BASIC

AIMS

CONCEPTS

using

Nikon
Electronic Total Stations

DTM-502 & DTM/NPL-302 Series

Tripod Data Systems, Inc., 345 SW Avery Avenue, Corvallis, OR 97333

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Table of Contents

Table of Contents (cont'd)

1.0 AIMS: Automated Investigation Measurement System

1.1 Introduction to AIMS

AIMS (Automated **I**nvestigation **M**easurement **S**ystem) is an integrated crime and accident scene measurement and Mapping system designed for crime and accident scene investigators and reconstructionists. AIMS allows the user to quickly and accurately measure the scene, record the data, download the data into a computer and generate a map to scale of the scene.

1.2 AIMS System Components

The **AIMS** system consists of:

Electronic Total Station

Nikon's high precision electronic total stations accurately measure distance and direction data and either transfers this information into an external data recorder or stores it on-board as X, Y, Z coordinate data.

Data Recorder

The external or internal data recorder leads the user through step by step measurement, collection and storage of scene measurement data including evidence item codes and descriptions. The standard serial connection transfers data directly to any PC or laptop computer.

AIMS Mapping Software

The PC-based AIMS mapping software automatically converts the measurement data into a map of the scene. The map may be viewed on-screen, output to virtually any printer or plotter or saved as a DWG file for use in animation software.

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2.0 Basic Measurement Principles

Surveying is traditionally defined as the science of making field measurements on or near the surface of the earth to determine relative positions of points. Survey field measurements include horizontal and vertical angles, horizontal and slope distances and vertical distances or height differences.

Generally these points are located by their relationship to each other through a **direction** and **distance**. (For example, Point Y is due East from Point X a distance of 1000 feet.)

A typical survey may require the following:

i. Research

Identifying the location, appropriate survey methods and equipment.

ii. Data Collection

Field measurements and recording of data.

iii. Data Processing

Computations based on the recorded data to determine locations, areas, volumes, slopes and elevations.

iv. Data Representation

Plotting measurements or computed data in map form or reporting such data in a printed format.

v. Stakeout

Setting monuments and stakes to establish boundaries or construction operations.

2.1 Types of Survey Measurements

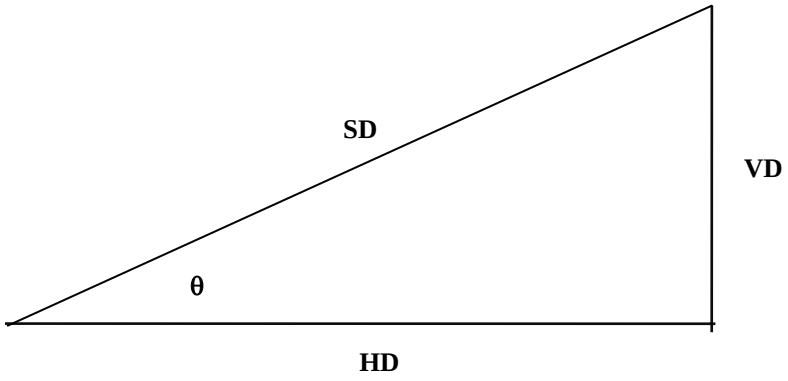

Fig. 2.1: Geometry of Survey Measurements

i. Horizontal Angles HA

Angle measured in the horizontal plane. May be the difference between two directions.

ii. Horizontal Distances HD (=SD cosθ)

Distance computed in the horizontal plane.

iii. Vertical Angles VA (=90° ± θ)

Angle measured in the vertical plane.

iv. Vertical Distances VD (=SD sinθ)

Distances computed in the direction of gravity.

v. Slope Distances SD

Distances measured along inclined planes.

2.2 Units of Measurement

Units	English	Metric
Length	Feet	Meter
Angle	Degrees, Minutes, Seconds	Degrees, Minutes, Seconds
Area	Square Feet or Acres	Square Meters or Hectares
Volume	Cubic Feet or Cubic Yards	Cubic Meters

Fig. 2.2: Units of Measurement

The location of points and orientation of lines depend on the measurement of angles and directions. In surveying, directions are supplied as bearings and azimuths.

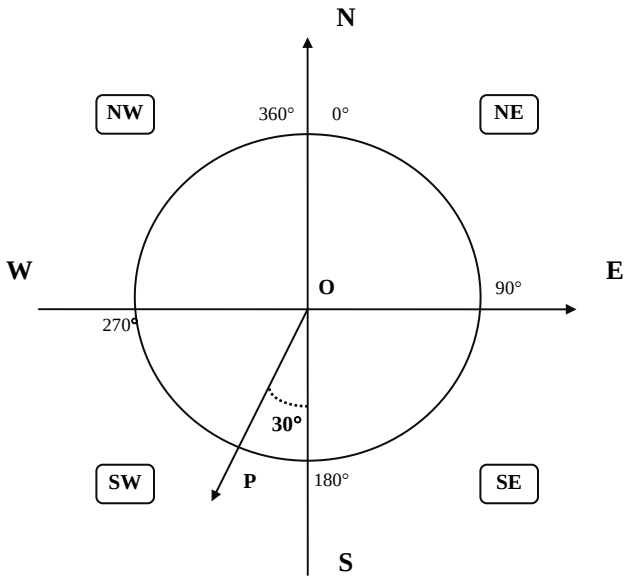

Fig. 2.3: Angles, Azimuths & Bearings

2.3 Angles

Angles are classified as Horizontal or Vertical according to the plane in which they are measured.

Angles are determined by the reference or starting line, the direction of turning and the angular distance or angular value.

Angular values are based upon Degrees, Minutes and Seconds with 360° contained in a circle.

Examples: ∠SOP=30° ∠EOP=120°

2.4 Directions

The direction of a line is the horizontal angle between the line and an arbitrarily chosen reference line termed a meridian.

Astronomic (or true) meridian is the North-South reference line through the earth's geographic poles.

Magnetic meridian is the North-South reference line through the earth's magnetic poles.

Assumed meridian is established by assigning any arbitrary direction to a line. Directions of all other lines are found relative to the assumed meridian.

2.5 Bearings

Bearings are a system of expressing directions of lines by means of an angle and quadrant letters. The bearing angle is the acute horizontal angle between the reference meridian and the line.

The angle is measured from either the North or South to the East or West and always gives a reading less than or equal to 90°.

Examples: **OP=S30°W** **ONW=N45°W** **OE=N90°E**

2.6 Azimuths

Azimuths are angles measured clockwise from a reference meridian (generally North) and range from 0° to 360°.

Examples: **OP=210°** **OW=270°** **ON=0° or 360°**

2.7 Distances

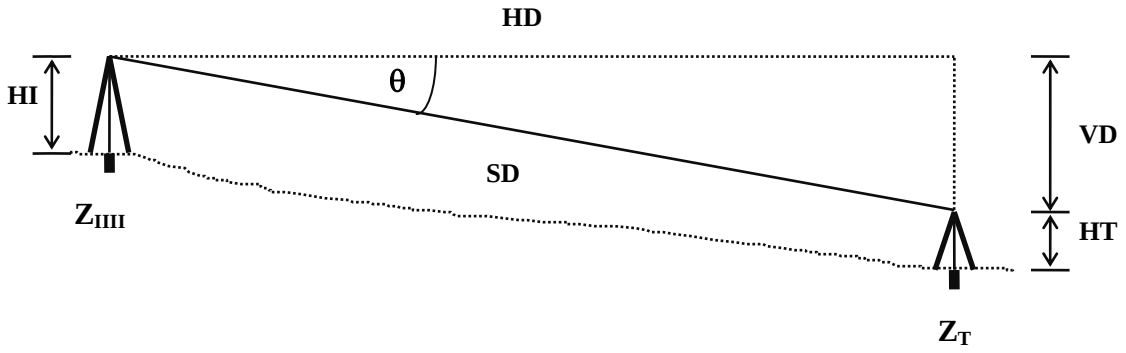

Fig. 2.4: Measurement Geometry

Slope Distance (SD) is the straight line distance from the center of the EDM to the center point of the reflecting prism.

Horizontal Distance (HD) is the straight line distance between plumb lines at the two points.

$$HD = SD \cos\theta$$

Vertical Distance (VD) is the vertical or elevation difference between the center of the EDM and the center point of the reflecting prism.

$$VD = SD \sin\theta$$

2.8 Instrument & Target Heights

The **Instrument Height (HI)** is the height of the instrument above its station.

The **Target Height (HT)** is the height of the prism above its station.

2.9 Elevations

If the elevation of the instrument station **(Z_{IIII})** is known, the instrument and target heights are measured and the slope distance and vertical angles to the target are observed, **elevations** to the target station **(Z_T)** may be computed.

$$Z_T = Z_{IIII} + HI - VD - HT$$

2.10 Coordinates and Coordinate Systems

The Rectangular Cartesian Coordinate System is based upon three axes (X, Y and Z) which are perpendicular (at right angles or 90°) to each other.

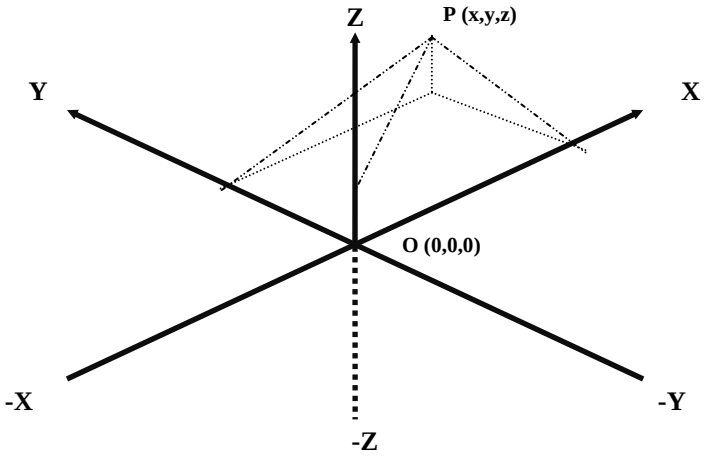

Fig. 2.5: Cartesian Coordinate System Axes

Rectangular Coordinates define the position of a point with respect to the perpendicular axes. The Y-axis points North-South and the X-Axis points East-West and both axes are in the same plane. The Z-axis is perpendicular to the X-Y plane.

