## Preface

Thanks a lot for purchasing our ZTS-320(R) series total station! As your handy construction toll, it will provide you with the most efficient and economic solutions to your job. To fully utilize the potential of your instrument and protect your investment, you need to, as we strongly suggest, thoroughly read this manual before starting any operations. Should you run into any problem, Hi-Target's technical support team will be happy to assist you.

Product insurance:In order to provide best service of our company, please send back the instruments' version, number, purchasing date and your valuable suggestions to us. Thank you for your cooperation.

Notice: We reserve the rights of the updating of the products and the improvement in the technical parameters which we may not announce in advance. The Pictures in the manual is for reference only, please take the actual item as the standard.

## Features

Abundant functions--- Our ZTS-320(R) series total station carry ample of survey applications and is capable of data storage, parameter settings and etc which suit all kinds of professional measurements.

1. Absolute coded disc is used to help an instant measurement without a calibration with reference points. The
2. A high-capacity RAM serves for an easy management of the file system, including the increase, deletion and transmission of the data.
3. Having no-prism in this series brings the function of laser ranging which may be survey for distant, speedy, precise measurement with all kinds of different materials and colors. e.g. metope of the building, telegraph pole, wire, cliff, massif, soil, timber pile etc., especially for the measurements of targets that cannot be accessed favorably.
4. Excepting for common functions, some special measurement procedures include Remote Height (REM) Measurement, OffsetMeasurement, MLM (MLM Measurement), resection, area measurement calculation, Roadway design and staking-out can be adequate for professional measurements.
5. The instrument can be equipped with changeable eyepieces. E.g. A bendable eyepiece may be used to measure the top-directions and high-rise buildings (something at a high altitude).
6. A laser plumb is adapted for convenient input of parameters of the stations set.

## Notice:

1. Avoid targeting sunlight with objective lens directly. Do not sight directly at the sun. Please install a sun filter to reduce the impact.
2. Do not leave the instrument in extreme temperatures (too high or too low) or employ it when there is a dramatic difference in temperature.
3. When not using the instrument, please load it in box and place it in ventilated dry place. Also make sure that the place is shockproof, dustproof and waterproof.
4. When there is a great difference in temperature between the storehouse and the work field, please do not unpack and draw outthe instrument from the tool-box until the instrument reaches the environmental temperature in order to obtain precise measurement.
5. If decide not to employ the instrument for a long term, the battery should be unloaded. A monthly charging is requiredfor promotion in longevity of the battery.
6. When transporting the instruments, please store them in boxes and avoid extrusion, collision and violent vibration during transportation. A soft mat around the boxes may be required for long-distance transport.
7. When setting the instrument, please use high-quality wooden tripod for stability to improve accuracy.
8. The lens must be kept clean to improve accuracy of No-Prism measurement. When cleaning exposed optical devices, please gently wipe them with absorbent cotton or lens paper only. Any other material is inadequate.
9. After a measurement, please purge away dusts from the instrument with flannelette or a hairbrush. Do not switch on the device when it has got wet inthe rain. Please wipe it dry with clean soft cloth and put it in ventilated place. Do not work with the instrument or pack it until it is fully dry.
10. Please check out that the indicators, functions, power supply, initial setting and correction parameters of the instrument meet the requirements before operating.
11. Any non-professional maintenance personnel are not allowed to dismantle the device, even if the instrument behaves abnormally, in case of any unnecessary disaster.
12. For security consideration, please do not sight the emitted light, laser, of the No-Prism Total Station ZTS-320(R).

## Security Guide

Persons as well as prevention of property damage, be sure to read this manual for the safety of your product and prevention of injury to operators and other.

Warnings:
Total station fit out laser level 3R/IIIa which is recognized by the symbolsstuck above the "horizon-axis locking knob" of the instrument, saying "Class 3A Laser Product". The Total Station is classified as Class 3R Laser Product and abides by the class of Laser Product according to IEC Standard Publication 60825-1:2001.

For Class 3R/IIIa Laser Product, its emitted laser with wavelength between 400 nm and 700 nmcan be at most 5 times of that of Class 2/II.


## Warnings:

See directly into laser beams constantly is destructive.

## Precautions:

Do not see directly into laser beams nor point laser to others. The reflection of laser beams received is essential signals of instrumental measurements.

Warnings:
Improper employment of Class 3R Laser instruments is destructive.

Precautions:
On the basis of IEC Standard Publication 60825-1:2001, please ensure that every employer of our ETS-121series Total Station takes apt safety measures and precautions.

Explanation of main part of the related IEC Standard Publication is as followed:

Class 3R Laser Products are employed outdoors and on construction plants (for no-prism measurements).
a. Personnel specially trained, qualified and authenticated are the only ones allowed to stall adjust and operate these laser instruments.
b. Laser warning symbols are to be set within the scope of the laser when operating these laser products.
c. Do not look directly into laser beams or look into laser beams with optical instruments.
d. An obstruction of laser beams is required at the terminal of working path (of the laser beams). When there is a person within the confined space (determined byInjurious Distance*) of laser beams, the operation of laser must be terminated instantly.
e. Working path of laser beams must be set above or below line-of-sight of working people.
f. Please store and safe keep idle laser products when laying them aside. Unauthenticated personnel are not allowed to employ them.
g. Prevent that the laser accidentally rays surfaces such as plane mirrors, metals and windows, especially the plane mirrors and concave mirrors.

* The injurious distance refers to the maximum distance between the source of the laser beams and the point where the laser beams decay enough to not harm human beings. The injurious distance of Class 3R/IIIa products is 1000 metres (3300feet). As exceeding this distance ( $1000 \mathrm{~m}=3300 \mathrm{ft}$ ), the laser intensity decays to that of Class 1 , which would not injure human eyes when looking directly into it.


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## 1.Uses of Total Station

A total station refers to such an instrument that measures azimuths and distances of targets and calculates the coordinates of targeted points automatically. It is fundamental in construction of national economy and defenses, as well as in building up of railways, motorways, bridges, irrigation, and programming and construction of cities. For example, as in military engineering, when preparing battlefields, harbor, fortress, airport, bases and military constructions, total station instrument can be employed to provide vase precise and detailed references for land surveying. In recent years, digital total stations has even become effective tools for large-scale precision engineering measurements, shipbuilding and aviation industry.

The ZTS-320(R) series total station is equipped with absolute code dial system, integrated-circuit-control-board ranging item and microcomputer for measurements of angle anddistance and for calculation, display, depositing and etc. It can exhibit horizontal and vertical angle, slope and horizontal distance and altitude difference simultaneously. Furthermore, it can be set to measure under different mode (e.g. Angle mode, Distance mode).

It is even designed for users specializing in construction projects with the no-prism ranging. The no-prism ranging can be comprehensively used in measuring three-dimensional coordinate, position determination, Remote Height (REM),
verticality, pipeline positioning, cross-section measurement etc.
It also meets requirements for measuring
trigonometrical-framework, relief(landform), cadastre and house property.

## 2.Names and functions of the components

### 2.1 Names of components




### 2.2 Functions of keyboards and the display of information



Symbols on the keyboard

| Symbol | Name | Function |
| :---: | :---: | :---: |
| ANG | Angle <br> Measurement | Enter Angle Mode <br> (can be also done by <br> pressing the Up key under <br> other modes or pages) |
| DIST | Distance <br> Measurement | Enter Distance Mode <br> (can be also done by <br> pressing the Down key <br> under other modes or <br> pages) |
| CORD | Coordinate <br> Measurement | Enter Coordinate <br> Mode (can be also done by |

$\left.\left.\begin{array}{|c|c|l|}\hline \text { MENU } & \text { Menu key } & \begin{array}{l}\text { pressing the Left key under } \\ \text { other modes or pages) }\end{array} \\ \hline \text { Enter Menu Page (can } \\ \text { be also done by pressing } \\ \text { the Right key under other } \\ \text { modes and pages) }\end{array}\right\} \begin{array}{l}\text { Accept and save the } \\ \text { inputs into the dialogue } \\ \text { box and end the dialogue. } \\ \text { Can be also used to open } \\ \text { and close the right-angle } \\ \text { buzzing function(when } \\ \text { detecting right-angle) } \\ \text { under basic measurement } \\ \text { modes(ANG, DIST, } \\ \text { CORD, MENU) }\end{array}\right\}$
$\left.\begin{array}{|c|c|c|}\hline 0 \sim 9 & \text { Number keys } & \begin{array}{l}\text { Enter numbers or } \\ \text { characters or choose menu } \\ \text { opts }\end{array} \\ \hline \sim- & \text { Special Symbols } & \begin{array}{c}\text { Enter symbols, } \\ \text { decimals and signs }\end{array} \\ \hline \star & \text { Star key } & \begin{array}{l}\text { Operate common } \\ \text { functions of the } \\ \text { instrument. Under pages of } \\ \text { distance measurement, star } \\ \text { key is for entrance of } \\ \text { dialogue box for choosing } \\ \text { opts. e.g. display contrast, } \\ \text { night lighting, }\end{array} \\ \text { compensation on/off, } \\ \text { distance measurement } \\ \text { parameters, files selecting. }\end{array}\right\}$

Symbols on the display screen

| Symbol | Indication |
| :---: | :---: |
| Vz | Zenith Mode |
| V 0 | When the telescope is leveled, the vertical <br> angle is displayed as $0^{\circ} 0^{\prime} 0^{\prime \prime}$ at face one. |
| Vh | Vertical angle Mode (being 0 and has a <br> positive angle of elevation and a negative angle of <br> depression) |
| $\mathrm{V} \%$ | Slope Mode |

$\left.\begin{array}{|c|c|}\hline \text { HR } & \begin{array}{c}\text { Horizontal angle (clockwise increment). } \\ \text { dHRis to stake out angle difference. }\end{array} \\ \hline \text { HL } & \begin{array}{c}\text { Horizontal angle (anticlockwise increment) }\end{array} \\ \hline \text { HD } & \begin{array}{c}\text { Horizontal distance. dHDisto stake out } \\ \text { horizontal distance difference. }\end{array} \\ \hline \text { VD } & \begin{array}{c}\text { Elevation difference. dVDisto stake out } \\ \text { difference between elevation differences. }\end{array} \\ \hline \text { SD } & \begin{array}{c}\text { Slope distance. dSD is to stake out } \\ \text { differences between slope distances. }\end{array} \\ \hline \mathrm{E} & \begin{array}{c}\text { North coordinate. dN is to stake out } \\ \text { differences between north-coordinates. }\end{array} \\ \hline \text { Z } \begin{array}{c}\text { East coordinate. dE is to stake out } \\ \text { differences between East-coordinates. }\end{array} \\ \hline \text { Elevation coordinate. dZ is to stake out } \\ \text { differences between Z-coordinates }\end{array}\right\}$

| Y | The magnitude of which deviates from the <br> base line horizontally in a point projection <br> measurement. |
| :--- | :--- |
| Z | Altitude of the target in a point projection <br> measurement. |
| Inter Feet | International feet |
| Us Feet | American feet |
| MdHD | Maximum error of evaluated distance (used <br> in resection measurement) |

Common reference functions of soft key

| Soft key <br> reference | Functions |
| :---: | :---: |
| B.S | (Backspace)Delete one last character on the <br> left of the inserter in the edited column. |
| Clear | Delete all typed in content in the edited <br> column. |
| Enter | End inserting in the currently edited column <br> and inserter goes to the next column. If there's <br> only one or no edited column in the dialogue box, <br> the soft key 'Enter' is also used to accept the <br> typed in content and end the dialogue box. |
| Input | Goes to Coordinate dialogue box and type in <br> the coordinates with keyboard |
| M.Pt | Obtain coordinates of points from measured <br> file |


| $\begin{gathered} \text { K.Pt } \\ \text { (Known) } \end{gathered}$ | Obtain coordinates of points from coordinate file |
| :---: | :---: |
| Search | Type in the name of the wanted point and search it in the current file to obtain coordinates. |
| View | List out details of the current record |
| Info. | Displays the name, code and coordinate of the current station and back-sight station. |
| Settings | Set theheight of the instrument and the target |
| STA | Enter coordinates of the station where instrument is placed. |
| BBS | Enter coordinates of the point where the target is. |
| Meas | Start distance meter to measure distance |
| Save | Start distance meter when being under Coordinate and Distance mode. Then save the result of this measurement and name of point is added by one automatically. Measurement cannot be saved when it is out of the scope of tilt compensation (Tilt over.) |
| Comp. | Display the inclination (tilt) of the vertical axis |
| Light | Turn on or off backlight and keyboard lighting (at the same time). |
| Para. | Set the atmospheric parameters, prism constant and signals. |

### 2.3 Functional keys under basic Measuring Mode

### 2.3.1 Angle Mode(including 2 menu pages)



| Page | Soft key | Reference | Function |
| :---: | :---: | :---: | :---: |
| 1 | F1 | Save | Save measured angle <br> record into selected file. |
|  | F2 | Set0 | Set the horizontal <br> angle to '0' |
|  | F3 | SetA | Set evaluated <br> horizontal angle with <br> keyboard which should <br> not be greater than $360^{\circ}$ |
|  | F4 | P1/2 | Display the second <br> page for soft key functions |
| Hold | Hold on the <br> horizontal angle readout. <br> The horizontal angle |  |  |


|  |  |  | readout displayed on the <br> screen would not change <br> at all. |
| :---: | :---: | :---: | :--- |
| F2 | L/R | Switch between HR <br> (horizontal right/ <br> clockwise) and HL <br> (horizontal left/ <br> anticlockwise) mode |  |
| F3 | VA | Vertical Angle Mode <br> (altitude angle, Zenith, <br> Horizontal '0', slope) |  |
| F4 | P2/2 | Display the first page <br> for soft key functions. |  |

