external flash/pen drive for taking printout.

9 Detail Survey (Data Collection)

A detail survey, also known as a topographic survey, is conducted to capture the precise locations and levels of natural and man-made features on the ground. Using a Total Station, this process becomes highly accurate, efficient, and digital.

Importance of Detail Survey Using Total Station:

- Provides high-precision data for engineering and construction projects.
- Ensures accurate mapping of terrain and features.
- Enables faster data collection compared to traditional methods.
- Allows real-time visualisation and checking of collected points.
- Essential for design, planning, and layout in civil and architectural projects.

9.1 Preparation for Detail Survey

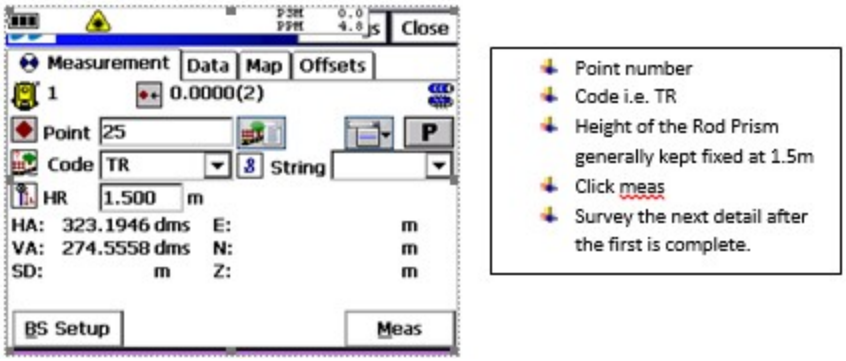
Before commencing detail survey, a probable code list is to be prepared. Example

- ➤ Tree TR
- ➤ Lamp Post LP
- ➤ Electrical Pole EP
- ➤ Hand pump HP
- ➤ Building B1, B2 etc.

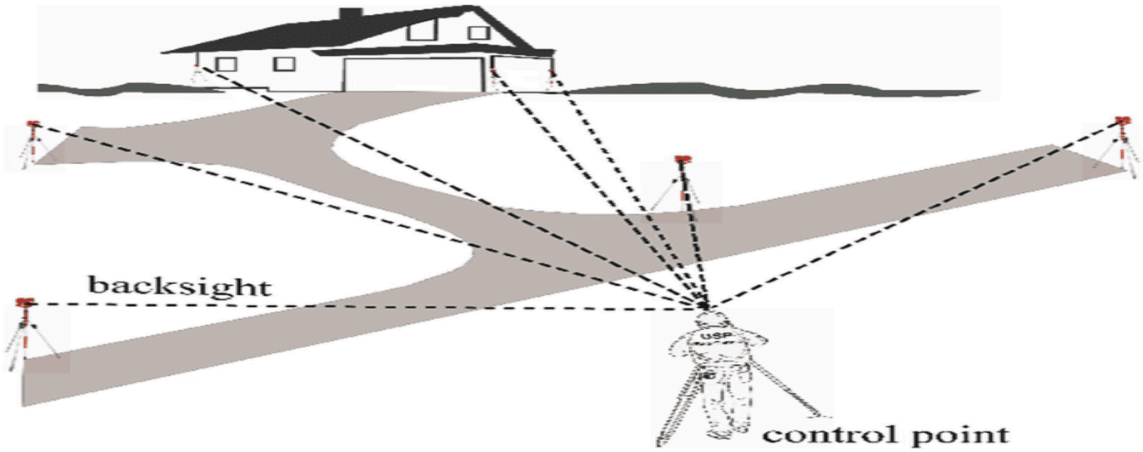
You can add any number of codes for the details to be picked up. It would depend on the Project Requirement.

9.2 Collection of details

- For detail Survey create a New job.
- Do the basic settings through config.(Configuration)
- Enter/ Import all the adjusted points that were saved after Traverse adjustment.
- Detail Survey is also a two step process.The first is the OCC/BS setup i.e. orienting the instrument into correct reference direction and is to be done as earlier.
- Goto Survey>>Data collection (here Detail Survey will be done in SSdir i.e. Side Shot Directory)



In this method all the detail points will be surveyed as point for point symbols, two end points for a line. Many points on the course for polyline detail and all the bend points for a polygon detail. Generalisation of detail survey will be done accordingly as per the plotting scale.



10 Stake Out (Relay of Known Coordinates)

The stake out function in a Total Station is especially useful when boundary pillars are missing or displaced. It allows surveyors to relocate accurately and mark the original positions of the boundary points based on recorded coordinates.

How it Works:

1. Known boundary coordinates (from previous surveys or land records) are entered into the Total Station.
2. The instrument is set up on a known reference point (control point), and a backsight is taken for orientation.
3. Using the stake out function, the Total Station calculates the direction and distance to each missing boundary pillar.
4. The surveyor moves as guided by the instrument to the exact location and places a new boundary marker or pillar.

Importance:

- Restores legal land boundaries accurately.
- Avoids disputes between neighbouring properties.
- Ensures compliance with land records and maps.

In summary, the stake out function in a Total Station is a crucial tool for re-establishing missing boundary pillars with precision and efficiency.

Step by Step Procedure for Stake Out (Relay of Missing Pillars) in Topsurv

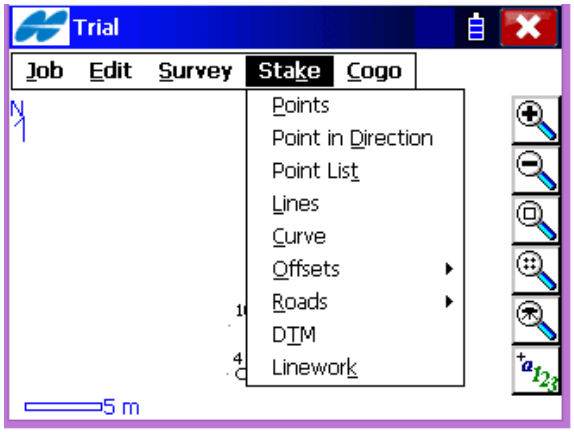
Enter the point to be relocated in the points menu through add. The steps are as followed –

- ➤ Enter the point or points to the points list (known on paper through coordinates but ground position not known i.e. ground position to be relocated).

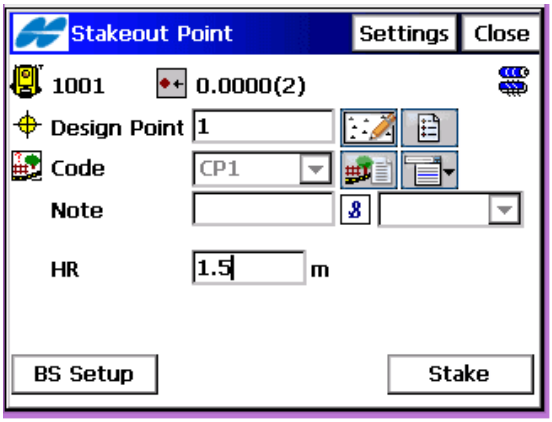
- ➤ Enter two nearby known points to the list of points (known means known on paper

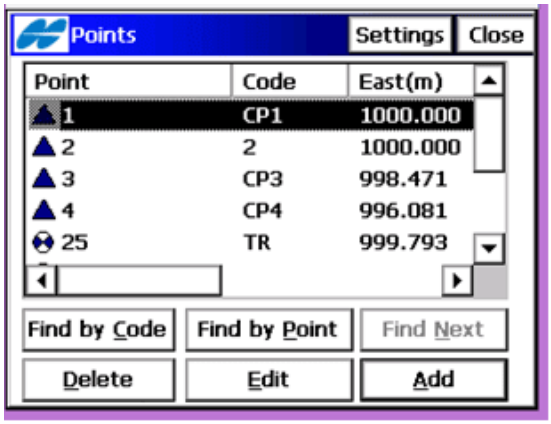
through coordinates as well as known on ground by position).

- Do the Occ/BS setup through Survey menu. Occ/ BS setup is a must.
- Go to the Stake menu and select points.