1. The Y-Coordinate **(Northing)** is the perpendicular distance from the point to the X-Axis.
2. The X-Coordinate **(Easting)** is the perpendicular distance from the point to the Y-Axis.
3. The Z-Coordinate **(Elevation)** is the distance along the Z-Axis.

Given the rectangular coordinates of a number of points, the relative positions are uniquely defined. Surveying terminology and convention describes the position of a point in terms of **Northing (N), Easting (E) and Elevation (Z)** and is written **(N,E,Z)**.

Examples: P=(Ny,Ex,Zz) or (y,x,z)

Coordinates are useful in a number of computations:

i. Calculating lengths and directions of lines.
ii. Calculating areas.
iii. Curve calculations.
iv. Calculating point positions.

Coordinates simplify mapping or plotting tasks.
Coordinates are the most simple and easily handled information in electronic storage devices.

3.0 Electronic Total Station Systems

Major instrument manufacturers define a "true" **(Electronic) Total Station** instrument as a fully electronic instrument with coaxial optics which measures horizontal angle, vertical angle and slope distance with a single pointing to the target. Using this measured data, the total station may then compute horizontal distance, vertical distance and two or three dimensional coordinates.

3.1 Total Station Components

A total station is comprised of three fully integrated components;

(i). Electronic Digital Theodolite,
(ii). Electronic Distance Meter (EDM), and
(iii). On-board Microprocessor or computer.

3.2 Electronic Digital Theodolite

The electronic digital theodolite component automatically measures and displays (in digital format) horizontal and vertical angles. Potential human error in reading graduated circles, optical micrometers and vernier scales is eliminated.

3.3 Electronic Distance Meter (EDM)

The electronic distance meter (EDM) is used to measure slope distance from the center of the objective lens of the instrument telescope to the center of the target. The EDM is generally contained in the telescope housing and emits a beam which is coaxial with the telescope optics (or line of sight).

There are two types of EDM technology based upon the signal source;

(i). **Infrared Light Emitting Diode (LED)** uses a continuous signal and measures the phase difference or shift between the transmitted signal from the EDM and the refected signal from the target to compute distance. A reflecting target such as a prism or reflector sheet is used.

(ii). **Pulse Laser Diode** transmits a timed-pulse infrared signal and measures the time required for the pulse of infrared light to travel from the instrument to the target and return to determine the distance. Using this technology, a prism is not necessary, the measured surface is used as the reflecting target.

Pulse laser technology has limited distance capability depending on the power of the laser diode and the reflective properties of the target surface.

3.4 On-board Microprocessor

The microprocessor(s) in an electronic total station can perform a variety of functions and mathematical operations including;

(i). Reduction of vertical angle and slope distance to horizontal and vertical distance.
(ii). Determination of X, Y, Z (N,E,Z) coordinates.
(iii). Coordinate geometry functions - inverses, intersections, etc.
(iv). Remote distance computation.
(v). Remote elevation determination.
(vi). Atmospheric and instrument corrections.
(vii) Recording measured and computed data internally.

3.5 Accessories

3.5.1 Tripod

The tripod is used to securely mount the total station (or a prism assembly) over a point at a height comfortable to the user

3.5.2 Prism Reflector

The reflecting prism is solid glass having a flat front panel and a prism shaped rear. The EDM transmitted signal enters the front of the prism and is reflected back to the instrument by the prism's rear surface. The prism is contained in a housing which is screwed into a targetting frame.

3.5.3 Prism Pole

The prism pole or rod is used to mount the targetting frame of the prism. At the other end of the pole is a sharp, replaceable point which is placed directly on the target, the prism facing the instrument and measurements taken. A circular level vial or bull's-eye bubble attached to the pole is used to ensure the rod is plumb. Most prism poles are telescopic via a quick release clamp to raise or lower the height of the prism (for line of sight issues).

4.0 Accuracies In Total Stations

Total stations are specified by angular accuracy and EDM range and accuracy.

4.1 Angular Accuracy

The accuracy or standard deviation of a direction, direct and reversed, (DIN specification) is an indication of how good the theodolite component of a total station is. This should not be confused with the smallest displayable horizontal circle unit which often gives a misleading impression as to the accuracy of the instrument.

A circle has	360° (degrees).		
	1° (degree)	=	60’ (minutes).
	1’ (minute)	=	60” (seconds).
Thus, a circle has	360x60x60	=	1,296,000” (seconds) of arc.

The **Accuracy** of a total station may be specified as 5”. This means, any direction measured will lie within ±5” of the mean of the direct and reverse readings of that direction (at the 68% confidence level). When measuring an angle, two directions are being measured - a backsight and a foresight which results in an angle accuracy of about 7” (√2 x 5”).

Angular accuracy of directions over a specified distance may be converted to a distance value as shown in the table below:

Angle Accuracy	**Distance to Target** **50ft.**	**100ft.** **Errors in Feet (Inches)**	**500ft.**
20”	0.0048’ **(1/16in)**	0.0096’ **(1/8in)**	0.048’ **(9/16in)**
10”	0.0024’ **(1/32in)**	0.0048’ **(1/16in)**	0.024’ **(1/4in)**
5”	0.0012’ **(1/64in)**	0.0024’ **(1/32in)**	0.012’ **(1/8in)**
1”	0.0002’ **(1/400in)**	0.0004’ **(1/200in)**	0.002’ **(1/40in)**

Fig. 4.1: Angular Accuracy in Linear Units

(Note: Conversions to fractions of an inch are approximate.)

4.2 Distance (EDM) Accuracy

Electronic Distance Meter (EDM) accuracy is measured in millimeters and parts per million (ppm). For example, ±(5+5ppm)mm or ±(0.02ft+5ppm) where the ±5mm (0.02ft.) is the instrument error which is independent of the length of the measurement and the 5ppm is the distance-related error.

A typical construction grade instrument may have an accuracy specification of ±(5+5ppm)mm. A high order survey instrument may be specified at ±(2+2ppm)mm.

The "± " in the specification indicates the EDM may measure short or long by this amount but the measured distance will fall within this range.

EDM accuracy over a specified distance may be converted to a distance value as shown in the table below:

EDM Accuracy	**50ft.**	**Distance to Target 100ft. Errors in Feet (Inches)**	**500ft.**
±(5+10ppm)mm	0.0169' **(7/32in)**	0.0174' **(7/32in)**	0.0214' **(1/4in)**
±(5+ 5ppm)mm	0.0166' **(7/32in)**	0.0169' **(7/32in)**	0.0189' **(7/32in)**
±(5+ 3ppm)mm	0.0166' **(7/32in)**	0.0167' **(7/32in)**	0.0179' **(7/32in)**
±(3+ 2ppm)mm	0.0100' **(1/8in)**	0.0100' **(1/8in)**	0.0110' **(1/8in)**
±(2+ 2ppm)mm	0.0067' **(3/32in)**	0.0068' **(3/32in)**	0.0076' **(3/32in)**

Fig. 4.2: EDM Accuracy in Linear Units

(Note: Conversions to fractions of an inch are approximate.)

4.3 Combined EDM and Angle Accuracy

The angle and EDM accuracies of a total station may be combined to give the maximum measurement error in a point's location due to the instrument's accuracy specifications.