### 2.3.2 Distance Mode(including two menu pages)



| Page | Soft <br> key | Reference | Function |
| :--- | :--- | :--- | :--- |
|  | F1 | Save | Start distance |


| 1 |  |  | measurement and save the measurement into selected files [measurement file 'File(.MEA)' and coordinate file 'File(.COO)'are selected in operating menu or by star key) |
| :---: | :---: | :---: | :---: |
|  | F2 | Meas | Start Distance Mode |
|  | F3 | Mode | Switch between four distance measurement mode [single accurate measurement (sngl)/ repeated accurate measurement (rept)/ continue measurement (cont)/ tracking (track)] |
|  | F4 | P1/2 | Display the second page for soft key functions |
| 2 | F1 | Offset | Start offset measurement (eccentric measurement) |
|  | F2 | Stake | Stake out distances |
|  | F3 | m/f/i | Switch distance units between meters, feet, feet\&inch. |
|  | F4 | P2/2 | Display the first page for soft key functions |

2.3.3 Coordinate Mode(including three menu pages)


| Page | $\begin{array}{c}\text { Soft } \\ \text { key }\end{array}$ | Reference | Function |
| :---: | :---: | :---: | :--- |
| 1 | F1 | Save | $\begin{array}{l}\text { Start coordinate measurement } \\ \text { and save measurement into } \\ \text { selected files [measurement } \\ \text { file 'File(.MEA)' or } \\ \text { coordinate file 'File(.COO)' } \\ \text { are selected in operating } \\ \text { menu or by star key] }\end{array}$ |
|  | F2 | Meas | $\begin{array}{l}\text { Start coordinate measurement }\end{array}$ |
|  |  | Mode | $\begin{array}{l}\text { Switch between four distance } \\ \text { measurement mode [single }\end{array}$ |
|  |  |  |  |
|  |  |  |  |
| measurement (rept)/ continue |  |  |  |$\}$


|  |  |  | measurement (cont)/ tracking (track)] |
| :---: | :---: | :---: | :---: |
|  | F4 | P1/3 | Display the second page for soft key functions |
| 2 | F1 | Setting | Set target height and instrument height |
|  | F2 | BBS | Set coordinates of BBS (back-sight point) and back-sight angle |
|  | F3 | STA | Set coordinates for station |
|  | F4 | P2/3 | Display the third page of soft key functions |
| 3 | F1 | Offset | Start offset measurement (eccentric measurement) |
|  | F2 | Stake | Stake out coordinates |
|  | F3 | SetA | Set azimuth (the same as setting horizontal angle under Angle mode) |
|  | F4 | P3/3 | Display the first page of soft key functions |

### 2.3.4 Explanation of Saving of data

If you have never selected the measurement fileand it is your first time to use reference function of 'Select file', then a dialogue box of 'Select file' would appear to the screen.
Mention that this is a good chance for you to select all files that the instrument may use.

When finishing single measurement or repeatedmeasurements under each mode, a dialogue box 'information' asking you to save coordinates, you may rename and code the points or set target height. Key 'ENT' saves the coordinates into measurement files.

If choosing not to edit points, the points would be saved with the present name, elevation and code after saving the name of the point is added by one.

### 2.4 Star(*) Key Mode

Under pages of distance measurement, pressing the key $\star$ (star key) can lead to a page as shown below.


Settings led by star $\operatorname{key}(\star)$ are as followed:
Adjust contrast ratio by pressing 'up' and 'down'

## $\operatorname{key}(\boldsymbol{\Delta}$ and $\boldsymbol{\nabla})$.

Adjust the lightness of backlight of the screen with 'left' and 'right' key ( $\downarrow$ ).

Turn on or off backlight of the screen by pressing Key 'F1'.

Turn on or off the display of compensation by pressing 'F2'.


Adjust reflector by pressing 'left' key $(\stackrel{)}{ }$. Each time a left key is pressed, reflectance target is switched between prism (Prism), no-prism (NP) and reflector board (RB).

Pressing key 'F3' to switch on or off visible laser beams.
Pressing key 'F4' to select 'parameters', which deals with settings of prism constants, PPM value and atmospheric temperature and pressure.

Pages for parameters setting with respect to distance measurement is shown below:(After entering the temperature and pressure data, the instrument would calculate PPM value
automatically. If the calculated PPM value is not favored, please reenter your expected value.)

| Temp: | $20.0^{\circ} \mathrm{C}$ |
| :---: | :---: |
| Press: | 1013.0 hpa |
| Prism c: | 0.0 mm |
| PPM: | 0.0 ppm |
| Signal: |  |
| BS Clear | Signal Enter |

Temp= Temperature
Press= Atmospheric pressure
Prism c= Prism constant
$\mathrm{PPM}=\mathrm{PPM}$ value
B.S= Backspace

Clear=clear up all typed in characters in the current column

Signal=Detect and display the intensity of signal of laser.
Notice that the laser will be on automatically even if you haven't set it on. Take care that your eyes are not in the scope of path of laser.

Enter=Move inserter to the next column.
Press ENT to save the settings.

## 3. Initial Setup

### 3.1 On \& Off

Press and hold the 'On/Off' key (and the buzzer buzzes once) until the screen displays pictures as below. The instrument is now switched on.
(Picture for reference. Kind prevail)


Now self-checking is accomplished and the instrumentautomatically enters Angle Mode (see details in $\underline{5}$.

## Angle Mode)

Repressing the 'On/Off' key leads to a dialogue box of 'Switch Off'. Press [ENT] to switch off.

ENT $\rightarrow$ Shut off
ESC $\rightarrow$ Quit

Quit after three seconds

### 3.2 Setup of Skewed Calibration of horizontal and vertical angles

When tilt (inclination) sensor is on, the instrument displays the automatic compensation to the horizontal angle caused by inclined plane. Concerning accuracy of angle measurement, please switch on inclination sensor wherever possible. According to the compensator, the instrument can be also better leveled with foot screw. If displaying 'Tilt over!' in the 'Vz' column, the instrument is now incapable of compensating the large inclination automatically. Then the instrument must be leveled by adjusting foot screw.

ZTS-320(R) series Total Station is capable of compensating and correcting horizontal-angle-readout errors caused by the tilt along the X -direction.

Switching off compensator is sensible when the instrument is under unstable condition or in a windy day. Thus, interruptions caused by vibration and constant displaying of 'Tilt over!' references of the instrument can be avoided. Switch off the compensator by using star $\operatorname{key}(\star)$ functions.

### 3.3 Setup of Target Type

In the ZTS-320(R) series, ZTS-320(R) Total Station has three options of reflectors: prism, no-prism and reflector board.ZTS-320(R), however, has only two: prism and reflector board. Each user may set up their favored type with star key $(\star)$ functions.

### 3.4 Setup of Reflecting Prism Constants

As a prism is selected as a reflector, a prism constant should be set before any measurement. If the constant is entered and set, it is saved and remains and will not be erased after switching off the instrument. After pressing 'parameters' key under star $\operatorname{key}(\star)$ mode, a dialogue box would appear as followed.

| Temp: | $20.0^{\circ} \mathrm{C}$ |
| :--- | :--- |
| Press: | 1013.0 hpa |
| Prism c: | $0.0 \quad \mathrm{~mm}$ <br> PPM:$\quad$0.0 ppm  <br> Signal:  <br> BS Clear Signal Enter |

Press soft key "Enter"to move inserter down to the 'Para.' column of prism constant and type in value.

### 3.5 Signal

The function of signal is to help display the intensity of signal of EDM (Electrical Distance Measurement). It can help achieve ideal aiming result under poor conditions. If it is too difficult to be found, using signal can easily aim at the target. Continuing with the explained operation in 3.4, you may press 'Signal' and the intensity of signal is displayed in the 'Signal' column above. The minimum measurable intensity should be 1 . Being less than 1 indicates that the target cannot be aimed and measured. Pressing any other keys to quit signal detection.

### 3.6 Setup of Atmospheric Correction

When measuring distances, the measured value can be influenced by the atmosphere. In order to reduce the influence, aatmospheric correction parameter is to be set.

Temperature: the surrounding atmospheric temperature
Atmospheric pressure: the surrounding atmospheric pressure

PPM: calculated and predicted atmospheric correction
The standard atmospheric value of ZTS-320(R) series Total Station (i.e. the atmospheric conditions when the correction is ' 0 ')

Atm: 1013 Pa
Temp: $20^{\circ} \mathrm{C}$
How is atmospheric correction calculated
$\Delta \mathrm{S}=277.825-0.29434 \mathrm{P} /(1+0.003661 \mathrm{~T})(\mathrm{ppm})$
In the formula:
$\Delta \mathrm{S}$ : correction constant (unit: ppm)
P : atmospheric pressure (unit: hPa )
T : temperature (unit: ${ }^{\circ} \mathrm{C}$ )

### 3.6.1 Alter Atmospheric Correction value (ppm) directly

Measure the temperature and pressure and find out the atmospheric correction ( ppm ) through correction formula or from the atmospheric correction chart. Continuing with the operations in 3.5, press soft key 'Enter' to move inserter down to the 'PPM' column. You may now type in the found value.

### 3.6.2 Calculate Atmospheric Correction out with temperature and pressure sensor

First, pre-measure the temperature and pressure of the surrounding at the measured station.
e.g. Temp: $+25^{\circ} \mathrm{C}$ atm: 1017.5

Press soft key 'Enter' to move inserter to the 'Temp' column and type in ' 25.0 ';

Press soft key 'Enter' to move inserter to the 'Press' column and type in '1017.5';

Press soft key 'Enter' to move the inserter to the 'prism c' column;
(the'PPM' column now displays 3 )
Press 'ENT' to save the parameter setting. Our system will display 'Record: ***(name of the point)' and quit the dialogue box. The point is now saved.

### 3.7 Correction of Atmospheric refraction and Earth Curvature

When measuring horizontal distance and elevation, our instrument is capable of correct the atmospheric refraction and the earth curvature.

The formulae of the two corrections of our instrument are as followed:

Measured Horizontal Distance after correction:
$\mathrm{D}=\mathrm{S} \times[\cos \alpha+\sin \alpha \times \mathrm{S} \times \cos \alpha(\mathrm{K}-2) / 2 \mathrm{Re}]$
Measured Elevation after correction:
$\mathrm{H}=\mathrm{S} \times[\sin \alpha+\cos \alpha \times \mathrm{S} \times \cos \alpha(1-\mathrm{K}) / 2 \mathrm{Re}]$
If not correcting Atmospheric Refraction and earth curvature, the formulae of our instrument for calculating horizontal distance and elevation are as followed:
$\mathrm{D}=\mathrm{S} \times \cos \alpha$
$\mathrm{H}=\mathrm{S} \times \sin \alpha$
In the formulae:
$\mathrm{K}=0.14---------$-Atmospheric refraction constant (can be selected by practical)

Re=6370 km---Radius of curvature of Earth
$\alpha$
The vertical angle (counted from the horizon)

S--------------------Slant distance
Alternative values for K are $0,0.14,0.2$.

### 3.8 Setup of the minimum readout of angles

See 9. Operating Menu.
The operation on the instrument follows'"MENU $\rightarrow 5$. Parameter settings $\rightarrow 6$. Minimum readout of angles"

### 3.9 Setup of Automatic Shutdown

See reference in 9.Operating Menu.

The setup of automatic shutdown on the instrument follows "MENU $\rightarrow 5$. options $\rightarrow 9$. Auto shut down. Opts displayed are as followed.

> Saving power
>Never
5 minutes
10 minutes
20 minute

## Enter

You may choose 'Never' to set off auto shutdown. When choosing 5, 10, 20 minutes opts, the instrument will automatically shut down after chosen time if there is no key pressed. Use $\boldsymbol{\Delta} \boldsymbol{\nabla}$ keys to move indicator ' $>$ ' up and down to the wanted opt. Press soft key 'Enter' or ENT to save the setting. Pressing ESC will result in no changes of settings.

### 3.10 Setup of Addictive and Multiplying Constants

See reference in 9 . Operating Menu.
The setup of addictive and multiplying constants on the instrument follows "MENU $\rightarrow 6$. Calibrate \&cofig $\rightarrow 3$.Add const"

The constants are already set through strict measurement when being sold. Generally users seldom have to adjust the setting. You may alter the constant after strict measurement (e.g.
in standardization site for baseline being measured by authenticated units).

### 3.11 Selecting Data File

Data file acts as a database for following measurement or a storehouse for finished measurement. Please select a proper data file before all measurements.

To select data file, see reference in 9 . Operating Menu.
Selecting data file on the instrument follows "MENU $\rightarrow$.Surveying $\rightarrow 1$.Select file". It can be also done by using star $(\star)$ key function.

Besides common measurement mode (Angle, Distance, Coordinate), you may also enter 'select file' page by star key ( $\star$ ) under 'Set up station' (Menu $\rightarrow 1$.Surveying $\rightarrow 2$.Station) or 'Set up BBS' (Menu $\rightarrow 1$. Surveying $\rightarrow 3$. Orientation(BBS)) or 'Stake out XX' (Menu $\rightarrow 2$.Stake out $\rightarrow 5$.Stake out) pages.

| Select File |  |
| :--- | ---: |
| $>$ File(.MEA) | A.MEA |
|  |  |
| File(.COO) |  |
| File(.LH) |  |
| Save | Enter |

MEA= Measurement File, working for storing data
$\mathrm{COO}=$ Coordinate File, being used when transferring coordinate
$\mathrm{COD}=$ Code File, being used when transferring code
$\mathrm{LH}=\mathrm{LS}=$ Defined line File, working for staking out roadway

Use $\boldsymbol{\Delta} \boldsymbol{\nabla}$ keys to move indicator ' $>$ ' to the wanted type of file and press 'Enter' soft key to enter the File list as followed:


Move the indicator to wanted file and press 'ENT' or soft key 'Enter' to select it.

## 4. Preparations before measurements

### 4.1 Drawing out and storing instruments

Unpacking
Lay down the tool box gently with top side facing up. Open the lock and unpack and draw out the instrument.

Storage
Mantle the telescope with its cover. Make sure that the vertical locking screw on the aiming component and the leveling bubble on the pedestal face upwards. Lay down the instrument into the tool box with objective lens of the telescope facing downwards. Tighten the vertical locking screw gently and mantle the box. Lock the box.

### 4.2 Storage the instrument

Reference for operation:
Install the instrument onto the tripod gently and level the centering of the instrument precisely with professional tripod which has connection screw on the center.