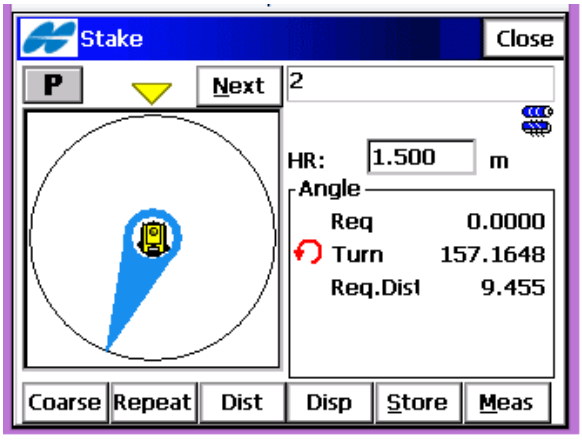


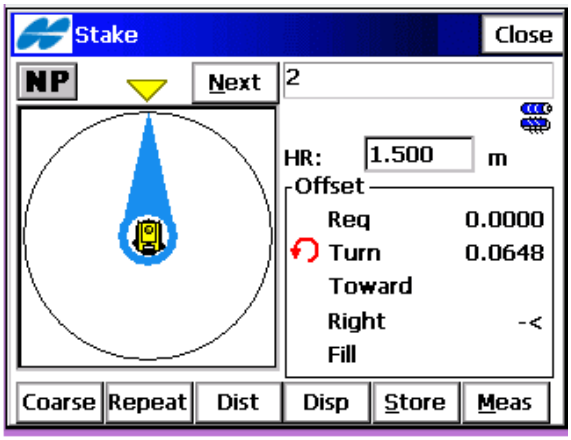
- Select the design point which has to be staked out. Note: Make sure that the coordinates have been entered/ stored in points.





- Press Stake. It will show the angle to be turned and required distance of the staked out point.





- Send the Prism pole in the direction as displayed on screen. Measure the prism.The required distance (+ or-) will be displayed.

- Repeat this process to pinpoint the missing point. The Required Distance and Turn to be shown as 0.00

- It is advisable to Stake out the missing point from two control points in order to confirm the location. This is crucial and necessary while locating Missing Boundary Pillars especially in International Boundary work.

11 Calculating Area in COGO

COGO (Coordinate Geometry) functions in a Total Station, such as those in Topcon's TopSURV, allow surveyors to perform geometric calculations directly in the field using coordinate data. One key feature is the calculation of area from a series of measured or stored points that define a closed boundary.

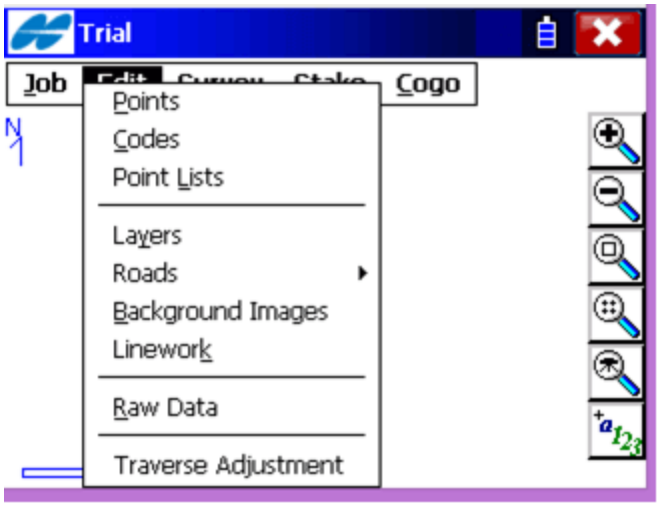
Importance of Area Calculation in COGO:

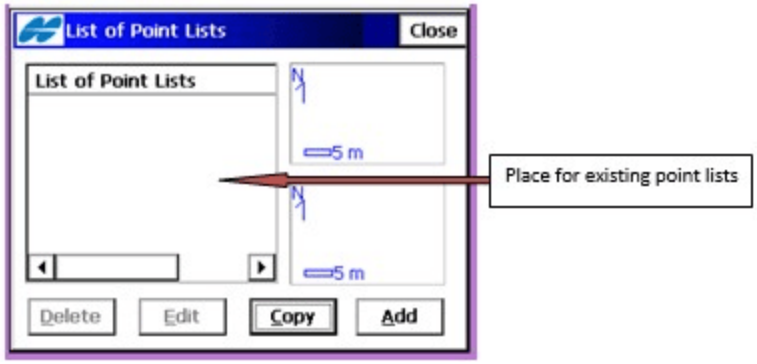
- Enables quick, on-site area determination for land parcels, plots, or construction zones.
- Saves time by eliminating manual calculations or post-processing.
- Ensures accurate and reliable results based on real coordinate data.
- Useful for land division, planning, earthwork estimates, and property documentation.

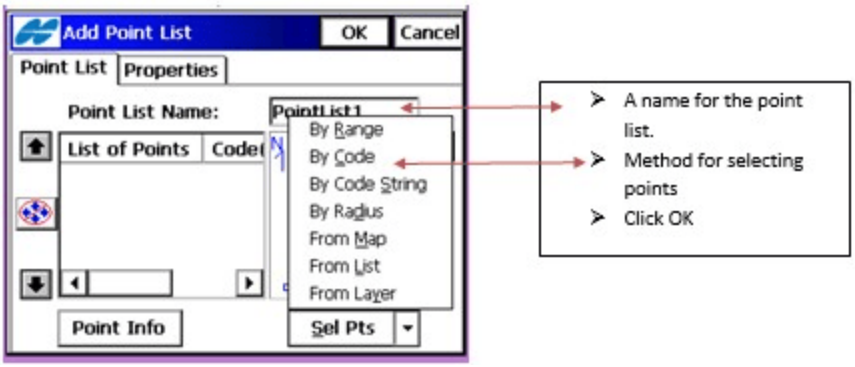
Step by Step Procedure for calculation of Area using Cogo function in Topsurv

➤ Creating Point List

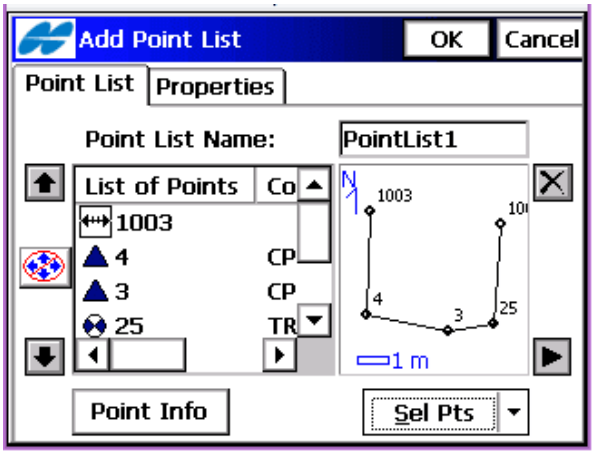
➤ Go to Edit and select Point List: Select all the points to be added to the list.