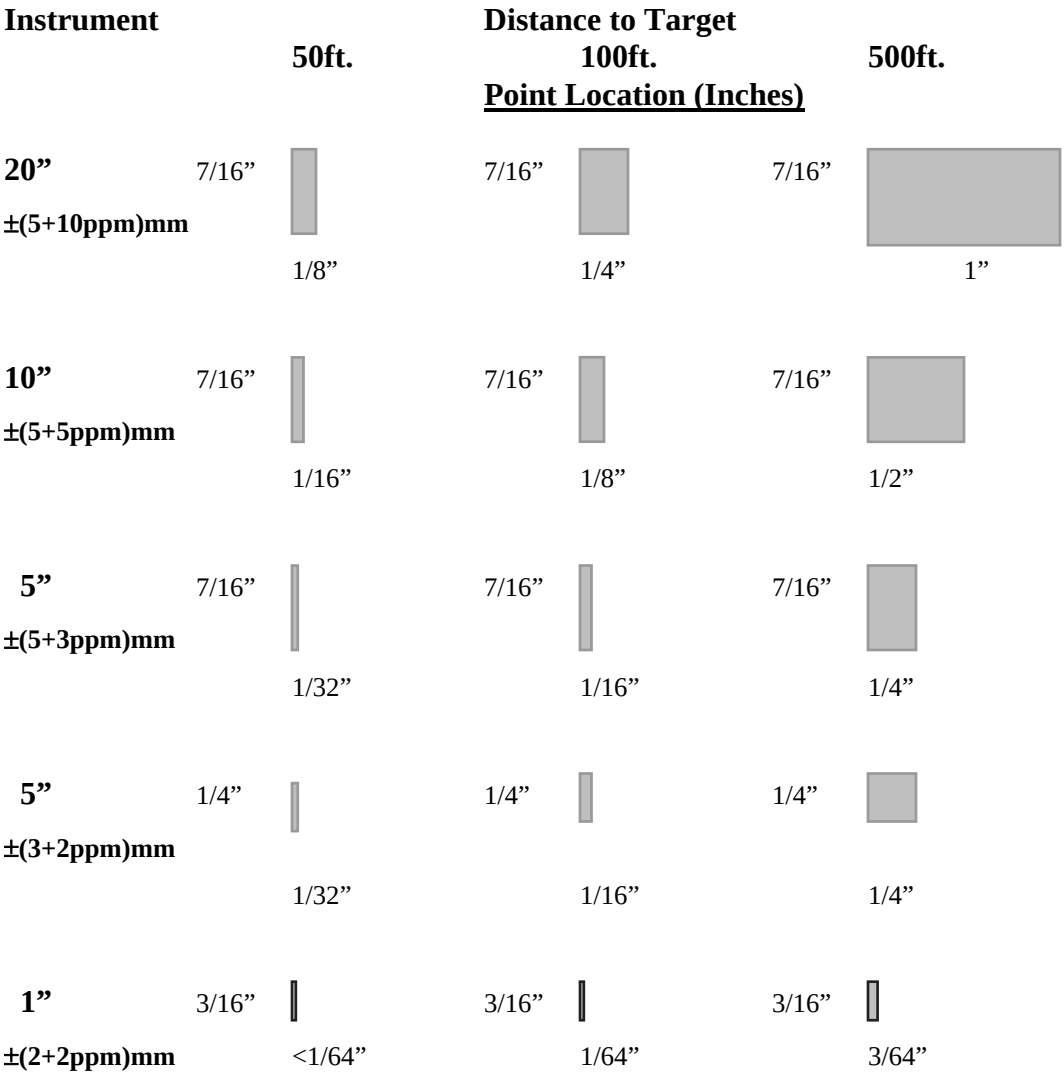

Fig. 4.3: Combined EDM and Angular Accuracies
(Note: Conversions to fractions of an inch are approximate.)

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5.0 Instrument Setup

5.1 Setting up the Tripod

- Extend all three legs of the tripod until they are about the same length.
- Set the tripod over the point.
- Open the legs wide enough for the instrument to be stable.
- Ensure the point is directly below the center hole in the tripod head.
- Firmly "plant" one of the tripod ferrules into the ground by stepping on the footplate.
- Ensure the top surface of the tripod head is roughly level.

5.2 Centering over the Point

Centering is the precise alignment of the instrument's central axis over a point.

- Set the instrument on the head of the tripod.
- With one hand holding the instrument, insert the tripod mounting screw into the center hole of the instrument's base plate and tighten.
- Ensure the instrument base plate is centered on the tripod head with the footscrews at the corners of the tripod head.
- Ensure the leveling screws are at the center of their adjustment range.
- Stand between the two legs of the tripod not "planted" in the ground.
- Place the toe of one foot next to the point on the ground.
- Pick up the two tripod legs and look through the optical plummet (OP).
- Move or pivot the instrument until the optical plummet's crosshairs are centered squarely over the point and "plant" the two legs in the ground.
- Using the circular level vial on the instrument base, roughly level the instrument by adjusting the tripod legs.

5.3 Leveling

Leveling is the precise vertical alignment of the instrument's vertical axis.

- Loosen the upper plate clamp.
- Rotate the alidade to position the plate level to a point parallel to any two of the leveling screws.
- Use these two screws to move the bubble to the center of the level.
- Rotate the alidade approximately 90° and adjust the **third screw only** to move the bubble to the center of the level.
- Repeat these two leveling procedures until the bubble remains centered.
- Look through the optical plummet to ensure the instrument is still over the point.
- If not exactly centered over the point, lightly loosen the tripod mounting screw.
- Slide the instrument over the tripod head until centered over the point.
- Re-tighten the tripod mounting screw.
- Check the level of the instrument and re-level if necessary.
- Power on the instrument.

5.4 Sighting to a Prism Reflector

Sighting refers to the aiming of the telescope at the target, bringing the target into focus and aligning the target with the center crosshairs of the reticle.

- Ensure the reticle cross hairs are sharply focused.
    - Point the telescope to a blank area.
    - Look through the eyepiece and rotate the diopter ring until the reticle crosshairs are in sharp focus.
- Use the optical sight to roughly point the telescope to the target.
- Tighten the horizontal plate clamp.
- Look through the eyepiece and move the telescope vertically until the target is in view.
- Tighten the vertical clamp.
- While looking through the telescope, use the horizontal and vertical tangent screws to sight the telescope crosshairs on the center of the prism reflector.
- Rotate the focusing ring to bring the target into sharp focus on the reticle crosshairs.
- Use the horizontal and vertical tangent screws to fine tune the sight to the target.

6.0 Configuring the Electronic Total Station

Instrument Configuration

All Nikon Total Stations have an **Initial Mode Set** or **Instrument Settings** function. The Initial Mode Set function in the total station is accessed by;

1. Press **[Menu]** key.

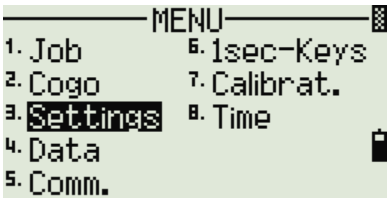


Fig. 6.1: Main Menu Screen

2. Select **3.Settings** by pressing ③ key.

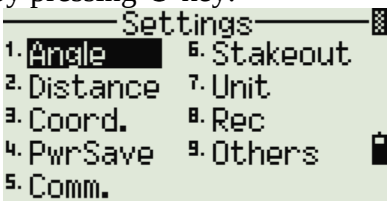


Fig. 6.2: Settings Menu Screen

These initial mode settings are extremely important as they determine the type of data being measured, any corrections being applied and communications to external storage devices. The following settings are the recommended defaults. To toggle between the available selections use the left or right arrow keys ◀/▶.

6.1 Settings

1. Angle

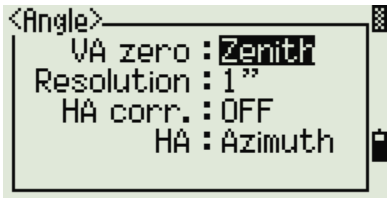


Fig. 6.3: Angle Settings Screen

2. Distance

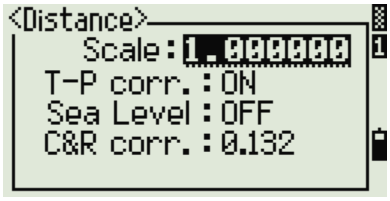


Fig. 6.4: Distance Settings Screen

3. Coord.

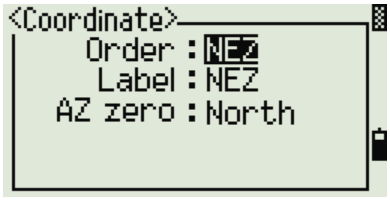


Fig. 6.5: Coordinate Settings Screen

6.1 Settings (cont'd)

4. PwrSave

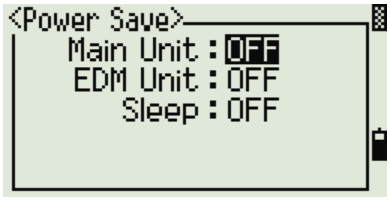


Fig. 6.6: Power Save Settings Screen

5. Comm.

Fig. 6.7: Communications Settings Screen

6. Stakeout

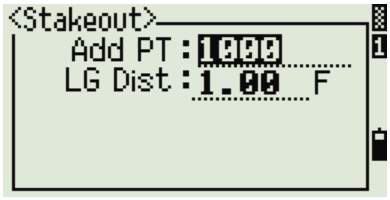


Fig. 6.8: Stakeout Settings Screen

7. Unit

Fig. 6.9: Units Settings Screen

8. Rec

Fig. 6.10: Record Settings Screen

9. Others

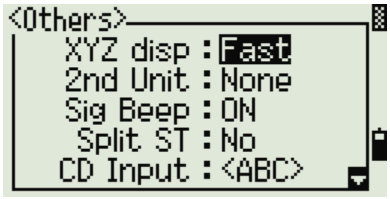


Fig. 6.11: Others Settings Screen

6.2 Prism Constant

The Prism Constant function is accessed by;

1. Press and hold **MSR1** key for one second.

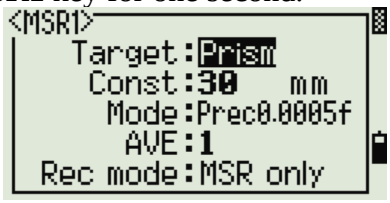


Fig. 6.12: Prism Constant for MSR1 Key

2. Press and hold **MSR2** key for one second.

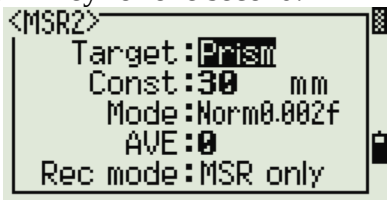


Fig. 6.13: Prism Constant for MSR2 Key

6.3 Height of Target

The Height of Target function in the total station is accessed by;

1. Press θ **HOT** key.

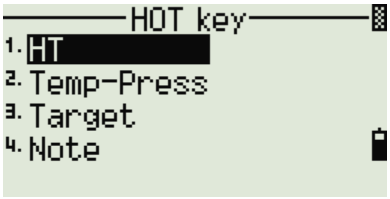


Fig. 6.14: HOT Key Menu Screen

2. Select **1.HT** by pressing ① key and input value for **HT**.

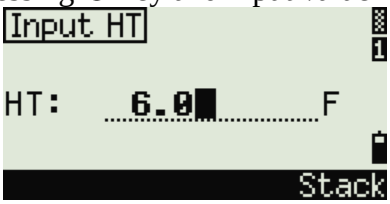


Fig. 6.15: Height of Target Input Screen

6.4 Temperature & Pressure

The Temperature & Pressure function in the total station is accessed by;

1. Press θ **HOT** key.

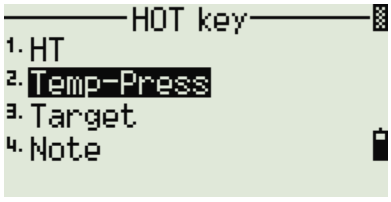


Fig. 6.16: HOT Key Menu Screen

2. Select **2.Temp-Press** by pressing ② key and input values for **Temp** and **Press**.

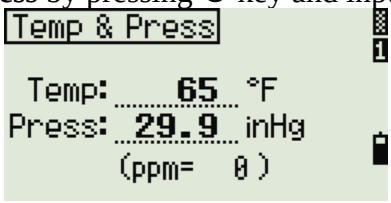


Fig. 6.17: Temperature & Pressure Input Screen

7.0 Scene Measurement or Data Collection

7.1 Collection of Scene Measurement Data

1. Instrument Setup.

- Set the instrument over the **Reference (station) Point (RP)**.
- Level the instrument.
- Power on the instrument.
- Tilt the telescope to initialize the Vertical Circle.
- **Basic Measurement Screen (BMS)** is displayed.