### 4.2.1 Using plumbs to centre and level (align)

1) Set up the tripod
(1) Open the tripod. Make sure that the three feet of the tripod are approximately equal in distance from the center and that the top is leveled. Screw up the three locking screw.
(2) Make sure that the center of the tripod top is rightabove the station.
(3) Stamp the tripod on the ground with your feet.
2) Install the instrument onto the tripod

Install the instrument onto the tripod gently. You may hold the instrument with one hand and unscrew the screwconnection on the instrument with the other. Move the instrument slightly on the top of the tripod until the plumb ball align with the center of station site sign. Screw up the connection screw.
3)Using circular level to level the instrument coarsely
(1) Twist and adjust the two leveling screw A and B on the bottom on the instrument until the bubbles of the circular level moves to the line perpendicular to the line of centers of screw A and $B$.
(2) Twist and adjust leveling screw C to move the bubble to the center of the circular level.

4)Using tubular level to level the instrument precisely
(1) Screw off the horizontal locking screw and turn the instrument around to make the tubular level parallel to the line connecting any two adjacent A and B to move leveling bubble to the center.

(2) Turn the instrument around about the vertical axis by $90^{\circ}$ and re-center the bubble


Screw A
Screw B
(3)Turn around the instrument by $90^{\circ}$ again. Repeat the process in $\downarrow$ and 8 until the bubble remains centered (leveled) at all sites.

### 4.2.2 Using centering device to centre

1) Set up the tripod
(1) Open the tripod. Make sure that the three feet of the tripod are approximately equal in distance from the center and that the top is leveled. Screw up the three locking screw.
(2) Make sure that the center of the tripod top is right above the station.
(3) Stamp one foot on the ground with your feet.
2) Install the instrument gently on the top of the tripod and screw up the screw connection. Open the laser plumb through star ( $\star$ ) key to aim at the station precisely.
3) Using circular level to level the instrument coarsely
4)Using tubular level to level the instrument precisely
4) Precise centering and leveling

Screw off the screw connection slightly and shift the instrument horizontally (mention that do not turn around the instrument about the vertical axis at all)according to the laser plumb the instrument aims at the station precisely.

Each hand held one of two other unstamped feet of the tripod and adjust their position according to the plummet.

As soon as the plummet aims at the stationcoarsely, stamp all three feet on the ground. Make the plummet aims at the station precisely by adjusting the three leveling screws of the instrument.

### 4.3 Unloading and charging batteries and information of battery conditions



## (1) Measurement is possible for both

(2) If first appear the second icon, the battery can support the instrument for another 4 hours

The battery is lower, it is better to replace

Measurement is impossible, it is necessary to replace and recharge battery

Notes:
(1) The working duration of batteries depends on the many factors. e.g. temperature, rate of charging and times
battery is charged. For insurance concerns, please charge the battery in advance and prepare spare charged batteries.
(2) Different measurement modes consume charges with different rates. e.g. Displaying enough remainder of charges under angle mode does not make sure that these charges can support the instrument under distance mode at the same level (because distance mode consumes charges at higher rates). A cessation of measurement may occur sometimes when switching from angle mode to distance mode due to a dead battery.

Notes for loading/ unloading batteries:
© For every time one unloads the battery case, the instrument must be firstly shut off.
© When loading the instrument with a battery, first insert the battery to the battery case. Then press the top of the battery until you hear a 'click'.
© Please press the button on the top of the battery case and release it as the case is inserted in.


Notes for recharging the battery:
Insert the battery into the charger. Press the top of the battery until you hear a 'click'.

Gently slide the battery on the charger slightly to make sure that it is finely positioned.

Plug the charger into the outlet of $110 \mathrm{~V}-220 \mathrm{~V}$ AC power supply. Recharging begins.

A The indicator light on the charger will illuminate three separate colors for various mode conditions:

Solid Red Light - the charger is working;
Solid Green Light - the charging has finished;
Flashing Red Light-no battery on charging, poor connection or some problems exist.
$\mathbf{\Delta}$ It is recommended to continue charging for 1 or 2 hours after the light turn green.
© Once the red light flashes constantly after the charger is plugged into the outlet of $110 \mathrm{~V}-220 \mathrm{~V}$ AC power supply, please remove the battery and reconnected it after 3 or 5 minutes.

A Though the charger is designed with overcharge protection circuit, one must unplug the charger after finished charging.
© Suitable temperature range for charging is between $-45^{\circ} \mathrm{C}$ and $+45^{\circ} \mathrm{C}$. Charging process may be abnormal if being over the temperature range.

A A battery can be recharged for 300-500 times. A monthly recharging is required even if the instrument is left idle.

### 4.4 Reflecting Prism

When measuring distance with prism selected as a reflector, a reflecting prism must be set at the target site. The reflecting prism can be connected onto the pedestal then onto the tripod with pedestal connection. It can be also positioned onto the centering rod. There are single prism group and three prism group available on the market. Users may equip their instrument based on the requirements of measurement.

### 4.5 Dismantling pedestal

Dismantle
The pedestal can be unloaded from the other pedestal of the reflecting prism of the instrument by loosening hook screw on the pedestal with a screw driver and anti-clockwise turn the screw around by $180^{\circ}$.

Install
Insert the three feet into corresponding holes on the pedestal and level. Clockwise turn the hook screw by $180^{\circ}$ to lock the instrument. Then tighten the screw with a screw driver clockwise.

### 4.6 Adjusting eyepiece lens of the telescope and shacking on the target.

How to aim at a target (only for reference)
(1) Aim at the bright sky with the telescope and adjust the eyepiece to focus until a sharp image of the cross wire forms;
(2) Aim at the target with the cross center in the coarse sighting device on the top of the lens. The eye should keep a proper distance (about 200 mm ) away from the sighting device.
(3) Obtain a sharp image of the target on the reticule with the focusing screw of the telescope. If optical parallax appears when angle of view changed, the focus or the diopter of the eyepiece may be unadjusted. For precision concerns, please adjust the eyepiece focus to eliminate the optical parallax.

### 4.7 Entering letters and numbers

The page for 'Setup Station'
(Menu $\rightarrow$ 1.Surveying $\rightarrow 2$.Station $\rightarrow$ Softkey F1[input] ) can involve inserting letters and numbers. Assume that the Pt. name is SUN1A and STN is - 123.456


The black box indicates that this column of information is selected and numbers and letters will be entered into this column only. The white slash in the box is the inserter.

Press soft key 'Num.' (F3) to switch between Numbers and Alphabet.


Press key ' 7 'for once displaying ' $S$ ' in the column
Cease operation for at least 0.4 seconds
Press key ' 7 ' for three times displaying 'SU' in the column (If the interval between pressing is over 0.4 s and the letter inserted is not desired, you may use keys to move the inserter left and right to letter to be altered. Then the letter can be altered by keys $\boldsymbol{\Delta} \boldsymbol{\nabla}$. The letter on the left of the inserter is the letter altered.

Press key ' 5 ' displaying 'SUN' in the column as followed


Press soft key 'Alph.' (F3) to switch between letters and numbers.

Press key ' 1 ' displaying 'SUN1' in the column
Switch to 'Alph.'again
Press key ' 1 ' for once displaying 'SUN1A' in the column


Press soft key 'Enter' to move inserter down to the STN column. The system switches to number entering mode automatically and no letters can be inserted in at all. The page is as followed.


Press keys ' $\pm$ '‘ 1 '" 2 ' 3 ' 3 .' ${ }^{\prime} 4$ ' $5^{\prime \prime} 6^{\prime}$ one by one.
Also, you may finish entering numbers first then press ' $\pm$ ' to alter its nature.

Now press 'ENT' to save the information entered and quit.

Notes: If information exists in the column already, the first number or letter you enter will clear up the column and be the first character of the column.

## 5. Angle Mode

The instrument would enter Angle Mode automatically when starting. You may also enter this Mode by pressing 'ANG' under basic measurement mode. Angle Mode involves two pages, being switched with soft key 'F4'. Their functions are explained as followed:

On the first page
Save: save measurement
After pressing soft key 'F1', dialogue box of 'Information' appears to the screen asking you to enter 'Point name', 'Code' and 'Target Height'. The natural name of the point is to add ' 1 ' to the previous point name. The code entered depends on your requirements and the target height depends on facts. Press 'ENT' to save measurement. P.S. If having not selected file at first when pressing 'Save' under Angle Mode, a dialogue box of 'Select File' will be on the screen before 'information'. You may now select file for saving.

When the measurement is out of the scope of compensator, the instrument will display 'Tilt over!' when pressing 'Save' and the measurement cannot be saved.

If the measurement is saved successfully, the instrument displays box of 'Record:*****' for 0.5 second and switch back to the Angle Mode.

Set 0: set horizontal angle to zero
Press soft key 'F2'
The instrument displays:

$$
\text { ENT } \rightarrow \text { Set } 0
$$

$$
\mathrm{ESC} \rightarrow \mathrm{Not}
$$

Now press 'ENT' to set 0 or 'ESC' to quit.
SetA: Set horizontal angle to desired degree
Press soft key 'F3' and the instrument enters page of 'Set HA'

If need to enter $123^{\circ} 45^{\prime} 56^{\prime \prime}$ under 'o'"', (degree minute and second) mode, then enter 123.4556. The page is as followed:

HR:123.4556

## B. 5

 Clear
## Enter

Now press 'F4' to save the setting or 'ESC' to quit. If the set angle is greater than $360^{\circ}$, the instrument will display 'HA ovetop!'

On the Second Page:
Hold: can be used to set horizontal angle
Turn around the aiming component to the wanted horizontal angle and press soft key 'F1'. Now the readout of horizontal angle is 'hold' and not changing with turning

Turn around the aiming component and aim at the target, press soft key 'F1' again and the horizontal angle is set at a new position.

When the horizontal angle is hold, any key beside 'Hold' will exert no effect on the instrument.

L/R:
Press soft key 'F2', the horizontal angle column is switched between HR and HL modes.

HR indicates that the angle increases as the instrument turns clockwise around the vertical axis

HL indicates that the angle increases as the instrument turns anti-clockwise around the vertical axis

VA:
Press soft key 'F3', the vertical angle column is switched between Vz, Vo, Vh and V\%

Vz is Zenith Mode
Vo indicates that when the telescope is leveled, the vertical angle is displayed as $0^{\circ} 0^{\prime} 0^{\prime \prime}$ at face one.

Vh is vertical angle Mode (being 0 and has a positive angle of elevation and a negative angle of depression)

V\% is Slope Mode. The range for slope that can be displayed is between $-99.9999 \%$ and $99.9999 \%$. If the slope is over the range, 'Overtop!' is displayed in the vertical angle column

When setting the horizontal angle, the set angle is the azimuth angle of the target. The instrument may be switched to display grid bearing through these operations.

## 6. Distance Mode

Pressing key 'DIST’ may enter Distance Mode. There are two pages for Distance Mode, being switched by soft key 'F4'. The functions explanations are as followed:

On the First Page:
Save: save measurement
After pressing soft key 'F1', dialogue box of 'Information' appears to the screen asking you to enter 'Point name', 'Code’ and 'Target Height'. The natural name of the point is to add ' 1 ' to the previous point name. The code entered depends on your requirements and the target height depends on facts. Press 'ENT' to save measurement. P.S. If having not selected file at first when pressing 'Save' under Angle Mode, a dialogue box of 'Select File' will be on the screen before 'information'. You may now select file for saving.

When the measurement is out of the scope of compensator, the instrument will display 'Tilt over!' when pressing 'Save' and the measurement cannot be saved.

If the measurement is saved successfully, the instrument displays box of 'Record:******' for 0.5 second and switch back to the Distance Mode.

Meas:
Measure the distance and display SD, HD, VD
Quit distance measurement with key 'ESC' under continue or tracking mode

Mode: used to select the working mode of the distance measuring device.

Sngl
Rept 5
Cont
Track

Use keys $\boldsymbol{\Delta} \boldsymbol{\text { to move the indicator ' } > \text { ' to the wanted opt. }}$ Press 'ENT' to save setting. When selecting Rept (repeated), move indicator ' $>$ ' to it and use keys $\boldsymbol{>}$ to choose the times for repeated measurement. The number of times can be between 3 and 9 .

## On the Second Page:

Offset: Enter off-center (eccentric) measurement
See reference in8.Offset
Stake: Stake out distances:


The key 'Mode' under this page is to switch the typed in distance between HD, VD and SD. The initial mode of typed in distance is HD. When finishing entering, press soft key 'Enter'
to enter 'stake-out by distance' mode of Distance Measurement as followed.

$>$ dhd is to stake out horizontal distance difference. A positive result indicates that the measured horizontal distance is greater than the evaluated one. The lens should be shifted to the instrument.
$>d v d$ is to stake out difference between elevation differences. A positive result indicates that the measured elevation difference is greater than the evaluated one. The lens should be shifted downwards (excavation).
$>$ dsd is to stake out differences between slope distances.A positive result indicates that the measured slope distance is great than the evaluated one. The lens should be shifted to the instrument.

Every time a stake-out is finished, go to the second page with soft key 'F4' and press 'F2' [Stake] to repeat the process, otherwise press 'DIST' to switch back to Distance Mode.
$\mathrm{m} / \mathrm{f} / \mathrm{i}$ : switch the units of the displayed distance between meters, feet, feet \& inches

Notes:"惯国" indicates that the distance measurement is under operation. Now pressing 'F1' or 'F2' appears "E " or " " on the screen, which indicates that the distance measurement is under operation and displays the current measuring mode ( $\mathrm{S}, \mathrm{R}, \mathrm{C}, \mathrm{T}$ ). When quitting distance measurement with 'ESC', the " (1) disappear. ' indicates distance measurement with prism.‘ ${ }^{\text { }}$ ' indicates distance measurement without prism.

## 7. Coordinate Mode

Presskey 'CORD' to enter Coordinate Mode. According to the diagram below, please set up the coordinate of the station, azimuth angle, target height and instrument height before coordinate measurement.