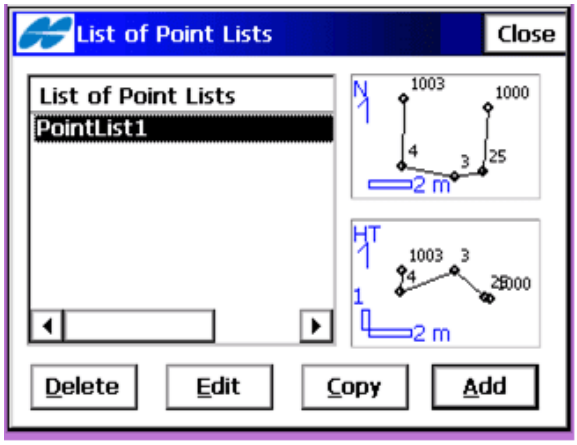




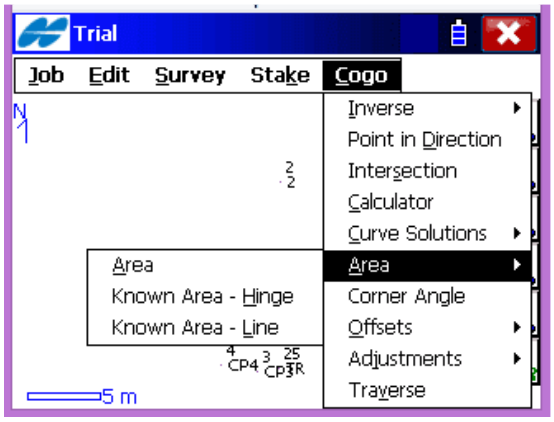


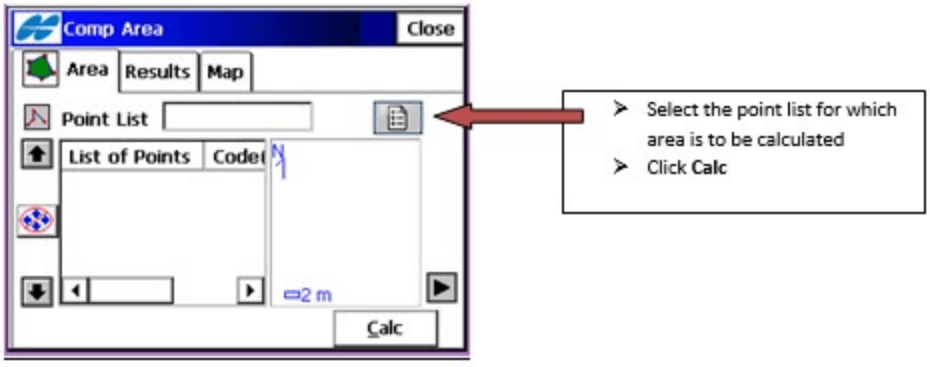
➤ Select points either by code or from list.

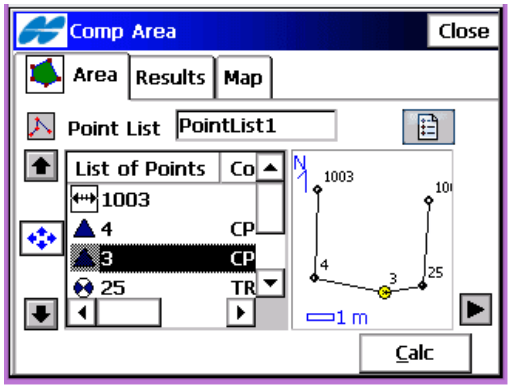




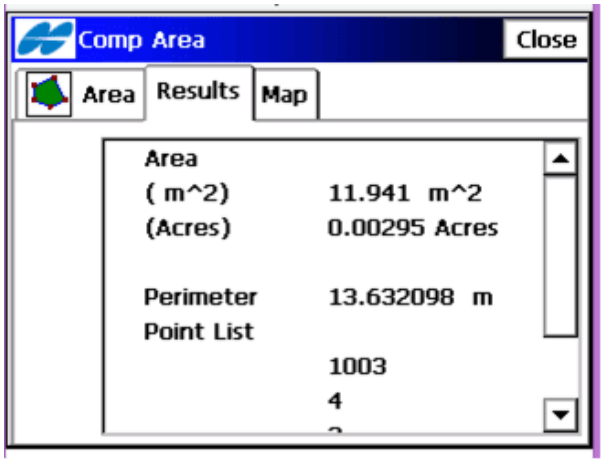
➤ Goto Cogo>>Area>>Area



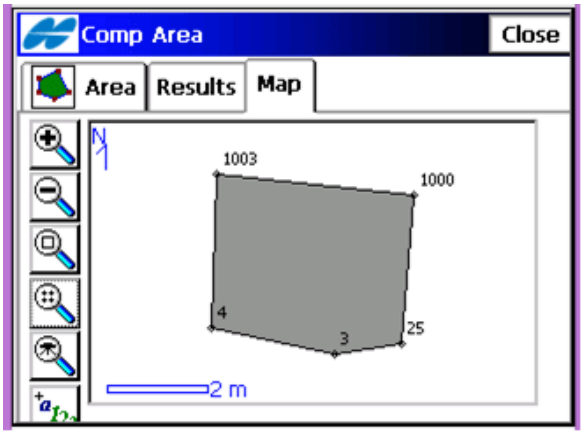




➤ The computed area with perimeter will be displayed.

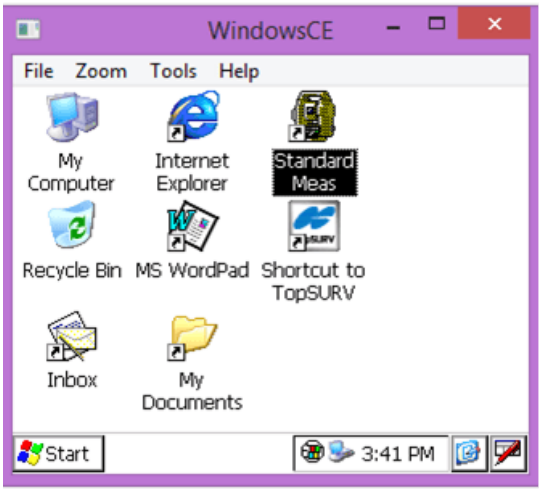


➤ The Map of the Area will be displayed in the Map Menu

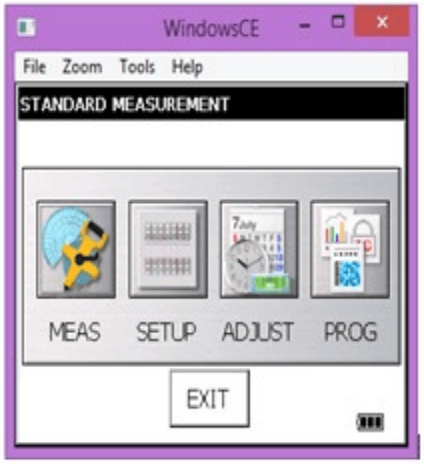


12 Standard Measurement

➤ Click on Standard Meas on the Main screen

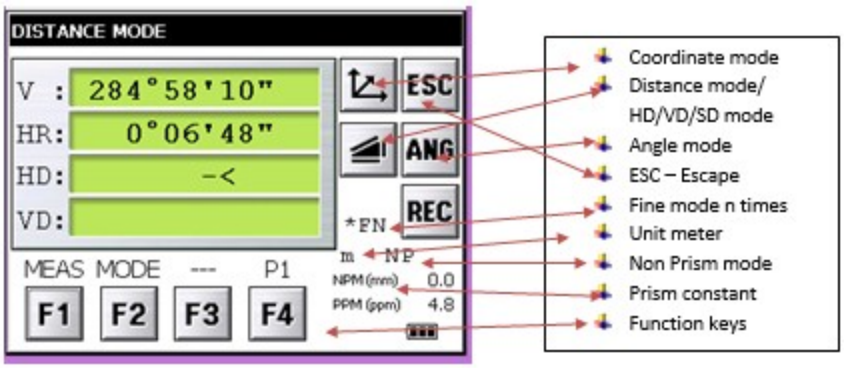


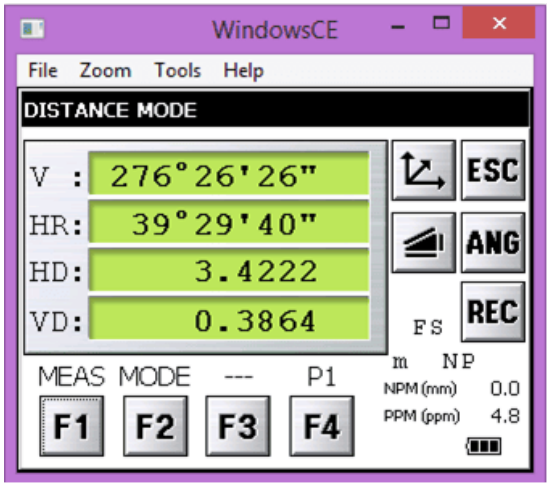
➤ The Following options will be visible



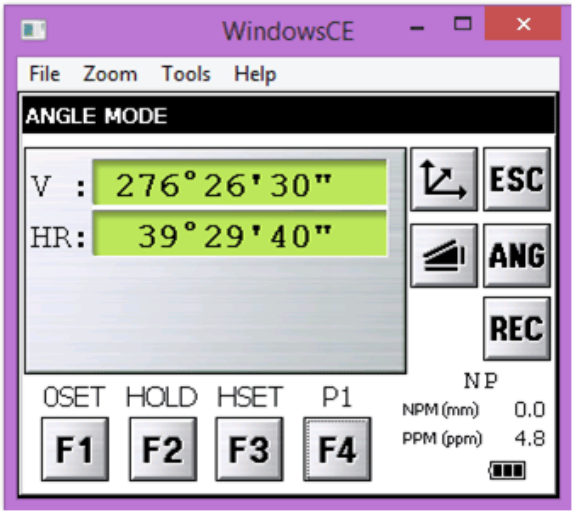
- ✓ MEAS – Measureement of angles. Distances and coordinates.
- ✓ SETUP – Setting up of units and other relevant values.
- ✓ ADJUST – Adjustment of basic parameter of the instrument.
- ✓ PROG –
  - Backward station setup
  - Remote elevation measurement
  - Remote distance measurement
  - Mean angle calculation

➤ The Distance mode will open by default.

