THEODOLITE SURVEYING

- The system of surveying in which the angles are measured with the help of a theodolite, is called Theodolite surveying.

CLASSIFICATION OF THEODOLITES

A.BASE ON HORIZONTAL AXIS

- **Transit Theodolite:** Telescope can be revolved through a complete revolution about horizontal axis in a vertical plane.
- **Non Transit Theodolite:** Telescope cannot revolved through a complete revolution about horizontal axis in a vertical plane.

B. BASE ON ANGLE

- **Vernier Theodolites:** For reading the graduated circle if Vernier's are used ,the theodolite is called as a Vernier Theodolite
- **Micrometer Theodolites:** If a *micrometer* is provided to read the graduated circle the same is called as a Micrometer Theodolite.
- **Electronic digital theodolite:** If electronic distance

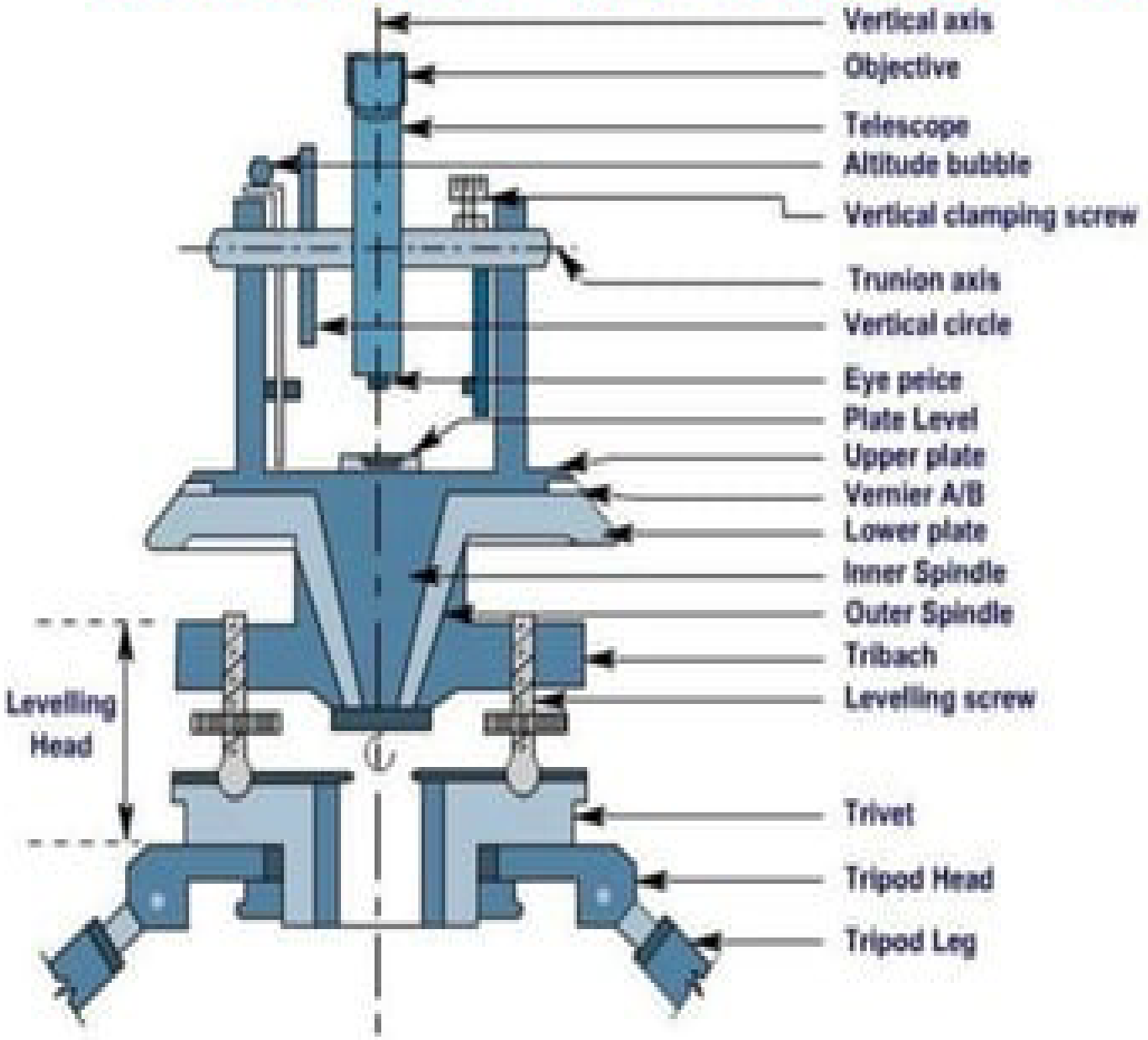
SIZE OF THEODOLITE

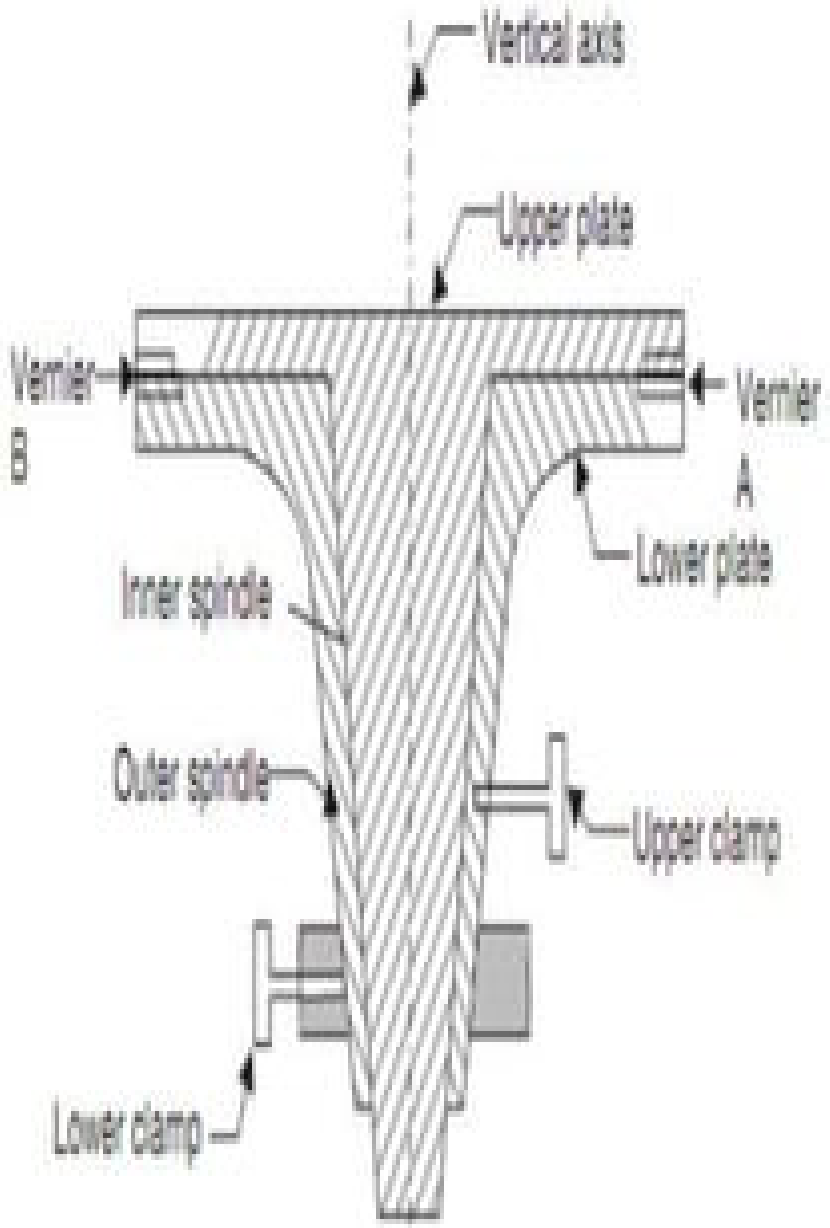
- A theodolite is designated by diameter of the graduated circle on the lower plate.
- The common sizes are *8cm to 12 cm* while *14 cm to 25 cm* instrument are used for *triangulation work*.
- Greater accuracy is achieved with larger theodolites as they have bigger graduated circle with larger divisions hence used where the survey works require high degree of accuracy.

USES OF THEODOLITE

- Measuring horizontal and vertical angles.
- Locating points on a line.
- Prolonging survey lines.
- Setting out grades
- Finding difference of level.
- Ranging curves
- Tacheometric Surveys

TRANSIT VERNIER THEODOLITE





Terminology

- **Centering :** Centering means setting the theodolite exactly over an instrument station so that its vertical axis lies immediately above the station mark. It can be done by means of plumb bob suspended from a small hook attached to the vertical axis of the theodolite.

- **Transiting :** Transiting is also known as *plunging* or *reversing*. It is the process of turning the telescope about its horizontal axis through 180^0 in the vertical plane thus bringing it upside down and making it point , exactly in opposite direction.

- **Swinging the telescope**: It means turning the telescope in the horizontal plane about its vertical axis.