## Coordinate measurement diagram

There are three pages for coordinate mode, being switched with soft key 'F4'. The functions explanation are as followed:

## On the First Page:

Save: save measurement
After pressing soft key 'F1', dialogue box of 'Information' appears to the screen asking you to enter 'Point name', 'Code' and 'Target Height'. The natural name of the point is to add ' 1 '
to the previous point name. The code entered depends on your requirements and the target height depends on facts. Press 'ENT' to save measurement. P.S. If having not selected file at first when pressing 'Save' under Angle Mode, a dialogue box of 'Select File' will be on the screen before 'information'. You may now select file for saving.

When the measurement is out of the scope of compensator, the instrument will display 'Tilt over!' when pressing 'Save' and the measurement cannot be saved.

If the measurement is saved successfully, the instrument displays box of 'Record:******' for 0.5 second and switch back to the Coordinate Mode.

Meas:
Press soft key 'F2' to start distance measuring device. The instrument will calculate out the coordinate of the target point and display. If the current distance measuring mode is continue or tracking mode, then you may continually press 'ESC' to quit distance measurement, otherwise press 'ANG' or 'DIST' to stop distance measurement and switch to Angle or Distance Mode.

Mode: The same as the key 'Mode' under Distance Mode

On the Second Page:
Setting:
Press soft key 'F1' to enter Settings of 'Height of Ins. \& Target'

## Height of Ins.\&Target <br> I.H <br> T.H m <br> B.S <br> Clear <br> Save <br> Enter

After finishing entering, press 'ENT' or soft key 'Save' to save the setting. However the setting will be erased when shutting off if using 'ENT' to save; inversely, using soft key 'Save' will remain the setting forever providing that there is no change of the setting. Press 'ESC' to quit without saving. When checking and viewing the instrument height and target height, you may also go to the page above.

The range for I.H and T.H is 99.999. If being over the range, a box of ‘I.H overtop!’ or ‘T.H overtop!' will appear on the screen.

BSS:
Press soft key 'F2' to enter page of 'BBS' as followed:


Setting up BBS is to relatethe coordinate of earth stationto the coordinate of the instrument (being used together with STA Function).

After setting the BBS and pressing 'ENT', the instrument asks users to aim at the BS (target point). After pressing 'ENT' to orient, the instrument will calculate the azimuth angle of the BBS, which is displayed in the HA (horizontal angle) column. The coordinate of the instrument is now related to that of the earth station, which is called as 'set station'

In order to avoid repeated operation, please first operate the function of 'STA' ('Station') then set the BBS and orient. When orientation, please aim at the BS (target) precisely. Orientation can be done with [Set 0], [Set A] and [Hold] under Angle Mode or Coordinate Mode. If the orientation is already done under Angle Mode, then setting BBS again is not necessary under Coordinate Mode.

Users may enter the coordinate of BBS with keyboard or by transferring from the file of measured points [M.Pt] or from the file of known points [Known] as shown in the picture above.

Press soft key 'F3' to select known points. Select a desired point from the current file and enter the list of points.


Select the points with the help of keys $\boldsymbol{\Delta} \boldsymbol{\nabla}$ and press 'ENT' to save the your choice. If cannot get the point, the coordinate will remain its origin and the instrument will display 'Can't be get!'.

Press 'M.Pt' to select coordinate data from the measurement file. Similar operation as using soft key 'Known'

When pressing 'ENT' to end the dialogue, the system will ask you to aim the BBS for concerns of orientation.

Tip: When selecting coordinate data, you may easily change files. We suggest you to establish a sub file for well categorizedcoordinate files and code files. It will help you to remember the point names and to speed up the process of searching for points.

## STA: The entering of STA is the same as that of setting

 BBS. Users must first operate STA before setting BBSOn the Third Page
Offset:

Press soft key'F1' to operate offset function. Offset function is designed to obtain coordinate information of the measured point when prism cannot be place at the measured point or when distance measuring cannot be done. Offset function is divided into Angle Offset, Single/ Double- distance Offset, Plane Offset and Column Offset. See reference in $\underline{8 .}$ Offset Mode.

Stake:
Press soft key 'F2' to operate staking-out function. With this function, you may put designed data onto earth points. See reference in 9.2 Staking out

Set A:
Press soft key 'F3' to enter the current azimuth angle of BBS. Mention that you must aim at the BBS to set up the angle.

## 8. Offset Mode

Offset function is designed to obtain coordinate information of the measured point when prism cannot be place at the measured point or when distance measuring cannot be done, being divided into Angle Offset, Single/ Doubledistance Offset, Plane Offset and Column Offset.

The functions are included in the 'Offset' Menu. To enter all the following offset functions discussed below, first press 'CORD' to enter coordinate measuring mode. Then turn the page of soft keys to 3 with soft key 'F4'. Press 'Offset' and now you enter the Menu for 'Offset'. You may choose the desired mode now.

Before operating these functions, please first set STA, orientation, instrument height and target height for the instrument

Mention that any time one selects repeated, continue or tracking mode (modes beside single mode) of offset to measure, one must first press key 'ESC' to stop measurement before any followed operations.

### 8.1 Angle Offset Mode

It is specifically adequate when facing difficulties setting up prism. E.g. in the center of a tree. Set up the prism at point P which is the same horizontal distance away from the instrument as A0 is from the that. The diagram for angle offset is as followed.


When measuring the coordinate of the earth point A1 of the projection of AO, set up the instrument height and target height.

When measuring the coordinate of AO, set up instrument height only (and the target height should be set to 0). Enter '1.Offset (Angle)' and the page is as followed:


The target height (H.T) indicates the point where prism is placed. You may use soft key 'T.H' to re-set target height before measurement if needed. Press 'Meas' to start measurement. After measurement, press 'ENT' to enter 'Offset (Angle)-Result': the offset points here indicate A0 or A1 on the working path.


Now turn around the aiming component to aim at the offset point.

The coordinate of the point is obtained and press soft key 'Next P' to enter the offset measurement of the next point; press soft key 'Record' to save the coordinate of the offset point.

Finally, press key 'ESC' to quit Angle Offset measurement.

### 8.2 Single-Distance Offset Mode

If have already known the front \&behind and left \& right offset along the direction of observationthat the measured point A0 is away from the target point A 1 , you may measure the coordinate of A0 through distance offset.

In order to measure the coordinate of A0, enter the offset distance'oHD' as shown below and measure A1 under distance offset mode. The coordinate and the horizontal distance from the instrument of the A 0 can be displayed on the screen.


Enter '2. Offset (Dist 1)' from the offset menu.


Seemeanings of ' + ' and '-' in the diagram of single-distance offset.

After entering the known offset distance, press 'ENT' to save the setting and enter 'Offset (Dist 1)—point'


Press 'Meas' to start measurement.
After measurement, press 'ENT' to enter 'Offset(Dist1)-result'.

The coordinate of the point is obtained and press soft key 'Next P' to enter the offset measurement of the next point; press soft key 'Record' to save the coordinate of the offset point.

Finally, press key 'ESC' to quit Distance Offset measurement.

### 8.3 Double-Distance Offset Mode

It is specifically adequate when the measured point is exactly on connection of two measurable points as well as the distance between measured point and the final measuring point is known.


Enter the 'Offset(dist2)—distance' page through the offset menu.

Firstly, enter the offset distance (OSD). If the directions of $\mathrm{P} 1-\mathrm{A} 0$ and $\mathrm{P} 0-\mathrm{P} 1$ are the same then the distance is positive, otherwise it is negative.

Press 'ENT' or soft key 'Enter' to save setting and enter page of 'Offset(dist2)-begin'. To measure the point, you must aim at P0 as shown above.

After the measurement press 'ENT' to end the dialogue and enter page of 'Offset(dist2)—End'

After the measurement, press 'ENT' and he instrument is now displaying the coordinate of the measured point.

If the measured point is A 0 , then the target height should be 0 . If the coordinate of A 1 is wanted, please enter the target height ahead depending on facts.

### 8.4 Plane Offset Mode

The plane offset mode is specifically adequate for measurement of points that cannot be measured with its horizontal distance. e.g Measuring the distance or coordinate of a ridge of a plane.

Firstly, measure any three points (P1, P2, P3) to define the measured plane. Aim at the measuring point P 0 , then the instrument will calculate and display the coordinate of intersection of the defined plane and the collimation axis. i.e the coordinate of P0.

Mention that the target height under this mode must be 0


Enter '4. Offset (Plane)' from the offset menu


Press soft key 'Meas' to measure the first point P1
After measurement, press 'ENT' to accept the result. Mention that the target height is set to be 0 automatically.

After pressing 'ENT', users enter 'Offset (plane)—Pt.2'. Repeat the process for P2 and P3 as for P1.

As the three points are measured, users enter 'offset (plane)-Result'


Now turn around the aiming component of the instrument to aim at the offset point. Mention that the offset point must be on the defined plane but not below the prism bar for concerns of precision.

The coordinate of the offset point is obtained. Press soft key 'Next P' to enter the offset measurement of the next point; press soft key 'Record' to save the coordinate of the offset point.

Finally, press key 'ESC’ to quit Plane Offset measurement.

### 8.5 Column Offset Mode

Firstly, users should measure the azimuth angle and coordinate of P1 on the cylinder under this mode. Then calculate the horizontal distance, azimuth angle and coordinate of the cylinder by measuring the surface points of tangency P2 and P3.

The average value of P 2 and P 3 is the azimuth angle of the cylinder.


Enter '5.Offset(column)' from the offset menu.


If coordinate of P0 is wanted, please set target height to be 0 before measurement.

If coordinate of P 0 ' is wanted, please set target height depending on facts. Then press 'Meas' to start measurement. Press 'ENT' to accept the measurement result and enter‘Offset(column)-Left edge’


Aim at the left edgeand press soft key 'Enter'
Enter 'Offset(column)—Right edge'. Aim at the right edge and press soft key 'Enter'

Enter 'Offset(column) - Center' which displays the result of Offset(column) measurement.

Offset(colum)-Result
HR: $181^{\circ} 26^{\prime} 16^{\prime \prime}$
$\mathrm{N}: \quad-4.663$
E: $\quad-0.117$
Z: 1.004
Next P
Record

Now press soft key 'Next P' to enter the offset measurement of the next point; press soft key 'Record' to save the coordinate of the offset point.

Finally, press key 'ESC' to quit columnOffset measurement

## 9. Operating Menu

Notes: all diagrams of menu under section 9does not fully display the options. Kind prevail.

Pressing 'MENU' under basic measurement mode appears a page as followed on the screen:

| Menu |  |
| :--- | :--- |
| 1. | Surveing |
| 2. | Stake out |
| 3. | Fileman |
| 4. | Program |
| 5. | Options |
| 6. | Calibrate\&Config |
| 7. | Grid scale |
| 8. | USART option |
| 9. | Select Disk |

The useful keys under menu page are:
A Shift upwards by one column
$\nabla$ Shift downwards by one column
4Shift upwards by five columns

- Shift downwards by five columns

ENT: Select the current column of function and enter its dialogue

ESC: Quit the menu
Numbers 1~9: Press to enter corresponding column of function. Each column are marked with a number. e.g pressing key ' 7 ' leads to an entrance to 'Grid scale'.

### 9.1 Surveying

Surveying includes functions as followed:

| Surveying |  |
| :--- | :--- |
| 1.Select file | - |
| 2.Station |  |
| 3.Orientation(BBS) |  |
| 4.Orientation(SetA) |  |
| 5.Surveying |  |
| 6.Config of Surveying |  |

### 9.1.1 Select files

The function 'Surveying' includes a sum of all preparation work before a survey.

A measurement file for storage of measurement result and record, a coordinate file for accessing known points and a code file for fast checking codes must be selected before any measurement. (An[.LS] file is specifically for staking out roadway)

The dialogue box of 'select file' is as followed:

```
Select File
>File(.MEA) A.MEA
File(.COO)
File(.COD)
File(.LH)
Save
Enter
```

MEA= Measurement File, working for storing data
$\mathrm{COO}=$ Coordinate File, being used when transferring coordinate
$\mathrm{COD}=$ Code File, being used when transferring code
$\mathrm{LH}=\mathrm{LS}=$ Defined line File, working for staking out roadway

Use $\boldsymbol{\Delta} \boldsymbol{\nabla}$ keys to move indicator ' $>$ ' to the wanted type of file and press 'Enter' soft key to enter the File list as followed:


Move the indicator to wanted file and press 'ENT' or soft key 'Enter' to select it.

### 9.1.2 Setup of stations

The dialogue box followed included all needed information to be entered of a station.


With keyboards or transferring coordinate from K.Pt (Known points) and M.Pt (Measured points), users may input the coordinate of a station.

Press 'Input'(soft key F1) to enter the coordinate of a station manually.


See reference in 4.7 entering numbers and letters to set station.

Press 'K.Pt' (Soft key F2) to enter a coordinate file. Select the desired point and enter the list of points.
(A.COO)1/2

COO: 1
COO: 2

Regin
End
View

## Search

Select the points with the help of keys $\boldsymbol{\Delta} \boldsymbol{\nabla}$ and press
'ENT' to save the your choice. If cannot get the point, the coordinate will remain its origin and the instrument will display 'Can't be get!'.

Press 'M.Pt' (Soft key F3). The operation is the same as that of 'K.Pt'

### 9.1.3 Setup of BBS(back-sight point)

To set up BBS is to relate the earth coordinate with the instrument coordinate.

To transfer coordinate of points from files under this function is the same as set up station. After inputting the coordinate of the BBS, users have to aim at the BBS to orient as well. As soon as the orientation finishes, the horizontal angle column on the screen displays the earth azimuth angle.

After entering or transferring the coordinate of the BBS, please 'Aim the BBS' and press 'Enter' to orient, otherwise, press 'ESC'

After pressing 'ENT', the coordinate of BBS is displayed on the screen and press 'Check' to measure the BBS and check the result

| HR: |  |
| :--- | :--- |
| DHR: |  |
| HD: |  |
| DHD: |  |
| dZ: |  |
| Meas |  |

After the measurement, the instrument displays the difference between theoretic distance and the measured distance. Press soft key F3 'Coord.' to display the coordinate of the measured current BBS. You may compare it with the entered value.