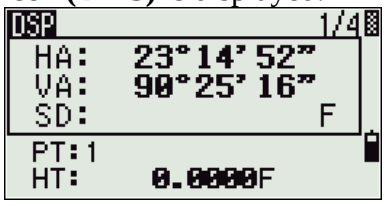


Fig. 7.1: Basic Measurement Screen

2. Create a Job

- Press **[Menu]** key**.**

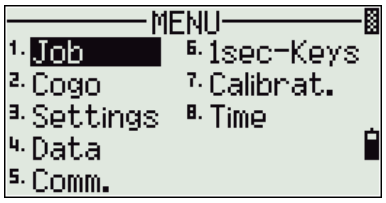


Fig. 7.2: Main Menu Screen

- Select **1.Job** by pressing ① key.

Fig. 7.3: Job Manager Screen

- Select **Creat** softkey by pressing **MSR1** key.

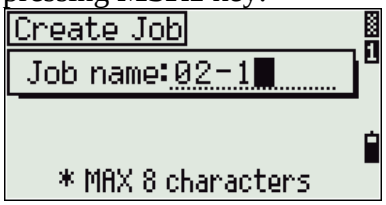


Fig. 7.4: Create Job Screen

- Input **Job Name** up to 8 characters.
- Press **ENT** key.

7.1 Collection of Scene Measurement Data (cont'd)

2. Create a Job (cont'd)

- **Create Job Confirmation Screen** is displayed.

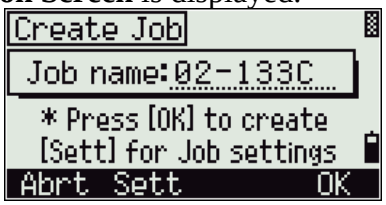


Fig. 7.5: Create Job Confirmation Screen

- Select **OK** softkey by pressing **ANG** key.
- **Basic Measurement Screen (BMS)** is displayed.

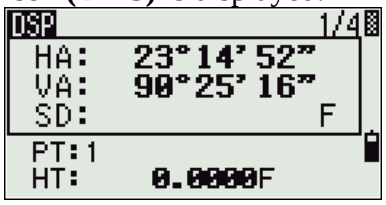


Fig. 7.6: Basic Measurement Screen

3. Station Setup/Establish a Reference Point (RP1)

- Press ⑦ **STN** key**.**

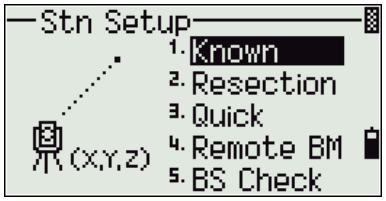


Fig. 7.7: Station Setup Menu Screen

- Select **1.Known** by pressing ① key.

Fig. 7.8: Station Input Screen

- Input Station Point Number **ST**, e.g. **1** and press **ENT**.

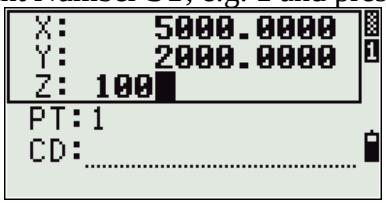


Fig. 7.9: Station Coordinates Input Screen

- Input Station Coordinates **N,E,Z** if displayed as blank and press **ENT**.
- Input Station Code or Description **CD** (type **RP1)** and press **ENT**.
- Input Station Height of Instrument **HI** and press **ENT**.

7.1 Collection of Scene Measurement Data (cont'd)

3. Station Setup/Establish a Reference Point (cont'd)

- **Backsight Menu Screen** is displayed.

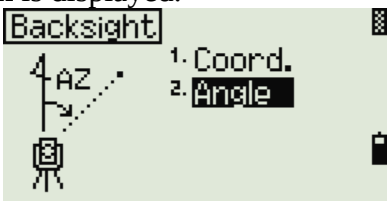


Fig. 7.10: Backsight Menu Screen

- Select **2.Angle** by pressing ② key.

(Only the direction to the backsight – approximately due North) is known.

- Perform backsight observation per prompt sequence below;

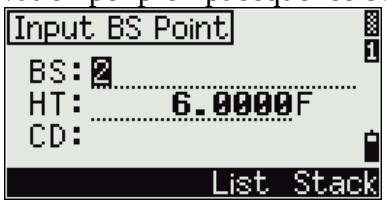


Fig. 7.11: Backsight Point Input Screen

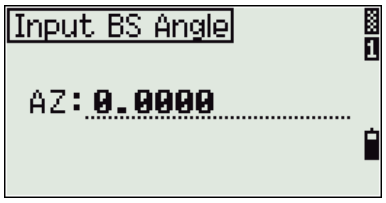


Fig. 7.12: Backsight Azimuth Input Screen

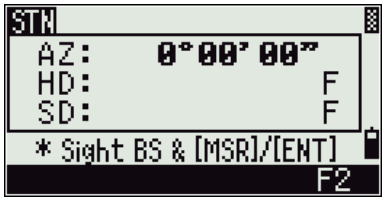


Fig. 7.13: Backsight Measurement Screen

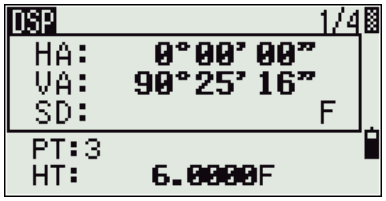


Fig. 7.14: Basic Measurement Screen

7.1 Collection of Scene Measurement Data (cont'd)

4. Measurement & Collection

- Sight the point to be collected.
- Press **MSR1** key.

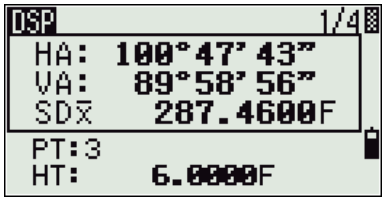


Fig. 7.15: Measurement Screen

- When distance **SD** is displayed, press **REC** key.
- A **"Record PT" Data Input Screen** is displayed.

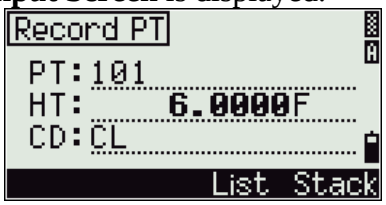


Fig. 7.16: Record Point Input Screen

  - Input Point Number **PT** if necessary.
  - Input Height of Target **HT** if necessary.
  - Input Code **CD** if necessary by manually typing, or
    - Select from a **List** by pressing **DSP** key, or
    - Select from a **Stack** by pressing **ANG** key.
  - Press **ENT** key to record the point.
- Repeat this sequence for all points to be collected.
- **If moving to new station setup,** measure and record the new Station/Reference Point.

5. Using Quick Code Mode to Speed Up Measurement & Collection

Instead of typing in the **Code or Description** for each evidence item measured, the **Quick Code** option is available to speed up measurement, code assignment and the recording of the location of the evidence item. **Quick Code Mode** enables the user to assign an individual code to a specific key on the instrument key pad. Consider the intersection diagram below;

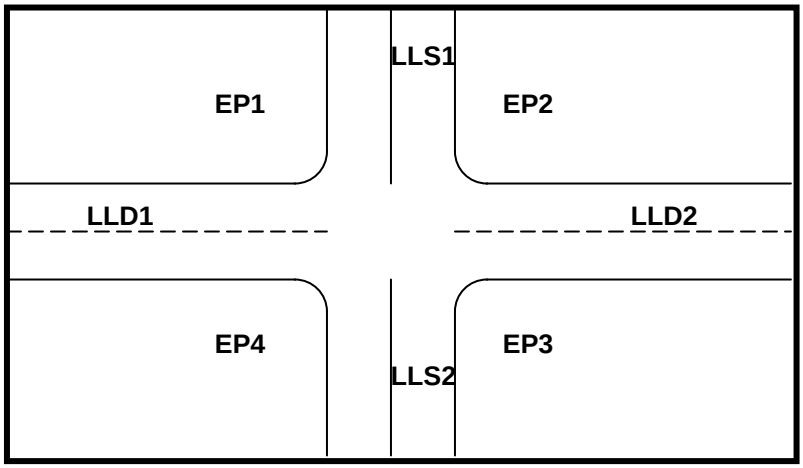


Fig. 7.17: Road Intersection Diagram

5. **Using Quick Code Mode to Speed Up Measurement & Collection (cont'd)**

In Fig. 7.17 above, the codes used are;

EP1	Edge of Pavement #1	**LLS1**	Lane Line Solid #1
EP2	Edge of Pavement #2	**LLS2**	Lane Line Solid #2
EP3	Edge of Pavement #3	**LLD1**	Lane Line Dashed #1
EP4	Edge of Pavement #4	**LLD2**	Lane Line Dashed #2

On the instrument,

- Press the blue **MODE** key to display the **Qcode Measurement Screen**.