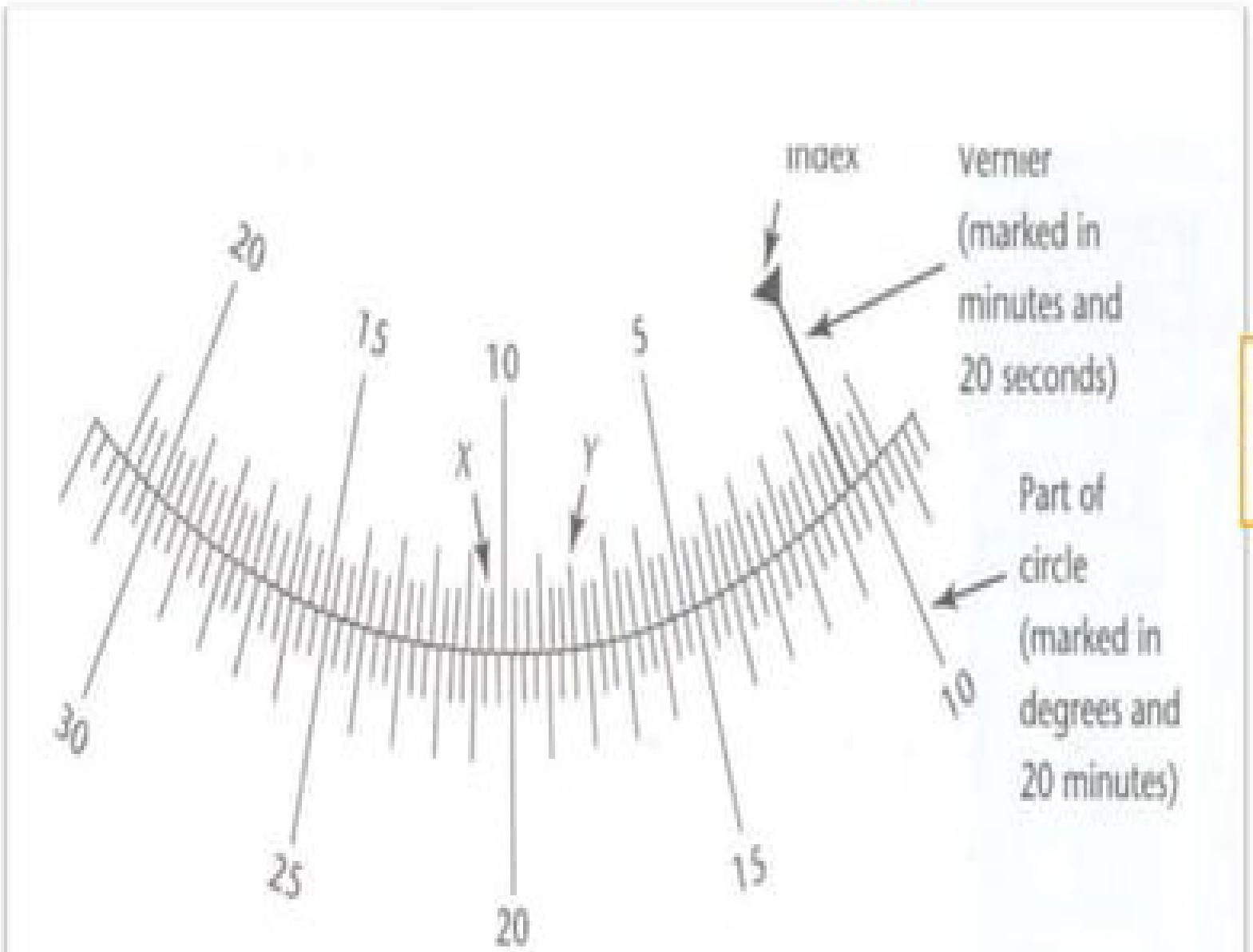
- **Face Left:** If the vertical circle of the instrument is on the left side of the observer while taking a reading ,the position is called the face left

- **Face Right:** If the vertical circle of the instrument is on the right side of the observer while taking a reading ,the position is called the face right

- **Line of Collimation :** It is also known as the line of sight .It is an imaginary line joining the intersection of the cross- hairs of the diaphragm to the optical centre of the object- glass and its continuation.