Press 'Save' to save the measured record.

### 9.1.4 Setup of azimuth

To set up the azimuth angle is the same as to set up BBS, which is also to relate earth coordinate with the instrument coordinate. However, setting up azimuth angle is impossible when BBS azimuth angle is unknown. Please aim at the BBS and input the BBS azimuth angle first.

Choosing one from 'Orientation (BBS)' and
'Orientation (SetA)' is adequate within one setup of station. They both work for orientation for BBS.

### 9.1.5 Surveying



If have set the instrument to 'survey first'how to set $\rightarrow$, after pressing soft key F4 'EDM', the instrument then start measurement of the coordinates. As soon as the measurement is done successfully, the soft key 'record'appears. Press 'Record' to enter page of 'information'. Edit the point name and code and save.

If have set the instrument to 'edit first'how to set $\rightarrow$, after pressing soft key F4 'EDM', users may first enter the 'Information' page, then measurement. The operations are similar.

Press soft key F2 'Offset' to enter offset menu. Select one mode and start offset measurement.

Press soft key F3 'Save' to start distance measurement. After a successful measurement, the coordinate will be saved automatically.

### 9.1.6 Config of Surveying

Use 4 to select
Sequence
Users may choose to 'survey first' or to 'edit first' when undertaking measurement under surveying mode.

Same point
Users may choose to check or not to check if there is a duplicate of name in the list.

If choose to check, then the instrument will first search for duplicated name in the file. If a duplicated name is found, a box of 'duplicated name found!' will appear on the screen. Press 'ENT' to overlay or 'ESC' to quit and go back to the previous page.

If choose not to check, the instrument will directly save the coordinate of the point.

Edit point
Users may choose if to edit the information of points when auto saving after measurement. If choose to edit 'manually', then the system will enter the page of 'Information' when pressing soft key 'Save'. If choose to edit 'Auto', then the system will save the measurement automatically with point name added by one.

Record
It indicates whether to display the coordinate by sequence 'NEZ' or 'ENZ' when surveying.

### 9.2 Staking out

Staking out is to find the earth point needed when designing. The common process to stake out is as followed:

1. Select a file for staking out to access to and transfer coordinate of STA and BBS and data of staking-out point etc.
2. Setup STA
3. Setup BBS
4. Enter the staking out coordinate and start staking-out.

The Menu for staking out is as followed:

| Stake |  |
| :--- | :--- |
| 1. I.H\&T.H | $\boldsymbol{\Delta}$ |
| 2. Station |  |
| 3. Orientation (BBS) |  |
| 4. Orientation (SetA) |  |
| 5. Stake out |  |
| 6. Fast station |  |

The 'Setup Station' and 'Orientation (BBS)' are the preparation work for staking out. If users have already setup station and orientation of BBS, re-setting them are not necessary.

### 9.2.1 Staking out points

Stake out XX point

```
Stake out:XX
N:
E:
Z:
```

```
BS M.Pt K.Pt Enter
```

```
BS M.Pt K.Pt Enter
```

The coordinate point can be defined manually with keyboard entering. It can be also defined by transferring coordinates from Measured points or Known points, which requires you to select a file in advance for transferring coordinates, otherwise the system will go to page for selecting file automatically. You may also select file under this 'Stake out: XX' page by using starkey $(\star)$ function. If users have transferred coordinates once, the system will enter the page which the users have transferred coordinates from.

Staking out survey
After defining the staking out coordinate, press 'ENT' to enter staking out survey.

HR:
DHR:
HD:
DHD:
dZ:
Meas
Mode
Coord
Next.P
dHR: a negative value indicates a clockwise rotation of aiming component. Inversely, positive value indicates a anticlockwise rotation.
dHD: a positive value indicates that the lens should shift to the instrument. Inversely, a negative value indicates that it should shift away.
dN : a negative value indicates that the lens can reach to evaluated staking out point if moving north. Inversely, it should move south.
dE : a negative value indicates that the lens can reach to evaluated staking out point if moving east. Inversely, it should move west
dZ: a negative value indicates that the lens can reach to evaluated staking out point if moving downwards (excavation). Inversely, it should move upwards (fill).

Next point: press it to staking out the next point. You may find the coordinate of the next point in the selected file and go back to the page of 'Stake out: XX' to display it. Press 'ENT' to stake out directly.

### 9.2.2 Fast station

When the current control station and the staking out point are not intervisible, users may have to set a new point as a control station. A fast station function is now helpful to use.

Vz: $\quad 90^{\circ} 12^{\prime} 22^{\prime \prime}$
N: $200^{\circ} 54^{\prime} 12^{\prime \prime}$
E: $\quad-10.756$
Z: -0.004
TH
Mode
Meas
Press 'Meas' to measure the coordinate of the new control station. Save it into proper file in relation to demand for concerns of transferring later on. 'Sequence', 'same point' and 'edit point' functions under 'Config of survey' is valid here as well.

### 9.2.3 Resection method

Enter the coordinate of the first point:


To input, see reference in 'STA' of 'Coordinate measurement'. Press 'ENT' to enter the measurement page of 'Resection-No.1'

Resection-No. 1
Vz: 77º $18^{\prime} 30^{\prime \prime}$
HR: $180^{\circ} 34^{\prime} 55^{\prime \prime}$
HD: 4.978
T.H: 1.000 Mode Angle Dist

Choose angle or distance to undertake resection. If choosing angle mode then the instrument will start measuring distance. After a successful measurement, the system will display 'Next P'

Press soft key 'Next P'. Repeat the process above. After measuring three points, soft key 'Calc' will appear on the screen.

Resection-No. 1
Vz: 77º $18^{\prime} 30^{\prime \prime}$
HR: $180^{\circ} 34^{\prime} 55^{\prime \prime}$
HD: 4.978
T.H: 1.000

Next p
Calc
If do not need resection, then pressing 'Calc' to display the result of resection.


Now press soft key 'F1' to setup station and record. After setting up station, users may find that the station name becomes 'RESSTA' and the coordinate is the resection one. Press 'F4' to switch between 'Coord.' and 'dCoord.' (difference between coordinates).

Resection-Result
dN: 0.002
dE: $\quad 0.005$
DZ: 0.005
MdHD: 0.020
Record

```
    dCord
```

Coord.- the displayed coordinate is the NEZ coordinate of the instrument station
dCoord. - the error of NEZ coordinate when redundant observation exists in resection.

MdHD - the maximum error of evaluated distance. A large value of it indicates an inaccurate coordinate of resection point or a error of BBS coordinate.

NaN - calculation error. The maximum number of resection points is 5

### 9.2.4 Equidistant stake-put

Sometimes users may need to stake out N points on a line uniformly. An equidistant stake-out is adequate in doing such work.


When undertaking equidistant stake-put, users may first measure the coordinate of the origin/begin (prism P0) then that of the terminal/end (prism P1).

After the measurement, the system enters a page of 'Equidistant-input' as followed.


The 'stakes' must be set while the space can left blank.
If setting the stakes to be 12 with space left blank, then the middle points can be staked out uniformly during the following equidistant stake-out.

Space is the number of points staked out uniformly from the begin to the end.

The equidistant stake-out page is as followed:

```
HR:
dHR:
dHD:
dZ:
Meas Mode
    TH
```


### 9.2.5 Entering coordinates

Sometimes, users may transfer a few of coordinate files when undertaking the following measurement. You may also enter the coordinate and other information of the point manually and save into the coordinate file for possible transferring later on.
P.name:

Cord:
N :
E:
Z:
BS Clear Num Enter

Using keys ' $4>$ ' helps to scan the sequence of each point. e.g' 1 ' indicates the number of the point when it is recorded or scanned. After setting up one record, press 'ENT' to accept the setting and enter the setting page of the next record. If do not need record any more, press 'ESC' to quit 'Input coordinates' function. The system will now ask users if he or she wants to save the record. After choosing 'save', the record will be saved into coordinate files.

### 9.3 File Management

The menu for fileman is as followed:

| Fileman |  |
| :--- | :--- |
| 1. File Dialogbox |  |
| 2. Import |  |
| 3. Export |  |
| 4.Format disk |  |
| 5. Informatino of disk |  |
| 6. Input Coordinates |  |

### 9.3.1 File dialogue box

| Select file |  |
| :--- | :--- |
| 1. File(.MEA) | $\boldsymbol{\Delta}$ |
| 2. File(.COO) |  |
| 3.File(COD.) |  |
| 4. File(.LS) |  |
|  |  |

Each file involves operations of 'establish new files' (New), 'delete files' (Del) and 'view'(View) which is called File management here.

After choosing a file, users may enter file list which displays the names of the file. All files obeys the same rules of operations. Now take measurement file as an example:

Select ' 1 . File(.MEA)' and enter its page.


Now use $\boldsymbol{\Delta} \boldsymbol{\nabla} \downarrow$ keys to shift the indicator column to the wanted file.

Select: Press soft key 'Select' to select the current working file of the instrument. You may select your file repeatedly and the selection can be checked in the 'Select file' dialogue box.

MEA= Measurement File, working for storing data
$\mathrm{COO}=$ Coordinate File, being used when transferring coordinate

COD= Code File, being used when transferring code
LS= LH =Defined line File, working for staking out roadway

The files relates to the related files. e.g .MEA files are specifically for measurement and .COO files are specifically for coordinates. However, the selected files are not saved to system files when shutting down. You may have to save the file names under 'Select files' dialogue box.

New: establish a new file in the instrument. Press soft key 'New' and the instrument will ask you to enter the file name.


The file type is the same as the file selected (under which you press 'New'). If the new file exists in the instrument, then the system will not establish a new file. Mention that the
instrument will not warn you for duplicated name when not establishing a new same file.

Del: delete the file the indicator column indicates. Box of 'Delete will lose data' appears on the screen when pressing soft key 'Del'. Press 'ESC' to quit or 'ENT' to delete.

View: when pressing soft key 'View' under coordinate file, then the system will display the coordinates one by one; under code file, the system will list out all codes in the file; under measurement file, the system displays the measured data under current indicator column one by one. Users may use $\boldsymbol{\Delta} \boldsymbol{\nabla}$ keys to view the former or latter record. Press 'Edit' to edit the angle, distance, coordinate, point name, code and target height. Mention that the LS file cannot be viewed under the 'Select file' page. Users can only 'view’[.LS] files by lining when staking out roadways.

### 9.3.2 Import

There are two ways to import files: one is importing from PC , another is importing from USB.

All files in the instrument are binary. To import data from the external into instruments, users must import the files. The import function supports transformation of ASCII code coordinate files, code files and LS files into binary files.

The files are categorized by their suffixes.
Thus, please pay attention to the file types when importing files, otherwise a failure in importing may occur. e.g when
importing code files, users must select files with suffix '.COD' and import .COD files into PC machine.

Importing from PC
Press the "MENU" button to enter the menu screen, select "Import file" option, enter the interface of file import, select the "Import from PC" option, the window as shown below:


The only column that can be set is the Baud. The Baud available are $2400,4800,9600,19200,38400,57600,115200$ with respect to the RS232C serial communication bus, being set with soft keys 'Fast' and 'Slow'. Usually, 115200 Baud is adequate for importing.

File:Used to select a file for storage of the imported data. After pressing 'File', a box asking you to select file will appear to the screen. Shift the indicator ' $>$ ' to the wanted file and press 'ENT' to select. You may establish a new file if not finding adequate file.

Import: Import data. The process of importing requires assistance of the connected computer. First, the data must be imported to the computer already, prepared for importing. Then press softy key 'Import' to import. After a success import, the coordinates will appear at the bottom of the selected file while
codes and defined line files will refresh all records automatically.

## Import from USB

The form of imported file which from $U$ disk must be a text file and only it be saved in the "ts_prj \import" directory of the U disk, can it be identified. The format of the text file is "PT, E, N, Z, CODE". each line of the data from text file ends with "Enter+Linefeed " and the last line of the data must be coupled with a " Enter+Linefeed ", or it will be missed in the last line. AT the USB interface of instrument's,you should insert U disk and turn on the instrument. Press the "MENU" button to enter the menu screen, select "File Import", enter the file imported menu, select "Import from a USB ", enter the importing function interface, which is shown below:


If the current coordinate file is saved in the flash memory the instrument, the name of it is the "filename" by default. Press the "From", and then press the "Select" to select ".txt "file under the corresponding directory, which is desired to be imported in the file list of $U$ disk. For example, if we select the file of 0712.txt,press the "File" button to choose file of
coordinates which you want to import (there you can create a new file) such as SVY.COO, then the interface is shown below:


Press the "Import " button, the coordinates data in"0712.txt"will be imported to the SVY.COO file of Total Station, then you can view the data in the menu of maintenance file.

### 9.3.3 Export

There are two ways to export the file: one is exporting to PC , another is exporting to USB.

Export to PC
Press "MENU" to enter the menu screen, select "File Export" to enter the file export screen, select "Export to PC" option, the export window as shown below:

Baud: 115200
Filename: A. MEA
NO.:

Fast
Slow
File
Export

The only files able to be exported are the measurement files. See references of the soft keys in 9.3.2

The connected computer may be set ready to receive files when exporting without special operations. The exported file will be in the format of ASCII. See explanations for forms in Appendix B.
2. Export to USB

AT the instrument's USB interface, Connect U disk and power on. Press "MENU" button to enter the menu screen, select " Export " to enter the menu of export file, select "Export to USB " , the exporting window as shown below (the file exported is defaulted to be measurement file, and you can re-select)


Select "File" button to choose the file you want to export, and the file name exported is defaulted to be a text file which is the same name of measurement file. Press the "Export" to export the data of a measurement file to the U disk "ts_prj \} import" directory. The format of data exported is text ,it can be processed by transfer software on the PC.

### 9.3.4 Format disk

After entering '4.Format disk', a box of 'Warning! Formatting will lose data. Export data first.' will appear on the screen. Press 'ENT' to continue formatting, otherwise 'ESC' to quit.