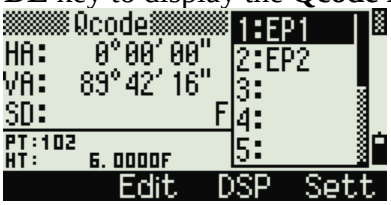


Fig. 7.18: Qcode Measurement Screen

- Move the highlight bar to the key to be edited using ▼/▲ arrow keys.

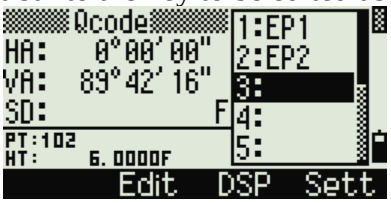


Fig. 7.19: Qcode Measurement Screen

- Press the **Edit** softkey (**MSR2** key).

Fig. 7.20: Qcode Edit Screen

- Type the code to be assigned to this key (**EP3**) and press **ENT** key.

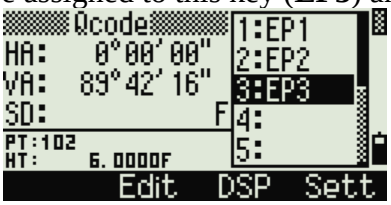
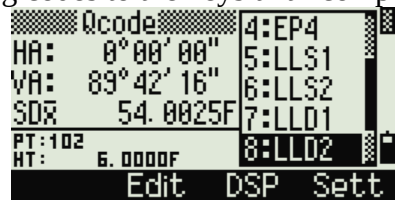


Fig. 7.21: Qcode Measurement Screen

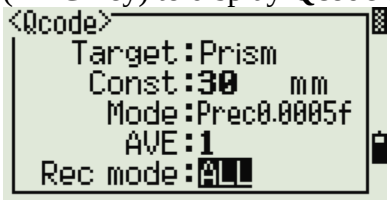
- Continue assigning codes to the keys until complete.



7.22: Qcode Measurement Screen

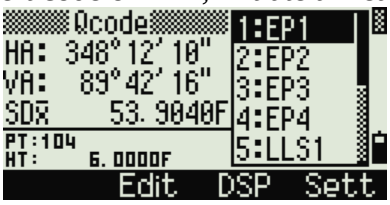
5. **Using Quick Code Mode to Speed Up Measurement & Collection (cont'd)**
When codes have been assigned to the keys, the manner in which the instrument uses the **Qcode keys** must be defined. This only needs to be defined once and is done by accessing the **Qcode Settings**.

- Press **Sett** softkey (**ANG** key) to display **Qcode Settings Screen**.



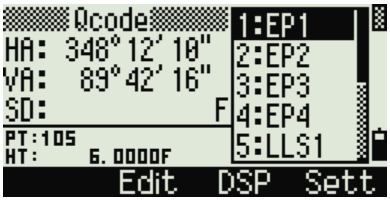
7.23: Qcode Settings Screen

- Ensure **Rec Mode:** is set to **ALL** by using ◀/▶ arrow keys. In **Quick Code Mode,** the **ALL** setting ensures the desired code is inserted, the measurement to this item is initiated and the data is stored all with a single key press.
- Press the **ENT** key to display the **Qcode Measurement Screen**.
- Press ① key to insert code of **EP1**, initiate a measurement and store the data.



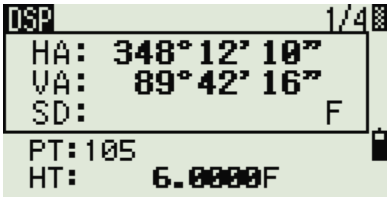
7.24: Qcode Measurement Screen

- Point number **PT** is updated by one and the **Qcode Measurement Screen** is displayed.



7.25: Qcode Measurement Screen

- When Qcode measurements are complete or an item is to be measured for which a Qcode has not been assigned, press **Mode** key to display the **Basic Measurement Screen**. Normal measurement and manual code entry by typing are performed at this screen.



7.26: Basic Measurement Screen

7.1 Collection of Scene Measurement Data (cont'd)

6. Move to New Station/Reference Point Setup (RP2)

- Move to new Station or **Reference Point (RP2)**.
- Repeat Step 1 above.
- Repeat Step 3 above till **Backsight Menu Screen** is displayed.

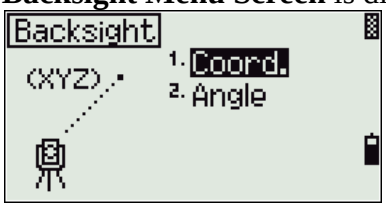


Fig. 7.27: Backsight Menu Screen

- Select **1.Coord.** (the backsight has known coordinates) by pressing ① key.
- Perform backsight observation per prompts.
- Repeat Step 4. or Step 5. as required.

7. Download the Survey Data.

- Prepare computer to accept data.
- Press **[Menu]** key.

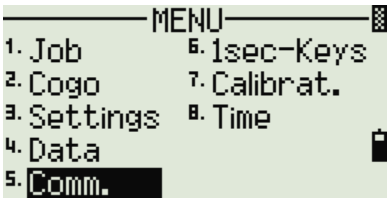


Fig. 7.28: Main Menu Screen

- Select **5.Comm.** by pressing ⑤.

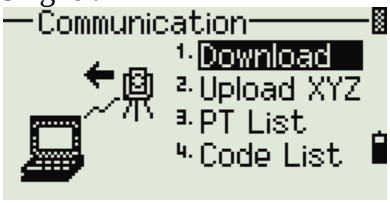


Fig. 7.29: Communications Menu Screen

- Select **1.Download** by pressing ①.
- **Download Settings Screen** is displayed.

Fig. 7.30: Download Settings Screen

7.1 Collection of Scene Measurement Data (cont'd)

- Select
  - **Format: NIKON** and
  - **Data: RAW** and press **ENT** key.

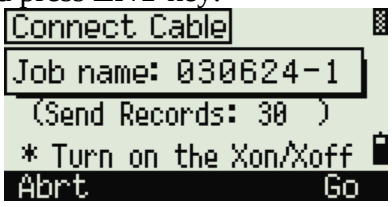


Fig. 7.31: Download Confirmation Screen

- Ensure cable is connected to instrument and computer.
- Select **Go** softkey by pressing **ANG** key.
- **SENDING screen** is displayed with record counter update till Complete.

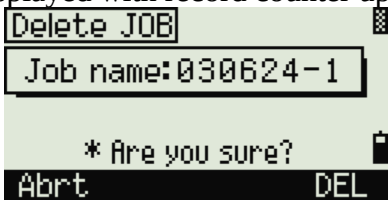


Fig. 7.32: Delete Job Screen

- At the **Delete JOB** screen, press either
  - **Abrt** softkey (**MSR1** key) to **NOT** Delete Job and return to **BMS Screen**, or
  - **DEL** softkey (**ANG** key) to Delete Job and return to **BMS Screen.**

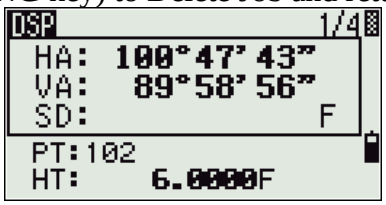


Fig. 7.33: Basic Measurement Screen

7.2 Small AIMS Field Exercise

Each member of each group to perform:

i. Create Job.
ii. Station Setup.
iii. Collection of 20-30 Data Points.
iv. Download Data in Office.

Codes to be Used:

i.	**EPx**	Edge of Pavement #1, Edge of Pavement #2, etc.
ii.	**TCx**	Top of Curb #1, Top of Curb #2, etc.
iii.	**BCx**	Bottom of Curb #1, Bottom of Curb #2, etc.
iv.	**LP**	Light Pole
v.	**TD**	Tree Deciduous
vi.	**TE**	Tree Evergreen
vii.	**ELV**	Elevation Shot

All linework to be straight lines.

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8.0 Data Transfer with TransIt Software

TransIt is data transfer software containing functions to transfer data bi-directionally between a Nikon Total Station and a personal computer via the RS-232 serial port and a cable.

Additional functions include the ability to create and edit jobs, download and upload data and export and import survey data between a number of third party data file formats.

8.1 Starting TransIt

- In Windows, double click the **TransIt** icon.
- The **TransIt Main Menu** is displayed.

8.2 TransIt Main Menu

File	Edit	Transfer	Process	Tools	Window	Help

Fig. 8.1: TransIt Main Menu

8.3 TransIt Main Menu Functions

Below is a brief description of each menu item in the **TransIt Main Menu**.

File

- **New Job:** Creates new job.
- **Open Job:** Opens an existing job.
- **Save Job:** Saves a job.
- **Save Job As:** Saves a job to a new location.
- **Import Job:** Imports data from third party data format to Nikon data format.
- **Export Job:** Exports data from Nikon data format to third party data format.
- **Print Report:** Prints Nikon raw and coordinate data file.
- **Properties:** Displays summary of job properties.
- **Exit:** Exits TransIt.

Edit

- **Delete Record:** Deletes current survey record.
- **Undelete Record:** Restores current deleted survey record.
- **Insert Record:** Inserts different types of survey data.
- **Append Record:** Appends survey record to end of current job.
- **Search Record:** Searches for specific survey record.

Transfer

- **Data Recorder to PC:** Transfers survey data from the Data Recorder to the PC.
- **PC to Data Recorder:** Transfers data from the PC to the Data Recorder.

8.3 TransIt Main Menu Functions (cont'd)

Process

- **Calculate Coords:** Calculates coordinate values.
- **View Reprocess Log:** Displays log record of reprocessing activity.
- **View Upload/Export:** Displays log record of data upload/export activity.

Tools

- **Comm. Settings:** Communications settings for Com Port and Baud Rates.
- **Export Settings:** Export settings for DXF and Coordinate options.
- **Job Settings:** Settings for data type and corrections.
- **Code List Tools:** Tool for creating Code Lists.
- **COGO:** Coordinate Geometry routines.

Window

- **Arrange Icons:** Arrange icons at the bottom of the window.

