CONTENTS

FOREWORD

1. Features ……..6
2. Precautions……..7
3. Nomenclature…… 9
4. Key functions……..11
5. Character entry……..14
6. Display symbol……..15
7. Mode Configuration……..15

PART 1 PREPARATION FOR MEASUREMENT……19

1. Unpacking and store of the instrument ……..19
2. Setting the instrument up……..19
3. Battery dismounting, information, recharging……..21
4. Reflector prisms…..22
5. Mounting and dismounting the instrument from tribrach……22
6. Eyepiece adjustment and object setting……23
7. Power on/off and preparation for measurement……..24
7.1 Power on/off……24
7.2 Vertical Angle Tilt Correction ……24
7.3 Display Illumination……26
7.4 Setting the Instrument Options……26
7.5 Setting Instrument Constant……29
7.6 Setting LCD Contrast……30
7.7 Setting Date and Time……31
7.8 Explanations……32

PART 2 BASIC MEASUREMENTS ……33

8. ANGLE MEASUREMENT……33
8.1 Measuring the Horizontal Angle Between Two Points（Horizontal Angle 0）……33
8.1.1 Example Measuring the Horizontal Angle between Two Points…..……34
8.2 Setting the Horizontal Circle to a Required Value ……35
8.2.1 Use HSET function to set a required direction value ……35
8.2.2Use HOLD to set a required direction value ……35
8.3 Horizontal Angle Display Selection（Right /Left）……36
8.4 Horizontal Angle Repetition ……37
8.5 Slope in ％……39
9. DISTANCE MEASUREMENT……39
9.1 Settings for Distance Measurement ……40
9.2 Laser direction and laser plummet ……42

9.3 Distance and Angle Measurement.....43
9.4 Review of Measured Data 44
9.5 Output Data to a Computer.....45
10. COORDINATE MEASUREMENT.....47
10.1 Entering Instrument Station Data.....49
10.1.1 Reading in Registered Coordinate Data.....50
10.2 Azimuth Angle Setting.....50
10.2.1 Set backsight point by Angle.....51
10.2.2 Set backsight point by coordinate.....51
10.3 Coordinate Measurement.....52

PART 3 ADVANCED MEASUREMENT 55

11. SETTING-OUT MEASUREMENT.....55
11.1 Distance Setting-Out Measurement.....56
11.2 REM Setting-Out Measurement 59
11.3 Coordinates Setting-Out Measurement.....61
11.4 Distance Measurement Parameters Setting 63
12. OFFSET MEASUREMENT 65
12.1 Single-Distance Offset Measurement 66
12.2 Angle Offset Measurement 68
12.3 Two-Distance Offset Measurement.....71
13. MISSING LINE MEASUREMENT 73
13.1 Measuring the Distance between Multiple Targets.....74
13.1.1 Measuring the distance between multiple targets 74
13.1.2 Slope in between 2 points.....75
13.2 Changing the Starting Point.....76
14. REM MEASUREMENT.....77
15. RESECTION MEASUREMENT 79
15.1 Re-Observing.....82
15.2 Add Known Points.....82
16. AREA CALCULATION.....83
17. SETTING OUT LINE.....86
17.1 Defining baseline 87
17.2 set-out line (point).....89
17.3 Seting out line (line).....90
18. POINT PROJECTION.....92
18.1 Defining baseline.....92
18.2 Point projection 93
19. ROAD DESIGN AND SETTING-OUT.....95

19.1.1 Define Horizontal Alignment (Maximum data quantity: 30)……...…95
19.1.2 Edit Alignment……...100
19.1.3 Define Vertical Curve (Maximum 30 data)……102
19.1.4 Edit Vertical Curve ……103
19.1.5 Inport Horizontal Alignment……105
19.1.6 Import Vertical curve……106
19.1.7 Receiving Horizontal Alignment Data……107
19.1.8 Receiving Vertical Curve Data……109
19.1.9 Deleting Horizontal alignment Data ……110
19.1.10 Deleting Vertical Curve……110
19.2 Road Setting-out……111
19.2.1 Set Station Point……112
19.2.2 Setting Backsight Point……113
19.2.3 Setting Out……116
19.2.4 Slope Setout……120
19A.SETTING-OUT ARC……122

PART 4 DATA RECORDING ……126

20 SETTING IN MEMORY MODE……127
20.1 JOB Selection ……127
20.1.1 Current JOB Selection ……127
20.1.2 Check Memory Status……128
20.1.3Create new working job……129
20.1.4 Change the job name ……130
20.1.5 Delect Job……131
20.1.6 Coordinate Selection……132
20.1.7 Job Export……132
20.1.8 Coordinate Import……134
20.1.9 Comms output……135
20.1.10 Comms input……136
20.1.11 Transfer coord data to job……137
20.2 Import Known Point Data…… 138
20.2.1. Input known Point Coordinate……138
20.2.2 Known Coordinate Data Import……139
20.2.3 Known Coordinate Data Export……140
20.2.4 Entering coordinate data from an computer ……140
20.2.5 Sending known point data to computer……141
20.2.6 Clearing Coordinate Data from Memory……142

20.3 Input Codes……142
20.3.1Code import……143
20.3.2 Receive code……143
20.3.3 All clear……144
20.4 U disk mode……144
20.5 Initialization……146
20.6 All Files……147
20.7 Setting for Grid Factor……148
21. DATA RECORDING IN RECORD MODE……149
21.1 Recording Instrument Station Data……149
21.2 Recording backsight data……151
21.2.1 Set backsight point by Angle……151
21.2.2 Set backsight point by coordinate……152
21.3 Recording Angle Measurement Data……152
21.4 Recording Distance Measurement Data……154
21.5 Recording Coordinates Data……156
21.6 Recording distance and coordinate data……157
21.7 Recording Notes……158
21.8 Reviewing JOB Data……159
PART 5 MEASUREMENT OPTIONS SELECTION……161
22. KEY FUNCTION ALLOCATION……161
22.1 Allocation and Registration……162
22.1.1 Allocating functions……163
22.1.2 Registering an allocation……165
22.2 Recalling an Allocation……166
23. INSTRUMENT PARAMETERS SETTING……166
23.1 Changing Instrument Parameters……166
PART 6 CHECKING AND ADJUSTMENT……170
24.1 Plate Vial……170
24.2 Circular Level……170
24.3 Inclination of Reticle……171
24.4 Perpendicularity of Collimation Line to Horizontal Axis (2c)……171
24.5 Vertical Index Difference Compensation……173
24.6 Adjustment of Vertical Index Difference (i angle) and Vertical Angle 0 Datum……173
24.7 The adjustment of horizontal axis error correction……175
24.8 Optical Plummet……175
24.9 Instrument Constant（K）……176

24.10 Parallel Between Collimation line and Emitting Photoelectric Axis……177
☞24.11 Reflectorless EDM……178
24.12 Tribrach Leveling Screw……178
24.13 Related Parts for Reflector……178
25. SPECIFICATION ……179
26. ERROR DISPLAYS……181
27. ACCESSORIES……182

APPENDIX A BIDIRECTIONAL COMMUNICATION……183

1.1 Outputting Commands……182
1.2 Entering Command……190
1.3 Set Command……192

APPENDIX-B CALCULATE ROAD ALIGNMENT……193

1.1 ROAD ALIGNMENT ELEMENTS……193
1.2 CALCULATION OF ROAD ALIGNMENT ELEMENTS……195

FOREWORD

Thank you for purchasing KOLIDA Total Station KTS-442UT series !
This manual is applicable for KOLIDA Total Station KTS-442UT series !
KTS-442UT series Total Station is equipped with visible laser reflector less distance meter.
Please read the manual book carefully before operating the instruments.

1. FEATURES

1. Complete Function

KOLIDA KTS-442UT series has complete surveying program, the functions of data record and parameter setting, is suitable for professional and construction survey.

2. USD Pen Drive

With the advantages of large memory storage, rapid transmission data system, removable and secure functions, various surveying data could be easily saved in the USB Pen Drive and moved into computer through the port of lap top computer. Please do not move out the USD Pen Drive when operating the data stored in it, otherwise the surveying data can be damaged. 1 MB space in USD Pen Drive may contains 15,000 data.

3. Powerful Memory Management

Very large memory and the enhanced file management system can help you easily realize the function of addition, deletion, modification, and transmission of the data.

4. Absolute Encoding Circle

With absolute encoding system, measurement can be started immediatley after booting up the instrument. No azimuth information is ever lost even in sudden power break.

5. Reflector less Distance Measurement ☞

The reflectorless function of KTS-442UT enables you to carry out long-distance and high-accuracy measurement directly towards various objects of different materials and colors (like wall of building, telegraph pole, wire, cliff, mountain, clay, wooden stake, etc.) It's the best solution to measure the hard-reach or unreachable object.

6. Abundant Surveying Programs

KTS-442UT not only has the basic surveying modes (angle, distance, coordinate measurement) but also equipped with special surveying programs, for example, REM, Offset, MLM, Staking-out, Road Design, Point Projection, Setout line, etc, to meet the demand of professional survey.

2. PRECAUTIONS

1.Never place instrument directly on the ground，as sand or dust may cause damage to the screw holes or the centering screw on the base plate.

2. Before carry on the measurment, we need to have an overall check with the inrsrument, such as: battery, parameters, and initial settings.

3. When working in a sun-baked (rainy or wet) day, please use the surveying umbrella to avoid damage. Besides, do not aim the telescope at the sun without a filter.

4. When the instrument is not in use, put it in the case and keep the instrument from shock, dust and humidity.

5. If there is great difference between the temperature in working area and that in store place, leave the instrument in the case till it is used to the temperature of outside working area

6. Clean its surface with a woolen cloth after using. If the instrument gets wet, dry it immediately.

7. Turn the power off before removing the battery, otherwise it may cause damage to internal circuit. When place KTS into its case, firstly remove the battery and place it in the case in accordance with its layout plan. Make sure that the inside of the carrying case and KTS are dry before closing the case.

8. No used for a long time, seperate the battery from the instrument and store them respectively. The battery should be charged once a month.

9. Clean exposed optical parts with degreased cotton or lens tissue only!

10. During transporting, the instrument should be placed in its carrying case. It will be better to place some cushion around the case to keep the instrument from the damage of shock.

11. If there is something wrong on the instrument, please do not disassemble the instrument unless you are a professional technician

☞ 12. Never aim the laser beam of KTS-442UT Series Total Station at human eyes.

☞SAFETY GUIDE

Interior EDM（Visible Laser）

Warning:

The total station is equipped with an EDM of a laser grade of 3R/IIIa, which could be recognized by the following labels:

On the vertical tangent screw, there is a label shows “CLASS III LASER PRODUCT”. A similar label is on the opposite side.

This product is classified as Class 3R laser product, which is coordinated with the following standards.

IEC 60825-1：2001 “SAFETY OF THE LASER PRODUCT”.

Class 3R/Ⅲa laser product: It is harmful to observe laser beam continuously. User should avoid sighting the laser at the eyes. It can reach 5 times the emitting limit of Class2/ II with a wavelength of 400nm-700nm.

Warning:

Continuously looking straight at the laser beam is harmful.

Prevention:

Do not stare at the laser beam, or point the laser beam to others' eyes. Reflected laser beam is a valid measurement to the instrument.

Warning:

When the laser beam is shooting at prism, mirror, metal surface or window, the reflector laser beam is also harmful to eyes.

Prevention:

Do not stare at the locations with laser reflection. When the reflectorless function is enabled for EDM, do not stare beside the laser beam or prism. Collimating the prism via the telescope unit is requested only.

Warning:

Incorrect application of Class 3R laser equipment is very dangerous.

Prevention:

To avoid being hurt, you must pay particular attention to the precaution measures and keep it under control within the distance of possible danger according to standard IEC60825-1:2001.

The following explain the key sections of the Standard:

Laser instrument of Class 3R is applicable outdoors and in construction field (measurement, defining lines, leveling).

a) Only those persons who are trained with related course and authenticated are allowed to install, adjust, and operate this kind of laser instrument.

b) Relevant laser warning symbols should be easily identified within the operating range.

c) Prevent any person to look straight at or use optical instrument to observe the laser beam.

d) To prevent the harm caused by laser, block the laser beam at the end of the working route. When the laser beam exceeds the limit area (harmful distance*) and when there are motivating persons, stopping the laser beam is a must.

e) The optical path of the laser should be set higher or lower than the line of sight.

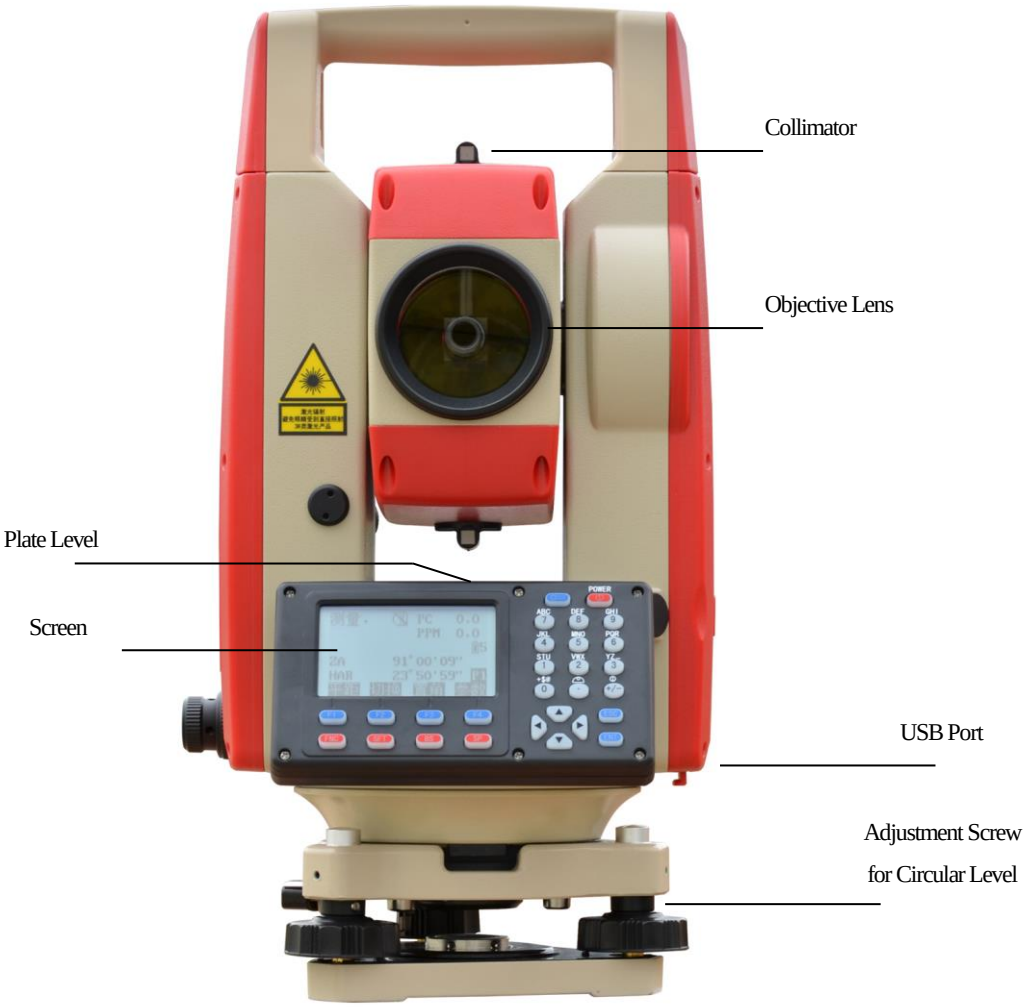
f) When the laser instrument is not in use, take care of it properly. The person who is not authenticated is not allowed to use.

g) Prevent the laser beam from irradiating plane mirror, metal surface, window, etc., especially beware of the surface of plane mirror and concave mirror.

* Harmful distance means the maximum distance between the start point and the point which the laser is weakened to a degree that doesn't harm people.

* The harmful distance of built-in laser unit is 1000m (3300ft). When the operation is beyond this range and laser beam is weakened to Class 1R, direct staring at laser beam is less harmful.

3. NOMENCLATURE



Eyepiece
Telescope Grip
Vertical Tangent Screw
Tribrach
Battery Lock
Battery
Trigger Key
Horizontal Tangent Screw
Circular Level
Levelling Screw
K148875

4. KEY FUNCTIONS

The KTS-442UT has a 28-keys keyboard. The keyboard has a power switch key, an illumination key, 4 soft keys, 10 operating keys and 12 alphanumeric keys.

Power ON ： Press POWER. Power OFF ： Press POWER for 3 seconds

Press key to turn ON or OFF backlight.

Soft Key

The functions of soft keys are showed on the bottom of the display window of KTS-442UT select these functions by using F1 to F4 keys, press FNC key to view other functions in another page.

For example, the following shows the initial setting of the soft keys displayed in MEAS mode

Page 1 ：

Name	Function
HD (SD or VD)	Start distance measurement
SHV	Select distance measurement category(change between SD, HD, VD)
HSET	Set the horizontal angle to a required value
EDM	Distance measurement parameter setting

Page 2 ：

Name	Function
0SET	0 Set of horizontal angle
CRD	Start coordinate measurement
S-O	Start setting-out measurement
REC	Record observed data

Page 3 ：

Name	Function
MLM	Start missing line measurement
RESEC	Start resection measurement
MENU	Display menu mode
HT	Set the height of instrument and the target

Operating Keys:

Name	Function
ESC	Cancel previous operation and return to previous screen or mode.
FNC	1. Change page. 2. Enable target-height inputting in staking-out, missing line, and remote measurement.
SFT	Turn SHIFT mode ON or OFF (switch number input and alphabet input)
BS	Delete a blank left
SP	1. Hot key to modify the distance measurement parameter. 2. Spacebar in IME(Input Method Editor)
▲	Move cursor / select options up view the previous data in data list
▼	Move cursor / select options down view the next data in data list
◄	Move cursor to the left / Select another options view the previous page in data list
►	Move cursor to the left / Select another options view the next page in data list
ENT	Confirm to entry or save data on that line and move the cursor to the next line

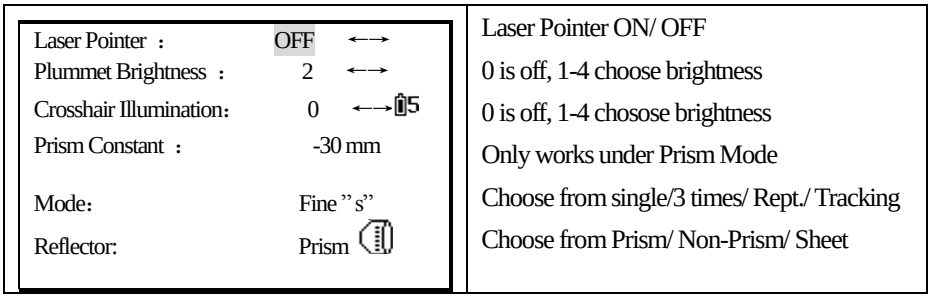
Alphanumeric keys with shift mode OFF ：

Name	Function
STU GHI 1 ～ 9	Alphanet input (enter the alphanet on the top of key)
1 ～ 9	1) Numerical input 2) 2) Selecting menu item
.	1) Input decimal point : . (in number input mode) 2) Input symbol : \ # (in alphabet input mode) 3) Input ° ′ ″ (in angle input screen)
+/-	1) Input minus symbol : - 2) Input symbol : * / + 3) Enter the laser guidance interface (None-Input mode)

Hot Key

1. SP key: EDM Settings

When you are not inputting numbers or alphabets, press SP key, a shortcut screen will be showed. Press ▲▼ key to move the cursor, press ◄► key to switch the setting. Press ENT to save the settings, press ESC to quit to upper menu.

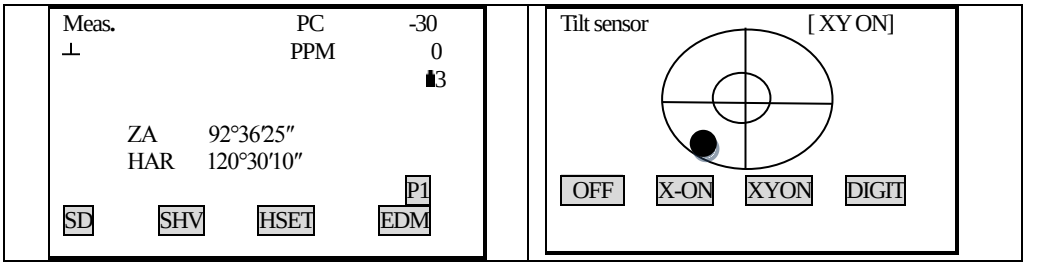


Note:

1) When you press SP to enter the above menu, laser plummet will be ON. Press ESC to quit, laser Plummet will be OFF.

2. SFT + •: Compensator ON/ OFF

When you are not inputting numbers or alphabets, press SFT key, then press •, compensator screen will be showed.



3. SFT + +/-: Laser Pointer and Laser Plummet

F1: Turn on Laser Pointer F2: Turn off

↑ and ↓: change the brightness of Laser Plummet point

Trigger Key

Under any measurement screen, you can press trigger key to perform a distance/ coordinate measurement.

Trigger Key, to perform a fast measurement without moving your eyes away from eyepiece

5. CHARACTER ENTRY

Job names, data numbers, codes, etc are entered to KTS-442UT using letters off the alphabet and numerals. Change between alphabetic and numerical entry by pressing **SFT** key. An S is displayed on the right side of the screen when in alphabet entry mode.