After formatting, all record in the instrument will disappear. Please pay special attention to it.

### 9.3.5 Information of disk

A box displaying the space available in unit KB of the electrical disk in the instrument will appear on the screen when entering '’Information of disk". Measurement data for ten points approximately occupy 1 KB .

### 9.3.6 Entering coordinates

See reference in 9.2.5

### 9.3.7 Update



1. Enter PIN code (82543) and press 'ENT'. The instrument will shut down automatically.
2. Connect the instrument to the computer through serial port connector. Open the hyper terminal softwareand set up the correct port. Then set 'Bits per second' to 115200 and 'Flow control' to 'None'. Finally, when all operations above are done, press 'ENT' to update. Mention that the computer must be installed with correct drivers.

3. Press key 'On/Off' on the instrument. The page of hyper terminal is as followed:

Note: Users must be specifically cautious when updating. As soon as users choose to update, the instrument will enter updating mode. If pressing key ' 3 ' under the page shown below, the previous program may be resumed.

4. Press key ' 1 ' on the instrument. The instrument enters wait state for sending programs. After the state, click'Send File...' on the computer.


## 5. Select the new version of total station software and

 click 'Send' on the computer.
6. Then the computer displays the process of sending. After finishing updating, please close the hyper terminal. Before starting and operating the instrument, please first unload the battery of it and then load it with battery again. The instrument is successfully pdated now.

### 9.3.8 The instrument as a memory disc

Users may use Mini USB connector to connect the instrument to PC machine. The USB port is below the SD card port. Start the instrument after connection.

The total station is now recognized as a memory disc by PC machine. After opening the instrument file on the PC machine, users may view the files saved in the instrument on the it. Also, users may copy files to the PC machine. Disconnect the PC machine to operate the instrument normally.

Note: never delete or alter the two '.sys' files in the instrument. Do not copy senseless files that have nothing to do with total station measurements to the instrument.

### 9.4 Programs

### 9.4.1 Remote height (REM)

REM is adequate for measuring target height when the prism cannot be placed at the target point. Under REM mode, users may place the prism on any point along the plumb line of the target point to obtain target height.


There are two modes for REM measurement: 'with TH' and 'without TH'. Users may select 'with TH' mode when altitude from ground to target is to be measured, otherwise 'without TH' when altitude from any reference point to target is to be measured.

## With TH:

1. Enter the instrument height and target height firstly.
2. Press 'ENT' to enter 'REM-Prism'
```
REM-Prism
Vz: 77 18' 18' 
HR: 169* 11' 14"
HD: 4.351
```

3.Aim at the prism and press soft key 'Meas' to obtain the horizontal distance of the target from the instrument. Press soft key 'Enter' to enter 'REM-Ground to target'

```
REM-Ground to target
Vz: 77 ' 18' 30"
HR: 169 }\mp@subsup{}{}{\circ}1\mp@subsup{1}{}{\prime}14\mp@subsup{4}{}{\prime\prime
VD: 0.000
4.Then, turn the telescope up and down to aim at the target point. The VD column displays the elevation difference from the ground to the target point.
5. After measurement, users may choose from three opts:
'T.H' to alter the target height;
'Hdist' to re-measure horizontal distance;
'ESC' to quit REM measurement.
Choose in relation to demand.
Without TH
1. The system goes to 'REM-prism' page directly.
```

REM-Prism
Vz: 71 % 34' 50"
HR: 169 % 11' 14"
HD: 4.357
2.Aim at the prism and press soft key 'Meas' to measure the horizontal distance of the prism from the instrument. Press soft key 'Enter' to enter 'REM-Base'.

```
REM-Base
Vz: 79 2 29' 53"
HR: 169* 11' 14"
VD: 0.000
```


## Select

3. Aim at the reference point and press 'Select' to enter 'REM-Altitude'

| REM-Altitude |  |  |  |
| :--- | :---: | :---: | :---: |
| Vz: | $93^{\circ}$ | $35^{\prime}$ | $08^{\prime \prime}$ |
| HR: | $169^{\circ}$ | $11^{\prime}$ | $14^{\prime \prime}$ |
| VD: | -1.081 |  |  |
|  |  |  |  |
|  |  |  |  |
|  | Set VA | HDist |  |

4. Then turning the telescope up and down. The elevation difference between the target and the reference point is displayed in the VD column.
5. After the measurement, users may choose from three opts:
'Set VA' to re-enter the 'REM-Altitude' page.
'HDist' to re-measure the horizontal distance;
'ESC' to quit REM measurement;

### 9.4.2 MLM



Measure the horizontal distance (dHD), slope distance (dSD), elevation difference (dVD) and azimuth angle (dHD) between two target. You may also enter the coordinate or transfer coordinate from files to calculate the value above out.

There are two modes of MLM:
1.MLM (A-B,A-C): measure A-B, A-C, A-D.... i.e the starting point is the reference point of all the others.
2.MLM (A-B, B-C): measure A-B, B-C, C-D.... i.e the previous point is the reference point of all the others.

You may also have to choose 'Considering Grid scale' or to 'Ignore Grid scale' before choosing measurement mode.

MLM (A-B, A-C)

1. Enter the 'MLM(A-B,A-C)-Step 1' page

MLM(A-B,A-C)-Step1
Vz: 69¹2'13"
HR: $\quad 170^{\circ} 12^{\prime} 21$
HD:
4.358

Meas T.H Coord Mode
2. You may measure the coordinate of the starting point out by pressing soft key 'Meas' under this page or you may enter its coordinate manually, pressing soft key 'Coord.'

Press 'ENT' to enter 'MLM(A-B,A-C-Step 2)' page.
Please enter the target height before measurement.

3. Input coordinate following the process on 'step-1' page. Press 'ENT' to enter 'MLM(1-B,A-C)-Result' page.

```
MLM(A-B,A-C)-Result
dSD: -3.852
dHD: -3.836 m
dVD: 0.344
HR: 9030'35"
Next P
```

4. Display the result of MLM measurement. Press soft key
'Next P.' to continue MLM Measurement, repeating the 'Step-2' and 'Result' pages.

The measuring process under $\operatorname{MLM}(\mathrm{A}-\mathrm{C}, \mathrm{B}-\mathrm{C})$ is all the same as that of MLM(A-B,A-C). See reference above.

### 9.4.3 Polar Coord. Measurement

The Polar coordinate measurement helps users to export polar coordinates (margin data). To operate it:

1. Enter 'Polar Coord. Measurement' under Program page.
2. Enter the information of station. Mention that the station name must be defined while code can be left blank. Enter the target height and press 'ENT' to save the settings and enter 'Setup BBS'
3. Enter information of BBS. Mention that the BBS name must be defined while code can be left blank. Enter the target height and press 'ENT' to continue.
4. Following the prompt on the screen, aim at the BS. As soon as pressing 'ENT' to finish setting up station, the instrument will undertake a measurement automatically. Horizontal Angle is set 0 and one marginal datum is saved.
5. After setting up station, users may stimulate process in surveying to survey polar coordinates.

See process of setting up station and BBS insurveying.
Note: If right-angle buzz is on currently, it will buzzes constantly after orientation. Turning the instrument around about the vertical axis to alter horizontal angle may close the buzz. Also you may switch the right-angle buzz off.

### 9.4.4 Coord.Z

Use the measured coordinate of known point to calculate the Z-coordinate of the station and reset the z-coordinate of the station.

The coordinates of known point can be transferred from coordinate file or can be entered with keyboard. The operation is as followed:

1. Prompt 'Setup station' asks users if they want to setup station. Press 'ENT' to setup.
2. Enter ‘Coord.Z-No.l' page

Coord.Z-No. 1
Pt.name
Code: m
TH:
[ $\star$ ] Select file
Input K.Pt Info M.Pt

To define Coord.Z-No.1, follow the process of defining BBS. Press 'ENT' to confirm and end the dialogue, entering 'Coord.Z-No.1' measurement page.

Coord.Z-No. 1
HR:
SD: m
HD:
VD:
Meas
Mode Enter
3. Press soft key 'Meas' to start measurement. After the measurement, the 'HR'SD"VD'are displayed on the each column. Press soft key 'Enter' to accept the measurement. If accepting, soft keys 'Next' and 'Calc' will appear on the screen. Press 'Next' to define and measure the second point (Coord.Z-No.2), otherwise press 'Calc’ to enter ‘Coord.Z-Result' page.

| Coord.Z-Resul |  |  |
| :---: | :---: | :--- |
| BSA: | $170^{\circ} 12^{\prime} 23^{\prime \prime}$ |  |
| Z: | 1.234 |  |
| $\mathrm{dZ}:$ | 0.001 | SetZ |
|  |  |  |

Then users may use 'SetZ' to set the z coordinate of the station. You may also use soft key 'Set A' to set the BBS of the instrument. Press 'ESC' to quit coordinate measurement.

### 9.4.5 Area

This function is to help calculate the area of the plane figure formed by measured and inputted coordinates out.

1. Enter 'Survey(Area)' page

2.Press soft key 'Input' to transfer coordinates from coordinate file or enter the coordinates manually with keyboard, otherwise press soft key 'Meas' to measure the coordinates of the target point. The coordinates are all listed in the screen and the maximum number of points when Area Surveying is 20 .

The inputted and measured coordinate is inserted below the indicator column, which determine the shape of the formed area.
3.The area enclosed is the connection of line from the begin to the end (begin) one by one in order. Thus, the instrument may not get the correct area of which has intersection on the half way. You may press ' $\star$ ' key to check the shape of the area.
4. At any time the number of points reaches 3, the calculation is available and the soft key 'Calc' appears on the screen. Press 'Calc' to display the area and circumference of the enclosed shape. Press 'ESC' to quit the area survey.

How to input coordinates:
Press soft key 'Input' and enter 'Point/Area' page


Press 'F2' to list out all coordinates in the current measurement file. Press 'F3' to list out all coordinates in the current coordinate file. The function explained above works in all pages inputing NEZ coordinates.

### 9.4.6 Projection



The function serves to measure the length (X), distance (Y) and altitude difference $(Z)$ the prism deviates from the baseline origin and the baseline.

The preparation work before measurement is: setting up instrument height, target height and defining the baseline.

Setup baseline: Press soft key 'Meas' under page of 'Project(Begin)' to start measurement. After the measurement of begin point, press soft key 'Enter' to measure the end point, following the steps of measuring begin. Finally, press soft key 'Enter' to end the defining of the baseline. Now you may start projecting.

Projection survey: Press soft key 'Meas' under page of 'Survey(Projection)' to start measurement. After the measurement, the deviated length( X ), distance $(\mathrm{Y})$ and altitude difference $(Z)$ are displayed on the screen.

The soft key 'T.H' serves to reset the target height. The soft key 'Mode' serves to switch between displaying 'rN, rE, rZ' and displaying 'SD, HD, VD' of the measured point from the baseline projection point.

### 9.4.7 Roadway

See reference in $\underline{10 \text {. Roadway }}$

### 9.5 Options

| Config |  |
| :--- | :--- |
| 1.Units |  |
| 2.Type of feet |  |
| 3.Mode of HA |  |
| 4.Mode of VA |  |
| 5.Mode of EDM |  |
| 6.Min readout(Angle) | $\mathbf{\nabla}$ |

Take the '5.Mode of EDM' as an example:


Use keys $\boldsymbol{\Delta} \boldsymbol{\nabla}$ to move the indicator ' $>$ ' up and down to the wanted opt. Press soft key 'Enter' to confirm your choice. The instrument will display box of 'saved' and the setting remains even after shutting down. Afterwards, the default EDM mode of the instrument will be that of your choice until next time you change the setting.

All the other settings under Config menu are similar to 'Mode of EDM'. Please refer to the explanation above.

Notes: the NEZ or ENZ displaying mode of coordinates are in relation to the order of the exported coordinate only.

### 9.6 Calibrate \&config

| Calibration |  |
| :--- | :--- |
| 1.Calibrate I.E | A. |
| 2.Calibrate LILT |  |
| 3.Add const |  |
| 4. Mul. const |  |
| 5.Date\&Time | $\mathbf{F .}$ |

### 9.6.1 Adjusting index error(I.E)

To adjust index error, the system will first ask you to 'Aim at a target F1'. Users may press 'ENT' to confirm after aiming and the instrument will measure its horizontal angle automatically. The HA will be displayed for one second and the system will ask you to 'Aim at a target F2'. Following the same
steps, the instrument will then calculate the index error and display it.

Now press 'ENT' to save the index error (calibration done), otherwise press 'ESC' to quit (previous I.E remains).

### 9.6.2 Calibrate TILT

When calibrating tilt, please make sure that the tilt is off and the index error is little.

First, Place the instrument as picture shown below with collimator facing up. This will help screw C to adjust the inclination of the instrument.


Enter the tilt calibration program:


1. After leveling the instrument, aim at the target F1 in th collimator, record the current vertical angle as V0.
2. Set the vertical angle to V0+3'with the help of the vertical inching screw. Adjust the screw C to aim at the target precisely. Press 'ENT' to confirm after a stable readout appears.
3. Set the vertical angle to V0-3'with the help of the vertical inching screw. Adjust the screw C to aim at the target precisely and press 'ENT' to confirm after a stable readout appears.
4. Set the vertical angle to V0 with the help of vertical inching screw. Adjust the screw C to aim at the target precisely.
5. Aim at the target F2 in the collimator and record the current vertical angle as V1.
6. Set the vertical angle to V1-3'with the help of the vertical inching screw. Adjust the screw C to aim at the target precisely and press 'ENT' to confirm after a stable readout appears.
7. Set the vertical angle to $\mathrm{V} 1+3^{\prime}$ with the help of the vertical inching screw. Adjust the screw C to aim at the target precisely and press 'ENT' to confirm after a stable readout appears.

Tips: Don't worry if cannot remember the exact order of steps. All the above will be displayed on the screen as small prompts. e.g'F2 Up 3'.

The instrument will then calculate out and display the correction constant and the difference between the compensator axis and the vertical axis of the instrument. Press 'ENT' to save the new calculated parameters, otherwise press 'ESC' to quit and the previous correction constant remains.