Help

- **Contents:** Displays TransIt Help Contents.
- **Search for Help On:** Searches for Help on Specific Topics.
- **Technical Support:** Technical Support user & problem information.
- **About:** Displays licensing and software information.

8.4 TransIt Data Downloading from the Total Station

Personal Computer

- Start **TransIt** by double clicking on the **TransIt icon** in Windows.
- Select **Transfer** from the **TransIt Main Menu**.
- Select **Data Recorder to PC** from the **Transfer Menu**.
- Ensure **Data Recorder** selection box displays **DTM-352/332 (or DTM-502)**.
- Enter name of job in the **Job Name** (Jobname.raw) selection box and click on **OK** box.
- At the "Prepare Nikon Total Station...." screen, click on **OK** box.
- At the **"TransIt Transfer Complete"** screen, select **OK**.

DTM-502/352/332 Total Station

To initiate the **Download** from the total station,

- Connect the total station-to-PC serial cable.
- Press **[Menu]** key.

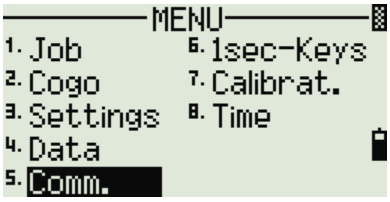

Fig. 8.2: Main Menu Screen

- Select **5.Comm.** by pressing ⑤.

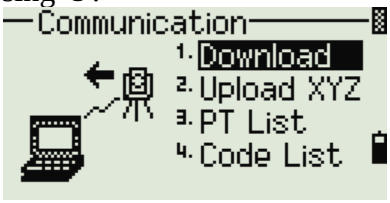

Fig. 8.3: Communications Menu Screen

- Select **1.Download** by pressing ①.
- **Download Settings Screen** is displayed.

Fig. 8.4: Download Settings Screen

- Select
  - **Format: NIKON** and
  - **Data: RAW** and press **ENT** key.

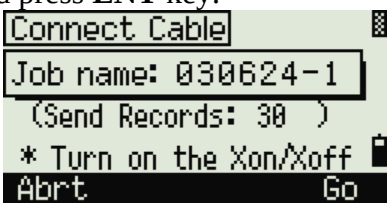

Fig. 8.5: Download Confirmation Screen

8.4 TransIt Data Downloading from the Total Station (cont'd)

- Ensure cable is connected to instrument and computer.
- Select **Go** softkey by pressing **ANG** key.
- **SENDING screen** is displayed with record counter update till Complete.

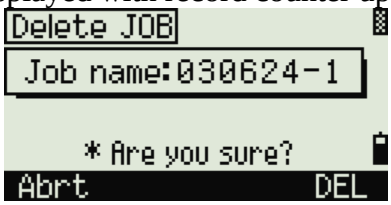

Fig. 8.6: Delete Job Screen

- At the **Delete JOB** screen, press either
  - **Abrt** softkey (**MSR1** key) to **NOT** Delete Job and return to **BMS Screen**, or
  - **DEL** softkey (**ANG** key) to Delete Job and return to **BMS Screen.**

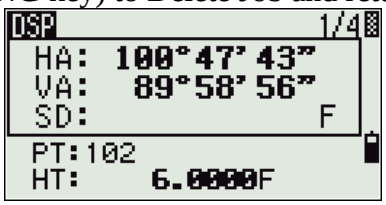

Fig. 8.7: Basic Measurement Screen

- Select **OK** at the PC after the download is complete.

8.5 TransIt Data Conversion

TransIt can **import** a variety of third party software data formats into total station format data and **export** total station format data to a variety of third party software data formats.

To perform a data conversion;

Data Export

To export Nikon data to a third party data format;

- Select **File** from the **TransIt Main Menu**.
- Select **Export Job** from the **File Menu**.
- Select the **Export Format** from the Export Format selection box.
- Verify the name of the job in the **Job Name** selection box and click on **OK** box.
- Type the name of the output file to be created and press **OK**.
- At the **"TransIt Export Complete"** screen, select **OK**.

Data Import

To import a third party data format into the Nikon data format;

- Select **File** from the **TransIt Main Menu**.
- Select **Import Job** from the **File Menu**.
- Select the **Data Format** from the Data Format selection box.
- Select the name of the job in the **Job Name** selection box and click on **OK** box.
- At the **"TransIt Import Complete"** screen, select **OK**.

8.6 TransIt Data Uploading to the Total Station

Personal Computer

- Start **TransIt** by double clicking on the **TransIt icon** in Windows.
- Select **File** from the **TransIt Main Menu**.
- Select **Import Job** from the **File Menu**.
- Select the **Data Format** from the Data Format selection box.
- Select the import job name in the **Job Name** selection box and click on **OK** box.
- At the **"TransIt Import Complete"** screen, select **OK**.
- Select **Transfer** from the **TransIt Main Menu**.
- Select **PC to Data Recorder** from the **Transfer Menu**.
- Select **DTM-502/352/332** from Data Recorder selection box and click **OK**.
- Enter the name of the job in the **Job Name** selection box and click on **OK** box.
- Prepare total station to accept the data to be uploaded.
- At the **"TransIt Information"** screen, select **OK**.

DTM-502/352/332 Total Station

To prepare the total station to accept the Uploaded data,

- Connect the total station-to-PC serial cable.
- **Create a Job** to receive the data.
  - Press **[Menu]** key**.**

Fig. 8.8: Main Menu Screen

  - Select **1.Job** by pressing ① key.

Fig. 8.9: Job Manager Screen

  - Select **Creat** softkey by pressing **MSR1** key.

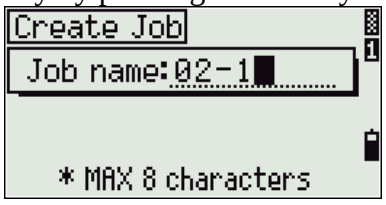

Fig. 8.10: Create Job Screen

    - Input **Job Name** up to 8 characters.
    - Press **ENT** key.

8.6 TransIt Data Uploading to the Total Station (cont'd)

- **Create Job Confirmation Screen** is displayed.

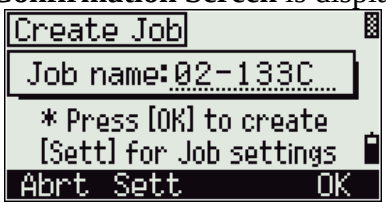

Fig. 8.11: Create Job Confirmation Screen

- Select **OK** softkey by pressing **ANG** key.
- **Basic Measurement Screen (BMS)** is displayed.

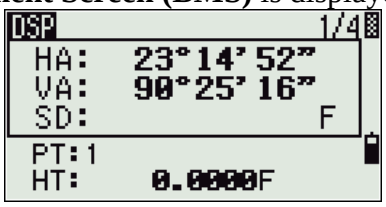

Fig. 8.12: Basic Measurement Screen

- Press **[Menu]** key.

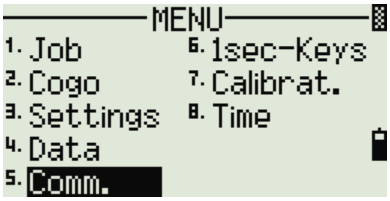

Fig. 8.13: Main Menu Screen

- Select **5.Comm.** by pressing ⑤.

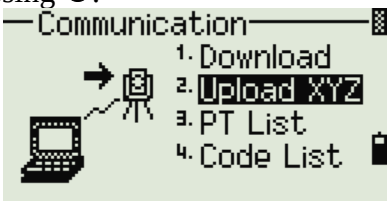

Fig. 8.14: Communications Menu Screen

- Select **2.Upload XYZ** by pressing ②.
- **Upload Format Screen** is displayed.

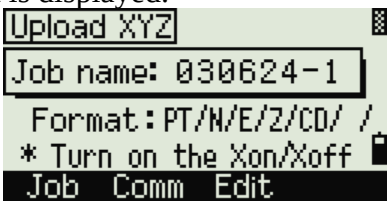

Fig. 8.15: Upload Format Screen

- Ensure cable is connected to instrument and computer and press **ENT** key.
- **Upload Confirmation Screen** is displayed.

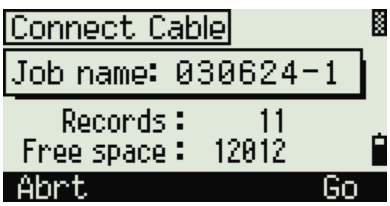

Fig. 8.16: Upload Confirmation Screen

8.6 TransIt Data Uploading to the Total Station (cont'd)

- Select **Go** softkey by pressing **ANG** key.
- **RECEIVING screen** is displayed with record counter update till Complete.
    - At the PC, select **OK** to initiate the data transfer.
- The **Basic Measurement Screen (BMS)** is displayed.

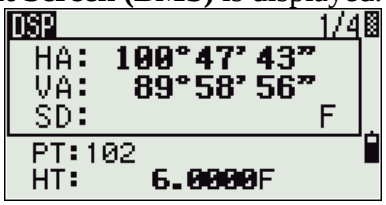

Fig. 8.17: Basic Measurement Screen

9.0 Automated Mapping - AIMS

9.1 Introduction to Automated Mapping

Automated or "Field-to-Finish" mapping software can generate a plan of an accident or crime scene complete with symbols, linework and text -- without user intervention.

In the Field

A **Feature Code** (or **Code** or **Descriptor**) is assigned to each data point collected prior to the point being recorded in the data recorder.

Example:	**Code**	**Type of Data Point**
	FH	Fire Hydrant
	EP	Edge of Pavement
	FCE	Fence
	BLD	Building
	TE	Tree - Evergreen

A **Field Parameter** or **Switch** may also be assigned at particular data points to assist the mapping software in drawing curved lines, closing linework on figures, etc.