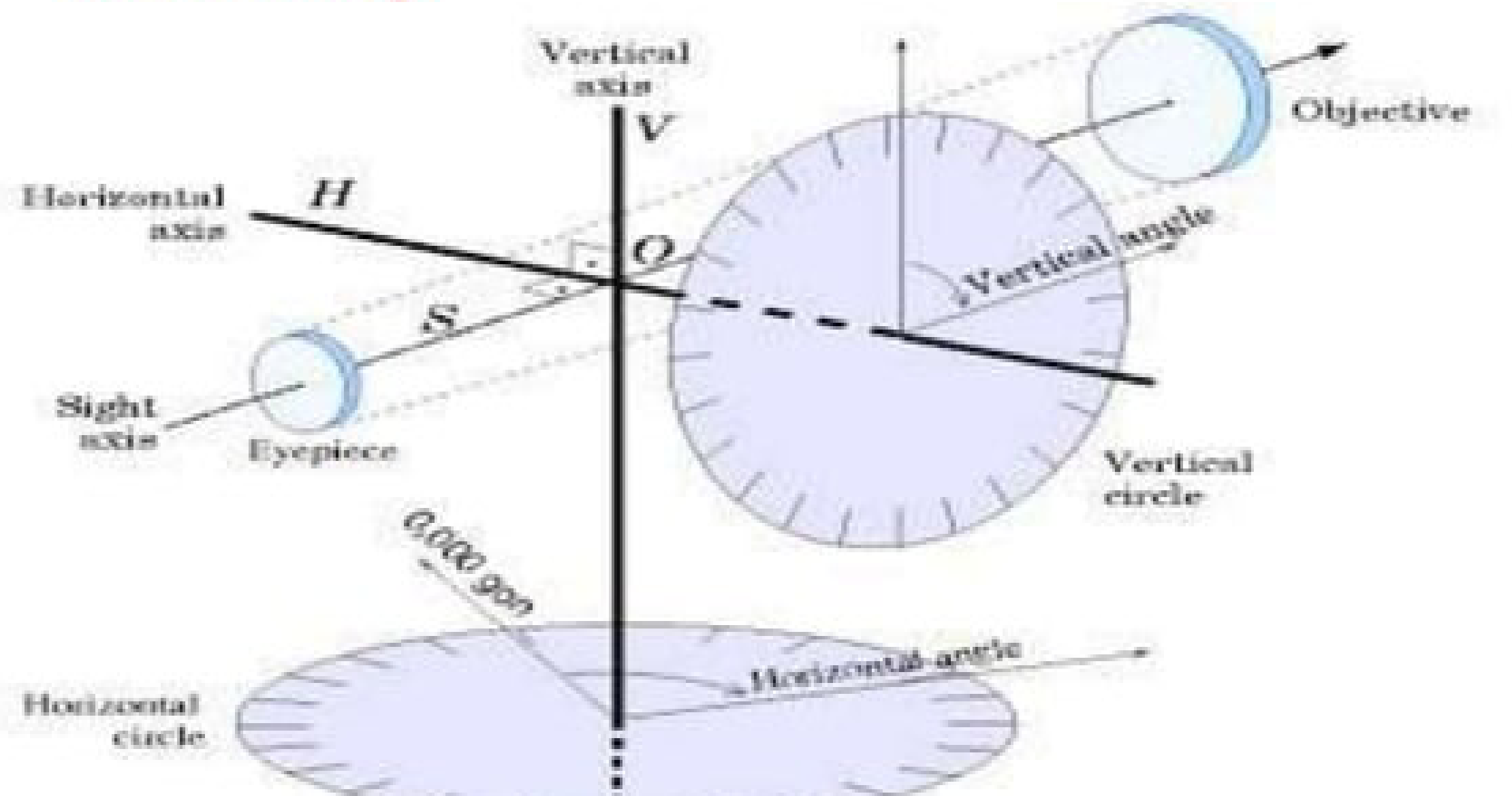
- **Axis of the telescope:** It is also known an imaginary line joining the optical centre of the object- glass to the centre of eye piece.
- **Axis of the Level Tube (bubble line):** It is a *straight* line *tangential* to the *longitudinal curve* of the level tube at the centre of the tube. It is horizontal when the bubble is in the centre.
- **Vertical Axis:** It is the axis about which the telescope can be rotated in the horizontal plane.
- **Horizontal Axis (trunion axis):** It is the axis about which

How to take Readings: VERNIER SCALE



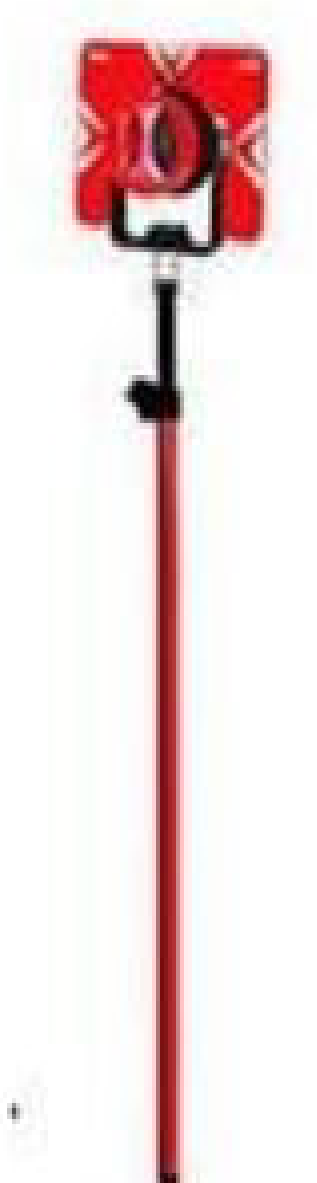
Main scale : 10 ^{0}
Vernier scale : 20' 20"

Fundamental axes of Theodolite & their relationship



TOTAL STATION

TOTAL STATION



TOTAL STATION

- An electronic / Optical Instrument
- An electronic theodolite having optical telescope integrated with EDM (Electronic Distance Meter) and Microprocessor with memory unit and other accessories
- Accessories consists of Keyboard , Display , Power Supply , data collectors, field computers, memory card etc…
- Provides (By measuring or estimating)all parameters (Distances&Angles) & derived values (corrections & cordinates) of surveying simultaneously
- Values of parameters can get displayed in viewing panel
- Precision may vary from 0.1" to 20"