Notes: Co.k (linear coefficient) must be less than 1.5;
Co.Z (zero position) is normally between -20 and +20 , otherwise the compensator(tilt) must be adjusted mechanically.

### 9.6.3 Add const\&Mul. Const

The addictive constant and the multiplying constant can be adjusted after strict measurement. We suggest you to employ professional and authenticated factories or units to measure and set these constants.

### 9.6.4 Date and Time



Date: 'two last figures of year +XXXX (date)'
Time: 'XX(hour)+ XX(minute) + XX(second)'
Press 'Enter' to save.
Notice: a ' 0 ' to occupy a place for month or days with single figures is required. e.g Second the March= 0203

### 9.7 Grid Factor

Formulae:

1) Altitude factor $=R /(R+$ Altitude $)$
$\mathrm{R}=$ average earth curvature radius
Altitude: The altitude above average sea level
2) Scale factor= The scale factor on the station
3) Grid scale factor $=$ Altitude factor $\times$ Scale factor

Distance measuring:

1) Grid scale distance $(\mathrm{HDg})=\mathrm{HD} \times$ Grid scale factor
$\mathrm{HD}=$ distance on the ground
2) Distance on the ground $(\mathrm{HD})=\mathrm{HDg} /$ Grid scale factor

'Enter' to calculate the Grid scale factor as shown in the picture above. Press 'ENT' to save the Grid scale and end the dialogue box. A box saying 'Saved' will flash once.

Grid scale calculated being less than 0.99 or greater than 1.01 indicates that there must be an error or errors in entering altitude or scale or both. The calculated Grid scale cannot be accepted by the system and users must re-enter the factors. Quit with key 'ESC', the new Grid scale will not be saved.

### 9.8 USART option

RS232C means that when two-way communication, the system will export and import through the RS232C port.

Bluetooth means that when two-way communication, the system will export and import via blue tooth.

### 9.9 Selecting disc

FLASH means that the working files and coordinate files will be saved into the internal storage.

SD means that the working files and coordinate files will be saved onto the SD card

USB means that the working files and coordinate files will be saved onto USB memory disc.

After choosing a disc, the following measurement data and coordinate data etc. will be saved onto the selected disc

After changing the storing disc, the system will ask you to re-select files. How to select file $\rightarrow$

## 10. Roadway

To open roadway program, follows 'Menu $\rightarrow 4$.Prog. $\rightarrow 7$. Roadway’

Roadway function is divided into two parts: Design Roadway and Stake-out Roadway. Users may stake out designed points according to the mileage and deviation of the Designed Roadway. You may practice with roadway function with the assistance of Appendix A.

The menu of roadway is as followed:

| Road |  |
| :--- | :--- |
| 1. Open Shape |  |
| 2. Re-define(H) |  |
| 3. Re-define(V) |  |
| 4. Resume H curve |  |
| 5. Resume V curve |  |
| 6. Stake out(road) |  |

If you have already imported LS files into the instrument from the external, then you may open the [.LS] file through '1.Open Shape file'. Users may choose from three opts after opening the LS file: 'Stake-out roadway', 'Resume H curve' or 'Resume V curve'.

### 10.1 Inputting Roadway

Roadway design requires input of horizontal lining and vertical lining. The input will be saved to LS files. The maximum number for elements is 21 in each file and the number of intersection cannot be greater than 7 .

### 10.1.1 Horizontal lining

An input for roadway design.
The element method
Enter through 'Re-Define (H)' and 'Resume H curve' under Roadway menu.

Enter 'Define (H)' box:


If the first time you select 'I.P' (input via intersection point), then the method to input will be I.P afterwards. The first point inputted is 'Define (H)- Begin'. Press 'ENT' to confirm and end the input box of 'Begin' point. If users have not entered anything, there will be no response from the instrument. Users may also quit 'Define (H)' by pressing 'ESC'.


You may then define horizontal lining with 'Line', 'Circle' or 'Spiral' alternately.

Note: Do not define the length as ' $0--0$ ', which serves for ending lining.

Input 'line':


Input 'Circle':



The input of Radius can be negative. The positive direction is the right direction along the designed roadway, and the left is negative. The length refers to Arc length.

Input 'Spiral'


The radius and length here is the same as those in 'Define (H)- Circle' above.

After defining Line, Circle or Spiral, press 'ENT' to accept the input and end the dialogue. The system goes back to 'Defin (H)' page. If you want to check or end the inputting now, press 'ENT'. The system will goes to 'List of H curve'

List of curve
01st: 7.000
02st: 7.000
02st: 10118.000

Save View Add

Now press soft key 'save' to save and quit the box.
If choosing to 'view', the system lists out the information of the inputted element. e.g.


If you found errors here, you may 'Edit' it now. Check other elements one by one with keys ' PgUp ' and ' PgDn '.

Press 'Add' to continue the input of Horizontal lining.
The Intersection method
After choosing 'I.P' and finishing inputting 'Define (H)-Begin', press 'ENT' to enter the page of inputting intersection as followed:


The column 'Pt.1' is in relation to your inputted intersection number.


The system will not accept negative Para. A1, Para. A2 nor Radius R. If inputting the radius, then the system will insert arc with defined radius in between the former point and the next point. If inputting parameters A1 and A2 of the spiral, then the system will insert defined spiral in between the line and the arc.
[Notes*]: When inputting A1 and A2 according to the length of the spiral L1 and L2, the formulae to calculate A1 and A2 are as followed:

A $1=\sqrt{ }($ L1 $\cdot$ Radius $)$
A $2=\sqrt{ }$ (L2 $2 \cdot$ Radius $)$
Press 'ENT' to input the next intersection now. If N, E coordinates and radius are not entered at all, there will be no response from the instrument. If inputting is done, press 'ESC' to quit the dialogue. The system will then goes to 'List of H curve'.

Now press 'Save' to save the information of lines into [.LS] files.

Press 'View' to check the inputted data and edit them.
Press 'Add' to go back to the 'Define (H)' page to continue define horizontal lining. Repeat the steps above until the inputting are finished. Go back to Roadway Menu

If users want to continue inputting, choose ' 4 . Resume H curve' under the roadway menu.

### 10.1.2 Vertical Lining

Vertical lining is formed by a group of intersection points. The intersection points possess mileage, altitude and curve length. The curve length of beginning and ending point of Vertical lining must be 0 . The number of intersection points of vertical lining can be 12 maximum.


Choose 'Re-define (V)' to enter box of 'Define(V)-Begin':
Define(V)-Begin
Mileage:
Altitude:
Length:

## B.S

Clear

## Enter

Enter the mileage, altitude and length one by one and press 'ESC' to end the input and go to 'List of V curve'. The uses of 'Save', 'View' and 'Edit' $\rightarrow$

You may continue inputting V curve through '5.Resume V curve'.

After finishing defining H and V curve, the last input will be saved in the buffer storage cache and will be erased when shutting the instrument down. The data should and can be used to staking out roadway immediately if needed.

### 10.2 Staking outRoadway

The inputted or imported LS files are to be employed in staking road way. When staking out roadway, you may select the desired file any time in relation to demand so that staking out roadway with any mileage can be done easily.

Therefore, users may not be worried about the capacity of 20 lining [.LS] files and 12 vertical lining because you may diveda roadway with any mileage into several pieces and save them into several sub [.LS] files.

The terms of staking out roadway:


The steps for staking out road way is as followed:

1. Select [.LS] files for stake-out
2. Setup station
3. Setup BBS
4. Inputting Roadway parameters, including mileage of begin (start mileage), space between, left and right deviation (Left/Right dist) and left and right altitude difference (Left/Right dV)
5. Then select center, left and right mileage to stake out.
6. Users may choose 'Dist' - polar coordinates or 'coord.'to stake out.

### 10.2.1 Selecting Roadway File

There are two routes to select roadway file ([.LS] file)

1) Menu $\rightarrow 4$.Program $\rightarrow 7$.Roadway $\rightarrow 1$.Open shape file
2) Menu $\rightarrow 4$.Program $\rightarrow 7$.Roadway $\rightarrow 6$.Stake out (road) $\rightarrow 1$.Select file.

Both ways above lead to page of 'select file'. Shift indicator > down to the opt 'File (.LH)' and press soft key 'Enter'. The system will list out the available [.LS] files. After selecting file, press 'ENT' to load the buffer storage cache with the selected [.LS] file. If users have already open the shape file successfully and the page of 'Select file'remains, then press 'ESC' to end the dialogue. If not, then repeat the steps above until the a file is selected and opened.

### 10.2.2 Setting stations and BBS (back-sight points)

See reference in setup BBS and setup station.

### 10.2.3 Staking outRoadway

Before staking out Roadway, please first enter the parameters required for staking out. e.g starting mileage, space between, left distance, right distance, left dV and right dV. Press 'ENT' to enter 'Roadway- Center' page. The soft key functions under this page are as followed:

| ey | Explanation |
| :---: | :---: |
| 1 | Setup any mileage and target height |
| 3 | calculate the coordinate of the staked out point first |
|  | Current mileage minus space to obtain new mileage |
|  | Switch between <br> 'Roadway-Right' $\rightarrow$ 'Roadway-Center' $\rightarrow$ 'Roadway-Left' |
|  | Switch between <br> Roadway-Left $\rightarrow$ Roadway-Center $\rightarrow$ Roadway-Right |

Press 'Stake' under this page:


Point name indicates the mileage of the selected stake. The system accepts maximum 8 characters of the point name. You may now press 'Record' to save the point to be staked out to the current coordinate file, otherwise, press 'ENT' to display the azimuth angle and horizontal distance of it.

Roadway-Calc
HR:
HD:

## Dist

Coord

You may now press 'Dist' to stake out polar coordinate or 'Coord.'to stake out coordinates. See reference in 9.4.3 Polar Coord. Measurement and 9.2.1 Stake out. Press 'ESC' under all pages above to go back to 'Roadway-Center/right/left' page.

## 11. Adjustments and Corrections

The ZTS -320(R) total station are all calibrated and checked before entering the market. However, it is inevitable that long distance transportation or environmental change alter the parameters of the optical components. Thus, for concerns of precision, please check and calibrate your instrument before any measurement.

### 11.1 Tubular Level

## Check

See reference in using tubular level to level the instrument precisely.

Calibration

1. If finding the bubble of the tubular level is deviate away from the center, adjust the bubble with the screws being parallel to the tube. Stop adjustment when half of the deviation is calibrated. The rest should be adjusted by screwing the level correction screw with a correction needle. The expected position of the bubble should be in the middle of the tube.
2. Turn the instrument around by $180^{\circ}$ to check if the bubble is centralized. If not, repeat process in 1 .
3. Turn the instrument around by $90^{\circ}$ and centralize the bubble with the third leveling screw.
4. Repeat checking and adjusting until the bubble remains in the in center at any position.

### 11.2 Circular Level

## Check

If the bubble of the circular level is centralized after adjusting the tubular level, then it is not necessary to adjust the circular one again.

Calibration
If the bubble is not centralized, adjust the correction screws under the bubble with a correction needle or a hexagon spanner until it is centralized. When calibration, please first screw off the 1 or 2 screws opposite to the direction which the bubble shifts to. Then screw up the correction screws at which bubble shifts to centralize the bubble. As the bubble is centralized, the three correction screw should be the same tight.

### 11.3 Reticule of the telescope

## Check

1. Aim at a target A from the telescope after leveling the instrument with the help of the cross wire on the reticule. Lock the instrument with vertical and horizontal locking screw after aiming at A.
2. Shift the image of A to the margin of the reticule with the help of vertical inching screw.
3. If the image of A shifts all the way down to the margin along the wire, then there is no need to calibrate the cross wire
(as shown on the left below), otherwise a calibration is necessary (as shown on the right below).


Calibration

1. Unload the reticule cover between the eyepiece and the focusing knob. Now you see three fixing screws of the reticule
2. Screw off three fixing screws (see picture below) uniformly with a screwdriver. Rotate the reticule about the collimation axis to shift image of A' onto the vertical wire precisely.
3. Screw up the fixing screws uniformly and check precision with methods above.
4. Cover the reticule.


### 11.4 Perpendicularity of Collimation axis and Cross axis (2C)

## Check

1. Set target A to be about 100 meters away from the instrument and set the vertical angle of the target to be within $\pm 3^{\circ}$. Level the instrument precisely and turn on the instrument.
2. Aim at the target A and readout the left horizontal angle.

## e.g. $\mathrm{HA} \mathrm{L}=10^{\circ} 13^{\prime} 10^{\prime \prime}$

3. Screw off the vertical and horizontal locking screw and turn around the telescope to aim at the same target A . When aiming at it precisely, lock the vertical and horizontal locking screw to read out the right angle. e.g. HA $\mathrm{R}=190^{\circ} 13^{\prime} 40^{\prime \prime}$
4. $2 \mathrm{C}=\mathrm{L}-\left(\mathrm{R} \pm 180^{\circ}\right)=-30^{\prime \prime} \geq \pm 20^{\prime \prime}$, then the instrument need to be calibrated.

Calibration

1. Turn the instrument to the correct horizontal angle which eliminates C with the help of horizontal inching screw:

$$
\mathrm{R}+\mathrm{C}=190^{\circ} 13^{\prime} 40^{\prime \prime}-15^{\prime \prime}=190^{\circ} 13^{\prime} 25^{\prime \prime}
$$

2. Unload the reticule cover in between the eyepiece and the coarse focusing knob. Adjust the two horizontal cross wire correction screw on the left and right by screwing off one then screwing up the other. Shift the reticule to aim at the target A with the cross wire center.
3. Repeat the steps above until the absolute value of 2 C is less than $10^{\prime \prime}\left(|2 \mathrm{C}|<10^{\prime \prime}\right)$
4. Screw up the correction screw and cover the reticule.