Alphabet entry mode ←SFT→ Numeral entry mode

Entry in alphabet and numeral mode is performed as follows : (Eg ： Character entry JOBM2)

Procedure	Operation	Display
(1) Enter Alpha-numeric input mode, each key stands for three alphabets and one number. Press the key, the first alphabet will be shown on the cursor position. Press the key by four times, the number will be shown.	Alpha Key +	Mem. Character Entry Code: JOB_ S OK
(2) Press **SFT** to enter numeral input mode.	**SFT**	Mem. CharacteEntry Code: JOBM2 OK
(3) When the entry is finished, press **ENT**. The original screen is restored.		Mem. Character Code: JOBM2 Saving OK

6. DISPLAY SYMBOLS

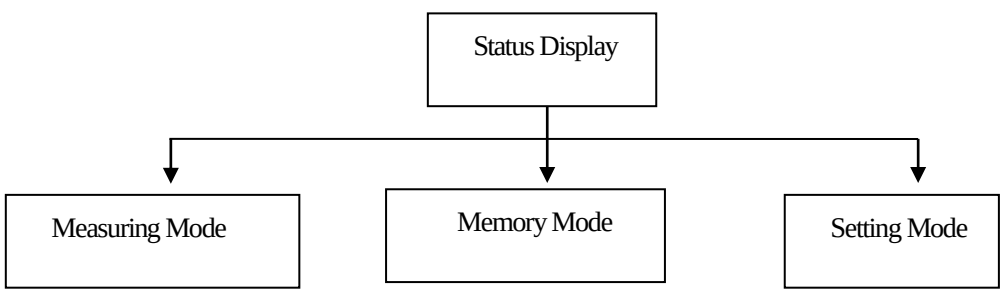
Some symbols are used in MEAS mode. Their meanings are presented below.

Symbol	Meaning
PC	Prism constant
PPM	Atmospheric correction
ZA	Zenith angle(Zenith 0)
VA	Vertical angle(horizontal 0 horizontal 0 ±90)
%	Slope in %
S	Slope distance
H	Horizontal distance
V	Height difference
HAR	Horizontal angle right
HAL	Horizontal angle left
HAh	Horizontal angle hold
⊥	Tilt angle compensation ON

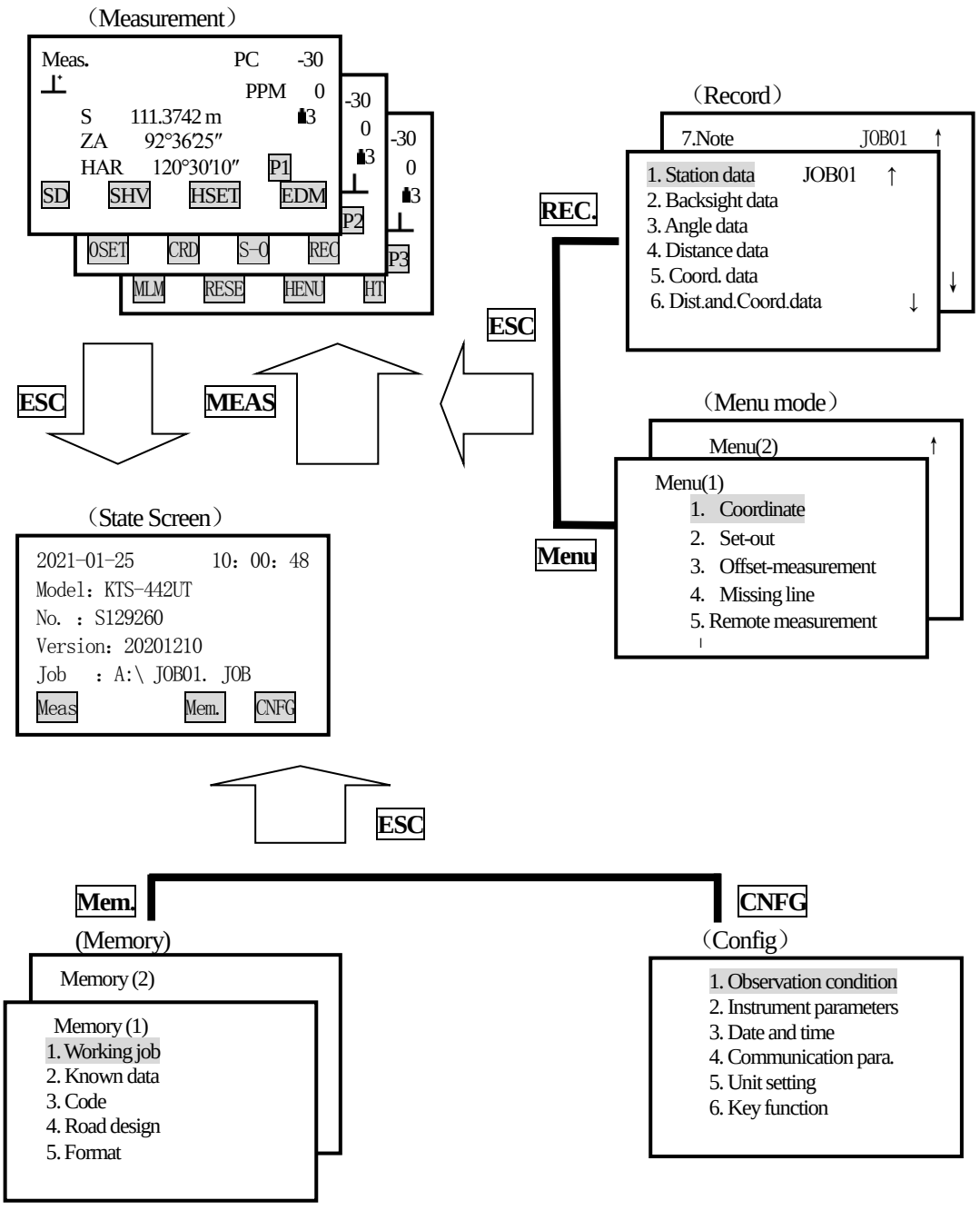
7. MODE CONFIGURATION

KTS-442UT operates in a series of modes depending on your measurement need. This section explains the relationship between the different modes and presents tables of the menus for each mode.

Mode Diagram



1. Quick guide



(1) MEAS mode menu

Name	Function
SD (HD or VD)	Distance measurement
SHV	Select distance mode (Select between slope distance, horizontal distance, height difference)
0SET	Set horizontal angle to 0
HSET	Set known horizontal angle
R/L	Select horizontal angle right/Left
REP	Horizontal angle repetition measurement
HOLD	Horizontal angle Hold/Release
ZA/%	Switch between Zenith angle / slope in %
HT	Set the instrument height and target height
REC	Data recording
REM	REM measurement
MLM	MLM measurement
RCL	Display final measurement data
VIEW	Display observation data for the selected JOB
EDM	Setting EDM (atmospheric correction and target, distance measurement mode setting)
COORD	Coordinates measurement
S-O	Setting-out measurement
OFFSET	Offset measurement
MENU	To menu mode
RESEC	Resection measurement
D-OUT	Output measurement result to external equipment
F/M	Switch between meters/feet
AREA	Area calculation
ROAD	Design and Set out road
PROJ	Point Projection
LINE	Line Setout

(2) REC Mode Menu

Name	Function
Stn data	Occupied station data recording
Backsight data	Record backsight bearing angle and coordinate data
Angle data	Angle measurement data recording

Dist data	Distance measurement data recording
Coord data	Coordinates measurement data recording
Dist.and Coord.	Record distance and coordinate data
Note	Note data recording
View	Review job data

(3) Memory Mode

Name	Function
JOB	JOB selection and management
Known data	Known data input and management
Code	Code input and management
Define roads	Design of road date
U disk mode	connect PC
Initialize	Restore factory setting
All file	management and editing of document
Grid factor	Grid factor

PART 1 PREPARATION FOR MEASUREMENT

1. UNPACKING AND STORE OF INSTRUMENT

·Unpacking of instrument

Place the case lightly with the cover upward, and unlock the case, take out the instrument.

·Store of Instrument

Cover the telescope well, place the instrument into the case with the vertical clamp screw and circular level upward (Objective lens toward tribrach), tighten the vertical clamp screw and lock the case.

2. SETTING THE INSTRUMENT UP

Place the instrument on the tripod. Level and center the instrument precisely to ensure the best performance. Use the special center point.

Operation Refer to "Leveling and Centering the Instrument"

1. **Setting up the tripod**

① Make sure the legs are spaces at equal intervals and the head is approximately level.

② Set the tripod so the center of the head is directly over the surveying point.

③ Step on the tripod shoes to make sure the tripod is firmly fixed on the ground.

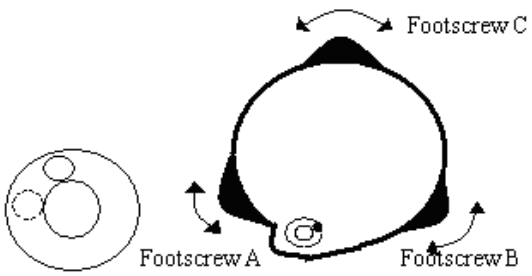
2. **Installing the instrument on the tripod**

① Place the instrument carefully on the tripod head

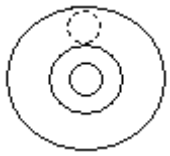
② Supporting the instrument with one hand, tighten the centering screw to fix it to the screw on the base plate of the instrument.

3. **Roughly leveling the instrument by the circular level**

①Turn the leveling screw A and B to move the bubble in the circular level, in which case the bubble is located on a line perpendicular to a line running through the centers of the two leveling screw being adjusted.

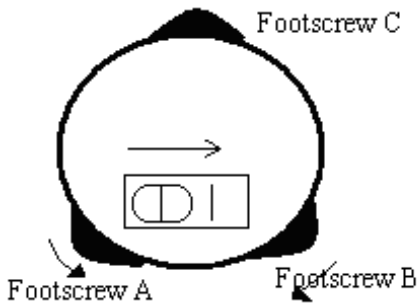


①Turn the leveling screw A and B to move the bubble in the circular level, in which case the bubble is located on a line perpendicular to a line running through the centers of the two leveling screw being adjusted.

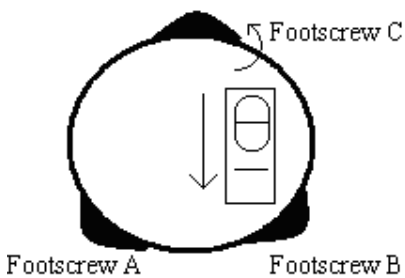


4. **Leveling by the plate level**

① Rotate the instrument horizontally by loosening the Horizontal Clamp Screw and place the plate level parallel with the line connecting leveling screw A and B, and then bring the bubble to the center of the plate level by turning the leveling screws A and B.



② Rotate the instrument 90 ℃(100g) around its vertical axis and turn the remaining leveling screw or leveling C to center the bubble once more.



③ Repeat the procedures ①② for each 90 °(100g) rotation of the instrument and check whether the bubble is correctly centered in all directions.

5. Centering by using the optical plummet

1) Set tripod

Lift tripod to suitable height, ensure equal length of three legs, spread and make tripod head parallel to the ground, and place it right above the measurement station point. Prop up tripod on the ground and fix one leg.

2) Install instrument and collimate the point

Set instrument carefully on tripod, tighten the central connecting screw and adjust optical plummet to make the reticle distinctly. Hold the other two unfixed legs with both hands and adjust position of these two legs through observation of optical plummet. As it approximately aims at the station point, make all three legs fixed on the ground. Adjust three leg screws of the instrument to make optical plummet collimate precisely to the station point

3) Use circular vial to roughly level the instrument

Adjust length of three legs of tripod, make the circular vial bubble of the instrument in the middle.

4) Use plate vial to level the instrument accurately.

①Rotate the instrument horizontally by loosening the Horizontal Clamp Screw and place the plate vial parallel to the line connecting leveling screw A and B, and then bring the bubble to the center of the plate vial by turning the leveling screws A and B.

②Rotate the instrument 90℃, make it perpendicular to the connecting line of level screws A and B. Turn level screw C to make the bubble of the plate vial in the middle.

5) Precisely centering and leveling

Through observation of optical plummet, slightly loosen the central connecting screw and move the instrument evenly (Don't rotate the instrument), making the instrument precisely collimating to the station point. Then tighten the central connecting screw and level the instrument precisely again.

Repeat this operation till the instrument collimate precisely to the measurement station point.

3. BATTERY DISMOUNTING, INFORMATION, RECHARGING

Battery Removal Caution

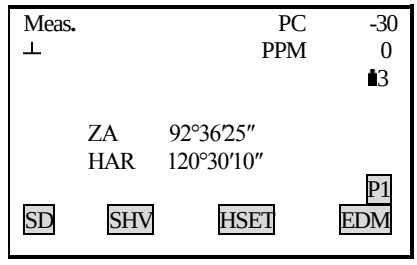
☆ Before taking the battery off, make sure that the power is turned off. Otherwise, the instrument can be damage.

▶PROCEDURE Inserting the battery

1. Put the battery on the main body of instrument.
2. Press the locking buttons on the top of battery to lock it.

▶PROCEDURE Removing the battery

1. Press the clamps on the top of the battery.
2. Take off battery.



Battery Power Remaining Display

- 3-5：70～100％ Full power
- 2：50％ battery power can last for almost 1 hour
- 1：10～50％ it is better to finish measuring soon, recharge it.
- 0： 0～10％ battery can last only less than 10 minutes only

Note: ① Working time of the battery is determined by environment condition, recharging time and etc.

② The remaining energy level of battery is related to current measuring mode.

·Battery Recharging

☆ Battery should be recharged only with the charger NC-30 together with the instrument.

☆ Remove on-board battery from instrument and connect to battery charger. When the indicator lamp on the battery charger is orange, the recharging process has begun and will be completed in about 1.5 hours. When

charging is complete (indicator lamp turn green), remove the battery from the charger and disconnect the charger from its power source.

Battery Recharging Caution

☆ The charger has built-in circuitry for protection from overcharging. However, do not leave the charger plugged into the power outlet after recharging is completed.

☆ Be sure to recharge the battery at a temperature of 0 ~ ±45 ℃, Recharging may be abnormal beyond the specified temperature range.

☆ When the indicator lamp does not light, even after connecting the battery and charger, either the battery or the charger may be damaged.

Battery Charging Caution

☆ Rechargeable battery can be repeatedly recharged 300-500 times. Complete discharge of the battery may shorten its service life.

☆ In order to get the maximum service life, be sure to recharge it once a month.

4. REFLECTOR PRISMS

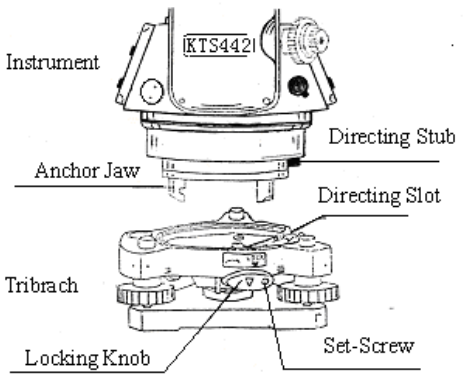
During distance measurement, a reflector prism needs to be placed at target place. Reflector systems come with single prism and triple prisms, which can be mounted with tribrach on a tripod, or mounted on a prism pole. Unique Mini prism systems allows to be set up at corners that are hard to reach.

Illustrated are the prism manufactured by KOLIDA:

5. MOUNTING AND DISMOUNTING INSTRUMENT FROM TRIBRACH

Dismounting

When necessary, the instrument can be dismounted from tribrach. Loosen the tribrach locking screw in the locking knob with a screwdriver. Turn the locking knob about 180 degree counter-clockwise to disengage anchor jaws, and take off the instrument from tribrach.



Mounting

Insert three anchor jaws into holes in tribrach and line up the directing stub with the directing slot. Turn the locking knob about 180 degree clockwise and tighten the locking screw with a screwdriver.

6. EYEPIECE ADJUSTMENT AND OBJECT SETTING

Method of Object Sighting（for reference）

① Sight the Telescope to the sky and rotate the eyepiece tube to make the reticle clear.

② Collimate the target point with top of the triangle mark on the collimator. (Keep a certain distance between eye and the collimator).

③ Make the target image clear with the telescope focusing screw.

☆ If there is parallax when your eye moves up, down or left, right, that shows the diopter of eyepiece lens or focus is not adjusted well and accuracy will be influenced, so adjust the eyepiece tube carefully to eliminate the parallax.

7. POWER ON/OFF AND PREPARATION FOR MEASUREMENT

7.1 Power ON/OFF

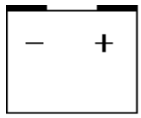
▶**PROCEDURE** Power ON

Operation	Display	Note
Press POWER	Type: KTS-442UT No: S188888 Ver.: 21.10.10	After power on, instrument process self-check as left.
	Finding USB…….	Checking the inserted USB drive
	Meas. PC -30 PPM 0 S 111.374 m ZA 92°36′25″ HAR 120°30′10″ P1 SD SHV HSET EDM	After Self-check, interface for measurement shows up.

Power OFF

Hold POWER for 3seconds.

NOTE : If the battery has reached the level where it should be replaced, the symbol shown on the left is displayed every 3 seconds. When it appears, stop all work as quickly as possible, shut off the power, and charge the battery.



7.2 Vertical Angle Tilt Correction

When the tilt sensor works, automatic correction of vertical angle is displayed due to not level instrument. (Press SFT and then press •).

To ensure an exact angle measurement, tilt sensors must be turned on. You choose“ 2- axis”,

The display can also be used to level the instrument better. If the “TILT OVER” display appears the instrument is out of automatic compensation range and must be leveled manually.

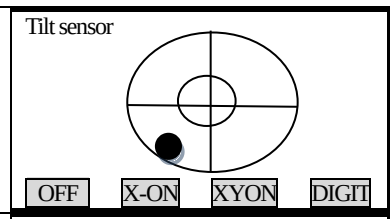
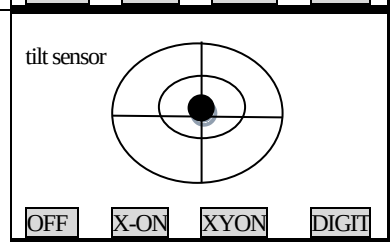
KTS-442UT compensates the vertical angle readings due to inclination of the standing axis in the X direction.

▶ PROCEDURE Setting Tilt Correction

Operating Procedure	Operation	Display
(1) Turn on the machine, enter MEAS screen.	POWER	MEAS. PC -30 PPM 0 3 ZA 92°36′25″ HAR 120°30′10″ P1 SD SHV HSET EDM
(2) Press ESC to enter status screen.	ESC	2021-01-01 10：00：48 KTS-442UT No.S109996 Ver.2020-1.02 File:JOB01 MEAS MEM CNFG
(3) From the status screen press CNFG to enter the configuration setting screen.	CNFG	Config 1. Obs. Condition 2. Instr. Const 3. Date& time 4. Comms setup 5. Unit
(4) Select "1. Obs. Condition" and press ENT (or press numeric key 1). Use ▲or▼ key to align the cursor to the fourth line "Tilt cm", use ◀or▶ to set the tilt correction method. Then press ENT to finish set. There are three options about tilt correction: There are three options: NO, 1-axis and 2-axis.	"1. Obs. Condition" + ENT + ▲or▼ + ◀or▶	Condition C&R cm.: No V. obs : Zenith Tilt cm. : Yes (H& V) Dist mode: HD Power off : Off ↓
(5) Press ESC to return to setting screen.	ESC	Config 1. Obs. Condition 2. Instr. Const 3. Date& time 4. Comms setup 5. Unit 6. Key function

If the instrument is not leveled, it is possible to see different results in different tilt correction settings.

▶ Steps Leveling instrument

Operation procedure	Key	Display
(1) If instrument tilts over correction range, system launch tilt correction function.		
(2)Leveling the instrument according to the related chapter until the black point centered in the circle X-ON: Only vertical angle be compensated XYON: Both horizontal and vertical angle are compensated Press OFF , tilt correction will be off..		
(3) DIGIT showing the tilt angle value respectively on axis "X" and axis "Y". Once the"out of range " shows on the screen, you need to level the instrument manually until "out of rang"disappears.		Tilt sensor 2- axis X: out of range Y: out of range OFF X-ON XYON GRAPH
When the electronic bubble is centered, the system goes back to previous screen.		

Note:

☆ For tilt correction, refer to "7.8 Explanations: Tilt auto correction"

☆ For contents of leveling instrument please refer to "2. Setup instrument".

7.3 Display Illumination

In dark places, it is possible to illuminate the display so it is easy to see.

▶ **PROCEDURE** **Backlight Illumination ON/OFF**

1. Press to turn the illumination on.
2. Press again to turn the illumination off.

7.4 Setting the Instrument Options

In setting Mode, make sure that the concerned parameters are set in accordance with measurement conditions.

To confirm or change the parameters options, see"19.1Changing Instrument Parameters".

Table 1 :

Screen Setting	Parameter	Options（*：Factory Setting）
Observation Condition	Atmospheric Correction	None *
		K=0.14
		K=0.2
	Vertical angle format	Zenith 0 *
		Horizontal 0
		Horizontal 0 ±90 °
	Tilt correction	None *
		1- axis
		2-axis
	Distance Mode	Slope distance * (Sdist)
		Horizontal distance(Sdist)
		Height difference (Vdist)
	Auto Power Off	Auto power off after 30 min *
		Switch ON/OFF by key
	Coordinates format	N-E-Z *
		E-N-Z
	Minimum angle display	0.1″ ： 1″ *
		5″ ： 10″
	Minimum distance	0.1mm
		1 mm*
	Key Beep	On*
		Off
	Angle deep	On*
		Off
	Result of Coordinate mearsurement in Face L/R	Equal
		Unequal

Table 2 ：

Screen Setting	Parameter	Options（*：Factory Setting）
Comms Setup	Baud rate	1200 b/s * ， 2400 b/s
		4800 b/s * 9600 b/s
		19200 b/s * 38400 b/s
		57600 b/s ， 115200 b/s
	Data length	8 Bits *
		7 Bits
		None *

	Parity	ODD
		EVEN
	Stop bit	1bit *
		2bits
	Check sum	No *
		Yes
	Transfer	USB*
		COM

Table 3 ：

Screen Setting	Parameter	Options（*：Factory Setting）
Unit	Temperature	℃ *
		℉
	Air Pressure	hPa *
		mmHg
		inchHg
	Angle	DEG *
		GON
		MIL
	Distance	M (meters)*
		Ft (feet)

7.5 Setting Instrument Constant

Refer to "24.9 Instrument Constant (K)" to get the instrument constant value. Set it as following:

▶PROCEDURE

Operating Procedure	Operation	Display
(1) From Status Mode Press CNFG to enter config mode.	CNFG	Config 1. Obs. Condition 2. Instr. const 3. Date & time 4. Comms setup 5. Unit
(2) Select"2. Instr. const", press ENT (or press numeric key 2)	2. Instr. const + ENT	Instr. const: 1. V angle 0 point 2. Instr. const 3. Contrast
(3) After selecting "2. Instr. const", press ENT (Press numeric key 2 is also ok) to enter instrument constant setting screen. The first row is **Additive constant.** The second row is **Multiplication constant.**	"2. Instrument constant" + ENT	Instr. const: Constant: 30 mm Mul cons: 0 ppm
(4) Enter the constant, press ENT, return to instrument constant setting screen.	Enter constant + ENT	Instr. const: 1. V angle 0 point 2. Instr. const 3. Contrast ADJ

Note ： The constant of the instrument has been strictly set in the factory, so generally the user needs not to set this item. If through strict measurement (ex. in standard baseline field and by special measuring organization) it is necessary, the user can do that.