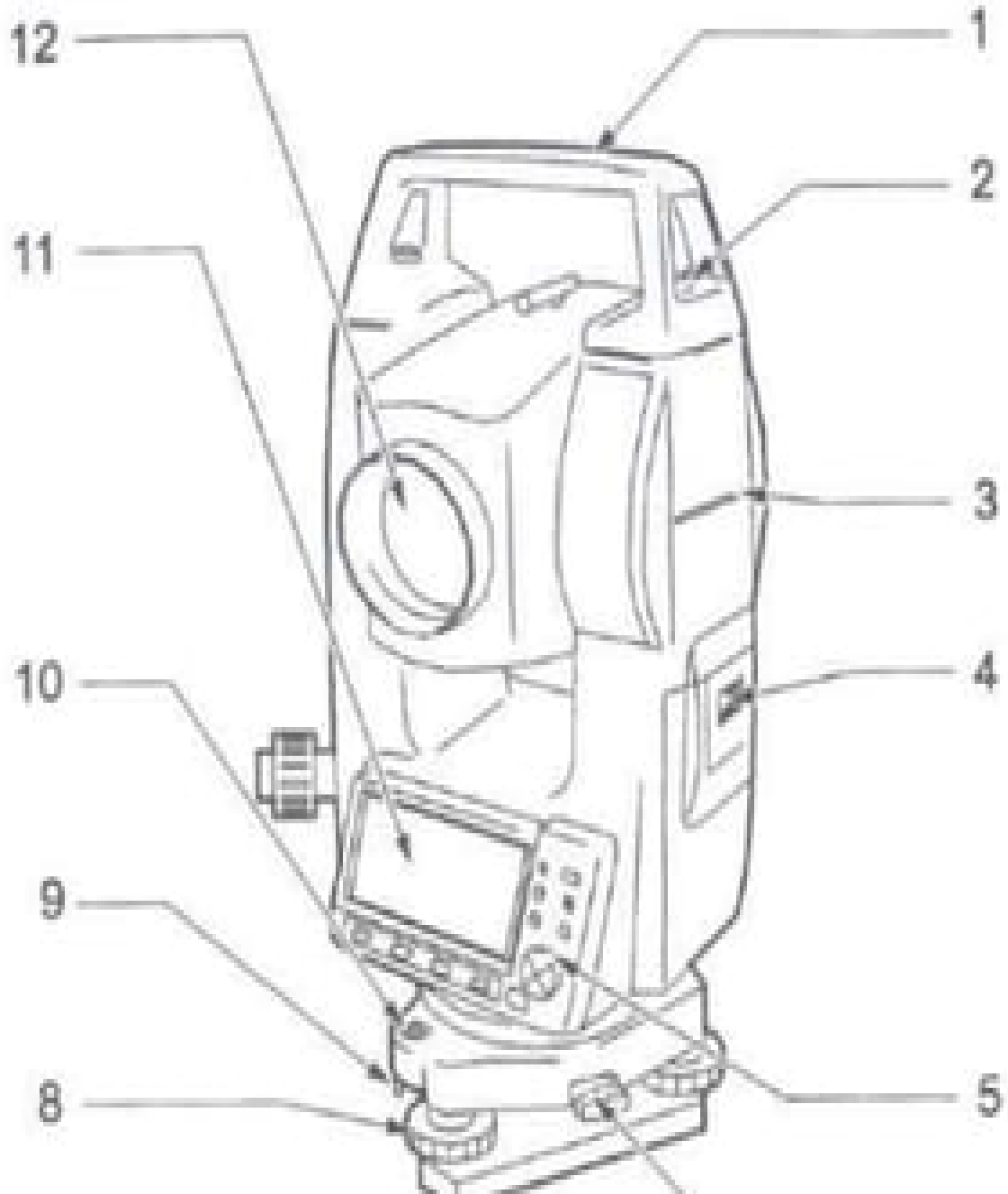
TOTAL STATION TYPES

- Based on minimum circle reading accuracy :