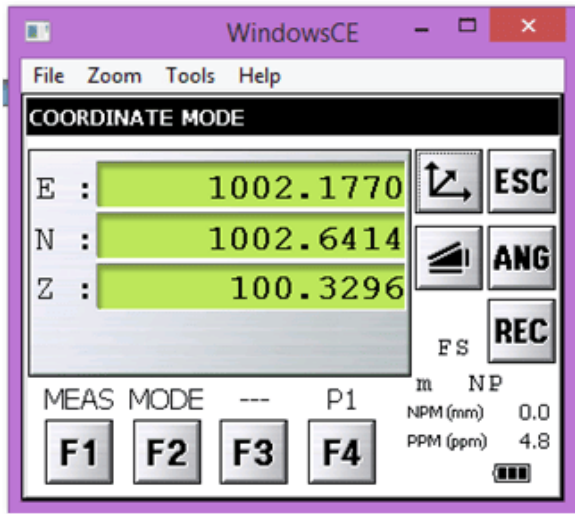




➤ On clicking the ANG tab, Angle mode will be visible.



➤ On clicking the 3 lines tab , Coordinate made will be displayed. Here Easting, Northing and Elevation will be shown.

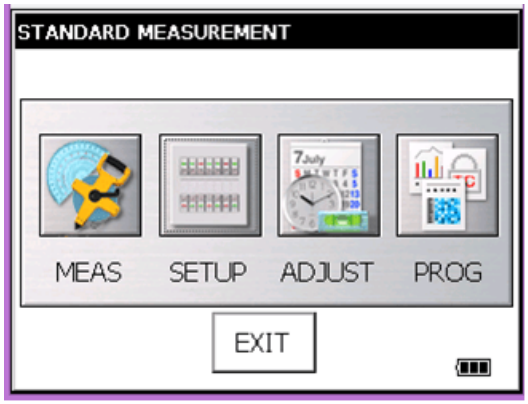


13 Utilities of ETS

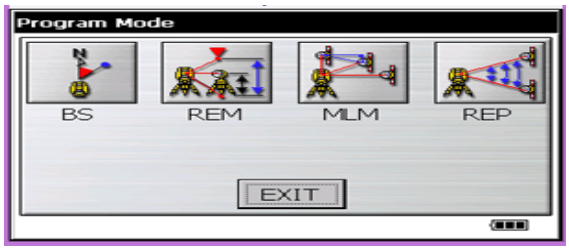
13.1 Backsight Mode

In Total Station, the backsight utility is a critical function used during the setup process to establish orientation. When using arbitrary coordinates, the instrument operator assigns a random coordinate (usually 1000,1000,500 or any convenient value) to the occupied station. The backsight is then measures and its coordinates are computed.

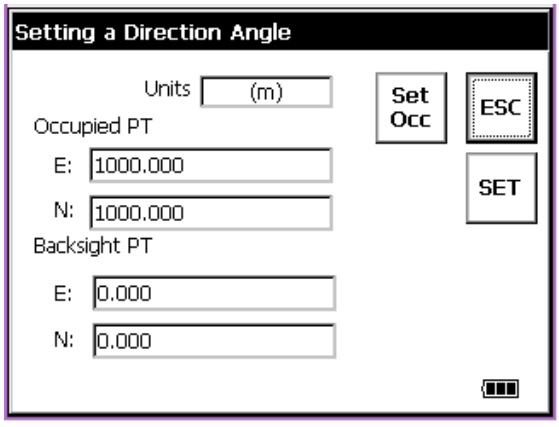
Click on PROG to display the predefined program modes in Standard Measurement



Click on BS to get into the Backsight mode.



- This is used in a condition where no known coordinates are given and the survey has to be carried out using Arbitrary Coordinates.
- Setup the Instrument on a point whose assumed arbitrary coordinates be E:5000 & N:5000. Click>> Set Occupied>>Set
- Place a Prism at another point whose coordinates are not known.
- Sight that prism and measure. The Coordinates of this 2nd point with respect to the assumed coordinates of 1st Point will be displayed.
- Now we have coordinates(Arbitrary) of two points which can be further used for detail Survey.

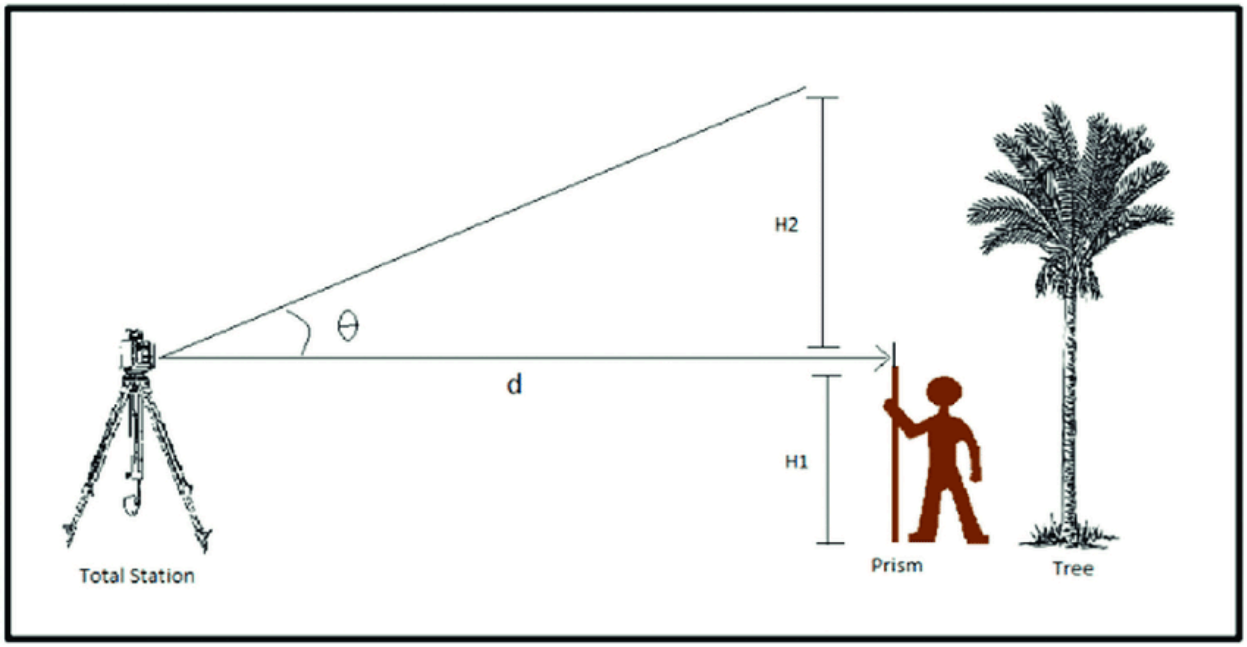


13.2 REM (Remote Elevation Measurement)

Remote Elevation Measurement (REM) is a function in Total Stations that allows surveyors to determine the elevation of a point that cannot be directly accessed, such as the top of a pole, building, or cliff.