Note: Mention that users have to check the depth of parallelism between Collimation axis Electro-optic Emission axis

### 11.5 Tilt compensator

## Check

1. After placing and leveling the instrument, align laser beams and the line of connection between the instrument center and any leveling screw on the bottom of the instrument. Then screw up the horizontal locking screw, named X.
2. Set 0 for the vertical angle and screw up the vertical locking screw. The instrument displays the current vertical angle the telescope laser aims at.
3. Screw the leveling screw towards one direction for circumferential distance around 10 mm , the vertical angle displayed will disappear through the process and 'Tilt over!' appears to the column. It indicates that the inclination of the
instrument is over $3^{\prime}$, which is over the range the instrument was designed to compensate. Screw the leveling screw back towards the opposite direction, the vertical angle re-appears on the screen. It shows that the tilt works well now. Users may observe the change of the readout about the critical point.

Calibration
When finding the tilt compensator abnormal, please send the instrument back to factories for servicing.

### 11.6 Vertical index error (angle i) and set vertical index 0

Please first adjust finely the reticule of the telescope and the tilt compensator before calibrating and checking index error.

Check

1. Turn on the instrument after placing and leveling it. Aim at any clear target A with the telescope and readout the left vertical angle $L$.
2. Turn the telescope around and aim at the same target A and readout the right vertical angle R .
3. Assume that the zenith of the vertical angle is $0^{\circ}$, then angle $\mathrm{i}=\left(\mathrm{L}+\mathrm{R}-180^{\circ}\right) / 2 \quad \mathrm{OR}$

Angle $\mathrm{i}=\left(\mathrm{L}+\mathrm{R}-540^{\circ}\right) / 2$
4. If the absolute value of $I$ is greater or equal to $10^{\prime \prime}\left(|i| \geq 10^{\prime \prime}\right)$, it will be necessary to set 0 for the vertical index.
5. The following steps see reference in 9.6.1.

Note: 1. Repeat the checking process to re-measure the index error (angle i). If the index error still does not requirement, a checking of the three steps of calibration ofset 0 for index is to be undertaken. It is highly possible that errors are made in the three steps.e.gwhther it was precise when aiming at the target. Mention that the vertical angle when setting 0 for index is not compensated or calibrated, which acts as a reference for setting without other measurement uses.
6. If the index error does not meet requirements at all, users may have to send the instrument back to factories for survicing.

### 11.7 Centering device

## Check

1. Place the instrument onto the tripod and draw a cross on a sheet of clean paper. Place the paper with a cross on the ground right below the instrument.
2. Open the laser plumb by using star key ( $\star$ ). Shift the paper to make the intersection of the cross being exactly aimed at by the laser.
3. Turn the leveling screw to make the center (labeled by a symbol) of the centering device coincides with the intersection of the cross.
4. Turn around the aiming component. For every $90^{\circ}$ it is turned, observe how the extent the center of the centering device coincides with the intersection of the cross.

Calibration

1. Unload the cover of the laser plumb and adjust the three correction screw with 1\# hexagon spanner to adjust the three screw. Obey the rule to screw off one side and screw up the other. Finally adjust the laser plumb spot to point 0 (origin).
2. Cover the laser plumb.

### 11.8 Addictive constant(K)

The addictive constant is checked and adjusted before the instrument enters the market. The constant is normally set to be 0 . The instrument constant seldom changes, though we still suggest you to check it once or twice a year. You may check it on standard baseline or you may fast check it as followed:

Check

1. Select a plane field to place the instrument and level it. Precisely mark point A, B and C with inner spaces about 50 meters on the same line with vertical wires. Place reflector prism on each point with precise certering.
2. After setting the temperature and atmospheric pressure of the instrument, measure the horizontal distance of A B and AC.
3. Place the instrument onto point $B$ then centering to measure the horizontal distance of BC precisely.
4. Obtain the Distance measurement constant of the instrument: $\mathrm{K}=\mathrm{AC}-(\mathrm{AB}+\mathrm{BC})$

K should approach to 0 . If the absolute value of K is greater than 5 mm , then users may have to set the instrument in a standardized baseline field for strict measurement.

## Calibration

If proving that the constant K changes and does not approach to 0 after a strict checking, then adjust the constant by setting the addictive constant as a integrated constant K . e.g the measured new K is -5 and the former instrument constant is -20 , then the new value to be set should be $-20-(-5)=-15$; input value -15 into 'Menu $\rightarrow 6$.calibration $\rightarrow 3$.Add const'.

Users should orient with the vertical wire of the instrument to align $\mathrm{A}, \mathrm{B}$ and C strictly. A fixed clear centering symbol should be on point $B$ on the ground.

To make sure that if the center of prism B at point B coincides with the instrument center exactly is an essential concern of precision. Therefore, please set up tripod and pedestal that can be employed by both (prism B and instrument). e.g. when exchanging three-point prism connector and pedestal, the pedestal and the three-point can remain at the origin. The only exchanged parts are prism and instrument, both being above the pedestal, so that the error can be minimized.

### 11.9 Depth of parallelism between Collimation axis Electro-optic Emission axis

Check

1. Place a reflector prism 50 meters away from the instrument
2. Aim at the reflector prism center precisely with the cross wire of the telescope
3. Observe the maximum signal through starkey $(\star) \rightarrow$ Para. $\rightarrow$ Signal, and find the center of the electro-optic emission axis.
4. Check if the cross wire coincides with the telescope center. If they approximately coincide, then it is generally considered tolerable.

Calibration
If the cross wire deviates a lot from the Electro-optic emission axis, users may have to send the instrument to authenticated factory or units for servicing.

### 11.10 No-prism ranging

The red laser beam sharing the same axis of the telescope is emitted by the telescope. If the instrument is finely calibrated, the red laser beam should coincide with the collimation axis. If external factors e.g vibration, drastic temperature change, may deviate the laser beam so that it does not coincide with our sight line.

Please first check the coaxality of the laser beam that if the laser beams deviates, otherwise the measurement can be inaccurate.

Warnings:
Do not look into laser beams directly! Do not aim at others with laser beams!

Check
Face the grey side of the provided reflector to the instrument, being about 5 and 20 meters away. Turn on the laser and aim at the reflector with the cross wire center. Check the position of the red laser spot. Generally, the telescope is equipped with special filter so that cannot exactly see the spot but can see the extent of deviation between the spot and the cross wire center above the telescope or from the side of the reflector. If the laser spot center coincides with the cross wire center, then the precision is now ensured. If the deviation is over the range, please send the instrument to authenticated units for servicing.

If the reflector is too bright under the illumination of laser beams, the grey side can be replaced by the white side.

## 12. Technical parameters

| Serial | ZTS-320(R) |
| :---: | :---: |
| Anglemeasuring (Hz, V) |  |
| Theory used | Absolute code disk |
| Min angle readout | 1 " |
| Precision | $2^{\prime \prime}$ |
| Telescope |  |
| Magnification | 30x |
| Field angle | $1^{\circ} 30^{\prime}$ |
| Min sight distance | 1.5 m |
| Cross wire | Lighting |
| Tilt compensator |  |
| System | Integrated liquid single-axis compensator |
| Working range | $\pm 3^{\prime}$ |
| Set precision | $1{ }^{\prime \prime}$ |
| Distance measuring (IR) |  |
| Ranging with single prism under fine/middling pressure | 2000m/2500m |
| Ranging with reflector | 800m |
| Precision (precise, coarse measurement; tracking) | $2 \mathrm{~mm} \pm 2 \mathrm{ppm}$ |
| Measuring time (single/ | 2.4s/ 1s/ 0.6 s |


| repeated/tracking) |  |
| :---: | :---: |
| No-prism distance measuring |  |
| Ranging with white target plate | 350m (short distance no prism measurement) |
| Ranging with single prism | $>7500 \mathrm{~m}$ |
| Precision (short distance/tracking/prism) | $3 \mathrm{~mm} \pm 2 \mathrm{ppm}$ |
| Measuring time (short distance/tracking/prism) | 2~6 s |
| Communication |  |
| Memory capacity | 20000 points |
| Port | Standard RS232 serial port |
| Data format | ASCII |
| Operation |  |
| Operating system | RTS |
| Display screen | Image: 192x96 pixel; <br> Character: 6 lines x 25 characters; LCD |
| Keyboard | Double-sided numeric keyboard |
| Laser Plumb |  |
| Type | Stepper brilliance control |
| Precision | 1 mm (instrument height: <br> $1.5 \mathrm{~m})$ |
| Environment conditions |  |
| Working temperature | $-20^{\circ} \mathrm{C} \sim+50^{\circ} \mathrm{C}$ |


| Storing temperature | $-40^{\circ} \mathrm{C} \sim+70^{\circ} \mathrm{C}$ |
| :---: | :---: |
| Water proof \& dust proof <br> (according to standard <br> IEC60529) | IP54 |
| Weight |  |
| Include battery and pedestal | 5.5 kg |
| Battery |  |
| Type |  |
| Voltage/ capacitance |  |
| Working duration | 16 hours (under $25{ }^{\circ} \mathrm{C}$ with <br> a fully charged battery, <br> measuring once for every thirty <br> minutes) <br> Constant angle measuring |
| mode |  |

## Appendix A: Explanation of file formats

Explanation of formats of files:

| STA | ST001, 1.2050, AD |
| :--- | :--- |
| XYZ | $100.0000,100.0000,10.0000$ |

SS BS001, 1.8000, BA
NEZ 200.0000, 200.0000, 10.0000
SC A1, 1.8000, CODE1
NEZ $\quad 104.6625,99.5679,10.2148$
SD A2, 1.8000, CODE1
HVD 1276939, 288678, 4.7510
SA A3, 1.8000, CODE1
HV 1276942, 288678
Every record consists of two lines:
$1^{\text {st }}$ line records the record type, point name, target height, code
e.g. $S T A=$ station point
$\mathrm{SS}=\mathrm{BBS}$ (back-sight point)
$\mathrm{SC}=$ coordinate data
$\mathrm{SD}=$ distance measured
SA = angle measured
$2^{\text {nd }}$ line records the data type and the data record
e.g. $\mathrm{NEZ}=$ the following figures are coordinates
$\mathrm{ENZ}=$ the following figures are coordinates
HVD $=$ the following figures are horizontal angle, vertical angle and slope correspondingly
$\mathrm{HV}=$ the following figures are horizontal angle and vertical angle correspondingly

## Appendix B Explanation of Protocol command

Another device can operate Total station through RS232 or Bluetooth using the commands as follow:
" 1006006 ", 0 -- command correct response
"\021021",1-- command incorrect response
"C067\003",2-- measure and return the data
"N078\003",3-- stop measuring
"ZA0043\003",4—direct to close
"ZA1067\003",5-- direct to open
"Z10091\003",6--H/V
"Z12089\003",7--HR
"Z13088\003",8--HL
"Z200881003",9--H/V
"Z31088\003",10—SD track
"Z32091\003",11--SD loose measurement
"Z33090\003",12—SD repeat loose measurement
"Z34093\003",13—SD accurate measurement
"Z35092\003",14—SD repeat accurate measurement
"Z41095\003",15--HD tracking measurement
"Z42092\003",16--HD loose measurement
"Z43093\003",17--HD repeat loose measurement
"Z44090\003",18—HD accurate measurement
"Z45091\003",19—HD repeat accurate measurement
"Z51094\003",20-VD tracking measurement
"Z52093\003",21—VD loose measurement
"Z53092\003",22—VD repeat loose measurement
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"Z54091\003",23—VD accurate measurement "Z55090\003",24—VD repeat accurate measurement "Z61093\003",25-NE tracking measurement "Z62094\003",26—NE loose measurement "Z63095\003",27—NE repeat loose measurement "Z64088\003",28—NE accurate measurement "Z65089\003",29—NE repeat accurate measurement "Z71092\003",30—NE tracking measurement "Z72095\003",31—NE loose measurement "Z73094\003",32-NE repeat loose measurement "Z74089\003",33—NE accurate measurement "Z75088\003",34—NE repeat accurate measurement "Z81083\003",35-Z tracking measurement "Z82080\003",36-Z loose measurement "Z83081\003",37-Z repeat loose measurement "Z84086\003",38—Z accurate measurement "Z85087\003",39—Z repeat accurate measurement

## Appendix C Explanation of format data

Total station will transmit measured data to extern device after receiving commands from the extern device.

1) SD mode
(ID: 3 FH )


ID : ‘?’ indicates slope distance (ASCII 3FH)
SD : Slope distance $1178.481 \mathrm{~m}(+/-, 8$ digits)
$\mathrm{m} / \mathrm{f}$ : meter/feet
V : Vertical angle $\quad 5^{\prime} 20^{\prime} 30$ " (7 digits)
H : Horizontal angle 120'30'40"(+/-)
$\mathrm{d} / \mathrm{g} / \mathrm{m} \quad$ : degree/grad/mil (usually ' d ')
HD : Horizontal distance1174.572m (+/-, 8 digits)
$\mathrm{t} *$ : $\quad$ Tilt correction -- $\mathrm{t}:$ yes, $*:$ no
L : EDM return signal level 15 (2 digits)
P : Don't care
0 : Don't care
BCC : Block check character 099 (3 digits)
ETX : 03 H to show the end of text
CR : The optional ASCII character (0DH)
LF : The optional ASCII character (OAH)
2) V or H angle mode
(ID: 3 CH )


TILT : Tilt correction (usually 0 )
3) N or E or Z coordinates mode
<Standard (8 digits) mode> (ID: 55H) $\begin{array}{ccccccc}\mathrm{U}-00596337+01011930+00095802 \mathrm{~m}+1203040 \mathrm{~d} & 110 & \text { ETX (CRLF) } \\ \text { ID } & \mathrm{N} & \mathrm{E} & \mathrm{Z} & \mathrm{m} / \mathrm{f} & \mathrm{H} & \mathrm{d} / \mathrm{g} / \mathrm{m} \\ \mathrm{ACCC}\end{array}$ $\mathrm{N}: \mathrm{N}(\mathrm{X})$ coordinate -596.337 m 8 digits) $\mathrm{E}: \mathrm{E}(\mathrm{Y})$ coordinate $+1011.930 \mathrm{~m} \quad 8$ digits) $\mathrm{Z}: \mathrm{Z}$ coordinate $+95.802 \mathrm{~m}(+/-, \quad 8$ digits $)$