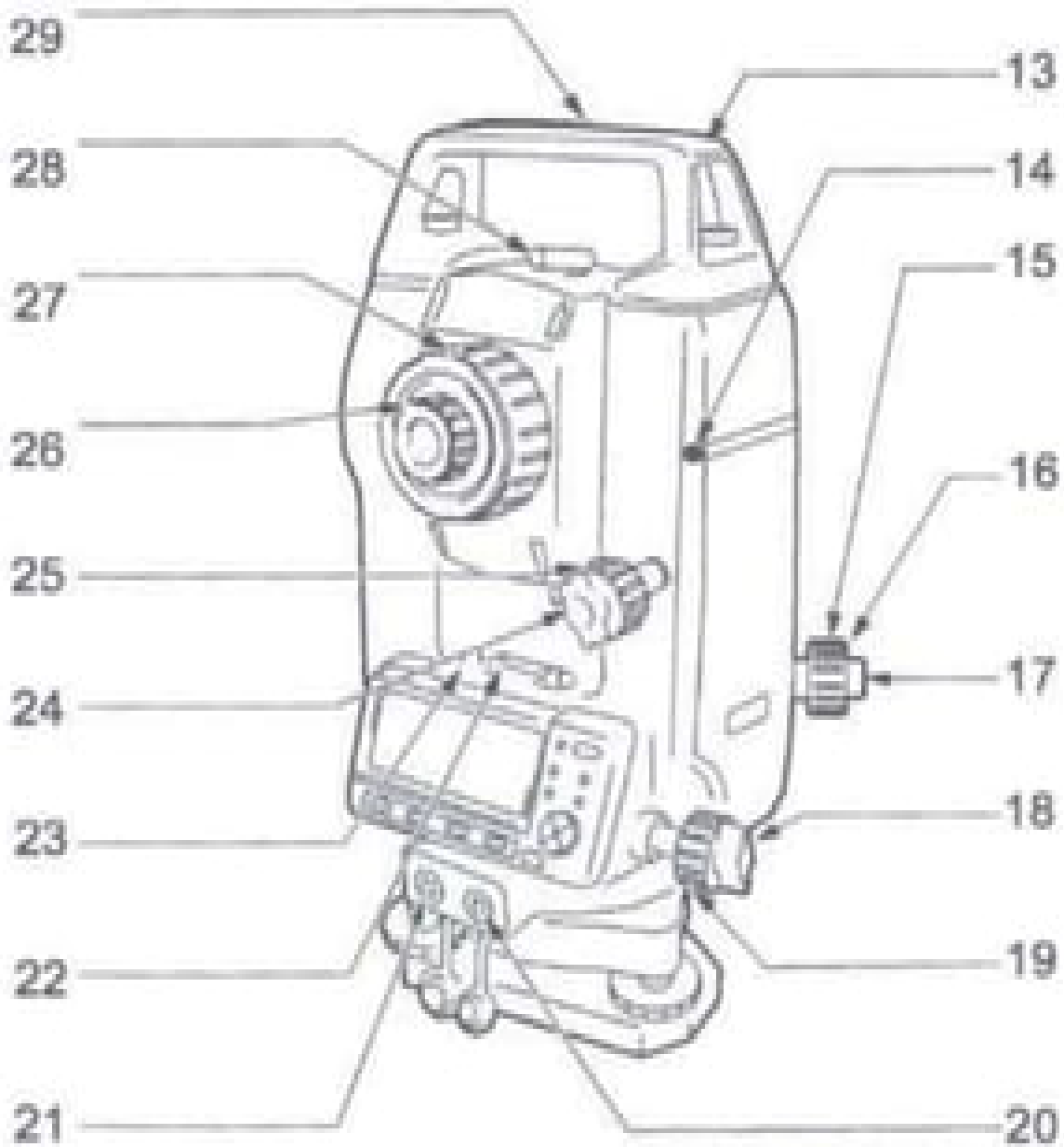
  0.1" to 20" (For eg: 1" total station, 2" total station, 5", 15" , 20" etc..)

- Based on Control
  - Manual
  - Robotic : (Operator controls from distance via remote)