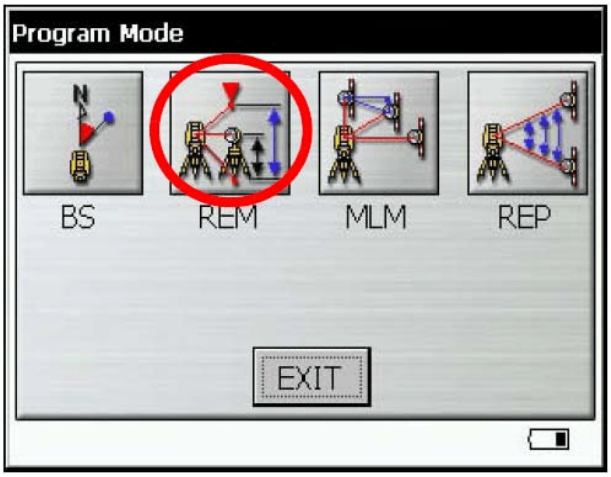
Importance of REM:

- Allows measurement of inaccessible or dangerous points.
- Increases safety by avoiding physical climbing or hazardous access.
- Ensures accurate elevation data for features like utility poles, overhead wires, or building tops.
- Useful in construction, topographic surveys, and monitoring structures.

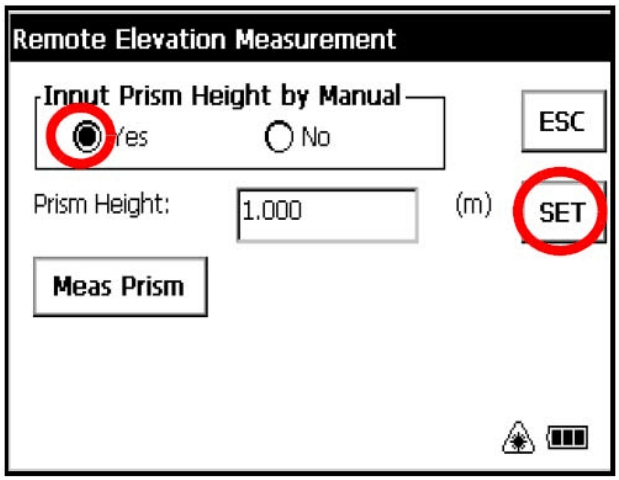


Step by Step Procedure for use of REM

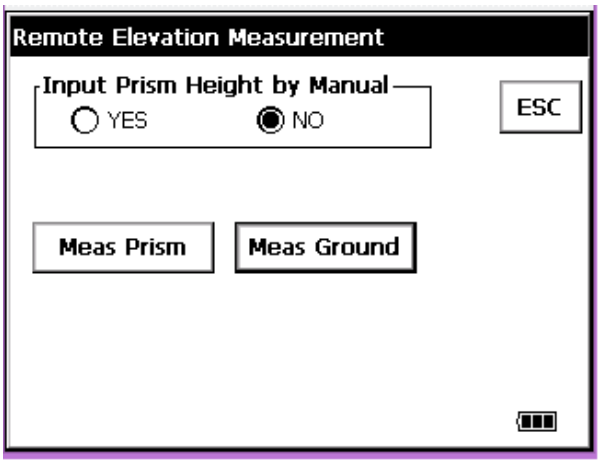
- Click Standard Measurement>> Prog>> REM
- First measure prism and click set.

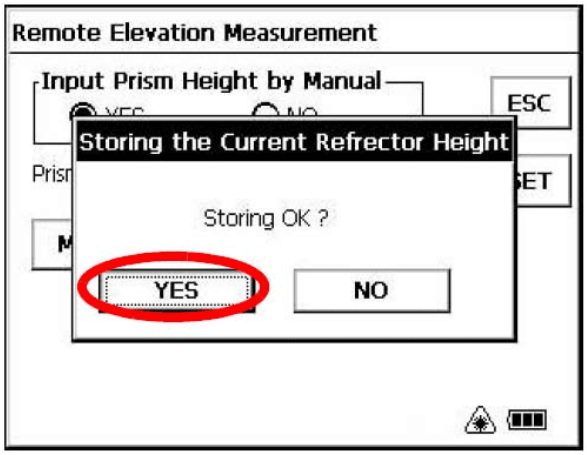


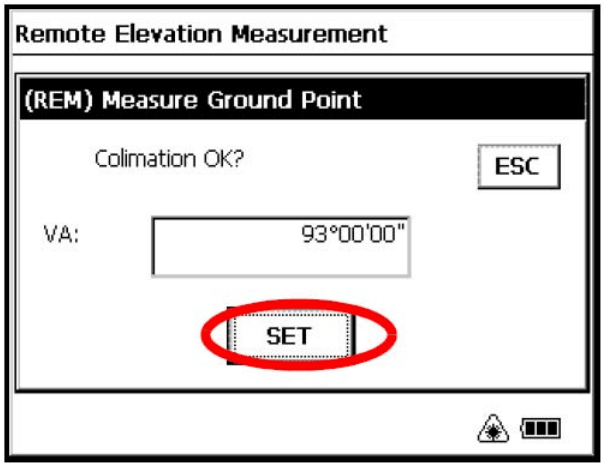
- Aim and Focus of the bottom of the Target whose height is to be measured
- If Prism is not being used then change settings to NP(Non Prism Mode)



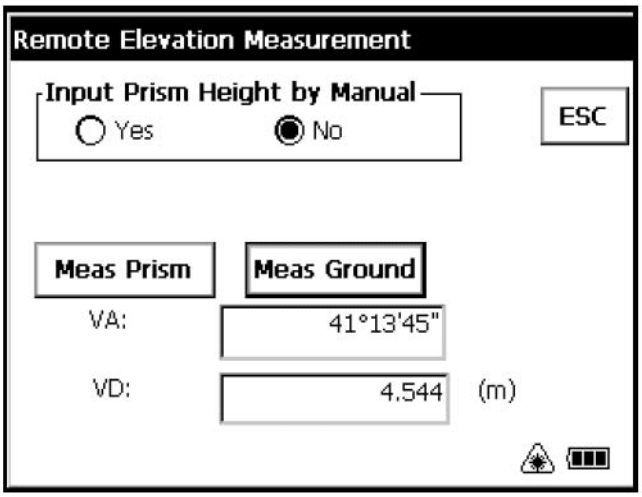
- First measure prism and click set.







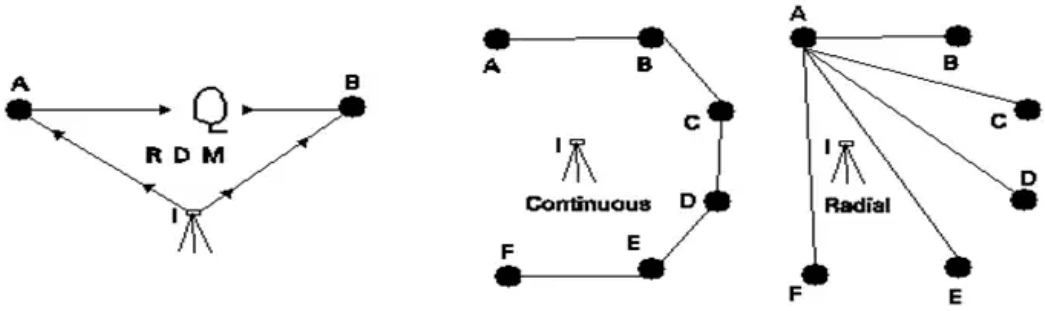
- After clicking set, the VD will be shown as 0.00
- Now move the telescope and aim at the designed point whose height has to be determined.
- The VD(height) will be displayed. eg 4.544(m) as shown below.