Example:	**Code**	**Switch**	**Type of Data Point**
	CL	CS	Start of a Curve on the Road Centerline
	EP	K	Close Back to First Point on Edge of Pavement
	BLD	R	Compute Last Point on Rectangular Building

In the Office

The mapping software compares the code assigned for each data point to a table of codes containing individual plotting instructions for each code.

These plotting instructions control the symbols, sizes, line styles, pen numbers and text used in producing a map.

Libraries of Codes, Symbols and Linestyles are provided in the mapping software and are usually user-definable.

9.2 AIMS Code List

AH	Arrow Hollow
AOI	Area of Impact
AS	Arrow Solid
ASMKx	After Impact Skid Marks
BBx	Bottom of Bank
BCx	Bottom of Curb
BDIx	Bottom of Ditch
BIKEx	Bicycle
BLDx	Buildings
BRDG	Bridge
BSMKx	Before Impact Skid Marks
BUSx	Bus
BUSH	Bush
BW	Brick Wall
BWALL	Brick Wall
CARCx	Car Compact
CARSx	Car Standard
CARIx	Car Intermediate
CARFx	Car Full Size
CLx	Centerline
CWx	Crosswalk
DEFAULT	Default Code
DPx	Debris Path
DRx	Driveway
DRAIN	Drain
EL	Elevation Shot
ELV	Elevation Shot
EPx	Edge of Pavement
FCEx	Fence
FH	Fire Hydrant
GLx	Gore / Fog Line
GM	Gas Meter
GMKx	Gouge Marks
HDG	Hedge
HWx	Handicap Walk
LLDx	Lane Line Dashed
LLSx	Lane Line Solid
LP	Light Pole
MB	Mail Box
MBIKEx	Motorbike
MHTR	Manhole Traffic
MHSS	Manhole Sewer
MHSW	Manhole Water
NG	Elevation Shot
PALM	Palm Tree
PIER	Pier
POF	Point of Frog
POI	Point of Impact
PP	Power Pole
PTP	Power & Telephone Pole
RLx	Railroad Line
RPx	Reference Point
RRF	Railroad Flasher
SBx	Stop Bar
RW	Retaining Wall
SEMIx	Semitrailer
SGN	Sign
SGNSPD	Sign Speed
SGNSTP	Sign Stop
SGNSTR	Sign Street
SGNYLD	Sign Yield
SLBx	Signal Light Support Bar
SLE	Signal Light East
SLN	Signal Light North
SLS	Signal Light South
SLW	Signal Light West
SLP	Signal Light Pole
SWx	Sidewalk
SZx	Safety Zone
TANKERx	Tanker
TBx	Top of Bank
TCx	Top of Curb
TD	Tree Deciduous
TDIx	Top of Ditch
TE	Tree Evergreen
TIx	Traffic Island
TLRx	Trailer
TP	Telephone Pole
TRB	Traffic Barrel
TREE	Tree
TRLx	Tree Line
TRUCKx	Truck
TS	Traffic Signal
TSB	Traffic Signal Box
UP	Utility Pole
VIC	Victim
WIT	Witness

9.3 Crime Scene Code List

(Interior)

BATHx	Bathroom
BRMx	Bedroom
DRMx	Dining Room
HALLx	Hall
LRMx	Living Room
DOORx	Door
WINx	Window
CHAIRx	Chair
COUCHx	Couch
SOFAx	Sofa
TABLEx	Table

(Evidence)

BDROPx	Blood Drop
BLOODx	Blood Drops
BPATHx	Blood Path
GUNx	Gun
AMMOx	Unspent Round
SSCx	Spent Round
KNIFEx	Knife
FINGERPx	Finger Print
HANDPx	Hand Print
SHOEPx	Shoe Print
VICx	Victim
WITx	Witness

(Exterior)

BCx	Bottom of Curb
BLDx	Building Exterior
BUSH	Bush
CLx	Centerline
DRx	Driveway
EPx	Edge of Pavement
FCEx	Fence
FH	Fire Hydrant
GS	Ground Shot
HEDGE	Hedge
LP	Light Pole
PALM	Palm Tree
PATIO	Patio
PORCH	Porch
PP	Power Pole
PTP	Power & Telephone Pole
RPx	Reference Point
SW1	Sidewalk
TCx	Top of Curb
TD	Tree Deciduous
TE	Tree Evergreen
TP	Telephone Pole
TREE	Tree
UP	Utility Pole
WALL	Wall

(Miscellaneous)

X	Miscellaneous

9.3 AIMS Field Parameters

STRING	Start of New String	**SS**
	Close to First Point	**K**
	Compute Last Point on Rectangle	**R**
CURVES	Start of Curve	**CS**
	End of Curve	**CE**
POINT	Descriptor	**D"desc"**
	Symbol Size	**xx.xx**
ELEVATION	Plot Elevation	**Z**
	Not for Contouring	**NZ**
RULES	Blank space between codes and field parameters.	**EP CS**
	Prefix second code with "+".	**EP +DR**

10.0 Large Scene Measurement & Collection

10.1 Large AIMS Measurement & Collection

Each member of each group to perform:

i. Create Job.
ii. Station Setup.
iii. Collection of 50-75 Data Points.
iv. Station Move
v. Download Data in Office.

Codes to be Used: As necessary to provide representative survey

Field Parameters to be Used:

i. **CS** Curve Start.
ii. **CE** Curve End.
iii. **K** Close String to First Point.
iv. **D** Descriptor

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11.0 AIMS Data Downloading & Mapping

AIMS is data transfer and mapping software containing functions to transfer data bi-directionally between a Nikon Total Station and a personal computer via the RS-232 serial port and a cable.

Additional functions include the ability to create and edit jobs, download and upload data and export and import data between a number of third party data file formats.

11.1 Starting AIMS

- In Windows, double click the **AIMS** icon.
- The **AIMS Main Menu** is displayed.

11.2 AIMS Main Menu

Fig. 11.1: AIMS Main Menu

11.3 AIMS Data Downloading from the Total Station

Personal Computer

- Start **AIMS** by double clicking on the **AIMS icon** in Windows.
- **AIMS Main Menu** is displayed.
- Select **Tools|Data Transfer**.
- Ensure **Transfer Type** selection box displays **DTM-352/332 (or DTM-502) RAW**.
- Enter name of the job in the **Nikon File** (Jobname.raw) selection box.
- Ensure
  Port is **COM1**
  Baud is **4800**
  Parity is **None**
  Units is **US Feet**
  Angles is **Azimuth**
- Click on **Download (Receive Nikon File)** box.
- At the **"Prepare Nikon Total Station...."** screen, click on **OK** box.
- Data will scroll across the computer screen.
- Click on **New File** box and type in **Job Name**.
- Click **OK**.

DTM-502/352/332 Total Station

To initiate the **Download** from the total station,

- Connect the total station-to-PC serial cable.
- Press **[Menu]** key.

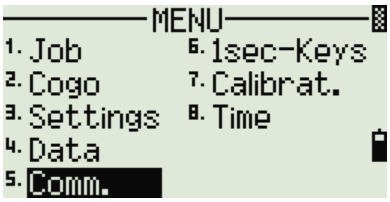

Fig. 11.2: Main Menu Screen

- Select **5.Comm.** by pressing ⑤.

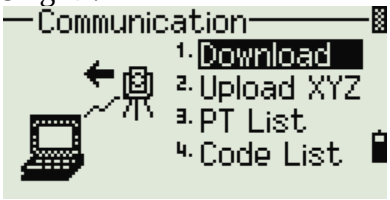

Fig. 11.3: Communications Menu Screen

- Select **1.Download** by pressing ①.
- **Download Settings Screen** is displayed.

11.3 AIMS Data Downloading from the Total Station (cont'd)

Fig. 11.4: Download Settings Screen

- Select
  - **Format: NIKON** and
  - **Data: RAW** and press **ENT** key.

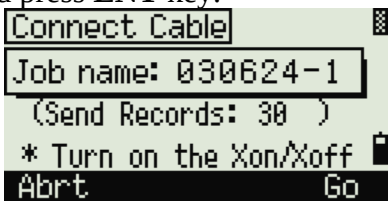

Fig. 11.5: Download Confirmation Screen

- Ensure cable is connected to instrument and computer.
- Select **Go** softkey by pressing **ANG** key.
- **SENDING screen** is displayed with record counter update till Complete.

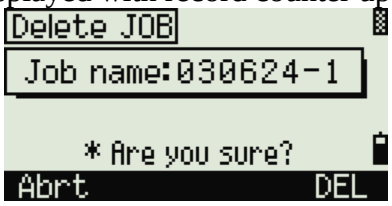

Fig. 11.6: Delete Job Screen

- At the **Delete JOB** screen, press either
  - **Abrt** softkey (**MSR1** key) to **NOT** Delete Job and return to **BMS Screen**, or
  - **DEL** softkey (**ANG** key) to Delete Job and return to **BMS Screen.**

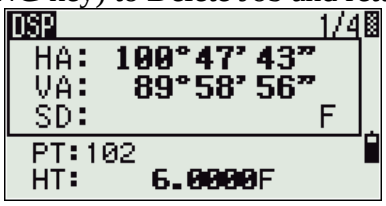

Fig. 11.7: Basic Measurement Screen

- Select **OK** at the PC after the download is complete.

11.4 Edit/Process Raw Data File

To process the raw data file;

- Select **Tools|Edit-Process Raw Data File.**
- Select **File** and click on **Open** box.
- Select **Process|Compute Coordinates** and click on **OK and OK** again.
- Close both **Report** windows.

11.5 Generating a Map of Scene

To generate a map of the scene;

- Select **Tools|Draw Field-to-Finish.**
- Click on **OK** box.
- The Scene Map is displayed.
- Close both **Report** windows.

11.6 Completing the Map of Scene

To complete a map of the scene;

1. **Adding Text**
   - Select **Draw|Text.**

2. **Adding Dimensions**
   - Select **Annotate|Point to Point** or **Point to Line**.