The **Additive Contant** is effective under **Prism mode** only (measuring distance with prism).

7.6 Setting LCD Contrast

▶PROCEDURE

Operating Procedure	Operation	Display
(1) From Status Mode Press CNFG to enter config mode.	CNFG	Config 1. Obs. Condition 2. Instr. const 3. Date & time 4. Comms setup 5. Unit 6.Key function
(2) After selecting "2. Instr const", press ENT (Press numeric key 2 is also ok) to enter instrument constant setting screen.	"2. Instrument constant" + ENT	Instr. const: 1. V0/ AXIS CONST 2. V0 Adjustment 3. Collimation 4.Horizontal Axis 5. Instr. Const. 6. Contrast Adj.
(3) Select "3. Contrast ADJ" press ENT (Press numeric key 3 is also ok) to enter contrast adjustment screen.	"3. Contrast ADJ" + ENT	Contrast adjustment Level : 6 ↑ ↓
(4) Press F2 or F3 to adjust contrast.	F2 or F3	Contrast adjustment Level : 5 ↑ ↓
(5) Finished setting, press ESC or ENT return to instrument constant screen.	ESC (or ENT)	Instr. const: 1. V0/ AXIS CONST 2. V0 Adjustment 3. Collimation 4.Horizontal Axis 5. Instr. Const. 6. Contrast Adj.

7.7 Setting Date and Time

It is possible to set or revise the date and time displayed in the "Status Screen".

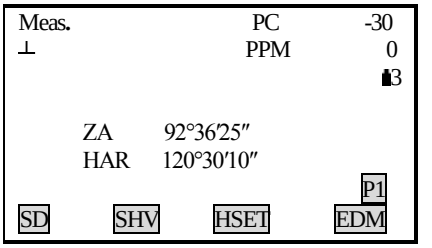
▶PROCEDURE

Operating procedure	Operation	Display
(1) From Status Mode press CNFG to enter config mode.	CNFG	Config 1. Obs. Condition 2. Instr. const 3. Date & time 4. Comms setup 5. Unit 6.Key function
(2) Select "3. Date & time" press ENT (Press numeric key 3 is also ok), use▲ or ▼ to select data and time options, enter the date and time by using the numerical keys. The year, month, day, hour, minute, and second are all two digit numbers. Eg: sep 9, 2009: 20090901 2 : 30 : 17 p.m : 143020	"3. Date & time" + ENT	Date & Time : Date : 2009-09-01 Time : 143020 OK
(3) When entering is completed, press OK, return to config screen.	OK	Config 1. Obs. Condition 2. Instr. const 3. Date & time 4. Comms setup 5. Unit 6.Key function

7.8 Explanations

▶ Automatic tilt compensation

When the "⊥" symbol is shown on the display, the vertical angles is automatically compensated for small tilt errors using the tilt sensor.



▶ Elimination of parallax

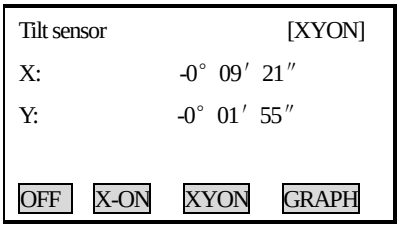
Parallax is the relative displacement of the target image with respect to the reticle when the observer's head is moved slightly up and down or to the sides while looking through the telescope. Parallax will introduce reading errors and must be eliminated before observations are taken. Parallax can be removed by refocusing the reticle.

▶ Power-saving automatic cut-off

To save power, power to the KTS-442UT is automatically cut off if it is not operated for 30 minutes. It is possible to turn the automatic power cut-off function ON or OFF function. Refer to "23.1 Changing Instrument parameters".

▶ Leveling by the tilt angle display

It is possible to display the state of tilt of the instrument graphically or numerically and level the instrument. The tilt angle correction range is ±3.5′. (As below, press SFT then press [•]) If the displayed angle value exceeds ±3.5′, the instrument needs to be leveled manually.

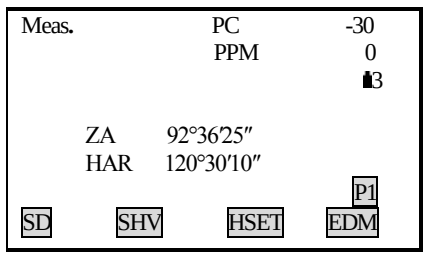


PART 2 BASIC MEASUREMENTS

·This section explains the angle measurement, distance measurement, and coordinate measurement: which three can be performed in MEAS mode.

·Measurement data can be recorded in the internal memory. For the recording method, refer to "21. Recording in Record Mode."

MEAS Mode Screen ：



When the preparations for measurement are completed, the instrument is in MEAS mode.

8. ANGLE MEASUREMENT

·This section explains following procedures:

8.1 Measuring the Horizontal Angle Between Two Points (Horizontal Angle 0)

8.2 Setting the Horizontal Angle to a Required value（Horizontal Angle Hold）

8.3 Horizontal Angle Display Selection (Right/Left)

8.4 Horizontal Angle Repetition

8.5 Slope in %

·When recording the measurement data, refer to "17.2. Recording Angle Measurement Data".

·Check the following one more time before measurement:

1. The instrument is precisely leveled.
2. The battery is fully charged.
3. The vertical circle indexing has been completed.
4. The parameters are set in conformity with measurement conditions.

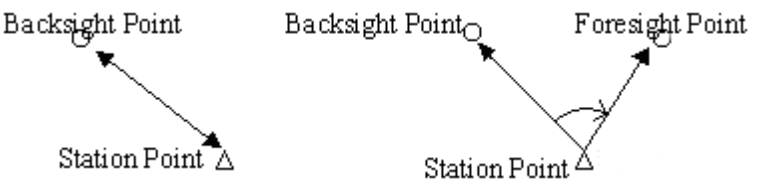
8.1 Measuring the Horizontal Angle Between Two Points（Horizontal Angle 0）

To measure the included angle between two points, the horizontal angle can be set to 0 at any direction.

▶ **PROCEDURE**

Operating Procedure	Operation	Display
(1) Press FNC on the first page of the "MEAS Mode Screen". Press 0SET, then 0SET flashes ON and OFF.	FNC + 0SET	Meas. PC -30 PPM 0 ZA 92°36′25″ HAR 120°30′10″ P2 SD SHV HSET EDM
(2) Press 0SET again, the horizontal angle of the collimation direction is 0°00′00″.	0SET	Meas. PC -30 PPM 0 ZA 92°36′25″ HAR 0°00′00″ P2 OSET CRD. S-O REC.

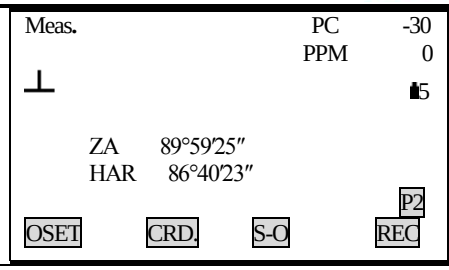
8.1.1 Example Measuring the Horizontal Angle between Two Points



(1) (2)

PROCEDURE

Operating Procedure	Operation	Display
(1) Using the horizontal clamp and the horizontal tangent screw, sight the backsight point. From the MEAS mode, page 2 menu, press 0SET, 0SET will flash, so press 0SET again, set the back sight direction to 0.	0SET + 0SET	Meas. PC -30 PPM 0 ZA 89°59′25″ HAR 0°00′00″ P2 OSET CRD. S-O REC

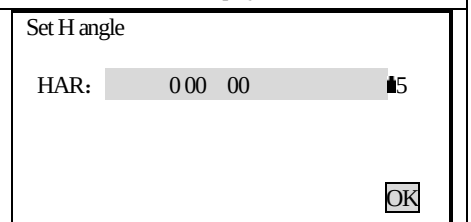
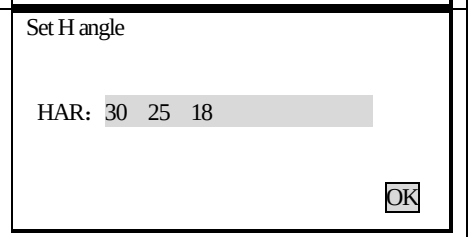
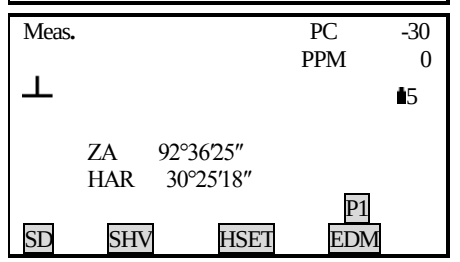
(2) Sight the foresight point, the displayed (HAR) value is the included angle between 2 points.	Sight Foresight Point	

8.2 Setting the Horizontal Circle to a Required Value

8.2.1 Use HSET function to set a required direction value

·It allows you to set the instrument sight direction to and required direction value.

PROCEDURE

Operating Procedure	Operation	Display
(1) After sighting the target, from the MEAS mode page 1, press HSET, enter the known direction value. The right angle and left angle are described as [HAR] and [HAL].	HSET	
(2) Enter the known direction value from keyboard, press ENT, the entered known value displayed.	Enter the known Horizontal angle value and press ENT	 

☆Rules:

Press [•] to set the symbol of **degree, minute, second.**

When you correct entered data,

BS: erases the letter/ numeral to the left to the cursor.

ESC: Erase the entered data.

Stop the entry ： ESC

Direction angle calculation ： BS (See "10.2Azimuth Angle Setting")

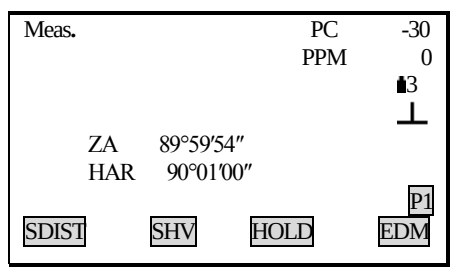
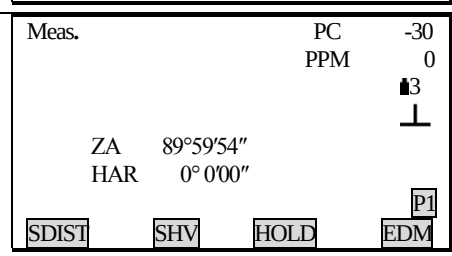
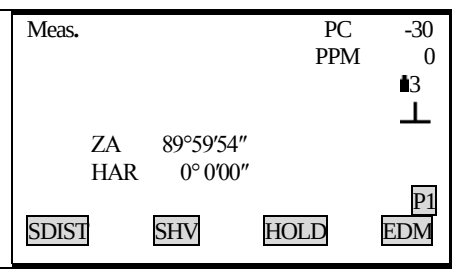
8.2.2 Use HOLD to set a required direction value

·It is possible to use the horizontal angle hold function to set the horizontal angle of the sighting direction to a required angle.

·In advance allocate the function keys to display HOLD. For the allocation method, see "18.1.1Key Function Allocation".

▶ PROCEDURE

Under MEAS Mode screen, Display the desired angle of the horizontal angle.

Operating Procedure	Operation	Display
(1) Under MEAS mode screen, Display the HOLD function.	Allocate the function keys to display HOLD	
(2) Use the horizontal clamp and tangent screw to display the required direction value. Press HOLD, the key start flashing, press HOLD again, the [HAR] is in the hold status.	HOLD + HOLD	
(3) Sight the target and press HOLD to unlock the angle, set the sighting direction to the required direction value.	HOLD	

8.3 Horizontal Angle Display Selection（Right /Left）

·It is possible to switch between Right Angle (horizontal angle clockwise) display and Left Angle (horizontal angle counterclockwise) display.

·In advance allocate the function keys to display [R/L]. Refer to "22. Key Function Allocation".

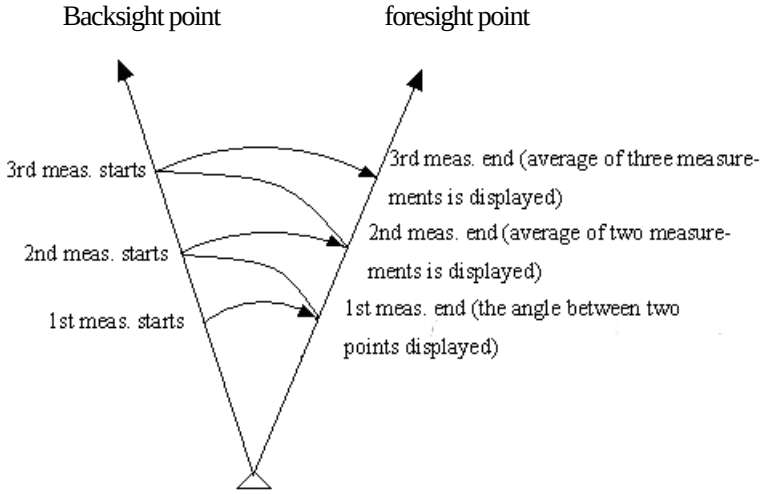
▶ **PROCEDURE**

Operating Procedure	Operation	Display
(1) In MEAS mode, display the screen in which [HAR] is registered. Horizontal angle display becomes [HAR].	Allocate the function keys to display R/L	Meas. PC -30 PPM 0 3 ZA 89°59′54″ HAR 117°31′50″ P1 SD SHV R/L EDM
(2) Press R/L, horizontal angle display switches from [HAR] to [HAL]. HAL = 360 - HAR	R/L	Meas. PC -30 PPM 0 3 ZA 89°59′54″ HAL 142°28′10″ P1 SD SHV R/L EDM

8.4 Horizontal Angle Repetition

·To find the horizontal angle with greater precision, perform repetition measurement.

In advance allocate the function keys to display [REP]. Refer to "22. Key Function Allocation".



▶ PROCEDURE

Operating Procedure	Operation	Display
(1) In MEAS mode, press REP, Repetition BS Sighting Screen is displayed. The horizontal angle is 0. "Take BS" means to sight to backsight point.	REP + Sighting BS point	Repetition Hah 0°00′00″ Reps 0 Ave 0°00′00″ HAh 0°00′00″ Take BS C E OK
(2) After sighting backsight point, press OK. Right screen is displayed. "Take FS" means to sight to foresight point.	OK	Repetition Hah 0°00′00″ Reps 0 Ave 0°00′00″ HAh 0°00′00″ Take FS C E OK
(3) After sighting the foresight point, press OK, Right screen is displayed. Press C E to cancel the measurement result and measure again.	Sighting foresight point + OK	Repetition Hah 40°00′00″ Reps 1 Ave 40°00′00″ HAh 40°00′00″ Take BS C E OK
(4) Sighting backsight point, press OK, right screen is displayed.	Sighting backsight point + OK	Repetition Hah 40°00′00″ Reps 1 Ave 40°00′00″ HAh 0°00′00″ Take FS C E OK
(5) Sighting foresight point and press OK, right screen is displayed. The cumulative value of the horizontal angle is displayed on the second line (Hah), the average value of the horizontal angle is displayed on the fourth line (Ave). When continuing the repetition measurement,	Sighting foresight point + OK	Repetition Hah 80°00′00″ Reps 2 Ave 40°00′00″ HAh 0°00′00″ Take BS C E OK

repeat step 4 and step 5. ·When the repetition measurement is completed, press ESC.		

·In repetition measurement mode, even if "Automatic Tilt Compensation On" is selected, horizontal angle compensation will not occur.

·Maximum measurement frequency ： 10 times

·Repetition display range ： 3599°59′59.5″

8.5 Slope in ％

KTS-442UT allows to displays the gradient as a %.

In advance allocate the function keys to display [ZA/%]. Refer to "20. Key Function Allocation".

▶ PROCEDURE

Operating Procedure	Operation	Display
(1) In MEAS mode, display the screen in which ZA/% is registered.	Allocate the function key to display ZA/%	Meas. PC -30 PPM 0 3 VA 89°59′54″ HAR 17°31′50″ P1 SD SHV HSET ZA/%
(2) Press ZA/%, the vertical angle (ZA) is displayed as a gradient (V%) Press ZA/% again to return to the original vertical angle display.	ZA/%	Meas. PC -30 PPM 0 3 V% 0.00 % HAR 17°31′50″ P1 SD SHV HSET ZA/%

☆ Display range : within ±100％

☆ When parameter "Vertical angle format" is set to "Horizontal 0°" or "Horizontal 0°±90°", "ZA" is displayed instead of "VA".

9. DISTANCE MEASUREMENT

·This section explains the following information about distance measurement. First complete the preparations in 9.1 to 9.2 in order to perform distance measurements.

9.1 Settings for Distance Measurements

9.2 Returned Signal Checking
9.3 Distance and Angle Measurement
9.4 Review of Measured Data
9.5 Outputting the Data to a Computer

Note:

For KTS-442UT series Total Station, Measuring to strongly reflecting targets such as to traffic lights in infrared mode should be avoided. The measured distances may be wrong or inaccurate

When the [MEASURE] key is triggered, the EDM measures the object which is in the beam path at that moment. If e.g. people, cars, animals, swaying branches, etc. cross the laser beam while a measurement is being taken, a fraction of the laser beam is reflected and may lead to incorrect distance values.

☞Avoid interrupting the measuring beam while taking reflectorless measurements or measurements using reflective foils.

☞**Reflectorless EDM**

●Ensure that the laser beams cannot be reflected by any object nearby with high reflectivity.

●When a distance measurement is triggered, the EDM measures to the object which is in the beam path at that moment. In case of temporary obstruction (e.g. a passing vehicle, heavy rain, snow, frog, etc.), the EDM may measure to the obstruction.

●When measuring longer distance, any divergence of the red laser beam from the line of sight might lead to less accurate measurements. This is because the laser beam might not be reflected from the point at which the crosshairs are pointing. Therefore, it is recommended to verify that the R-laser is well collimated with the telescope line of sight. (Please refer to "24.11 REFLECTORLESS EDM")

●Do not collimate the same target with 2 total stations simultaneously.

☞**Red Laser Distance Measurement Cooperated with Reflective Foils.**

The visible red laser beam can also be used to measure to reflective foils. To guarantee the accuracy the red laser beam must be perpendicular to the reflector foil and it must be well adjusted (refer to "24.11 REFLECTORLESS EDM").

Make sure the additive constant belongs to the selected target (reflector) has been input on total station.

9.1 Settings for Distance Measurement

·Perform the following settings before distance measurement.

·Atmospheric correction factor.
·Prism constant correction value.
·Distance measurement mode.

▶ **EXPLANATION** **Atmospheric correction**

·After setting atmospheric correction, the distance measurement result will be corrected automatically, because the

velocity of the light in air is affected by the temperature and air pressure.
Calculate the atmospheric correction factor as shown in following formula.

$$PPM = 273.8 - \frac{0.2900 \times \text{air pressure (hPa)}}{1 + 0.00366 \times \text{air temperature (℃)}}$$

If the unit is mmHg, please convert as:

1hPa = **0.75mmHg**

If the atmospheric correction is not required, set the ppm value to 0.

·The KTS series are designed so that the correction factor is 0 ppm at an air pressure of 1,013 hPa and a temperature of 20℃.

►EXPLANATION Distance measurement mode

·The following are the measuring time and the smallest distance displayed for each measurement method when a reflective prism is used.

·Fine Measurement

Accuracy ： ±（2 + 2PPM×D）mm （D is the measuring distance）
Measuring time ： 3 sec
Minimum display： 1mm

·Tracking Measurement

Measuring time ： 1sec
Minimum display： 10mm

·Settings for distance measurements

Operation	Display
Press EDM in page 1 of MEAS mode. Set the following items 1 Temperature 2 Air pressure 3 Atmospheric correction factor PPM 4 Prism constant 5 Distance measurement method	Temp ： 20 ℃ Press ： 1013.0 hPa PPM ： 0.0 ppm PC ： -30 mm Mode： Fine" s" Reflector: NON-P

After setting these, press ENT.	

· Setting method and content ：

Items	Methods
Temperature	Methods 1: After entering temperature, pressure value, the atmospheric correction will be calculated automatically and PPM in 4 is displayed. Method 2: Directly entering the atmospheric correction factor (ppm), after entry, the values for [Temp], [Press] are erased.
Pressure	
Atmospheric correction PPM	
Prism constant	Enter the prism constant correction value suited to the reflector used.
Measurement mode	Select it with ◄ or ► in following modes: Fine"r", Fine AVG"n=", Fine"s", Tracking

NOTE ： Temperature entry range: -40 ℃～ +60 ℃(step length 1℃) or –40 ～ +140℉（step length 1℉）
Pressure entry range: 560 ～ 1066hPa (step length 1hPa) or 420 ～ 799.5mmHg (step length 1mmHg) or 16.5 ～ 31.4inchHg (step length 0.1inchHg)
Atmospheric correction PPM entry range: -999 ～ +999 PPM (step length 1 PPM)
Prism constant PC entry range: -99mm ～ +99mm (step length 1mm)

☞Reflector type：KTS442UT series Total Station can be set infrared laser distance measurement and unvisible infrared distance measurement ， The reflector includes prism,non-prism and reflector sheet. You can set by yourself according to your need.KTS442UT series Total Station has the infrared distance measurement function only, and the prism should match with the prism constant.