PARTS OF A TOTAL STATION

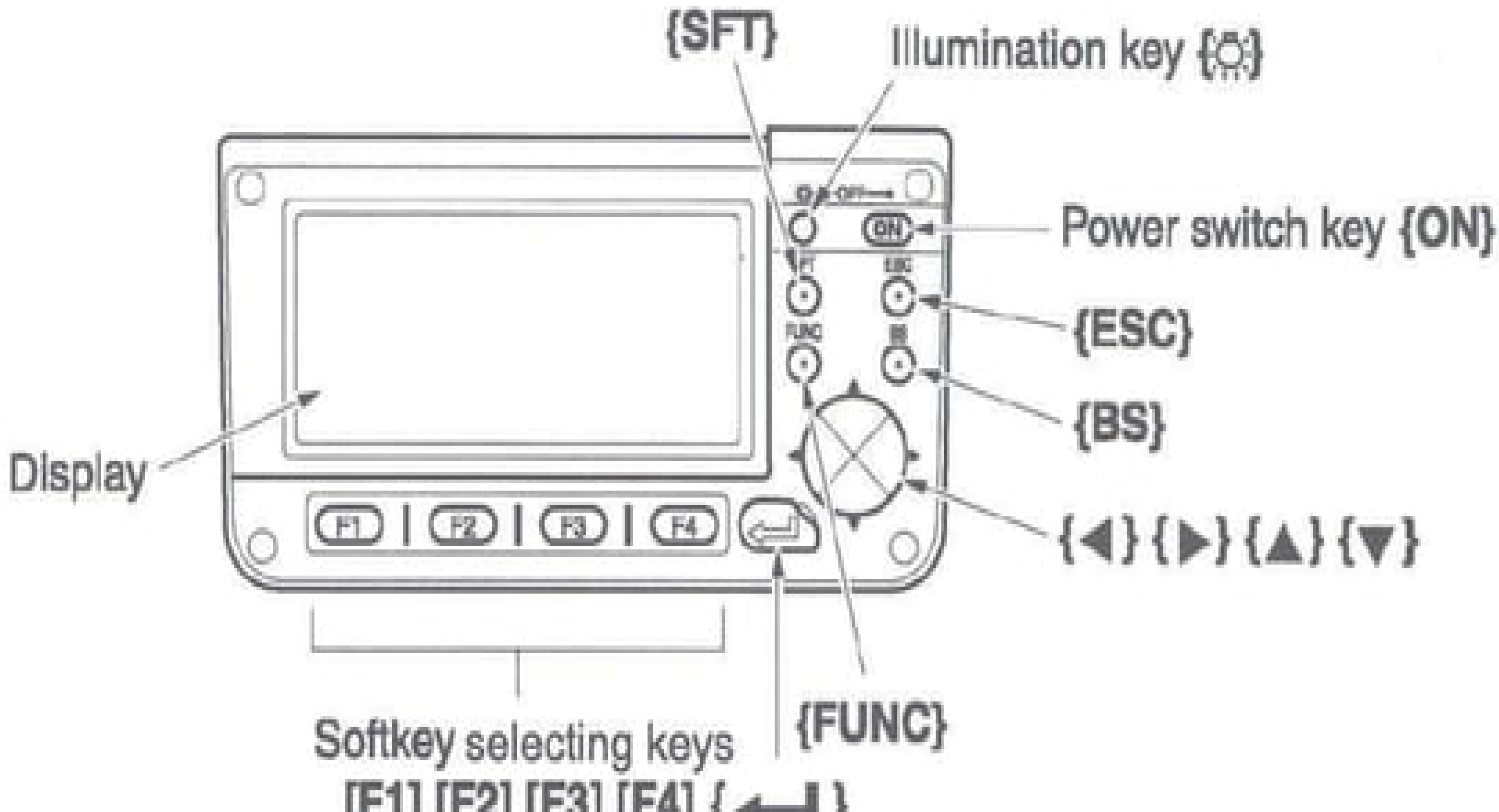


1 Handle
2 Handle securing screw
3 Instrument height mark
4 Battery cover
5 Operation panel
6 Tribrach clamp (SET310S/510S/610S: Shifting clamp)
7 Base plate
8 Levelling foot screw
9 Circular level adjusting screws
10 Circular level
11 Display
12 Objective lens



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

SCREEN AND KEYS



WORKING OF SALIENT PARTS

- Handle : To carry the Instrument physically
- Bluetooth antenna : To communicate via Bluetooth wireless technology
- External interface hatch : To connect to external devices
- Instrument height mark : To measure height of Instrument
- Luminance sensor : Adjusts the brightness of screen automatically
- Guide light : To carry out setting out measurement effectively
- Objective lens :
- Laser pointer function : To sight a target in dark location
- Vertical clamp screw :

- Trigger key: To carry out operation indicated by the soft key in bold type on the screen
- Horizontal clamp screw:
- Horizontal fine motion screw:
- Tribrach clamp: clamp the upper part of the instrument with lower part
- Telescope eyepiece screw:
- Telescope focusing ring:
- Sighting collimator : To aim in the direction of measurement point
- Instrument centre mark

- A Total Station primarily consist of an electronic theodolite, an EDM, Microprocessor and many other accessories

- Body of a theodolite is divided into two broad parts, upper part -The Alidade & lower part – The Tribrach

- Alidade includes standards, telescope,EDM, Circles (horizontal & vertical) and other elements for measuring angles and distance

- Tribrach contains foot screws, circular level, clamping devise and treads

- **TELESCOPE**

  - Objective lens : focus on the object to form image at the plane of reticle
  - Eyepiece lens : focus on the plane of reticle
  - Axis or line of sight : Line joining the objective lens and the eyepiece lens
  - Parallax : If there is relative motion between Image formed & reticle, parallax is present which should be avoided
  - Lock & tangent screws for revolutions & rotations

- **AUTOFOCUS**

  - It makes the telescope focus automatically to target. After aiming the

- **ANGLE MEASUREMENT SYSTEM**

  - For horizontal angle measurement, two glass circles within the alidade are mounted parallel one on the top of other , with a slight spacing between them. In a levelled TS (Total Station) horizontal angle circles should be in horizontal plane

  - For vertical angle measurement, two more glass circles are mounted in parallel with slight spacing between them but aligned in a vertical plane automatically in a levelled TS

- **MICROPROCESSOR**
  - Controls , measures , computes , Reduces observations/ data by providing commands through keyboard.
  - **Some salient functions**
    - To make circles zeroed instantaneously
    - To observe angles by method of reiteration in either direction
    - To observe angles by method of repetition
    - Averaging multiple distances and angle observations
    - Reducing slope distances into horizontal & vertical distances
    - Computation of elevation from vertical distance components
    - Computation of coordinates from horizontal angle and horizontal distance components

- **AUTOMATIC COMPENSATOR**
  - To get TS precisely indexed with the direction of gravity
  - Automatically align vertical circles having zero degree oriented precisely upward towards the zenith.