3. **Adding Title Block**
   - Select **Tools|Title Block**.

4. **Adding Scale Bar**
   - Select **Tools|Draw Barscale**.

5. **Adding North Arrow**
   - Select **Tools|Insert Symbols**.

12.0 Uploading Coordinate Data

A scene which has previously been measured may have its points uploaded into the total station.

12.1 Uploading Coordinates into the Total Station.

Personal Computer

- Start **TransIt** by double clicking on the **TransIt icon** in Windows.
- Select **Transfer** from the **TransIt Main Menu**.
- Select **PC to Data Recorder** from the **Transfer Menu**.
- Select **DTM-502/352/332** from Data Recorder selection box and click **OK**.
- Enter the name of the job in the Job Name selection box and click on **OK** box.
- Prepare the total station to accept the data to be uploaded.
- At the "TransIt Information" screen, select **OK**.

DTM-502/352/332 Total Station

To prepare the total station to accept the Uploaded data,

- Connect the total station-to-PC serial cable.
- **Create a Job** to receive the data.
  - Press **[Menu]** key.

Fig. 12.1: Main Menu Screen

  - Select **1.Job** by pressing ① key.

Fig. 12.2: Job Manager Screen

  - Select **Creat** softkey by pressing **MSR1** key.

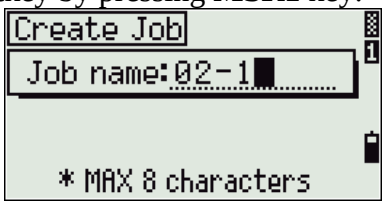

Fig. 12.3: Create Job Screen

  - Input **Job Name** up to 8 characters.
  - Press **ENT** key.

12.1 Uploading Coordinates into the Total Station (cont'd)

- **Create Job Confirmation Screen** is displayed.

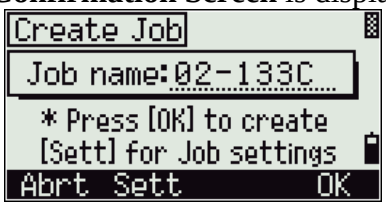

Fig. 12.4: Create Job Confirmation Screen

- Select **OK** softkey by pressing **ANG** key.
- **Basic Measurement Screen (BMS)** is displayed.

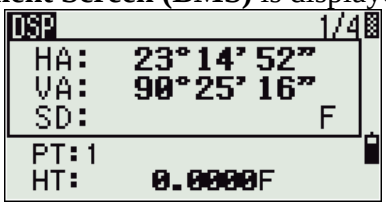

Fig. 12.5: Basic Measurement Screen

- Press **[Menu]** key.

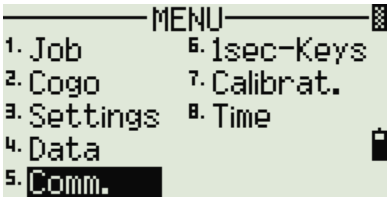

Fig. 12.6: Main Menu Screen

- Select **5.Comm.** by pressing ⑤.

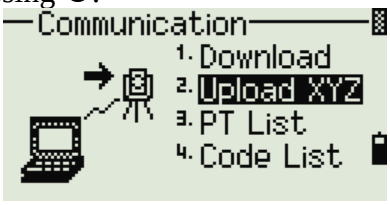

Fig. 12.7: Communications Menu Screen

- Select **2.Upload XYZ** by pressing ②.
- **Upload Format Screen** is displayed.

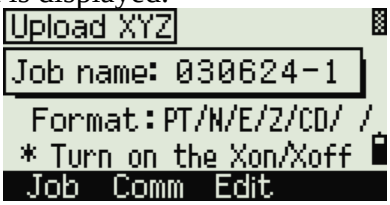

Fig. 12.8: Upload Format Screen

- Ensure cable is connected to instrument and computer and press **ENT** key.
- **Upload Confirmation Screen** is displayed.

12.1 Uploading Coordinates into the Total Station (cont'd)

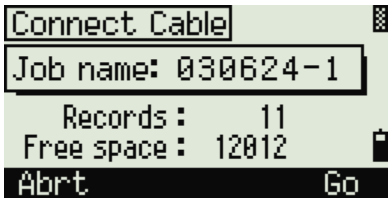

Fig. 12.9: Upload Confirmation Screen

- Select **Go** softkey by pressing **ANG** key.
- **RECEIVING screen** is displayed with record counter update till Complete.
    - At the PC, select **OK** to initiate the data transfer.
- The **Basic Measurement Screen (BMS)** is displayed.

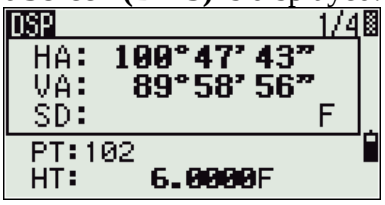

Fig. 12.10: Basic Measurement Screen

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GLOSSARY

Glossary of Surveying Terminology

Accuracy is the relationship between the value of a measurement and its "true or actual" value. The higher the accuracy, the smaller the errors in measurement.

Alidade is the upper assembly of the instrument which may be rotated about the base.

Angles are classified as Horizontal or Vertical according to the plane in which they are measured and are determined by the reference or starting line, the direction of turning and the angular distance or angular value.

Azimuths are angles measured clockwise from a reference meridian (generally North) and range from 0° to 360°.

Backsight is an initial reference point or direction from which angles and distances are measured to compute the positions of other points for stakeout and collection.

Bearings are a system of expressing directions of lines by means of an angle and quadrant letters. The bearing angle is the acute horizontal angle between the reference meridian and the line. The angle is measured from either the North or South to the East or West and always gives a reading less than or equal to 90°. **Examples:** N10°20'30"W, S18°E

Benchmark (BM) is a point of known elevation.

Centering is the precise alignment of the instrument's central axis over a point.

Circle reading is the current displayed value on the instrument for the Horizontal and/or Vertical angles.

COGO (COordinate GeOmetry) refers to the mathematical computations performed in solving unknown relationships between points having known coordinates. Examples include calculation of length and direction of a line between two known points, the point(s) of intersection of two lines, a line and a distance or two distances, and area.

Coordinates define the position of a point by perpendicular distances from the axes of the coordinate system. Northing, Easting and Elevation are survey coordinates.

Coordinate Geometry (COGO) refers to the mathematical computations performed in solving unknown relationships between points having known coordinates. Examples include calculation of length and direction of a line between two known points, the point(s) of intersection of two lines, a line and a distance and two distances, and area.

Crosshairs are the horizontal and vertical lines in an instrument's telescope which are used to sight to the target.

Data collection is the process of taking survey field measurements and recording them internally in a total station or externally in a data recorder.

Direction of a line is the horizontal angle between the line and an arbitrarily chosen reference line termed a meridian.

Easting (E) coordinate of a point's position is the perpendicular distance from the point to the North-South Axis.

Elevation (Z) is the vertical distance above or below a reference (known or assumed) datum.

Free Station (Resection) is the determination of an instrument's position or coordinates by measurement to two or more points having known coordinates.

Height of Instrument (HI) is the height of the instrument above its station.

Height of Target (HT) is the height of the prism above its station.

Horizontal Angles (HA) are angles measured in the horizontal plane. May be the difference between two directions.

Horizontal Clamp is used to lock and prevent horizontal movement of the instrument.

Horizontal Distances (HD=SD cosθ) are distances computed in the horizontal plane representing the straight line distance between plumb lines at any two points.

Horizontal Tangent Screw is used to fine adjust the horizontal motion of the instrument.

Leveling is the precise vertical alignment of the instrument's vertical axis.

Meridian (Astronomic or true) is the North-South reference line through the earth's geographic poles.

Magnetic Meridian is the North-South reference line through the earth's magnetic poles.

Assumed Meridian is established by assigning any arbitrary direction to a line. Directions of all other lines are found relative to the assumed meridian.

Nadir point is a point on a vertical line directly beneath below the instrument position.

Northing coordinate of a point's position is the perpendicular distance from the point to the East-West Axis.

Online refers to the target being located at the correct horizontal angle usually in stakeout.

Optical Plummet is the smaller eyepiece near the base of the instrument which is used to ensure the instrument is centered over a point.

Plumb is a vertical line from the point to the center of the earth.

Prism refers to the reflective piece of glass used to reflect the light signal back to the total station.

Resection (Free Station) is the determination of an instrument's position or coordinates by measurement to two or more points having known coordinates.

Sighting refers to the aiming of the telescope at the target, bringing the target into focus and aligning the target with the center crosshairs of the reticle.

Slope Distances (SD) are distances measured along inclined planes representing the straight line distance from the center of the EDM to the center point of the reflecting prism.

Stakeout is the process of transferring points with known design positions to their locations in the field.

Station is a point on the ground, generally having known coordinates, above which the instrument is set.

Target is a point to which the instrument is being sighted for measurement purposes.

Telescope is the tube assembly on the instrument which contains the objective and eyepiece lenses.

Total Station is a fully electronic instrument with coaxial optics which measures horizontal angle, vertical angle and slope distance with a single pointing to the target.

Tribrach is the detachable base, containing the leveling screws, of the instrument.

Vernier Scale is a graduated precision scale used in conjunction with graduated horizontal and vertical circles to determine a more precise angular value.

Vertical Angles (VA) are angles measured in the vertical plane from the horizontal.

Vertical Clamp is used to lock and prevent vertical movement of the telescope.

Vertical Distances (VD=SD sinθ) are distances computed in the direction of gravity representing the vertical or elevation difference between the center of the EDM and the center point of the reflecting prism.

Vertical Tangent Screw is used to fine adjust the vertical motion of the telescope.

Zenith point is a point on a vertical line directly above the instrument position.

Zenith Angles are angles measured in the vertical plane from the Zenith.