9.2 Laser direction and laser plummet

1. Press SFT and press +/- key to enter below screen.

Laser point
F1 Laser point ON
F2 Laser point OFF
Laser Plummet
Intensity: 2

F1 turn on Laser direction

F2 turn off Laser direction

2. Laser Plummet will automatically turn on after entering the interface.

Press▲ or ▼: to adjust the brightness of laser plummet.

Brightness value 0 : the centering device shut down.

Brightness value 4 : the maximum value.

Laser plummet will turn off automatically after quite laser direction inferface.

Note: This fuction is only available on the instruments which equipped with Laser-plummet.

9.3 Distance and Angle Measurement

KTS-442UT supports angle measurement and distance measurement at the same time.

·For recording measurement data, see "21.4. Recording Distance Measurement Data".

·Check the following once more before measuring a distance:

1 The KTS-442UT is set up correctly over the surveying point.

2 The battery is full charged.

3 The horizontal and vertical circle indexing is completed.

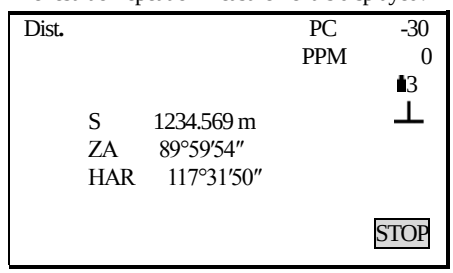
4 The parameters are set in conformity with measurement conditions.

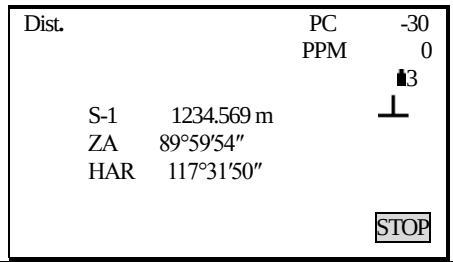
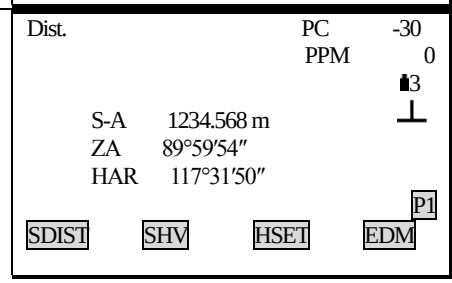
5 The atmospheric correction factor has been set, the prism constant correction value has been set, the distance measurement mode has been selected.

6 The center of the target is correctly sight, the light intensity of the returned signal is sufficiently high.

▶PROCEDURE S/H/V selection and distance measurement

Operating Procedure	Operation	Display
(1) In the first page of MEAS Mode, press SHV, to select the desired distance mode. Each time SHV is pressed, the distance measurement mode changes. S: slope distance H: horizontal distance V: height difference	SHV	Meas. PC -30 PPM 0 S m ZA 89°59′54″ HAR 117°31′50″ P1 SDIST SHV HSET EDM
(2) Press SDIST, when measurement starts, EDM information (distance mode, prism constant correction value, atmospheric correction factor, distance measurement method) is represented by a flashing display.	SDIST	Dist. Dist PC = -30 PPM = 0 Fine "r" STOP

<table>
<tr>
<td>(3)When distance measurement is completed, a short beep sounds, and the measured distance data (s), vertical angle (ZA), and horizontal angle (HAR) are displayed.</td>
<td></td>
<td>The result of repetition measurement is displayed:
 

During average measurement, the distance data is displayed as S-1, S-2……
 
</td>
</tr>
<tr>
<td>(4)When repeat measurement is performed, press STOP after displaying the measurement values to conclude distance measurement and display the final results of the measurements.</td>
<td>STOP</td>
<td> 

During average measurement, the average value of the distance (S-A) is displayed when the designated number of measurements has been completed.</td>
</tr>
</table>

☆ The distance and angle which are most recently measured remain stored in the memory until the power is turned off. It is possible to display the measured values converted into the horizontal distance, height difference, and the slope distance by pressing SHV. For the display method, see "9.4 Review of Measured Data."

☆ If the single measurement mode and N-times= N are selected, measurement automatically stops after appointed measurements completed.

9.4 Review of Measured Data

·The distance and angle measured most recently are stored in the memory until the power is switched off. The distance measurement value, vertical angle, horizontal angle, and the XYZ coordinates can be displayed, it is possible to display the distance measurement values converted into the horizontal distance, elevation difference, and the slope distance by pressing [SHV].

· In advance allocate the function key to display [RCL]. For the allocation method, see "20. Key Function

Allocation".

▶PROCEDURE

Operating Procedure	Operation	Display
(1) In MEAS mode, display the screen in which [RCL] is registered, and press [RCL].	RCL	MEAS. PC -30 PPM 0 S 0.156 m ZA 34°45′09″ HAR 126°31′23″ P1 SD SHV RCL EDM
(2) The stored data which is most recently measured is displayed.		RCL (1) S 0.156 m ZA 34°45′09″ HAR 126°31′23″ SHV RCL (2) N -1234.856 E 3445.988 Z 1223.778 SHV
(3) Each time [SHV] is pressed, S (slope distance), H (horizontal distance), V (height difference) are displayed alternately.	SHV	RCL (1) H 0.089 m ZA 34°45′09″ HAR 126°31′23″ SHV
(4) Press ESC to return to MEAS mode.	ESC	MEAS. PC -30 PPM 0 S 1234.456 m ZA 34°45′09″ HAR 126°31′23″ P1 SD SHV HSET EDM

9.5 Output Data to a Computer

The data of distance measurement can be quickly output to a computer.

In advance allocate the function key to display DOUT. For the allocation method, see "20. Key Function Allocation."

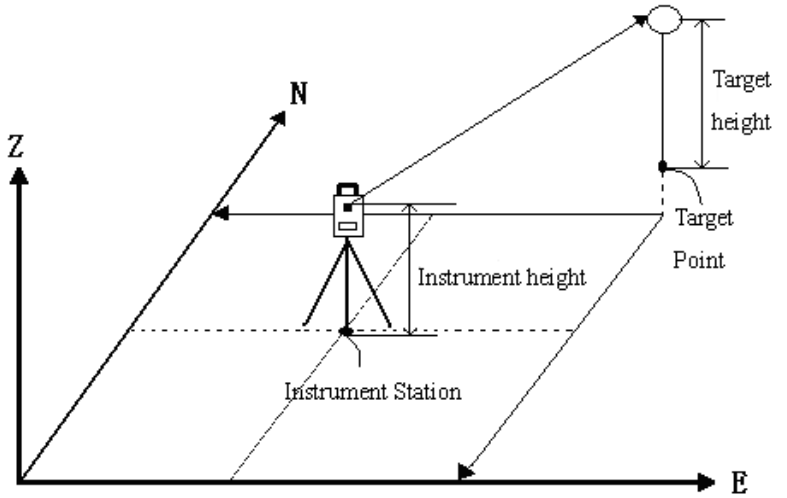
▶PROCEDURE

Operating Procedure	Operation	Display
(1)In MEAS mode, display the screen in which DOUT is registered, press DOUT, following screen is displayed.	DOUT	DOUT 1. Dist data 2. Angle data
(2) Use ▲▼ to select "1. Dist data," and press ENT (or numeric key 1) to start distance measuring. Then distance mode, prism constant correction value, atmospheric correction factor, distance measurement method are represented by a flashing display.	Select "1. Dist data" + ENT	Dist. Dist PC = -30 PPM = 0 Fine[s] STOP
(3) When distance measurement is completed, a short beep sounds, and the measured distance data(s), vertical angle (ZA), and horizontal angle (HAR) are displayed. Then the measured data begins being out put. When repeat fine mode is selected, press STOP key to stop the output.		Dist. PC -30 ⊥ PPM 0 S 1234.569 m 3 ZA 89°59′54″ HAR 117°31′50″ P1 STOP

NOTE: When "2.Angle data" is selected in step 2, the angle data which is displayed on the screen can be output.

10. COORDINATE MEASUREMENT

After inputting instrument height and target height, it is possible to find the 3-dimensional coordinates for the target based on station point coordinates and azimuth angle.



It is possible to set the azimuth angle of a backsight station by entering the coordinates of the instrument station and a known point (backsight station) and then sighting at the backsight station.

The following preparations are needed for coordinate measurement.

Station point coordinates setting

Azimuth angle setting

·For the coordinate measurement method, see "7.4 Setting the Instrument Options".

There are two modes of coordinate measurement:

1) From MENU program, it saves only coordinate data.
2) From REC. program, it can save angle/ distance/ coordinate/ distance + coordinate, measurement data can be automatically saved. (refer to chapter 21. DATA RECORDING IN RECORD MODE)

10.1 Entering Instrument Station Data

Before coordinate measurement, enter instrument station coordinates, the instrument height, target height.

·Use a tape to measure the instrument height and target height.

·It is possible to set coordinate data into instrument.

·It is possible to record the set instrument station data in the JOB which has been selected. For the JOB selection method, see "20.1 JOB Selection".

·It is also possible to perform coordinate measurement when MENU on the third page of the MEAS mode is pressed to enter Menu Mode, then "1. Coordinate" is selected.

▶PROCEDURE

Operating Procedure	Operation	Display
(1) Press CRD. in the second page of the "MEAS mode screen", or press MENU in the third page, the **Coordinate Measurement Menu Screen** is displayed.	CRD. or MENU	Coord 1. Observation 2. Stn data 3. Back sight data
(2) Select "2. Stn Data" and press ENT (or press numeric key 2) to enter the station data.	"2. Stn Data" + ENT	N0 : 1234.688 E0 : 1748.234 3 Z0 : 5121.579 Inst. h : 0.000 m Tgt. h : 0.000 m READ REC OK
(3) Set the following items: N0, E0, Z0 (instrument station coordinate), instrument height, target height. Each time you set an item, press ENT. Then press F2 REC to record instrument station data, then press F1 SAVE. For the method of setting each item, see "17.4 Recording Instrument Station Data", then press F4 OK to record in JOB. (you can also READ point from memory)	Enter the station data + ENT	N0 : 1234.688 E0 : 1748.234 3 Z0 : 5121.579 Inst. h : 1.600 m Tgt. H : 2.000 m READ REC OK
(4) Press OK, setting complete. Coordinate measurement menu screen is displayed. You can go to set 3.Backsight data	OK	Coordinate 1. Observation 2. Stn data 3. Back sight data

NOTE: Coordinates input range

-99999999.999 to +99999999.999 (m)

Instrument height input range

-9999.999 to + 9999.999 (m)

Target height input range

-9999.999 to +9999.999 (m)

☆ Stop entry in progress: ESC (return to the coordinate measurement menu screen)

☆ Reading in the coordinate data : Press READ (See "10.1.1 Reading in Registered Data")

☆ Saving instrument Station Data: Press REC (See"21.1 Recording Instrument Station Data")

10.1.1 Reading in Registered Coordinate Data

·When you wish to read in and set coordinate data from memory, press READ in the "Instrument Station Setting Screen." It is possible to search for the registered data.

·Both coordinate data saved in the memory and that saved in the JOB which has been selected.

☆ **Note**: The designated JOB mentioned here, is not the JOB which is selected from Memory mode, but the coordinate file which designated from Config mode "1. Obs condition".

▶PROCEDURE

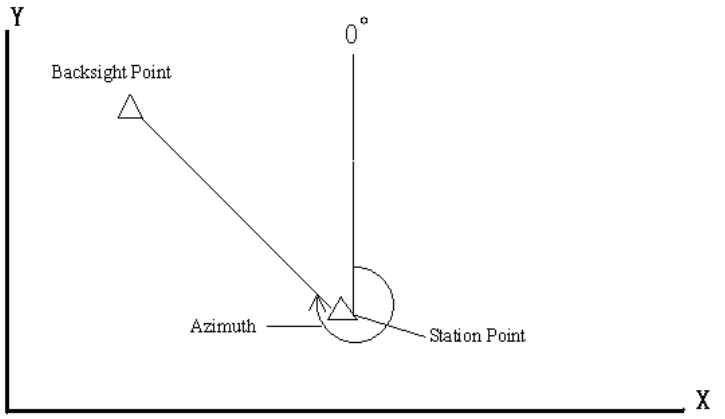
Operating Procedure	Operation	Display
(1) Press READ in the "Instrument Station Setting Screen", the "Coordinate Data Point Number Display screen" is displayed. Stn or Crd ： Coordinate data saved in the job which has been selected,	READ	Read data Pt 1 Stn 1 Stn 2 Crd 1 ↓ VIEW SRCH
(2) Press ▲or▼ to align the cursor with the required point number which was read in. To use the point number to search for coordinate data, press [SRCH]. Pt: Point number ▲ view previous data ▼ view next data ◄ turn back to previous page ► go to next page	SRCH	Read data Pt ： 1 OK
(3) Press OK to read in the selected point and display the coordinate data. LAST :View other data TOP :View other data Press the key ESC to return to previous menu	OK	N ： 1234.688 E ： 1748.234 Z ： 5121.579 Pt: 100 TOP LAST P1 Code : KOLIDA TOP LAST P1

(4) Press ENTER, the coordinate Measurement screen is displayed.	ENTER	N0 : 1234.688 E0 : 1748.234 Z0 : 5121.579 Inst. h : 1.600 m Tgt. h : 2.000 m READ REC OK
(5)Press ok, display comes back to coordinate measurement screen.	OK	Coordinate measurement 1. Observation 2. Set station 3. set backsight

10.2 Azimuth Angle Setting

·After entering the coordinates of the instrument station point and backsight point, the backsight azimuth angle can be calculated and set.

·Based on the instrument station coordinates and backsight station coordinates which have already been set. Sight the backsight point, by a key operation, the azimuth angle of the backsight station will be automatically set.



10.2.1 Set backsight point by Angle

It allows you to set backsight azimuth angle by inputting angle value directly.

▶Steps

Operation procedures	Key	Display
(1) Under coordinate measurement screen, usd▲▼ to select "3. Back sight data" Press ENT (or numeric key 3), displays as right, choose"1. Angle".	"1.Angle"	Back Sight Data 1. Angle 2. Coord.

(2) Input Azimuth and press OK key.	Input angle value + OK	Set Azimuth HAR: 5 OK
(3) Sight at backsight point and press YES.	OK	Set Azimuth Sight BS point HAR: 120°00′00″ NO YES Record BS data
(4) Finish azimuth zetting and returns to coordinate measurement screen.		Coordinate 1. Observation 2. Stn Data 3. Back sight data

10.2.2 Set backsight point by coordinate

You can set backsight azimuth angle by inputting backsight coordinate, the machine calculates azimuth angle by station point coordinate and backsight coordinate.

Operation Procedure	Key	Display
(1) In backsight setting menu, choose "2.coord.".	"2 Coord"	Backsight data 1. Angle 2. Coord.
(2) After inputting backsight point coordinate NBS, EBS, ZBS, after each entry press ENT, then press F4 OK. To use data in memory, press Read key.	Input backsight point coordinate + ENT + OK	Back sight point NBS : 1382.450 EBS : 3455.235 ZBS : 1234.344 READ OK
(3) the machine calculates backsight azimuth by station point coordinate and backsight point coordinate, screen shows as right.(HAR is the backsight azimuth)		Set Azimuth Sight BS Point HAR: 40°00′00″ NO YES

(4) Sight at backsight point, press YES, finish setting and returns to coordinate measurement menu screen.		Coordinate 1. Observation 2. Stn data 3. Back sight data

NOTE: Read coordinate value from memory.

Observation station coordinate value: Move the cursor to N0orE0orZ0 and press READ.

Backsight station coordinate value: Move the cursor to NBS or EBS or ZBS and press READ.

10.3 Coordinate Measurement

·The coordinate values of the target can be found by measuring the distance and angle to the target based the settings of station data and azimuth angle.

The coordinate values of the target are calculated and displayed using the following formula:

Station point coordinates: (N0, E0, Z0)

Instrument height

Prism height

Height difference: Z

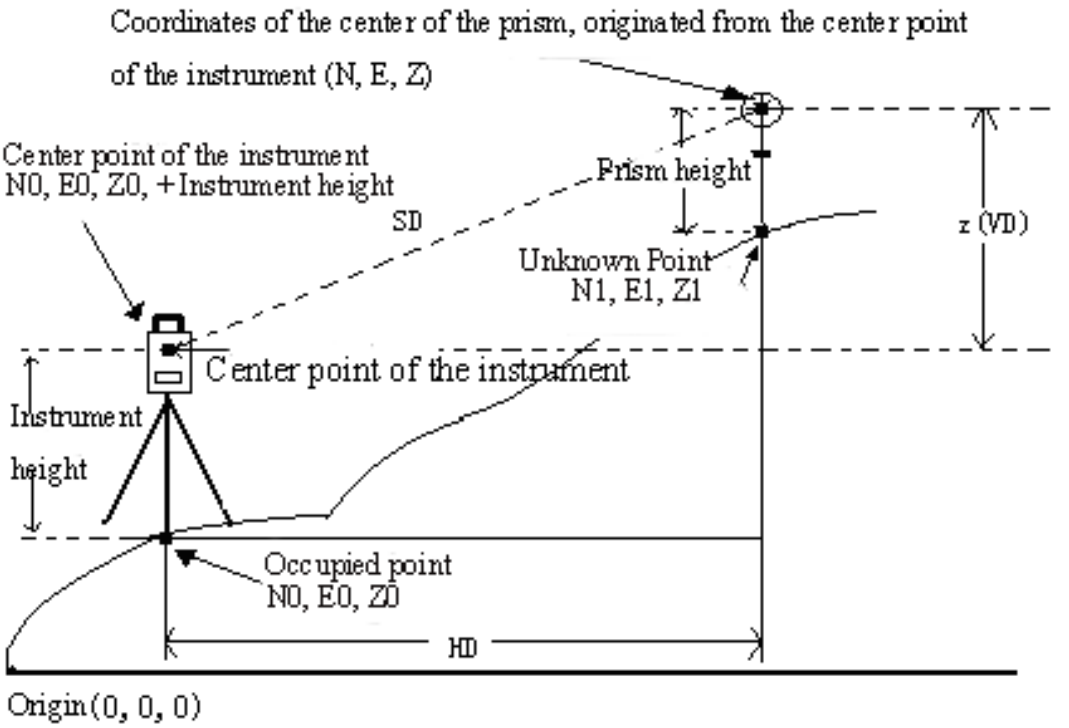
The coordinate difference from the instrument center to prism center: (n,e,z)

Unknown point coordinate: (N1，E1，Z1)

N1 = N0 + n

E1 = E0 + e

Z1 = Z0 + instrument height + z – prism height



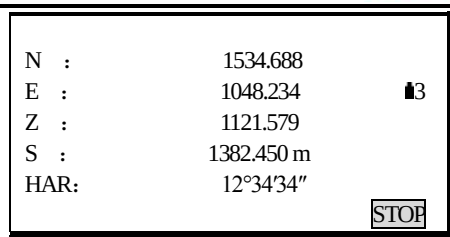
· Measurement data can be recorded in the JOB which has been selected. For the JOB selection method, see "20.1JOB selection".

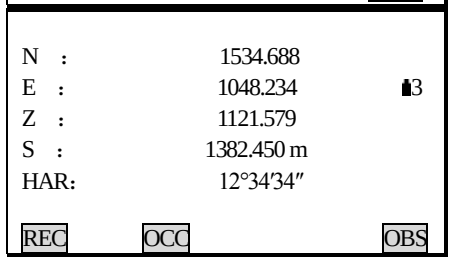
·Check the following once more before measuring.

1. The KTS-442UT is set up correctly over the surveying point.
2. The battery is fully charged.
3. The horizontal circle and vertical circle indexing have been completed.
4. The parameters are set in conformity with measurement conditions.
5. The atmospheric correction factor and prism constant correction, distance measurement methods are set.
6. The center of the target is correctly sighted and the light intensity of the returned signal is sufficiently high.
7. The coordinate measurement preparations in 10.1 and 10.2 are completed.

▶PROCEDURE

Operating Procedure	Operation	Display
(1) Sight at the target center point, select "1. Observation" from the coordinate measurement menu screen, then press ENT (or press numeric key 1 directly).	Select "1. OBS" + ENT	Coord. Coord PC = 0 PPM = 0 Fine "r" STOP

<table>
<tr>
<td>(2) When measurement is completed, the coordinate value and the distance of the target, the vertical angle, and the horizontal angle are displayed. (If the current measurement mode is set be repeat mode, press STOP key to stop measuring and display the measurement value.)</td>
<td></td>
<td>




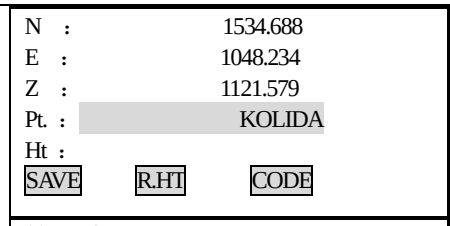
</td>
</tr>
<tr>
<td>(3) To record the coordinate data in the JOB, press F1 REC. Enter the following items:

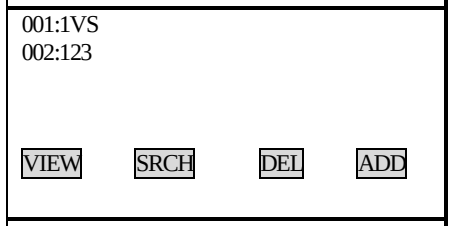
1. Point name: target point number
2. Code: Codes or notes.
After each entry press ENT

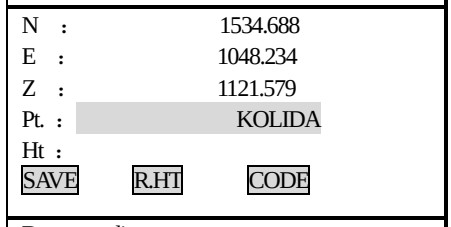
When the cursor is on the code line, code function key show up automatically

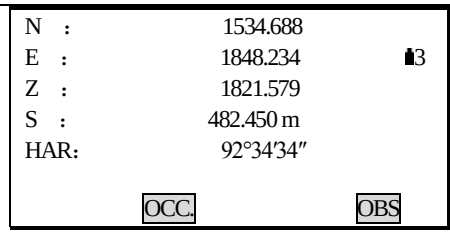
Press the code function key, code list popup, and then press ▲▼ to select code.
Or read in the code by imputing its serial number
For example , imput 1 and its equivalent code could be used

ENT :return to previous menu

SAVE Save the data</td>
<td>REC
+
SAVE</td>
<td>






</td>
</tr>
<tr>
<td>(4) Sight next target point and press OBS to begin measuring. Press OCC. to access the station data input screen, re-enter the station data.
·The re-entered station data will affect next measurement. So if the target height changes, enter the new value before measurement.</td>
<td>OBS</td>
<td>


</td>
</tr>
</table>

(5) Press ESC to end and restore the "Coordinate Menu Screen."	ESC	Coord. 1. Observation 2. Stn data 3. Set H angle

☆ When recording coordinate data, note that:

The maximum entry length for point number is 14 characters.