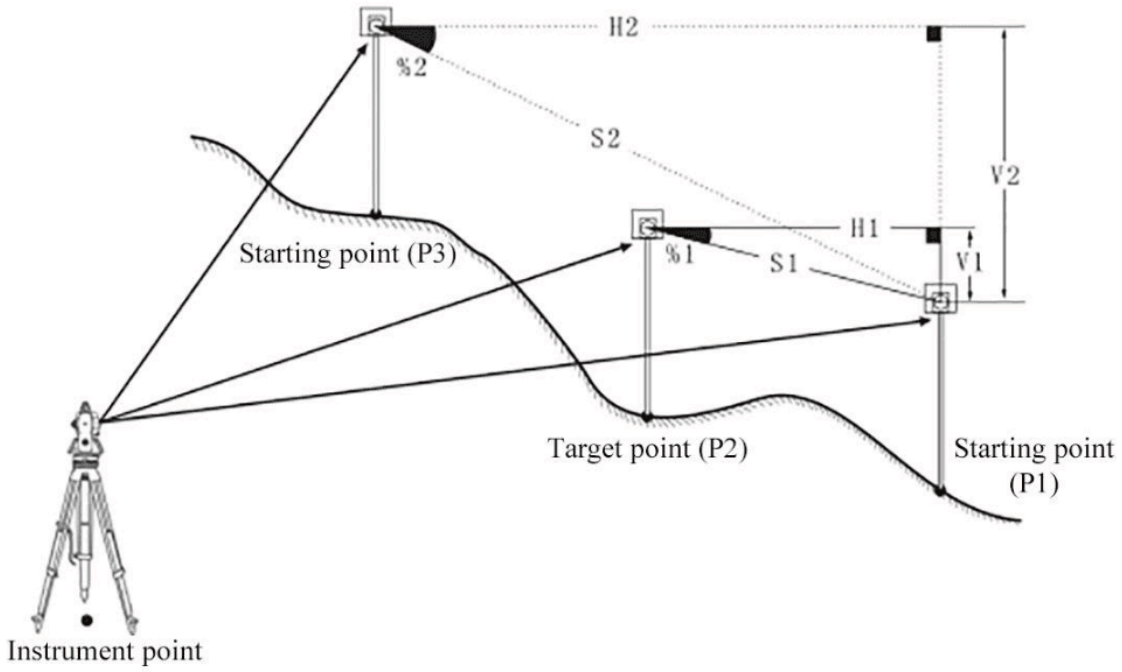

Remote Elevation Measurement
Input Prism Height by Manual
Yes
No
ESC
Meas Prism
Meas Ground
VA:
41°13'45"
VD:
4.544
(m)

13.3 MLM (Missing line Measurement) or (RDM) Remote Distance Measurement

A Total Station's "Missing Line Measurement" (MLM) or "Remote Distance Measurement" (RDM) feature allows users to determine the horizontal distance and height difference between a known starting point and an unknown target point that cannot be directly sighted from the instrument.

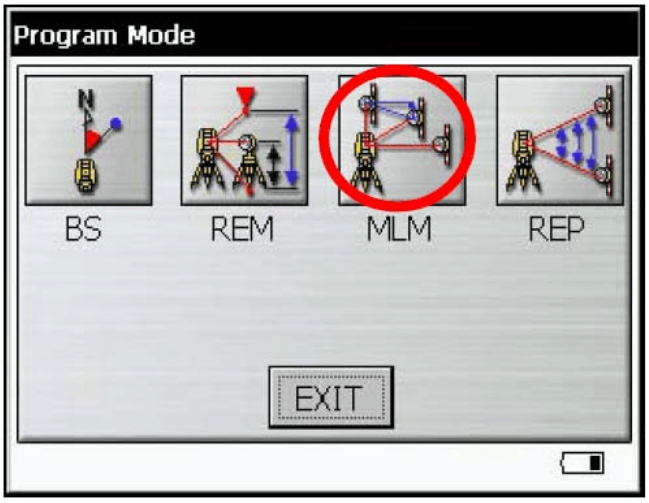
The two main methods are MLM-Radial, which measures the distance from a single reference point to multiple points, and MLM-Polyline, which measures the distance between a series of connected points from a single instrument setup.





Step by Step Procedure for using MLM

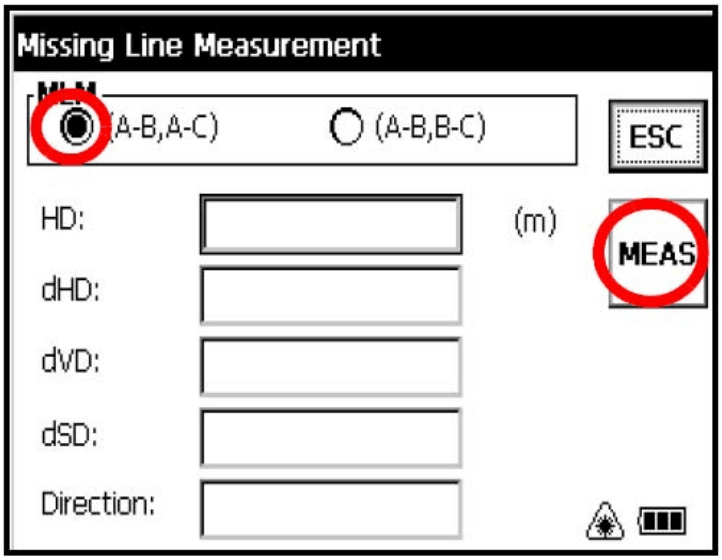
- Click Standard Measurement>> Prog>> MLM



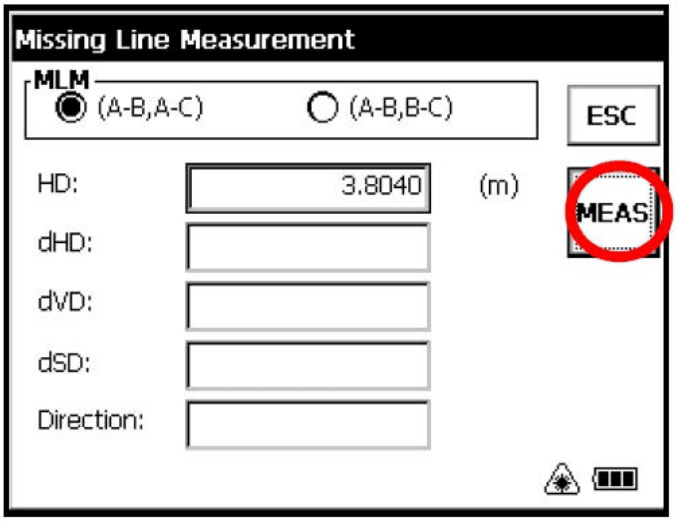
- Two methods are available:

(A-B,A-C) in which it will compute the distance between A to B, A to C and so on.

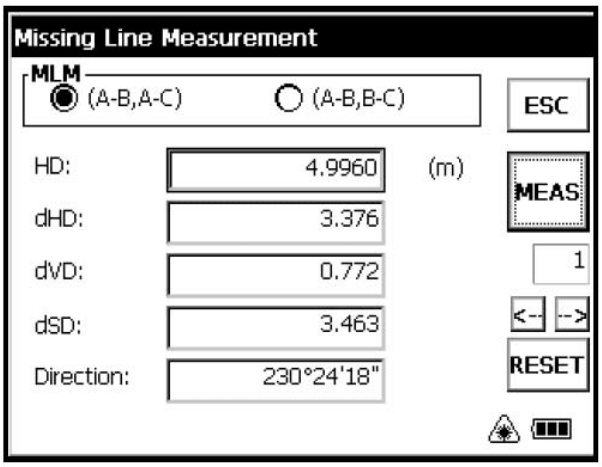
(A-B, B-C) in which it will compute the distance between A to B, B to C and so on



- Set up the Instrument at any point (Not necessarily known- Since this utility only gives distances as an output so known coordinates are not required)
- Now target 1st prism placed at point A>> MEAS
- Now target 2nd prism placed at point B>> MEAS
- Carry on similarly if there are more points



- The individual distances i.e. A to B, A to C would be visible as below. use < > to navigate.



13.4 REP (Repetition Angle Measurement)

Repetitive angle measurement (also called repetition method) is a surveying technique where a horizontal or vertical angle is measured multiple times using a Total Station, and the average value is taken to improve accuracy.