- **PLUMMET**
  - Build into either alidade or tribrach
  - Provides a line of sight that is directed downwards , collinear with the vertical axis after leveling
  - For accurate centering
  - Laser variety provides a beam of collimated light

- **OPTICAL GUIDANCE SYSTEM**
  - One or two above or below the telescope tube at the end of the objective lens. These are light emitting diodes and emit a visible light pattern which enables a detail pole to be set directly on the line of sight and at the correct distance without the need for hand signals from the total stations
  - In some instruments , OGS is represented as Guide Light . It is composed of lights that is divided into Green and Red sections. A poleman can ascertain the present position by checking the Guide light color as follows

LIGHT STATUS	MEANING
Increased flashing speed	Move towards TS
Decreased flashing speed	Move away from TS
Fast Flashing	Target at the correct distance
Red	Move target left

ACCESSORIES

• INTRODUCTION

Apart from salient components, some accessories are required for working with TS. Some of the Accessories are present as integral part of the TS – Control Panel , Data Collector , Memory Etc…

Some others totally independent – Reflectors

These are the Major accessories

- CONTROL PANEL
- DATA COLLECTORS
- MEMORIES
- REFLECTORS
- SOFTWARE

ACCESSORIES - CONTROL PANEL

- Control panel of a total station consist of a keyboard & multiple line LCD (liquid Crystal Display)
- The keyboard enables the user to select & implement different measurement modes, enable instrument parameters to be changed and allow special software functions to be accessed. Multifunction keys in the keyboard carry out specific tasks and some other keys activate& display menu systems which enable the TS to be used as computer
- Keyboard is also used to code data generated by the instrument for mapping. If a code is entered from the keyboard to define the feature being observed, the data can be processed much more rapidly when it is downloaded into and processed by an offline based computer plotter.

- The keyboard and display can be detached from the instrument and interchanged with other total stations and with GPS receiver. This enables data to be shared between different instruments and systems using single interface
- Thus combination of keyboard and display unit not only controls the operations of total station but also stores measurements and data

- **KEYBOARD**
- Keyboard contains different types of keys to provide different commands to its micro processor which subsequently gets works carried out by its different parts. It contains different alpha numeric keys , option selection keys, switching keys, Power key , lighting keys etc..

- **Salient Keys**
- Power Key : To switch between ON & OFF
- Illuminator Key : For lighting the reticle/keys and to select screen backlight brightness . To turn laser- pointer/guide light ON /OFF
- Star Key : To jump from each mode screen to the screen of checking/changing the various settings directly
- ESC Key : To cancel the input data/to return to previous screen
- TAB Key : To shift to next item

- B.S Key : Delete a character on the left
- S.P Key : Input a blank space
- FUNC Key : To toggle between observation mode screen pages
- ENT Key : Select/Accept input word/Value
- Numeric – Alpha Keys : To input numerals and alphabetic characters
- α key : Input Mode Key (To switch between numeric and alphabetic characters)
- SHIFT Key : To switch between lower case and uppercase characters
- Target Keys : To switch between target types (Reflector & Non Reflector)
- PRG Key : To switch between program mode and basic mode
- Luminance sensor/ Microphone key

ADVANTAGES OF TOTAL STATION

- Quick setting of the instrument on the tripod using laser plummet
- On-board area computation program to compute the area of the filed
- Local language support
- Full GIS creation
- Automation of old maps
- Greater accuracy in area computation
- Graphical view of plots and land for quick visualization
- Integration of data base
- The area computation at any user required scale

APPLICATIONS OF TOTAL STATION

- To measure horizontal and vertical angles
- To obtain the horizontal distance, inclined distance and vertical distance between points.
- To get the three-dimensional co-ordinates i.e.[x,y,z] of a point in space.
- To find the length of a missing the line
- To find the elevation of the remote object.
- To find the distance to a remote object
- To locate the points at a predetermined distance along gridlines.
- Calculation of Area of a closed figure

DISADVANTAGES OF TOTAL STATION

- It may be difficult for the surveyor to look over and check the work while surveying.
- The instrument is costly. And for conducting surveys using Total station, Skilled personnel are required.
- For an over all check of the survey, It will be necessary to return to the office and prepare the drawings using appropriate software
- The instrument contains sensitive electronic assemblies which have to be well protected against dust and moisture

PRECAUTION TO BE TAKEN WHILE USING A TOTAL STATION

- Use both hands to hold the total station handle
- Set up the tripod as stable as possible
- Do not move or carry a tripod with the Total Station fixed on it , except for centering
- Store the battery pack with the battery discharged
- Do not over tighten any of the clamp screws
- Take maximum care when the tribrach is removed from the Total Station