The maximum entry length for code is 16 characters.

☆ To enter codes in advance, see Explanation "20.3 Input Codes".

PART 3 ADVANCED MEASUREMENT

·This section explains resections, setting-out measurements, offset measurements, missing line measurements, REM measurements, area calculation, road design and others which can be performed in MEAS Mode.

11. SETTING-OUT MEASUREMENT

·The setting-out measurement is used to set out the required point. The difference between the previously input data to the instrument (the setting-out data) and the measured value can be displayed by measuring the horizontal angle, distance or coordinates of the sighted point.

Display value = Difference between measured value and setting-out data

·For setting-out measurement, perform observation in face left.

·PROCEDURE:

1. Set occupied point.
2. Set backsight direction angle.
3. Input setting-out data

There are two methods:

Input distance and angle.

Input the coordinate of setting-out point (Np、Ep、Zp), the distance and the angle between occupied point and setting-out point will be automatically calculated.

4. Perform Setting-out measurement

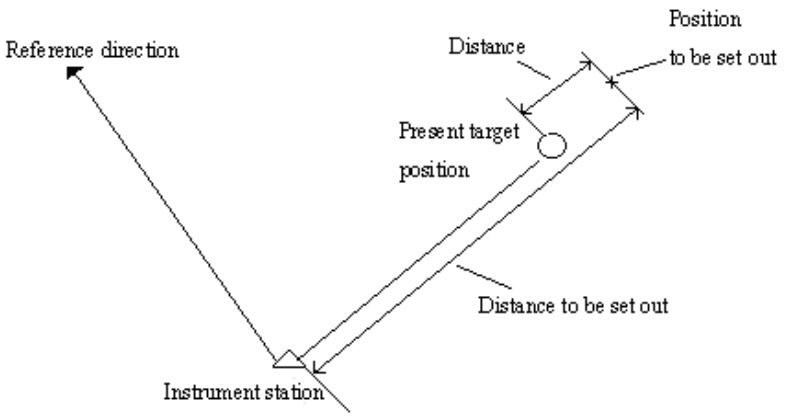
There is two method:

A、 From "2. S-O" screen, set above data, press OK to perform setting-out.

B、 After setting above data, return to set-out menu screen, select "1. OBS" to perform setting-out measurement.

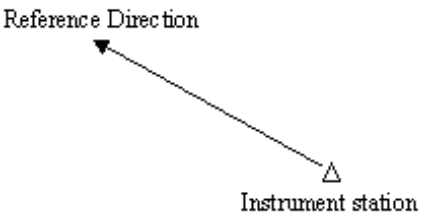
11.1 Distance Setting-Out Measurement

·The point can be found based on the horizontal angle from the reference direction and the distance from the instrument station.

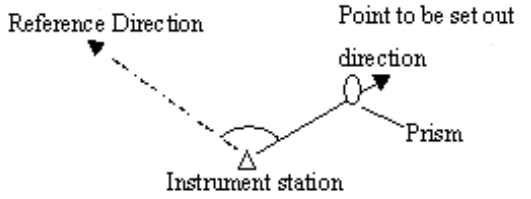


·From the menu mode, selecting "2. S-O" also can perform setting-out measurement.

▶PROCEDURE



(1)



(2)

Operating Procedure	Operation	Display
(1) Sight the reference direction, press [0set] twice in the second page of MEAS Mode. The horizontal angle of the sighting direction is 0.	[0set] + [0set]	Meas. PC -30 PPM 0 ZA 89°59′54″ HAR 0°00′00″ P2 [SD] [SHV] [0SET] [EDM]
(2) Press [S-O] in the second page of "MEAS Mode Screen". The "Setting-Out Measurement Menu Screen" is displayed.	[S-O]	S-O 1. Observation 2. Set-out 3. Stn data 4. Set h angle 5. EDM

(3) Select "2. S-O", then press ENT, input following data: 1. Distance from the instrument station to the position to be set out. 2. Included angle between the reference direction and the position to be set out. After each entry, press ENT.	Select "2. S-O" + ENT	S-O Np: 1223.455 Ep: 2445.670 Zp: 1209.747 Tgt. h: 1.620 m Dist: 23.450 m H ang: 45°12′08″ REC READ OK S-O Dist: 23.450 m H ang: 45°12′05″ REC OK
(4) Press OK, the "setting-out observation screen" is displayed. S.O S: the distance to the point to be set out. dHA : the horizontal angle to the point to be set out ·to stop entry, press ESC	OK	SO. H 23.450m H 21.502 ZA 89°45′23″ HAR 150°16′54″ dHA -0°00′06″ REC SHV <--> HD
(5) Press <-->. The angle to the point to be set out is displayed on the first line. An arrow pointing to the left or right displays which direction the target should be moved.	<-->	← 15°34′28″ ↑ 6.324 S 6.324 m ZA 89°45′23″ HAR 150°16′54″ REC SHV <--> HD
(6) Rotate the top of the instrument until the angle in the first line is 0 °. When the angle is within a range of ±30″, both arrows are displayed. Meaning of the arrows. ←: Move the target to the left looking from the instrument station. →: Move the target to the left looking from the instrument station. ·Restore the setting-out observation screen: <-->		←→ 0°00′00″ S 6.324 m ZA 89°45′23″ HAR 150°16′54″ REC SHV <--> HD

(7) Set the prism on the sight-line and sight it. Press HD to start distance setting-out measurement. Press SHV to select measurement mode.	HD	S-O S-O PC = 0 PPM = 0 Fine " S" STOP
(8) When the observation is completed. The distance to the point to be set out is displayed on line 2.The movement direction of the target is indicated by the arrows pointing upwards and downwards.		←→ 0°00′00″ ↑ 2.456 ▮3 S 123.234 m ZA 89°45′23″ HAR 150°16′54″ REC SHV <--> HD
(9) Move the prism toward and backward until distance on line 2 is 0 m, then press SHV select SD, VD to perform the measurement. When it is within a range of ±1cm, both arrows are displayed. (If repeat measurement or tracking measurement is performed at this time, it is possible to display the measurement results without any key operations while sighting the target which was moved.) ↓: Move the prism towards your side. ↑: Move the prism away from your side.	SHV	←→ 0°00′00″ ↑↓ 0.000 ▮3 S 12.234 m ZA 89°45′23″ HAR 150°16′54″ REC SHV <--> HD
(10) Find the place where the distance is 0 m.		←→ 0°00′00″ ↑↓ 0.000 ▮3 S 12.234 m ZA 89°45′23″ HAR 150°16′54″ REC SHV <--> HD
(11) Press ESC to return to Setting-out measurement menu screen.	ESC	S-O 1. Observation 2. S-O data 3. Stn data 4. Set h angle 5. EDM

·To record the coordinate of measured point: REC

·Select setting-out measurement mode:

Each time press SHV, setting-out measurement mode changes:

SD → HD → VD → COORD → REM

SD: slope distance setting-out measurement.

HD: Horizontal distance setting-out measurement.

VD: height difference setting-out measurement (the height difference between the instrument height mark and the center point of prism)

COORD: coordinate setting-out measurement (refer to 11.3 Coordinate Setting-Out Measurement)

REM: Remote setting-out measurement (refer to 11.2 REM setting-out measurement)

11.2 REM Setting-Out Measurement

·To find a point where a target can not be directly installed, perform REM setting-out measurement.

▶PROCEDURE

Operating Procedure	Operation	Display
(1) Place a prism directly below or directly above the point to be found, then use a measuring tape to measure the prism height (height from the surveying point to the center of prism). Sight the prism, press SD in MEAS mode.	SD	Dist. Dist PC = 0 PPM = 0 Fine "S" STOP
(2) The measurement result is displayed (If in repetition mode, press STOP). S: the slope distance to prism ZA: the vertical angle to prism HAR: the horizontal angle to prism		Meas. PC -30 PPM 0 S 18.678 m ZA 89°59′54″ HAR 90°01′00″ P1 SD SHV S-O EDM
(3) Press S-O from the second page of MEAS mode.	S-O	Set-out 1. Observation 2. Set-out 3. Stn data 4. Backsight data 5. EDM

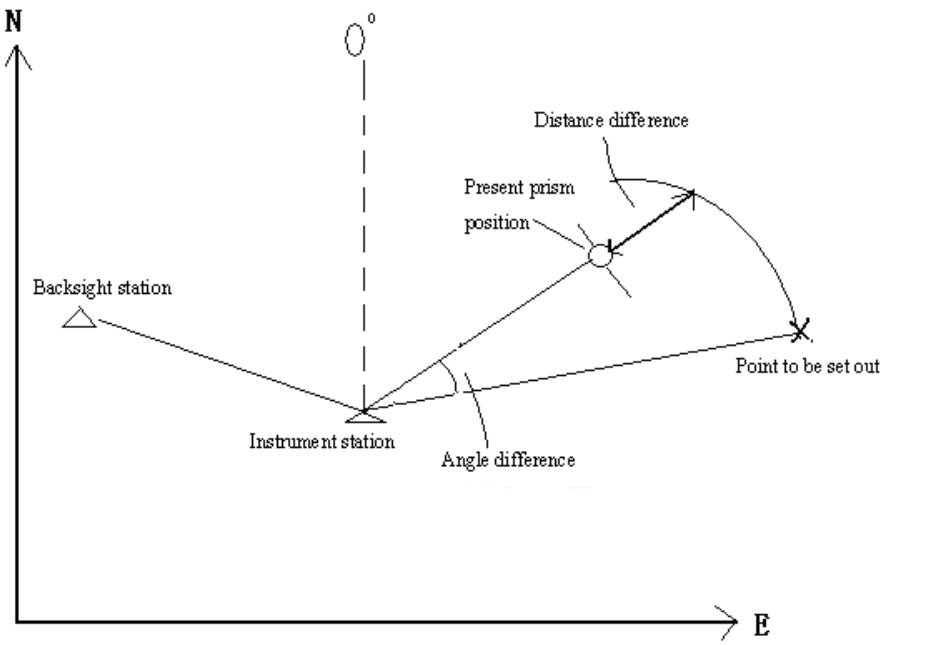
(4) Select "2. S-O data", then press ENT, input following data: 1. prism height 2. the setting-out point height (the distance from the surveying point to the point to be set out) After each entry press ENT.	Select "2. S-O data" + ENT	S-O Np: 1223.455 Ep: 2445.670 Zp: 1209.747 Tgt. h: 1.620 m REC READ OK S-O (2) SO dist: 23.450 m SO H set: 45°12′08″ OK
(5) Press OK.	OK	SO.H 1.828 M H 1.828 M ZA 89°45′23″ HAR 150°16′54″ dHA -0°00′06″ REC SHV <--> HD
(6) Press SHV, REM is displayed on the bottom line of the screen.	SHV	SO.Ht m S 80.123 m ZA 89°45′23″ HAR 150°16′54″ dHA 0°00′00″ REC SHV <--> REM
(7) Press REM to begin the setting-out, after 0.7 seconds, the distance between the setting-out data and the measured distance is displayed on the third line. (S-O. Ht). Measurement results are displayed every 0.5 seconds.	REM	SO. Ht. –0.002 m S 80.123 m ZA 89°45′23″ HAR 150°16′54″ dHA -0°00′06″ STOP
(8) After pressing <-->, then press REM, the displayed value is the distance from the sighted point and the setting-out point. Two arrows mean the required direction meaning of the arrows: ↑: Move the telescope near the zenith. ↓: Move the telescope near the nadir.	<--> + REM	← 1°00′00″ ↑ -0.002 H 80.123 m ZA 89°45′23″ HAR 150°16′54″ REC SHV <--> REM

(9) Rotate the telescope up and down until the value which displays on the second line is 0 m (As it nears 0 m, both arrows are displayed), the point to be set out is now the center of the reticle of the telescope.		← 1°00′00″ ↓ 0.000 S 80.123 m ZA 89°45′23″ HAR 150°16′54″ REC SHV <---> REM
(10) Press ESC to end measurement and return to setting-out measurement menu screen.	ESC	Set-out 1. Observation 2. Set-out 3. Stn data 4. Back sight data 5. EDM

11.3 Coordinates Setting-Out Measurement

This measurement is used to set out the point of a certain coordinate away from the reference point.

After inputting the coordinates for the point to be set out, the required horizontal angle and horizontal distance and store them in the memory. By using the horizontal angle and distance setting-out function, the required coordinate location can be set out.



It is possible to perform coordinates setting out measurement by selecting "2. S-O" from Menu Mode.

It is possible to output the coordinate data previously entered and set it as the setting out coordinate.

To find the Z coordinate, attach the prism to a pole, etc., with the same target height.

▶PROCEDURE

Operating Procedure	Operation	Display
(1) Press S-O from the second page of the MEAS mode, or from the MENU, the "Setting-out Measurement menu screen" is displayed.	S-O	Set-out 1. Observation 2. Set-out 3. Stn Data 4. Back Sight Data 5. EDM
(2) Select "3. Stn data", then press ENT (or press numeric key 3 directly). Enter instrument station data (Refer to "10.1 Entering Instrument Station Data") Enter the prism height, measure the distance from the center of the target to the bottom of the pole.	"3. Stn data" + ENT	N0: 123.789 E0: 100.346 Z0: 320.679 Inst. h: 1.650 m Tgt. h: 2.100 m READ REC OK
(3) After inputting station data, press OK to enter setting-out measurement menu. Select "4. Back sight data" and press ENT (or press numeric key 4 directly) to enter Angle Setting screen. (Set the bearing angle while referring to "10.2 Azimuth angle setting". The setting-out Measurement Menu screen is displayed.	Select "4. Back sight data" + ENT	Set-out 1. Observation 2. Set-out 3. Stn data 4. Back sight data 5. EDM
(4) Select "2. Set-out" and press ENT. Np, Ep, Zp are the coordinates of the point to be set out. After each entry, press ENT. Stop entry in progress: ESC Reading in data: READ Recording data: REC	"2. Set-out" + ENT	S-O Np : 1223.455 Ep : 2445.670 Zp : 1209.747 Tgt. h: 1.620 m REC REC OK
(5) After entering above data, the required distance and horizontal angle will be automatically calculated and displayed on screen. Press OK to enter the setting-out observation screen.	OK	SO. H -2.193 m H 0.043 m ZA 89°45′23″ HAR 150°16′54″ dHA -0°00′06″ REC SHV <--> REM

(6) Perform the procedure from the step 5 to step 10 in "11.1 Distance Setting-out Measurement" to find the point to be set out. To find the height of the point to be set out, press SHV to display CRD.. Press CRD. to begin Elevation Setting-out Measurement.	SHV + CRD.	SO. N 0.001 E -0.006 ▮3 Z 5.321 HAR 150°16′54″ dHA 0°00′02″ REC SHV <--> CRD.
(7) When the measurement is completed, the "Setting-out Observation Screen" is displayed. Press <-->, then press CRD. to show the Setting - out Guidance screen. The value which is displayed on the fourth line is the height difference to the point to be set out. The arrows which contain 2 triangles show the required direction to move the prism. (If you want the difference to the point displayed as the coordinate values, press <--> again after measurement is completed.	<--> + CRD.	← 0°00′00″ ↓ -0.006 ▮3 ↑ 0.300 ZA 89°45′20″ HAR 150°16′54″ REC SHV <--> CRD.
(8) Press CRD., move the prism up and down to display the height difference value to be 0 m (When it is near 0 m, both the arrows are displayed.). When the values which display on the second, third, fourth lines are 0, the point to be setout is found. Meaning of arrows: ↑: Move upwards ↓ : Move downwards **Note: Press FNC on keyboard to change target height**	CRD.	→ 0°00′00″ ↑ 0.000 ▮3 ↑ 0.003 ZA 89°45′20″ HAR 150°16′54″ REC SHV <--> CRD.
(9) Press ESC to return "Setting-Out" measurement menu screen". To set out the next point, repeat the procedure from step 4.	ESC	Set-out 1. Observation 2. Set-out 3. Stn data 4. Back sight data 5. EDM

11.4 Distance Measurement Parameters Setting

It is possible to set distance measurement parameters here, such as temperature, pressure, atmospheric correction, prism constant correction and distance measurement mode. The user should set above parameters before measurement.

Operating Procedure	Operation	Display
(1) Select "5.EDM" from the Set-Out menu.	Select "5.EDM"	Set-Out 1. Observation 2. Set-Out data 3. Stn data 4. Set H angle 5. EDM
(2)Select following parameters: 1. Temperature 2. Air pressure 3. Atmospheric correction value PPM 4. Prism constant correction 5. Distance measurement mode		Temp : 20 ℃ Press : 1013.0 hPa PPM : 0 PC : -30 Mode: Fine "s" 0PPM
(3) Set all parameters and press ENT.	ENT	Set-Out 1. Observation 2. Set-Out data 3. Stn data 4. Set H angle 5. EDM

·Methods and contents

Items	Setting methods
Temperature	Method ①: After entering temperature and pressure, the atmospheric correction value will be calculated and displayed in PPM. Method ②: Enter the atmospheric correction value PPM, now temperature and pressure value will be cleared.
Pressure	
Atmospheric correction PPM	
Prism constant	Enter the prism correction value for current prism
Distance mode	Press ◀ or ▶ to select from following modes: Fine repetition, Fine N-time, Fine single, tracking

Note:

Temperature input range: -30 °～ +60 °(Foot length 1℃) or –22 ～ +140℉（Foot length 1℉）

Air pressure input range: 560 ～ 1066hPa (Foot length 1hPa) or 420 ～ 800mmHg(Foot length 1mmHg)or16.5 ～ 31.5inchHg (Foot length 0.1inchHg)

Atmospheric correction PPM input range: -999 ～ +999 PPM (Foot length 1 PPM)

Prism constant input range: -99mm ～ +99mm (Foot length 1mm)

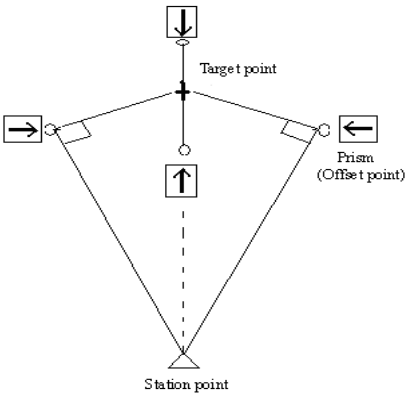
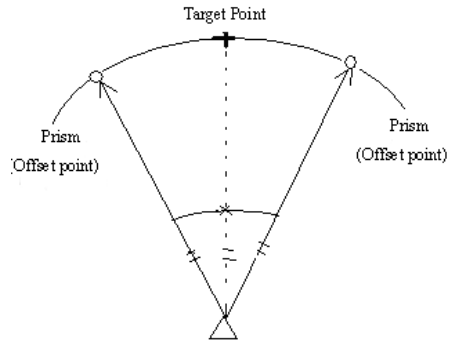
☞Reflector type：KTS-442UT series Total Station can be set visible laser distance measurement and unvisible

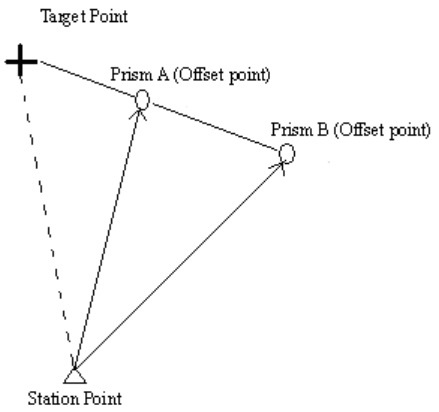
laser distance measurement ， The reflector includes prism,non-prism and reflector sheet. You can set by yourself according to your need. KTS-442UT series Total Station has the unvisible laser distance measurement function only, and the prism should match with the prism constant.

12. OFFSET MEASUREMENT

·Offset measurements are performed in order to find a point where a target can not be installed directly or to find the distance and angle to a point which can not be sighted. It is possible to find the distance and angle to a point you wish to measure (target point) by installing the target at a location (offset point) a little distance from the target point and measuring the distance and angle from the surveying point to the offset point.

·The target point can be found in the three ways explained below:

Diagram	Method
1. Single distance offset measurement 	·When the offset point is positioned to the left or right of the target point, make sure the angle formed by lines connecting the offset point to the target point and to the instrument station is approximately 90 °. ·When the offset point is positioned in front of or behind the target point, install the offset point on a line linking the instrument station with the target point.
2. Angle offset measurement 	·Install the offset point as close as possible to the target point to its left or right.

3. Dual distance offset measurement  	· Install the offset point A and B on a line extending from the target point, measure A and B, then enter the distance between B and the target point to find the target point.

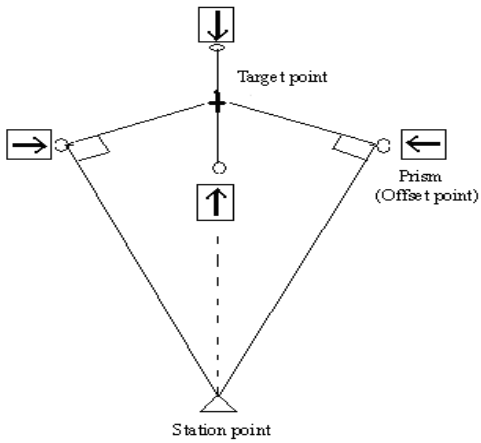
Ⱡ In advance allocate the function keys to display OFFSET. For the method, see "20. Key Function Allocation."