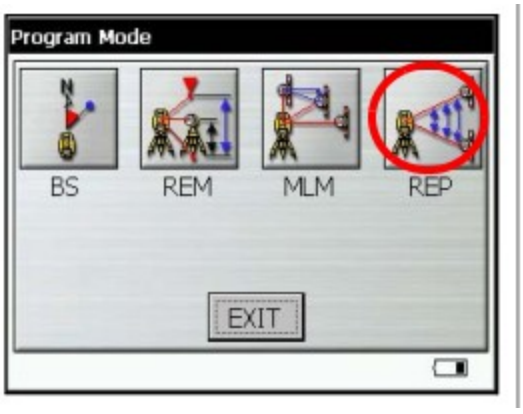
Used in precise angle measurement tasks such as:

- Triangulation
- Control surveys
- Engineering layout
- Helps in detecting and minimising instrumental and observational errors.

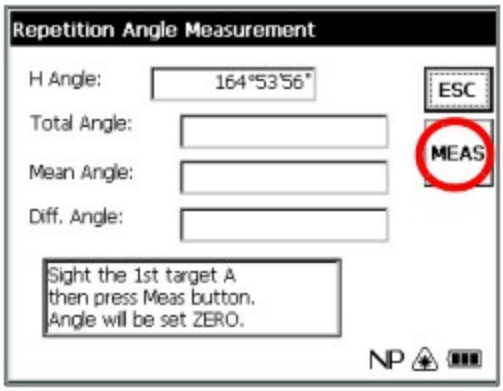
Repetitive angle measurement is a critical method in Total Station surveying for ensuring precise angular data. By taking multiple readings and averaging, surveyors can achieve greater accuracy, which is especially important in control networks and high-precision engineering projects.

Step by Step Procedure for use of REP

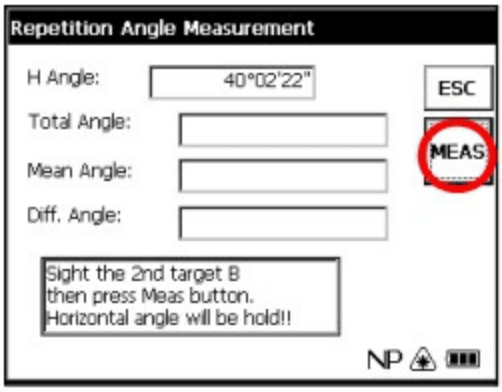
➤ Click Standard Measurement>> Prog>> REP



➤ Focus to 1st target, Collimate>> Press Meas

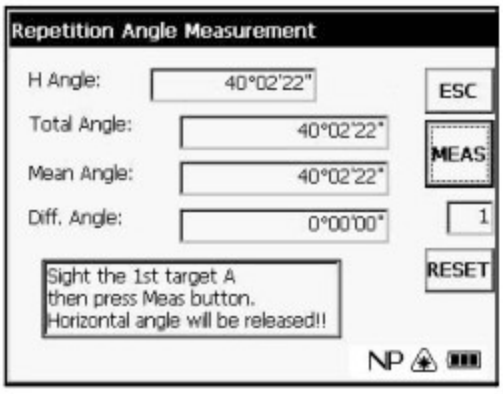


➤ Focus to 2nd target, Collimate>> Press Meas



➤ The total of angles and mean angle are shown.

➤ Repeat procedure to measure other angles.(Horizontal angle can be accumulated up to 99 times)



14 Resection

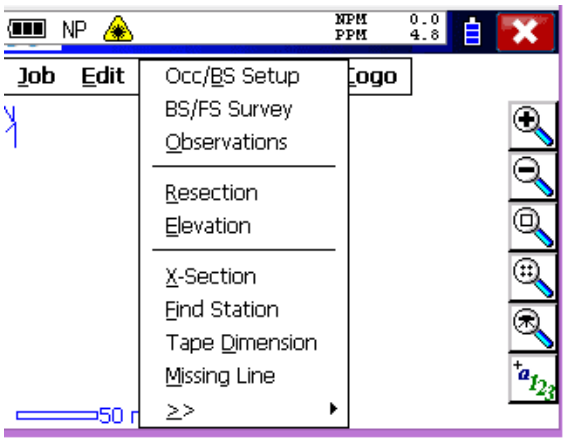
Resection is defined as a method of measuring the coordinates of a point whose coordinate is not known but is visible from at least two points whose coordinates are known. Resection is a powerful and practical method in Total Station surveying for establishing the instrument's position using existing control points. It is essential for maintaining accuracy and flexibility in fieldwork, especially in complex or restricted environments.

Importance of Resection:

- Allows for flexible instrument setup when the known point is not accessible.
- Commonly used in confined areas, construction sites, or when control points are far apart.
- Ensures precise positioning of the instrument relative to the survey network.
- Saves time by avoiding the need to set up directly over a known point.

Step by Step Procedure for Resection

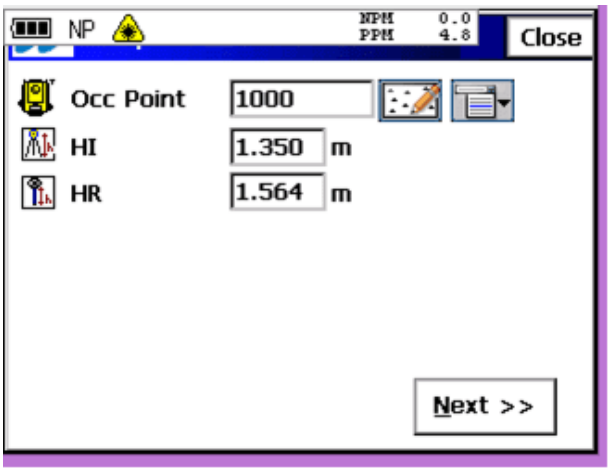
➤ Goto Survey>>Resection



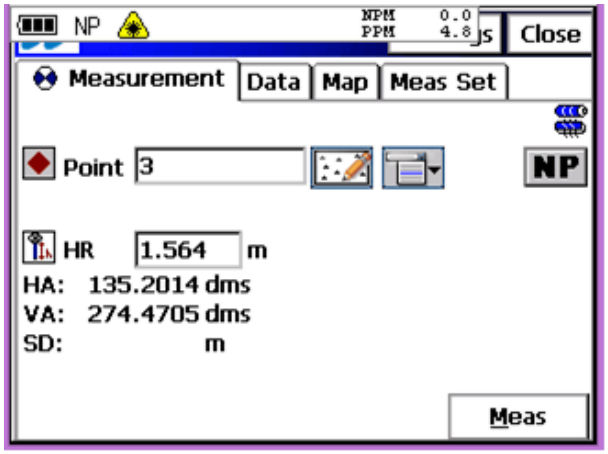
➤ Enter Point Number where the Instrument is placed e.g. 1000 (the coordinates will be stored against this point number)

➤ Enter height of Instrument HI

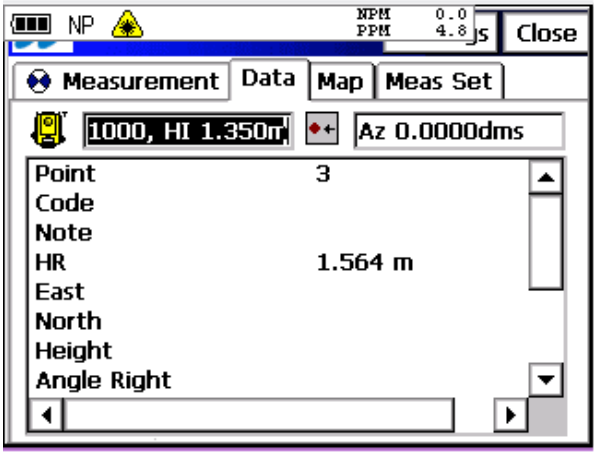
➤ Enter height of Reflector prism placed at 1st known point. Click Next