Ⱡ It is also possible to perform offset measurement when "3. Offset" is selected from Menu Mode.

Offset measurement is performed using the measurement method used before you started up the offset measurement.

12.1 Single-Distance Offset Measurement

Ⱡ When the offset point is positioned to left or right of the target point, make sure the angle formed by lines connecting the offset point to the target point and to the instrument station is almost 90 °. When the offset point is in front of or behind the target point, installs the offset point on a line linking the instrument station with the target point.



▶PROCEDURE

Operating Procedure	Operation	Display
(1) Sight the offset point then press SD in the MEAS Mode Screen.	SD	Dist Dist PC = 0 PPM = 0 Fine "S" STOP
(2) When the measurement is completed, or during repeat measurement, press STOP, the slope distance from station point to offset point, vertical angle, horizontal angle are displayed.		Meas. PC -30 PPM 0 S 18.678 m ZA 89°59′54″ HAR 90°01′00″ P1 SD SHV HSET EDM
(3) In Meas Mode, display the screen in which OFFS is registered. Press OFFS to enter the "Offset Menu Screen" is displayed.	OFFS	Offset 1. Offset/Dist 2. Offset/Angle 3. Offset/2D 4. Stn data
(4) Select "1. Offset/Dist" then press ENT, the Offset Observation Screen is displayed. Select the following items: 1. Horizontal distance from the target point to the offset point. 2. Direction of the offset point. After each entry press ENT.	"1. Offset/Dist" + ENT	S 10.865 m ZA 87°58′38″ HAR 112°34′23″ Dist: 2.450 m Direc: → OK OBS
(5) Press OK to display the Offset Measurement result screen. There will be different contents under different measurement mode.	OK + COORD (or DIST)	Offset/Dist S 10.865 m ZA 87°58′38″ HAR 112°34′23″ REC COORD Offset/Dist N 2.345 E 1.234 Z 0.569 REC DIST

(6) Press REC to record the results. Set the following items while referring to "21.4 Recording Distance Measurement data." 1. Point number (Target point number) 2. Code (press CODE to read in code) 3. Target height (press R.HT) After each entry press ENT. ·Maximum point number size: 14 characters ·Maximum code size input: 16 characters	REC	*N: 10.29m *E: 50.22m *Z: 10.4 m Pt.: 10 Code: KOLIDA SAVE R.HT CODE Input Tgt. h Tgt.h: 0.000m OK
(7) Press SAVE to record the data and return to Offset Menu Screen. ·To return to Offset Measurement Menu screen press ESC	SAVE	Offset 1. Offset/Dist 2. Offset/Angle 3. Offset/2D 4. Stn data

NOTE: ☆In step 4, offset distance entry range: 9999.999 m, Input unit: 0.001 m

☆Direction of offset point:

→ offset point on the right of the target point

← offset point on the left of the target point

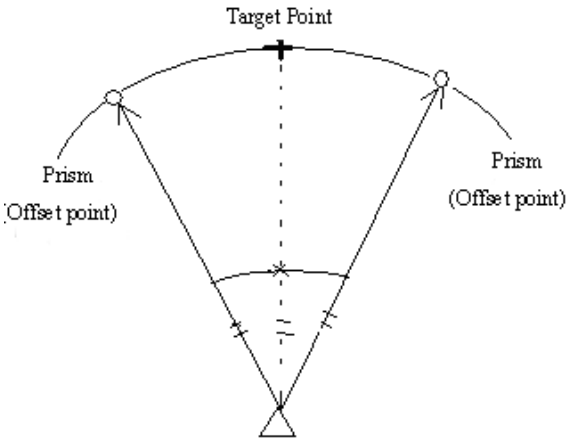
↑ offset point in the front of the target point

↓ offset point behind the target point

☆Re-observation of the offset point: OBS.

12.2 Angle Offset Measurement

·Install offset points for the target point on the right and left sides of and as close as possible to the target point. The target height and the height of offset points should be identical.



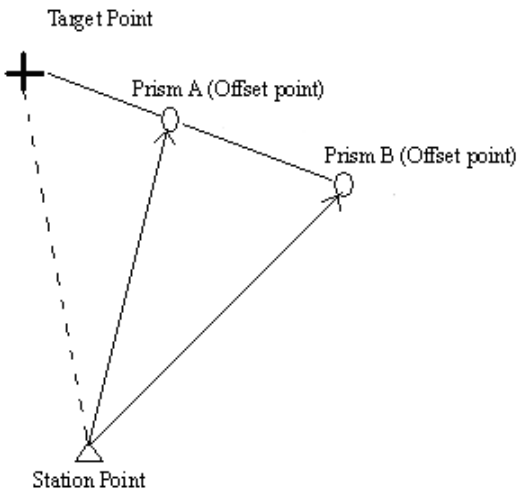
▶PROCEDURE

Operating Procedure	Operation	Display
(1) Sight the target of the offset points and press SD in Meas mode.	SD	Dist Dist PC = 0 PPM = 0 Fine "S" STOP
(2) When observation is completed or after the measurement values are displayed during continuous measurement, press STOP to restore the "MEAS Mode Screen." The slope distance, vertical angle and horizontal angle from the station point to offset points are displayed.		Meas. PC -30 PPM 0 S 11.678 m ZA 59°39′54″ HAR 90°01′00″ P1 SD SHV OFFS EDM
(3) In MEAS mode, display the screen in which OFFS is registered. Press OFFSET, the "Offset Menu Screen" is displayed.	OFFS	Offset 1. Offset/Dist 2. Offset/Angle 3. Offset/2D 4. Stn data

(4) Select "2. Offset/Dist" and press ENT, the "Target Point Observation Screen" is displayed.	"2. Offset/Dist" + ENT	Offset/Angle. 2nd obs. ok? S 22.200 m ZA 76°42′05″ HAR 156°34′23″ OK OBS
(5)Press OK to display the Offset Measurement Result screen.	OK + CRD. (or DIST)	Offset/Angle. S 22.200 m ZA 76°42′05″ HAR 156°34′23″ REC DIST Offset/Angle. N 2.345 E 1.234 Z 0.569 REC CRD.
(6) Press REC to record measurement result. (See "21.4 Recording Distance Measurement.")	REC	*N: 10.29m *E: 50.22m *Z: 10.4 m Pt.: 10 Code: KOLIDA SAVE R.HT CODE Input Tgt. h Tgt.h: 0.000m OK
(7) Press SAVE to record the data and return to the Offset Measurement Menu Screen.	SAVE	Offset 1. Offset/Dist 2. Offset/Angle 3. Offset/2D 4. Stn data

12.3 Two-Distance Offset Measurement

Install two offset points (1st target and 2nd target) on a straight line from the target point, observe the 1st target and 2nd target, then enter the distance between the 2nd target and the target point to find the target point.



☆ NOTE:

1. The offset distance of Two-distance Offset Measurement depends on the distance between offset point 2 and target point on the line which consisted of target point, offset point 1and offset point 2.
2. Measure the distance from the target point to the 2nd target.

▶PROCEDURE

Operating Procedure	Operation	Display
(1) In Meas Mode, display the screen in which OFFS is registered. Press OFFS to display the "Offset Measurement Menu Screen."	OFFS	Offset 1. Offset/Dist 2. Offset/Angle 3. Offset/2D 4. Stn data
(2) Select "3. Offset/2D" and press ENT.	"3. Offset/2D" + ENT	Offset/2D Take 1 st point. ZA 89°47′23″ HAR 150°16′12″ OBS.

(3) Sight prism 1, press OBS. to begin measurement.	OBS.	Dist Dist PC = 0 PPM = 0 Fine "S" STOP
(4) When observation has been completed or after the measurement values are displayed during repeat measurement, press STOP to display the "1 st Target Observation Result Screen." The coordinates of the 1 st are displayed.		Offset/2D N 19.234 E 5.098 Z 1.234 Sure ? NO YES
(5) Press YES, the "2 nd Target Observation Screen" is displayed. (If to re-observe prism 1, press NO)	YES	Offset/2D Take 2 nd point. ZA 89°47′23″ HAR 150°16′12″ OBS.
(6) Sight prism 2 and press OBS. to begin measurement.	OBS.	Dist. Dist PC = 0 PPM = 0 Fine "S" STOP
(7)after measurement finished. Press STOP to display the "2 nd Target Observation Result Screen." The coordinates of the 2 nd are displayed.		Offset/2D N 9.234 E 5.098 Z 1.234 Sure ? NO YES
(8) Press YES, the "Offset Distance Entry Screen" is displayed. (Discard the data and observe the 2 nd target again: press NO)	YES	Offset/2D B-C: 1.800 m OK

(9) Enter the distance from the 2 nd target to the target point and press ENT. The coordinates of the target point are calculated and displayed.	ENT	Offset/2D N 9.234 E 5.098 Z 1.234 REC CRD.
(10) Press REC to input the Pt and code. Press R.HT to input Target height. Press CODE to read in the recorded code in memory.		N 9.234 m E 5.098m Z 1.234m Pt k2009 Code KOLIDA SAVE R.HT CODE
(10) Press SAVE to save data and return to the "Offset Measurement Menu screen."	SAVE	Offset 1. Offset/Dist 2. Offset/Angle 3. Offset/2D 4. Stn data

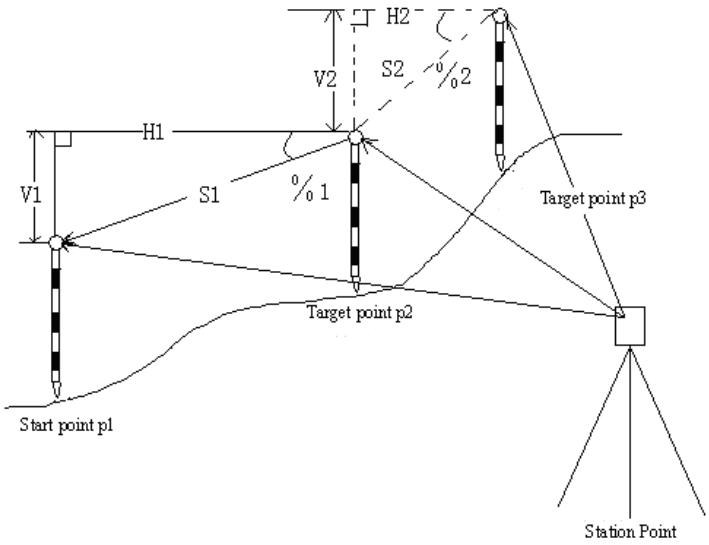
Offset distance entry range: ±9999.999 m Minimum entry unit: 0.001 m

·Discard the data and observe again: press ESC

·Record the result in JOB: SAVE (See "21.4 Recording Distance Measurement Data")

13. MISSING LINE MEASUREMENT

·Missing line measurement is used to measure the slope distance, horizontal distance, and height difference to a target from the target which is the reference (point 1) without moving the instrument.



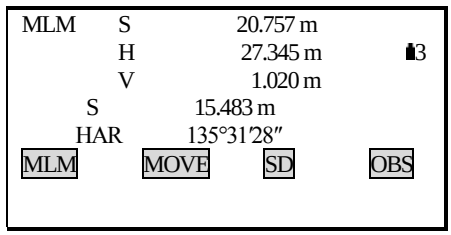
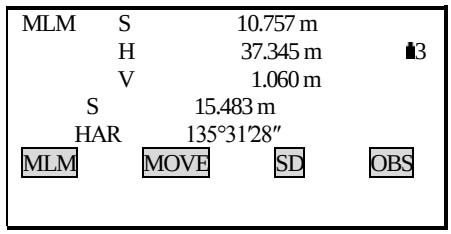
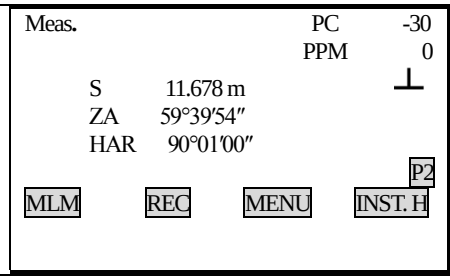
·To find the height difference between 2 points, use a pole to make the target height of all the targets identical.

13.1 Measuring the Distance Between Multiple Targets

·It is possible to perform Missing Line Measurement by selecting "4. MLM" from the Menu mode.

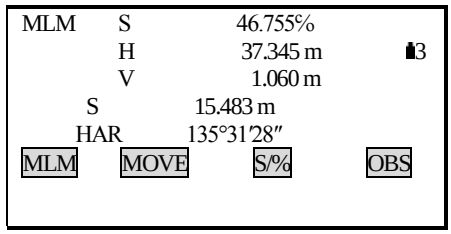
13.1.1 Measuring the distance between multiple targets

Operating Procedure	Operation	Display
(1) Sight the target of the first target P1, then press SD in Meas Mode. After the measurement finished, press STOP after the measured values are displayed to restore the "MEAS Mode Screen."	SD	Meas. PC -30 PPM 0 S 11.678 m ZA 59°39′54″ HAR 90°01′00″ P2 SD SHV HSET EDM
(2) Sight the target P2, then press MLM in the third page of the "MEAS Mode Screen."	MLM	MLM Dist PC = 0 PPM = 0 Fine "S" STOP

(3) When the measurement is completed, the "Missing Line Measurement Result Screen" is displayed. MLM S: Slope distance of the starting position and 2nd target. H: Horizontal distance of the starting position and 2nd target. V: Height difference of the starting position and 2nd target. S: Slope distance of the instrument station and 2nd target. HAR: Horizontal angle of the instrument station and 2nd target.		
(4) Sight the target P 3 and press MLM. When the observation is completed, the slope distance, horizontal distance, and height difference from between starting position P1 and target point P3. It is possible to measure the slope distance, horizontal distance, and height difference from starting point to any other point using the same procedure. ·Re-observe the starting point: OBS	MLM	
(5) Press ESC to end the MLM measurement.	ESC	

13.1.2 Slope in between 2 points

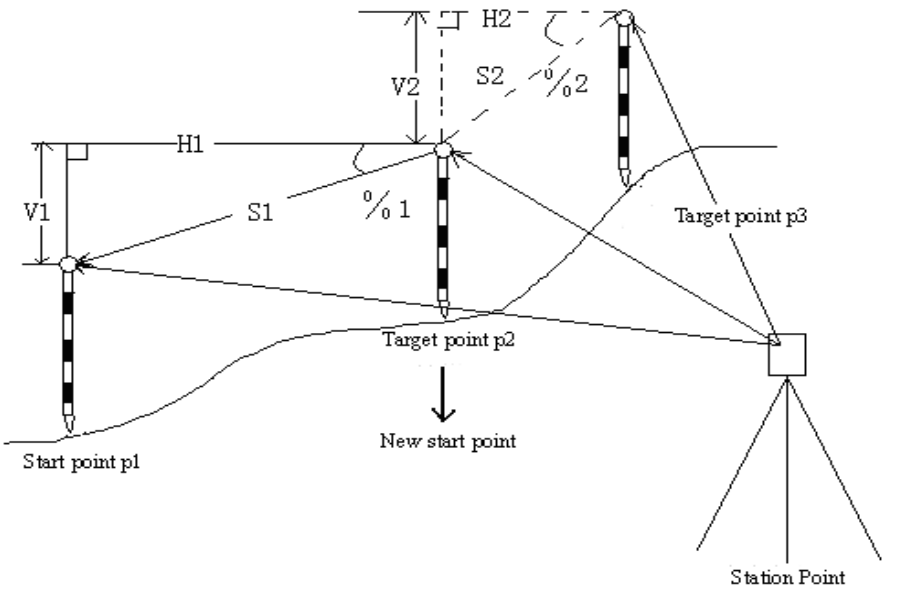
It is possible to display the gradient of the starting position and target as a %.

Operating Procedure	Operation	Display
(1) Press S/% with the MLM measured values displayed. The gradient of the two points is displayed as a% on the second line. Then S/% is changed to SD.	S/%	

(2) Press SD again, returns to the original screen.	SD	MLM S 10.757 m H 37.345 m 3 V 1.060 m S 15.483 m ZA 70°24′18″ HAR 135°31′28″ MLM MOVE SD OBS

13.2 Changing the Starting Point

·It is possible to change the last measured point to the next starting point.



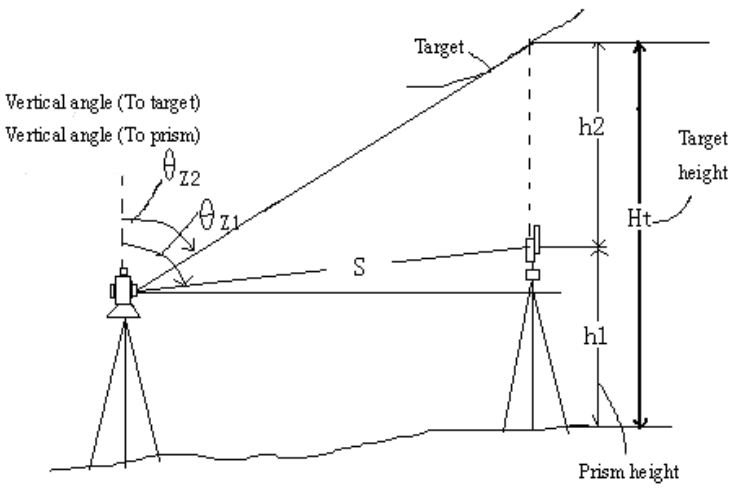
▶PROCEDURE

Operating Procedure	Operation	Display
(1) Observe the starting position and target following the steps 1 to 3 in "Chapter 13.1.1 Measuring the distance between multiple targets."		MLM S 46.755% H 37.345 m 3 V 1.060 m S 15.483 m HAR 135°31′28″ MLM MOVE S/% OBS
(2) Press MOVE with the "Missing Line Measurement Results Screen" displayed. Press MOVE to change the last measured point to the starting point.	MOVE	Move ? S 15.483 m ZA 70°24′18″ HAR 135°31′28″ NO YES

(3) Press YES, the last target measured becomes the new starting position. Refer to "13.1.1 Measuring the Distance Between Multiple Targets", perform missing line measurement of the next target point.	YES	MLM S 15.483 m ZA 70°24′18″ HAR 135°31′28″ MLM MOVE S/% OBS

14. REM MEASUREMENT

·An REM measurement is a function used to measure the height to a point where a target can not be directly installed, for example a power cable, bridge, etc.



·The height of the target is calculated using the following formula.

$Ht = h1 + h2$

$h2 = \sin\theta z1 \times \mathrm{Ctg}\theta z2 - S\cos\theta z1$

· When an REM measurement is performed, the initial measurement is performed after 0.7 seconds and later measurements are performed at 0.5 second intervals no matter which distance measurement method is selected.

· In advance allocate the function keys to display REM. For the allocation method, see "20. Key Function Allocation."

·It is also possible to perform REM measurement when "5. REM" is pressed under the Menu Mode.

▶PROCEDURE

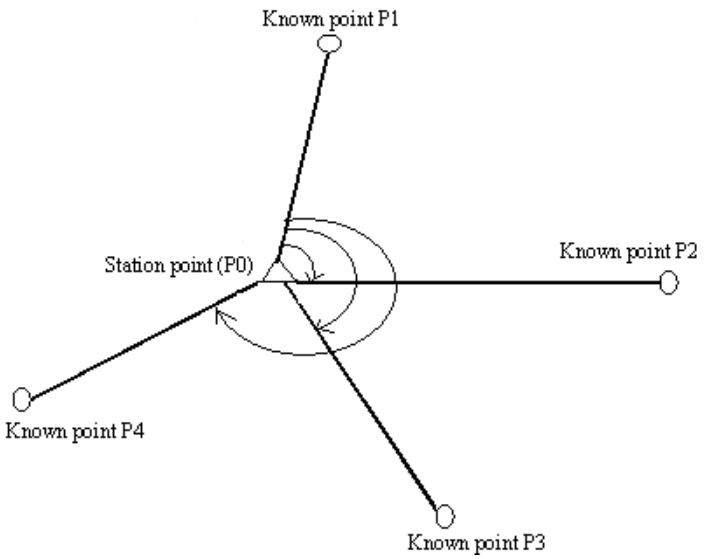
Operating Procedure	Operation	Display
(1) Set the prism directly under or directly over the object and measure the target height with a tape measure. Press HT on the third page of "MEAS Mode Screen". The "Height Setting Screen" is displayed.	HT	Height Tgt.h. : 1.650 m Inst. h. : 2.000 m OK
(2) Enter the prism height and press OK, sight the prism. Press SD on the first page of the MEAS Mode to begin distance measurement. (The Distance mode may be either SD, HD, or VD).	OK + SD	Dist. Dist PC = 0 PPM = 0 Fine "S" STOP
(3) When the observation is completed, the distance measurement result is displayed.		Meas. PC -30 PPM 0 S 11.678 m ZA 59°39′54″ HAR 90°01′00″ P2 SD SHV HSET EDM
(4) Sight the target, display the screen in which REM is registered. Press REM to begin the REM measurement. 0.7 seconds later, the height from the surveying point to the target is displayed in HT. Afterwards, the measurement values are completed every 0.5 seconds.	REM	REM Ht. 0.052 m S 13.123 m ZA 89°23′54″ HAR 117°12′17″ STOP
(5) Press STOP to end the REM measurement operation. ·Re-observe the target (distance measurement): OBS (Afterwards returns to step 2.) ·Start REM measurement: REM	STOP	REM Ht. 0.052 m S 13.123 m ZA 89°23′54″ HAR 117°12′17″ REM OBS

(6) Press ESC to return to the measurement mode screen. Maximum angle of measurement possible: ±89 ° Max. measurement distance (Ht.): ±9999.999 m **Note:** **To change target height, press FNC key**	ESC	Meas. PC -30 PPM 0 S 11.678 m ZA 59°39′54″ HAR 90°01′00″ P2 SD SHV REM EDM

15. RESECTION MEASUREMENT

·Resection is used to determine the coordinates of the instrument station by performing multiple measurements of points whose coordinate values are known.