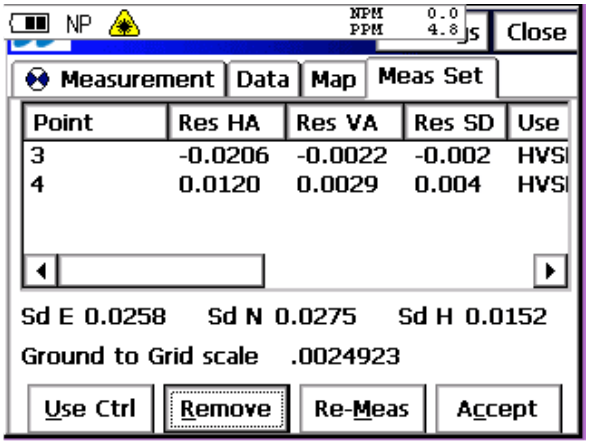
- From the drop down menu>> List Seclect the Point number of known point where the Reflector Prism is placed.
- Click>> Meas



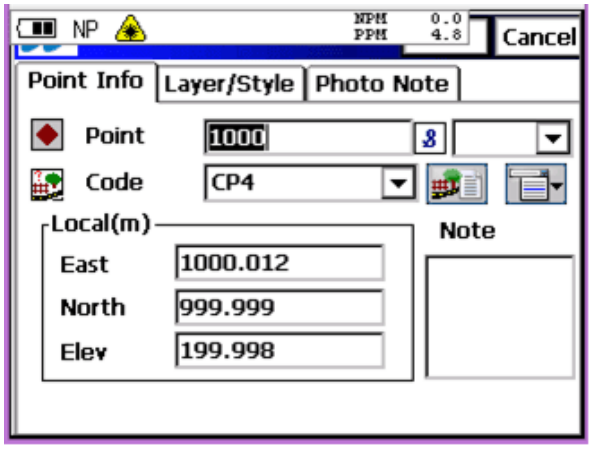
- You can view point number e.t.c by clicking Data



- Now place Reflector Prism at the 2nd known point and repeat the procedure.
- If you have more than 2 known points carry out the measurements in similar fashion.
- After completing the set of measurements Click on Meas set to check the Residuals of the observations. If any measurement is not within accepted tolerances you can remove that point also by selecting that point & Clicking>> Remove
- If the observations are within acceptable tolerances Click>>Accept



- The coordinates of the desired point i.e. point no. 1000 are computed and can be seen by Clicking>> Edit>> Points



This method is beneficial when the two known stations are not Inter visible but visible from a 3rd point whose coordinates can be found out using the Resection method.

15 Data Export

Data export in a Total Station refers to the process of transferring measured field data (such as coordinates, angles, distances, and elevations) from the instrument to a computer or external device for further processing, analysis, or record-keeping.

Total Stations store survey data internally during fieldwork. This data can then be exported via various methods, including:

- USB flash pen drive
- SD card
- Serial cable (RS-232)

The exported data is usually in formats like CSV, TXT, DXF, or proprietary formats compatible with surveying or CAD software (e.g., AutoCAD, Civil 3D).

Purpose of data export:

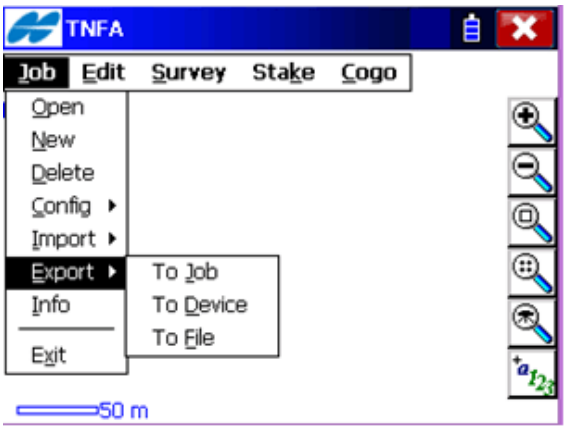
- To process and analyze survey data using software
- To generate maps, plans, or reports
- For backup and documentation
- To integrate with GIS or CAD systems

Exporting data efficiently ensures accurate and streamlined workflows between fieldwork and office-based processing.

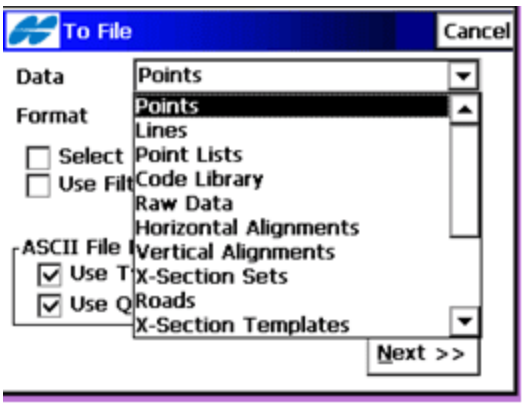
Step by Step Procedure for Data export and Downloading

➤ Open current Job

➤ Goto Job>>Export>>To file

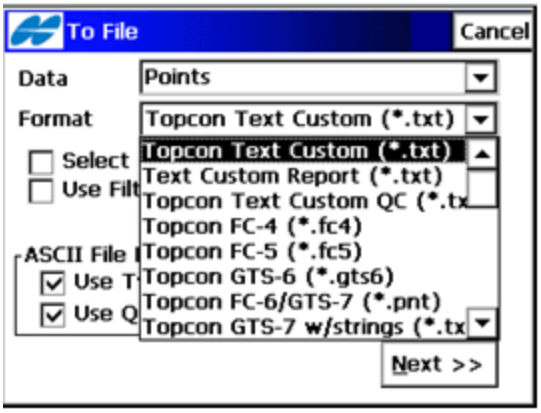


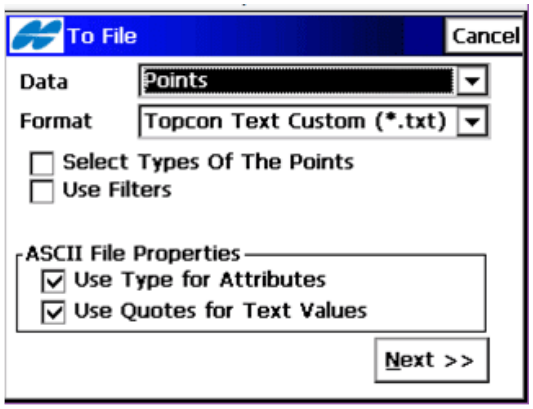
➤ Select Points>>Next



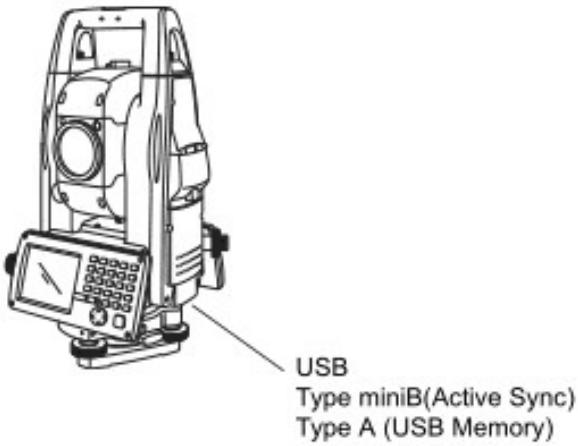
➤ Select the required format e.g. Topcon Text Custom(*.txt)

➤ Click>> Next





- The export will start and show the number of points & number of Codes exported.
- It will prompt for the filename. Enter Filename. click OK
- Now to copy this file. Goto>> Internal disk>> IE Files>> copy Desired File.
- Insert a USB Flash Drive. Paste the copied file into Pen drive.



16 Conclusion

This Standard Operating Procedure (SOP) has been developed for a specific Instrument

(Topcon-7501) and is aimed to equip a Surveyor to carry out the following tasks:

a. To extend the horizontal and vertical control from known geodetic/control stations to the survey area.

b. To conduct a detail survey by collecting precise measurements of land parcel vertices and topographic features.

c. To re-establish and mark missing boundary pillars or survey monuments using control points and ETS observations.

d. To utilize inbuilt ETS functions such as Remote Elevation Measurement (REM), Missing Line Measurement (MLM), Repetition Angle Measurement (REP), and other advanced modes for specialized survey requirements.

This SOP is a living document and may be updated as processes evolve, technologies advance, or new best practices emerge.