Entry	Output
Ni, Ei, Zi: coordinates of known point	N0, E0, Z0: station point coordinates
Hi : Observed horizontal angle	
Vi : Observed vertical angle	
Di : Observed distance	



·The KTS-442UT can calculate the instrument station coordinates by observing 2 to 4 known points.

1. When the distance can be measured, at least 2 known points are required.
2. When it not possible to measure distance, at least 3 known points are required.

·It is also possible to perform resection measurement by selecting "6. Resection" in the menu mode.

·It is possible to read in a coordinate data registered in advance.

·It is possible to record set known point coordinate data or calculated instrument station data in the JOB which has been selected. For the JOB selection method, see "16.1 JOB Selection".

·The target height set here returns to its previously set value after the resection process is completed.

▶PROCEDURE

Operating Procedure	Operation	Display
(1) Press RESE in the third page of Meas. Mode, or from page 2 of Menu Program. Input coordinate values for the 1 st known point and press F4 OK. ·Stopping an entry in progress: ESC ·Reading in data: READ ·Record data: REC	Input Coordinate + F4 OK	Resection Pt. 1 N 0.000 m E 0.000 m Z 0.000 m READ REC OK Resection Pt. 1 N 2705009.600 m E 585500.964 m Z 3.201 m READ REC OK
(2) When coordinate entry for the 1 st point has been completed, press OK. The "2 nd Point Setting Screen" is displayed. ·Repeat step 1 to input the coordinates of all the known point.	Input coordinate values	Resection Pt. 2 N 2705618.561 m E 585502.155 m Z 3.254 m MEAS READ REC OK
(3) When all required known points have been set,s press MEAS.	MEAS	Resection N 2705009.600 m E 585500.964 m Z 3.201 m Sight Pt. 1 ANG DIST
(4) Sight the 1 st known point, press ANG for angle measurement only. Or press F4 DIST for angle and distance measurement. When DIST is selected, the "Observation Start Screen" is displayed.	F4 DIST	Resection Dist PC = 0 PPM = 0 Fine "S" STOP

(5) When the measurements are completed, or when STOP is pressed after the measurement values are displayed during repeat measurement. ·When ANG has been selected, the distance can not be displayed. If adopt the result, enter the target height of the first known point and press YES. Then go to observe next known point. ·Discard the result, press NO.	YES Or NO	Resection Point: 1 S 6.979 m ZA 99°31′28″ HAR 67°11′15″ Tgt. h : 1.500 m NO YES
(6) Repeat steps 4 to 5 in the same way from the second point. When the minimum quantity of observation data required for the calculation is present, CALC is displayed. Press F1 CALC to automatically start calculations after observations of all known points are completed. Re-measure the point: NO Measure next point: YES Calculate occupied station: CALC	CALC (or YES Or NO)	Resection N 2705018.561 m E 585502.155 m Z 3.254 m Sight Pt. 2 ANG DIST Resection Pt. 2 S 13.901 m ZA 94°32′45″ HAR 32°56′31″ Tgt. H : 1.500 m CALC NO YES
(7) When dHD, dZ are close to 0, it means the result is precise, press F4 OK If you don't need Elevation value, no need to care about dZ value. ROBS: remeasure the known points. ADD: add a new known point REC: accept the result and record it.	OK	N 2705006.931 E 585494.619 Z 4.326 dHD 0000 mm dZ 0000 mm ROBS ADD REC OK
(8) Follow the screen notice and sight at the known point, press F4 to set bearing angle. Station Point is set.		Resection Please sight at the 2nd point Set bearing angle HAR 32°56′27″ NO YES

·Abandon the results and stop measuring: ESC

·Abandon the results and re-measure: RE_OBS (See 15.1 Re-observing")

·Abandon the results and add known points: ADD

·Adopt the results and record in JOB: REC (Refer to"21.4 Recording Distance Measurement Data")

(To set direction angle press OK, otherwise press ESC)

15.1 Re-Observing

It is possible to perform re-measuring from the first known point or only the last known point.

▶PROCEDURE

Operating Procedure	Operation	Display
(1) In the "Resection Result Screen," press ROBS.	ROBS	Re-OBS 1. Start point 2. Last point
(2) Select "1. Last point" or "2. Last point" and press ENT. The following procedures are same with the procedures after the steps 4 in "15. RESECTION MEASUREMENT."	Select + ENT	Resection Pt. 1 N 4456.343 E 4321.890 Z 215.557 Take the first point. ANGLE DIST

15.2 Add Known Points

▶PROCEDURE

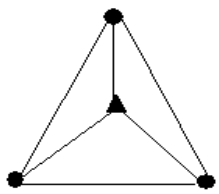
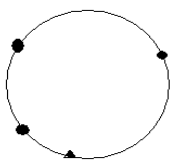
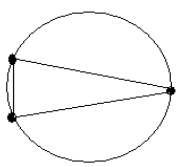
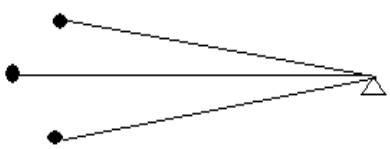
Operating Procedure	Operation	Display
(1) Press ADD in the "Resection Result Screen".	ADD	N0 56.343 E0 21.890 Z0 15.557 dHD 0015 mm dZ 0012 mm ROBS ADD REC OK
(2) When the former known points are not observed, right upper screen is displayed.		Resection Pt 4 N 4116.343 E 4021.840 Z 200.557 Please take the fourth point ANGLE DIST
When the observation for former known points is finished, and some known points are in adding, neither screen is displayed.		Resection Pt 4 N 0.000 m E 0.000 m Z 0.000 m MEAS READ REC OK

☆When there is a known point not yet measured; perform measurement using the same procedure beginning with step 3 in "Chapter 15. Resection Measurement."

☆When a known point is to be added, perform measurement using the same procedure beginning with step 1 and 2 in "Chapter 15. Resection Measurement."

▶EXPLANATION

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

	An arrangement such as that shown on the left is desirable. ▲: Unknown point ●: Known point
	Sometimes it is impossible to perform a correct calculation in a case such as that on the left.
	When they are on the edge of a single circle, take the following measures. Move the instrument station as close as possible to the center of the triangle.
	When the distance between known points are fixed. When distance between station point and known points are increased, their included angle are lessened, the known points can easily be on the edge of a single circle. It is impossible to calculate the coordinates of the instrument station if the included angle between the known points is too small.

16. Area Calculation

It is also possible to calculate the area of land enclosed by three or more known points on a line by manually inputting or reading the coordinates of the points.

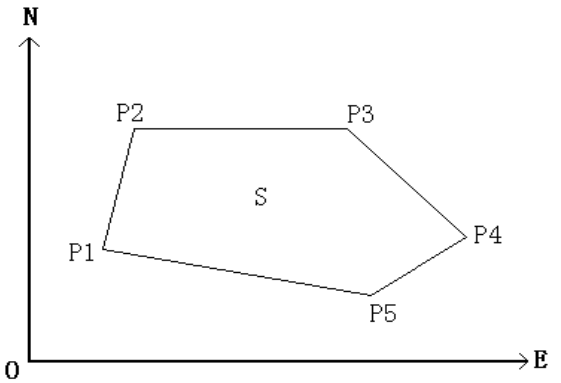
Coordinates(Known value): P1 (N1, E1)　　Area (calculated value): S

P2 (N2, E2)

P3 (N3, E3)

P4 (N4, E4)

P5 (N5, E5)



·Number of specified coordinate points: 3～20

·Area is calculated by observing the points on a line enclosing an area in order or reading in the previously registered coordinates in order.

※NOTE:

·If two or less points are used to measure an area, and error will occur.

·Be sure to observe (or recall) points on an enclosed area in a clockwise or anticlockwise direction. For example, the area specified by entering (or recalling) point numbers 1, 2, 3, 4, 5 or 5, 4, 3, 2, 1 implies the same shape.

·Every point used during calculation can be gotten by measuring or reading from memory.

▶PROCEDURE

Operating Procedure	Operation	Display
(1) In the page 2 of the menu, select "8. Area".		Menu(2) ↑ 6. Resection 7. Repetition 8. Area 9. Roads

(2) Every point use during calculation can be gotten by measuring or reading from memory. For example Measuring point 1: Sight the first point on the line enclosing the area and press OBS. to start measuring. The result will be displayed.	Sight Point 1 + OBS.	01: 02: 3 03: 04: 05: READ OBS. N: 40.028 m E: -10.002 m 3 Z: 0.076 m S 2.043 m HAR: 20°45′22″ OK MEAS
(3) Press OK to enter the value of point 1 in "pt_01".	OK	01: pt_01 02: 3 03: 04: 05: READ CACL MEAS
(4) Repeat steps from 2 to 3 until all points have been measured. Points on an enclosed area are observed in a clockwise or anticlockwise direction. Coordinates value also can be read from memory. For example: read in coordinates value from memory as point 2. Press READ to display the point list in memory. Pt : Known values in memory Crd / Stn: coordinates value which stored in designated JOB files.	READ	01: pt_01 02: 3 03: 04: 05: READ CACL MEAS Pt 1 Crd 2 Crd 3 Crd 4 Crd 5 ↓ VIEW SRCH
(5) In the known points list, select the point number which corresponding for point 2 and press VIEW to read the point in.	VIEW	NO 510.000 EO 206.000 ZO 123.000 Pt : ST002 H 1.600 M TOP LAST P1

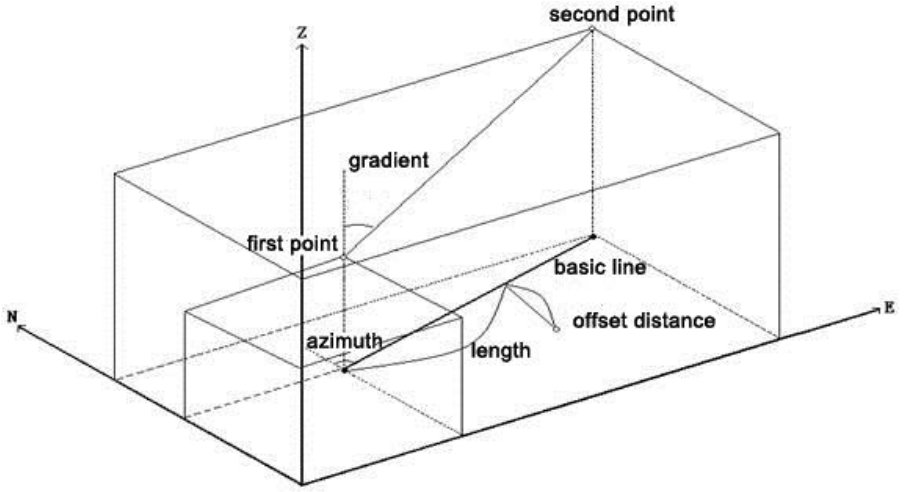
<table>
<tr>
<td>(6) Move the cursor to the third point, if the coordinates is gotten by measuring, it displays “pt_03”. If the coordinates is read from memory, it displays the point number. (For example: 6)

When known points amount is enough to be used in area calculation (at least 3 points), CALC key will be displayed.
To read in coordinate data in known data and read in Station point, observation point, in working jobs, press READ</td>
<td></td>
<td>01：pt_01
02：6 ▮3
03：pt_03
04：
05：
READ CALC MEAS</td>
</tr>
<tr>
<td>(7) Press CALC to calculate and display the result.</td>
<td>CALC</td>
<td>Points： 5
0.338 m. sq
0.0000 ha
0.0001 acre
3.64 ft. sq
NEXT END</td>
</tr>
<tr>
<td>(8) Press END to end calculation and return to menu screen. Press NEXT to re-enter area calculation.</td>
<td>END</td>
<td>Menu(2) ↑
6. Resection
7. Repetition
8. Area
9. Roads</td>
</tr>
</table>

Note： It is also possible to perform area measurement by pressing AREA key under MEAS mode when AREA function is allocated in soft key. For the method, refer to “20. Key function allocation”.

17. Setting-out line

Setting-out line is used for setting out a required point at a designated distance from the base line and for finding the distance from the baseline to a measured point.



17.1 Defining Baseline

You need to define the base line before setting out straight line. You can define a baseline by inputting two points' coordinates. The scale factor value is the difference between the input coordinate and the observed coordinate.

$$\text{Scale (x,y)} = \frac{\text{Hdist' (Horizontal distance calculated from themeasured value)}}{\text{Hdist' (Horizontal distance calculated from the inout coordinates)}}$$

·When not observing first or second points, scale factor is set to "1".

·Defined baseline can be used in both setting-out line measurement and point projection.

Procedure	Key	Screen display
（1）Under the measurement mode, define the function of LINE into the soft Key	See 20"key function allocation"	Meas. PC -30 PPM 0 S 4.583m ZA 92 36' 25" HAR 30 25' 18" PROJ LINE HSET EDM
（2）Select LINE	LINE	Set-out line 1 Stn data 2 back sight data 3 define baseline 4 point 5 line

<table>
<tr>
<td>（3）Select “1. Stn data.” The station data can be manually input or read in by pressing READ key and press OK, return to the “Set-Out Line screen.”

Then set Backsight Data.</td>
<td>Set Stn data and Backsight Data</td>
<td>NO: 0.000
EO: 0.000
ZO: 0.000
Inst.h: 0.000mm
Tgt.h: 0.000mm
READ REC OK</td>
</tr>
<tr>
<td rowspan="2">（4）
Select “3. Define Baseline”.
It is possible to press READ, to read in the known data which is stored in memory,

Or manually input: input the start point and end point data and press F4 OK</td>
<td rowspan="2">define baseline</td>
<td>Define baseline (1)
Nb1: 2705209.985 m
Eb1: 121143.128 m
Zb1: 90.327 m
READ REC OK</td>
</tr>
<tr>
<td>Difine baseline (2)
Nb2: 2705201.125 m
Eb2 121144.997 m
Zb2: 89.297 m
READ REC MEAS OK</td>
</tr>
<tr>
<td>（5）Press F1 OK to return to Setout Line Screen.</td>
<td>F1</td>
<td>Define Baseline (1)
AZ: 92° 36’ 25”
Hcalc: 14.142 m
Hmeas:

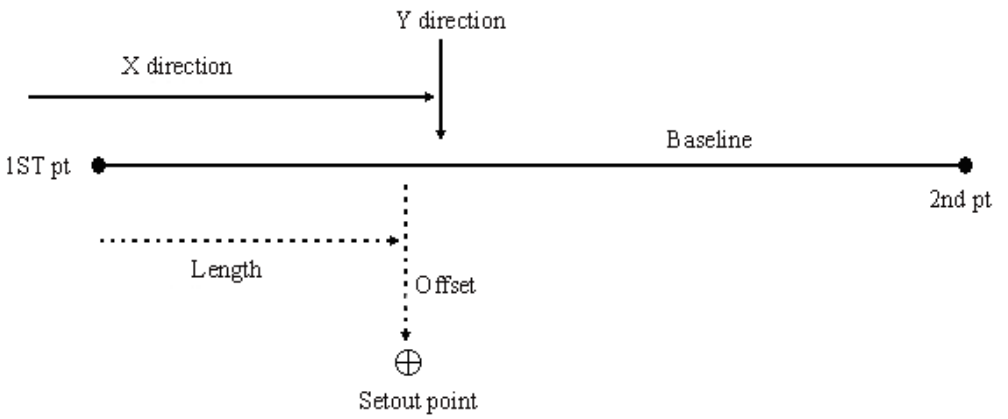
OK P1</td>
</tr>
</table>

Note: It is possible that you don’t have known point coordinates to set station and backsight point. You can assume a Station Point coordinate, input angle to set backsight point. Then measure the start point and end point to get their coordinates, use them when you are designing baseline.

17.2 Setting-out Line (Point)

Setting-out line point measurement can be used to find the required point coordinate by inputting the length and offset based on the baseline.

·Before performing setting-out line point, the baseline must be defined.

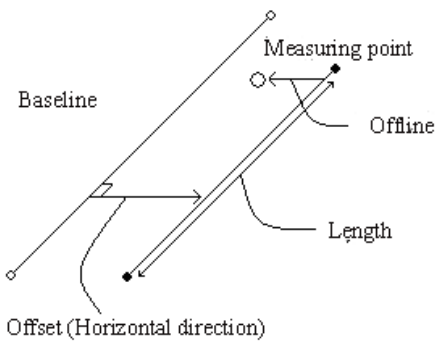


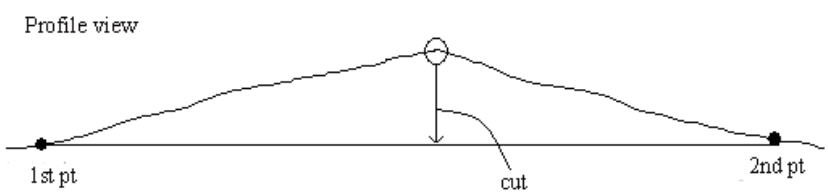
Procedure	key	Display
(1) After set Station Point, Backsight Point, define baseline, then Select "4 point".	point	set out line 1 Stn data 2 back sight data 3 define baseline 4 point 5.line
(2) Set the following items: **Length:** Distance along the baseline from the first point to the position at which a line extending from the required point intersects the baseline at right angles(X direction). **Offset:** Distance from the required point to the position at which a line extending from the required point intersects the baseline at right angles (Y direction).	Input length and offset	Set-Out Line (PT) Length 9.029 m Offset 0.000 m OK

(3) Press F4 [OK]. The coordinate value of the required point is calculated and displayed. (to enter the second page, press F4 [P1]). ·[REC]: records the coordinate value as a known point data. （Refer to "21. Recording in Record Mode"） Press F1 [S-O] to perform setting-out measurement of the required point. (Refer to"11. Setting-Out Measurement")	[OK]	Set out line (PT) Np: 2705201.124 Ep: 121144.997 Zp: 89.297 [S-O] [REC] [P1] Set out line (PT) Dist: 40.212 m Angle: 310°51′36″ Tg. h: 1.650 m [S-O] [REC] [P2]

17.3 Setting-out Line (Line)

Setting-out line line measurement is used to measures the horizontal distance and vertical distance from the required point to the baseline. The base line should be defined before seting out the straight line.



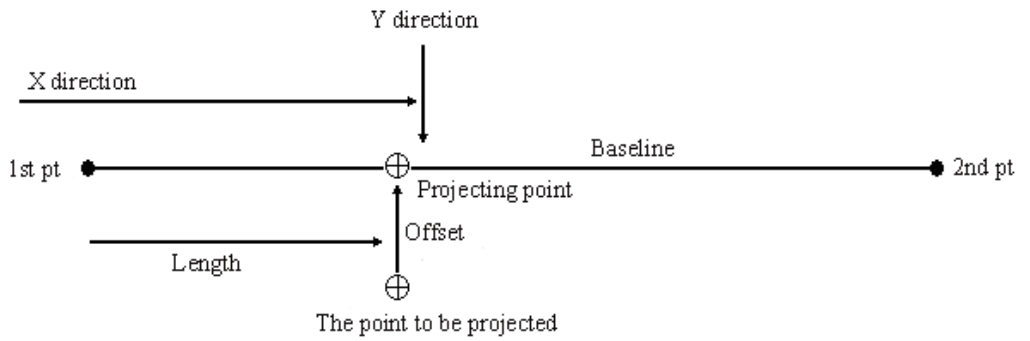


Procedure	Key	Display
(1) After set Station Point, Backsight Point, define baseline, Select "5. Line" in the "Set-Out Line Menu.	5.line	set out line 1. Stn data 2. back sight data 3. define baseline 4. point 5. line
(2) Enter the offset value and press F4 OBS Offset: How much to move the baseline. Right side indicates positive value and left side indicates negative value. When not setting offset value, go to step (3).	Enter length and offset and Sight at Target	Set-out line (L) Offset : 1.0 m OBS
(3) Sight the target and press F4 OBS. The result is shown, press F4 YES R.HT: target height to be input	Sight target + OBS	Set-out line (L) N: 2705209.958 m E: 121143.127 m Z: 90.328 m HAR 13° 30' 07" R. HT NO YES
(4) Press YES to accept the measurement results. Displays the difference between the measured point and the baseline. Offline: the offset value from the occupied point and the line to be set out. A positive value indicates that the point is on the right of the line. A minus value indicates that the point is on the left of the line. Cut: The height difference between the occupied point and the baseline. A positive value indicates the point is above the baseline. A positive value indicates the point is below the baseline. Length: Distance along the baseline from the first point to the measured point. OBS : to observe the target again, or measure the next target.	YES	Set-out line (L) OFF.L: -0.999 m d.E1ev: 0.000 m Length: -0.000 m OBS REC P2 Set-out line (L) N: 2705209.958 m E: 121143.127 m Z: 90.328 m OBS REC P1

(5) Sight at the next target and press OBS to continue the measurement. ·Press REC to record the measurement results.	Sight the next target + OBS	Set-out line (L) N: 2.219m E: 1.115m Z: -0.097m HAR 27 43' 58" R. HT NO YES

18. Point projection

Point projection is used for projecting a point onto the baseline. The point to project can be either measured or input. After projecting, the total station will calculate the coordinate of "Projecting Point", and display the distance between the 1st point and the "Projecting Point".



18.1 Defining baseline

Defined baseline can be used in both setting-out line measurement and point projection.

procedure	Operation	Display
(1) Under the measuring mode , define the function of point projection onto the key	allocate PROJ	Meas PC -30 PPM 0 ZA 92 36' 25" HAR 30 25' 18" PROJ LINE HSET EDM

(2) Select PROJ, the Point Projection menu is shown.	PROJ	Point projection 1. Stn data 2. back sight data 3. define baseline 4. point projection 5. EDM
(3) Input the Station and backsight data and difine the base line. Please take "17.1 define baseline "as a reference.		Define base line(1) AZ: 236 18'35" Hcalc: 3.606 m Hmeas: 3.606 m OK P1 ↓
		Define base line(2) ScaleX: 1.000000 ScaleY: 1.000000 Grade: -166.410% OK Sy=1 Sy=Sx P2 ↓
(4) Press OK to complete defining baseline and move to point projection measurement. Refer to "18.2 Point Projection".	OK	Point projection Coord. Point N: 0.0000 m E: 0.0000 m Z: 0.000 m READ MEAS REC. OK

18.2 Point projection

The base line should be defined before point projection

Procedure	key	Display
(1)Define the basic line Please take "17.1 define baseline "as a reference.		Point projection 1 Stn data 2 back sight data 3 define baseline 4 point projection 5.EDM
(2)Select "4. point projection"		

<table>
<tr>
<td></td>
<td></td>
<td>Point projection
Coord. Point
N: 0.0000 m
E: 0.0000 m
Z: 0.000 m
READ MEAS REC OK</td>
</tr>
<tr>
<td>(3) Enter the point coordinate.
·Press MEAS to measure the coordinate.
·When recording the coordinate data, press REC.</td>
<td></td>
<td>Point projection
Coord. Point
N: 2705195.064 m
E: 121139.542 m
Z: 91.678 m
READ MEAS REC OK</td>
</tr>
<tr>
<td>(4)
Press OK, the following items are calculated and displayed.
Length: Distance along the baseline from the first point to the projected point (X direction).
Offset: Distance from point to project to the position at which a line extending from point of project intersects the base line at right angles. (Y direction)
d. Elev: Elevation between the baseline and the projected point.
Press HT to set instrument height and target height.
·Press REC to record the projection coordinate as known point.</td>
<td>OK</td>
<td>Point projection (1)
Np: 2705196.429 m
Ep: 121145.991 m
Zp: 88.749 m
HT REC S-O P1

Point projection (2)
Length: 13.828 m
Offset: 6.592 m
d.Elev: 2.929 m
HT REC S-O P2</td>
</tr>
<tr>
<td>(5)
Press S-O to move to setting-out measurement of the projected point.</td>
<td>S-O</td>
<td>So.H -5.607 m
H-A 0.482 m
ZA: 65 °40’ 00”
HAR: 8 °44” 27”
dHA 82 °12’ 34”
REC SHV <--> HD</td>
</tr>
</table>

(6) Press ESC, repeat steps from step 3.	ESC	Point projection Coord. Point N: 1.686 m E: 1.128 m Z: -1.132 m READ MEAS REC OK

Note: It is possible that you don't have known point coordinates to set station and backsight point. You can assume a Station Point coordinate, input angle to set backsight point. Then measure the start point and end point to get their coordinates, use them when you are designing baseline.

19. ROAD DESIGN AND SETTING-OUT

It is possible to perform designated point setting-out base on the chainage and offset which are determined by road design.

The Road Design menu contains the alignment design functions.

19.1.1 Define Horizontal Alignment (Maximum data quantity: 30)

Horizontal alignment data can be edited manually or downloaded from computer. Horizontal alignment consisted of following elements: start point, straight line, circular curve and transition curve.

▶PROCEDURE

Operating Procedure	Operation	Display
(1) From page 2 on MENU, select "9. Roads."	MENU +"9. Roads"	Menu(2) ↑ 6. Resection 7. Repetition 8. Area 9. Roads

(2) Slect "1. Define Roads" in the "Roads Menu" and select "1. Define HZ AL."	Select"1.Define HZ AL"	Roads 1. Define Roads 2. Set-Out Roads Roads(1) 1. Define HZ AL 2. Edit HZ AL 3. Define VT AL 4. Edit VT AL 5. HZ AL IMPORT ↓
(3) Enter the start point information: chainage, N coordinate, E coordinate, and press OK. It is also allows you to press READ to read in the coordinate which is stored in memory.	Enter chainage, N, E coordinate + OK	Start Point CH: 1000.000 3 N : 1000.000 m E : 1050.000 m READ OK
(4) After entering start point information, the "Main Line input Screen" is displayed.		Define HZ AL Chain: 1000.000 3 AZ: 0°00′00″ 1 STR ARC TRNS PT (Main line input screen)

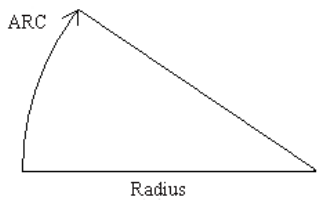
The main line input screen displays current chainage and the bearing angle (the tangent line from the chainage) and the function key (For creating new line). System provides four functions: defining straight line, circular curve, transition curve, point. Select a function key, enter the detailed information of the chainage, the alignment elements will be created. Press ENT key, the new chainage and bearing angle will be calculated automatically and the main alignment screen will be restored. Now other line style can be defined. Press ESC to exit current screen. To modify the element which entered in advance, you should enter the "Edit Alignment" option; the new elements can be added only in the end of the original alignment file.

Straight line

When the start point or other line style is well-defined, it allows you to define straight line. A straight line consists bearing angle and distance, the distance value can not be minus.

Operating Procedure	Operation	Display
(1) Press STR key in the "Input Process Screen", the "Define Straight Screen".	STR	Define HZ AL Chain: 1000.000 ▮3 AZ: 0°00′00″ 1 STR ARC TRNS PT
(2)Enter the bearing of straight line, press ENT key to access next entry option, after straight length, press ENT key.	Enter bearing + ENT Enter length + ENT	Straight AZ: 0.0000 Distance: 0.000 m OK
(3) Press OK to record this alignment data, and display the bearing angle and the chainage in the end of straight line Now, other alignments can be defined. When the straight line is in the middle of the road, the bearing is calculated from the original elements. To change this bearing angle, input a new angle manually.	OK	Define HZ AL Chain : 1020.000 ▮3 AZ: 4°25′00″ 2 STR ARC TRNS PT

Circular Curve

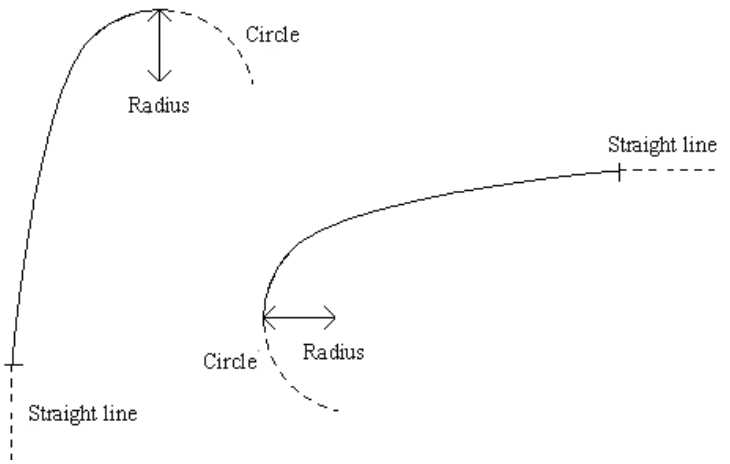


Press ARC key in the "Main line Input Screen", the circular curve can be defined. Circular curve consists of Arc length and Radius. The rule of radius value: along the forward direction of the curve.When the curve rotates to right, the radius value is positive. When the curve rotates to left, the radius value is minus. The arc length can not be minus.

Operating Procedure	Operation	Display
(1) Press ARC key in the "Input Process Screen",the "Define Arc" is displayed.	ARC	Define HZ AL Chain: 1000.000 ▮3 AZ: 0°00′00″ 1 STR ARC TRNS PT

(2) Enter radius and arc length, then press ENT to record this data.	Enter radius and arc length + ENT	Arc Radius: 0.000 m Arc length 0.000 m OK
(3) Press OK to record the alignment data.	OK	Define HZ AL Chain: 1020.000 3 AZ: 75°37′11″ 2 STR ARC TRNS PT

Transition curve



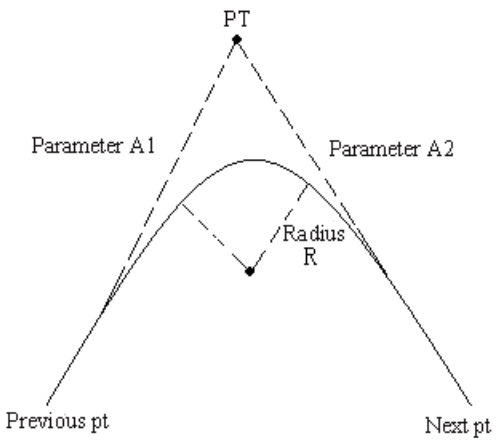
Press TRNS key in the "Main Line Input Screen", the transition curve can be defined. Transition curve consists of the minimum radius and arc length. The rule of radius value: along the forward direction of the curve.When the curve rotates to right, the radius value is positive. When the curve rotates to left, the radius value is minus. The arc length can not be minus.

Operating Procedure	Operation	Display
(1) Press TRNS key in the "Input Process Screen."	TRNS	Define HZ AL Chain : 1000.000 3 AZ : 0°00′00″ 1 STR ARC TRNS PT

(2) Enter the minimum radius and Spiral length of transition curve, and press ENT.	Enter the minimum radius and arc length + ENT	Transition Radius: 0.000 m Spiral length: 0.000 m OK
(3) Press OK to record the data and restore the main screen. If press ESC key, it will restores the main input screen without saving.	OK	Define HZ ZL Chain: 1028.000 3 AZ : 83°15′32″ 2 STR ARC TRNS PT

PT (Point, intersection point)

Press PT key in the "Main line input screen", the point can be defined. A point element consists of coordinates, radius and clothoid parameter A1 and A2. Radius, A1 and A2 can not be minus. If radius is entered, an arc is inserted with the specified radius. If clothoid parameter A1 or A2 is entered, a clothoid is inserted between straight and arc with the specified length.



Operating Procedure	Operation	Display
(1)Press PT key in the "Main line input screen"	PT	Define HZ AL Chain: 1000.000 3 AZ: 0°00′00 1 STR ARC TRNS PT

(2) It allows to enter N, E coordinate, radius and A1, A2 manually, and press ENT. Or press READ to read in the coordinates stored in memory.	enter N, E coordinate, radius and A1, A2 + ENT	N : 0.000 m E : 0.000 m R : 0.000 m A1 : 0.000 A2 : 0.000 READ OK
(3) Press OK to record data, and restore the main screen. Press ESC to restore the main screen without saving.	OK	Define HZ AL Chain : 1046.000 P3 AZ: 153°15′32″ 2 STR ARC TRNS PT

[NOTE]: When you want to enter A1, A2 from clothoid length L1, L2, the following equations are used:

$$A_1 = \sqrt{L_1 \cdot Radius}$$

$$A_2 = \sqrt{L_2 \cdot Radius}$$

Any changes to the alignment must be done using the edit alignment option.

19.1.2 Edit Alignment

To edit the alignment select Edit Alignment from the menu.

▶PROCEDURE

Operating Procedure	Operation	Display
(1) Select "2 Edit HZ AL" from the "ROADS" menu.		Roads(1) 1. Define HZ AL 2. Edit HZ AL 3. Define VT AL 4. Edit VT AL 5. HZ AL IMPORT ↓

(2) The first alignment data in memory is displayed.		Start Point CH : 1046.000 N : 201.000 m E : 102.000 m READ NEXT LAST SRCH
(3) Press NEXT to find the alignment data to be edited.		Straight AZ: 48.3000 Distance: 56.678 m PREV NEXT SRCH P1 ↓
(4) Enter new data, press ENT to store the modified data and to enter next point. Press ESC to exit without saving.		Straight AZ: 91.5631 Distance: 40..000 m PREV NEXT SRCH P1 ↓

PREV: Press this key to display the previous point data.

NEXT: Press this key to display the previous point data.

SRCH: Press this key to search for data, after pressing this key, enter the required chainage and press ENT, the data for the chainage will be displayed.

STRT: Press this key to go to the strart of the file.

END: Press this key to go to the end of the file.

P1: Press this key to go to page 2.

Use SRCH to edit alignment data

Operating Procedure	Operation	Display
(1) In the "Edit alignment" screen, press SRCH key.	SRCH	Start Point CH : 1046.000 N : 200.000 m E : 100.000 m PREV NEXT SRCH P1
(2) Enter the required chaiage.	Enter the chainage	Search HZ AL Chain: 1111.561 OK

<table>
<tr>
<td>(3)

A:
If the entered chainage is not existed in memory, an error message will be displayed. After several seconds, it restores previous screen which SRCH is displayed.

B:
If the entered chainage is existed in memory, its information will be displayed.</td>
<td></td>
<td>Search alignment

Invalid chainage !

Start Point

CH : 1046.000
N : 200.000 m
E : 100.000 m

PREV NEXT SRCH P1

Edit arc

Radius: 20.000 m
Arc: 20.000 m

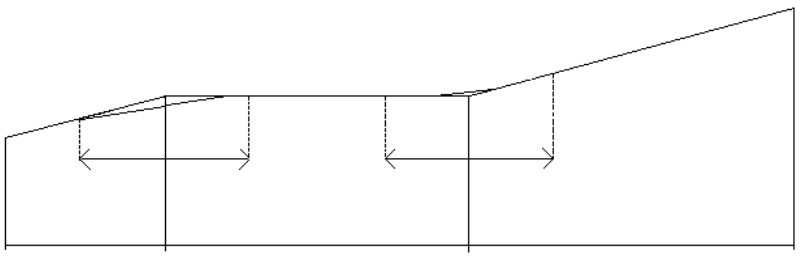
PREV NEXT SRCH P1</td>
</tr>
<tr>
<td>(4) Enter new data and press ENT to record.</td>
<td>Enter new data + ENT</td>
<td>Edit arc

Radius: 10.000 m
Arc : 20.000 m

PREV NEXT SRCH P1</td>
</tr>
</table>

19.1.3 Define Vertical Curve (Maximum 30 data)

A vertical curve consists of series of intersection points. The intersection point consists of a chainage, elevation and curve length.The sart and end intersection points must be a zero curve length.



Chainage	1000	1300	1800	2300
Elevation	50	70	60	90
Curve length	0	300	300	0

Intersection points can be entered in any order. After entering a point data, press ENT to save it and go to enter next one. Press ESC to exit without saving.

▶PROCEDURE

Operating Procedure	Operation	Display
(1) Select "3. Define VT AL" from Roads menu.	Select "3. Define VT AL"	Roads(1) 1. Define HZ AL 2. Edit HZ AL 3. Define VT AL 4. Edit VT AL 5. HZ AL IMPORT ↓
(2) Enter chainage, elevation and curve length.	Enter chainage, elevation and curve length.	Define VT AL CH: 1000.000 m3 Elevation: 50.000 m Len.: 0.000 m OK
(3) Press OK to record the data. Then enter next data.	OK	Define VT AL CH: 1000.000 m3 Elevation: 50.000 m Len.: 0.000 m OK

19.1.4 Edit Vertical Curve

To modify the curve data, the procedure is same with editing alignment data.

▶PROCEDURE

Operating Procedure	Operation	Display
(1) Select "4. Edit VT AL" from Roads menu.		Roads(1) 1. Define HZ AL 2. Edit HZ AL 3. Define VT AL 4. Edit VT AL 5. HZ AL IMPORT ↓

(2)The first curve data in memory is displayed.		Edit VT AL CH.: 1000.000 3 Elevation: 50.000 m Len.: 0.000 m PREV NEXT SRCH P1 STRT END READ P1
(3) Press PREV or NEXT to find the required curve data.		Edit VT AL CH: 1106.000 3 Elevation: 200.000 m Len.: 100.000 m PREV NEXT SRCH P1
(4) Enter new data, press ENT to record the modified data and go to enter next point. Press ESC to exit without saving.		Edit VT AL CH.: 1100.000 3 Elevation: 200.000 m len.: 10.000 m PREV NEXT SRCH P1

It is possible to use SRCH function to edit vertical data.

Operating Procedure	Operation	Display
(1) Press SRCH key in the "Edit VT AL" screen.	SRCH	Edit VT AL CH.: 1000.000 3 Elevation: 50.000 m Len.: 0.000 m PREV NEXT SRCH P1
(2) Enter the chainage of the required curve.	Enter the chainage	Search VT AL Chainage: 1100.000

(3) A: If the entered chainage is not existed in memory, the first vertical curve data will be displayed. B: If the entered chainage is existed in memory, its information will be displayed.		A: Search alignment Invalid chainage ! B: Edit VT AL CH.: 1100.000 3 Elevation: 50.000 m Len.: 0.000 m PREV NEXT SRCH P1
(4) Enter new data and press ENT to record, then go to enter next point. To exit without saving, press ESC		Edit curve Chain: 1100.000 3 Elevation: 200.000 m Curve lengt: 10.000 m PREV NEXT SRCH P1

19.1.5 Import the Horizontal alignment

This function requires SD card. It is to transfer a horizontal alignment data from SD card to local disk or SD card. This function can not be performed to transfer data in local disk.

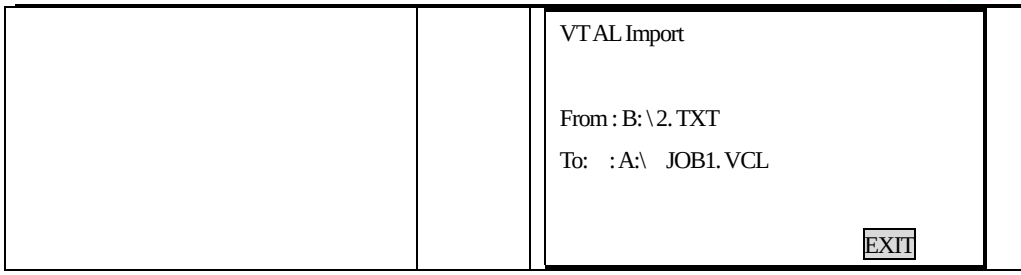
procedure	key	Display
(1)Select "5. HZ AL Import" from "Define Road menu".		Define road(1) 1. Define HZ AL 2. Edit HZ AL 3. Define VT AL 4. Edit VT AL 5. HZ AL Import
(2)Input the HZ AL file name or press LIST to read in the file from SD card. the format for the file is "TXT"	OK	File import Job : LIST OK
(3)If the horizontal line data already exist in the memory. You would be informed whether		

overwrite it or not. YES : start importing NO : Exit	YES	HZ AL Import Overwrite File? NO YES
(4) After transmission it returns into "Define Road "menu.		Import HZ AL From : B: \ 2. TXT To: : A:\ JOB1. HAL EXIT Finishing

19.1.6 Import the Vertical curve (vertical alignment)

The princelpe is same to the last chapter.

procedure	key	Display
(1) Select "6. VT AL Import" from the second page of "Define Roads" menu.		Define road (2) 6. VT AL Import 7. Receive HZ AL 8. Receive VT AL 9. Delete HZ AL 10. Delete VT AL
(2)Input the VT AL file name or press LIST to read in the file from SD card. The format for the file is ".TXT".	OK	File import Job : LIST OK
(3)If the horizontal line data already exist in the memory. You would be informed whether overwrite it or not. YES : start importing NO : Exit	YES	VT AL Import Overwrite File? NO YES
(4) After transmission it returns into "design road" menu		Finishing



19.1.7 Receiving Horizontal Alignment Data

The horizontal alignment can be transferred from computer to instrument by using alignment elements. The default definition should be included. The default definition consists of the start chainage and the point's coordinate. Alignment element consists of point, straight line, arc and transition curve.

The format for each record:

KEYWORD	**nnn, nnn [,nnn]**
START	Chainage，E，N
STRAIGHT	Bearing，distance
ARC	Radius，arc length
SPIRAL	radius，length
PT	E，N，Radius, A1，A2 (A1，A2: length)

Example 1：

START	1000.000，1050.000，1100.000
STRAIGHT	25.000，48.420
SPIRAL	20.000，20.000
ARC	20.000，23.141
SPIRAL	20.000，20.000
STRAIGHT	148.300，54.679

Example 2：

START	1000.000，1050.000，1100.000
PT	1750.000，1300.000，100.000，80.800
PT	1400.000，1750.000，200
PT	1800.000，2000.000

Before downloading data, make sure that the receiving software in computer and the instrument are in the same

parameters setting.

To transfer data from computer, you should have corresponding program, the required format for data can be provided by the software, and the data can be sent in any parameter method.

▶PROCEDURE

Operating Procedure	Operation	Display
(1) Select " 7. Receive HZ AL " in the "Define Roads" screen.		Define road(1) 1 define HZ AL ↑ 2 Edit HZ AL 3 Define VT AL 4 Edit VT AL ↓ 5 HZ AL Import Define road(2) 6 VT AL Import ↑ 7 Receive HZ AL 8 Receive VT AL 9 Delete HZ AL 10 Delete VT AL ↓
(2)Start receiving software in computer, when the KTS displays "Ready? ", press OK. (if you select USB communication then it shows "initializating USB")	OK	Receive HZ AL Ready? OK
(3) If any alignment data is existed in memory, it will display "Overwrite file?" Press YES to begin receiving, press NO to exit. If there is no alignment data, see step 3.	YES	Receive HZ AL Overwrite file? NO YES
(4) Start receiving. To stop receiving, press STOP.		Receive HZ AL Tansfer : USB JOB: A:\JOB1. HAL Receiving STOP

19.1.8 Receiving Vertical Curve Data

The vertical curve data can be transferred from computer to instrument by using character point and chainage. The vertical curve data shoud consists of elevation, curve length. The start and end curve length should be 0.

Data format:

Chainage, elevation, length

For example:

1000.000，50.000，0.000
1300.000，70.000，300.000
1800.000，70.000，300.000
2300.000，90.000，0.000

▶PROCEDURE

Operating Procedure	Operation	Display
(1)Select "8. Receive VT AL" in the "define Roads" screen.		Define road(2) 6 VT AL Import 7 Receive HZ AL 8 Receive VT AL 9 Delete HZ AL 10 Delete VT AL
(2)Start the receiving software in computer, when the KTS displays "Ready? ", press OK. (if you select USB communication then it shows "initializating USB")	OK	Receive VT AL Ready? OK
(3)If any curve data is existed in memory, it will display "Overwrite file?" Press YES to begin receiving, press NO to exit. If there is no alignment data, see step 4	YES	Receive VT AL Overwrite file? NO YES

(4)Start receiving. To stop receiving, press STOP.		Receive VT AL Tansfer : USB JOB: A:\JOB1. VCL Receiving STOP

19.1.9 Deleting Horizontal alignment Data

The alignment data in memory can be deleted.

▶PROCEDURE

Operating Procedure	Operation	Display
(1) Select "9. Delete HZ AL" in the "Roads" screen.		Define road(2) 6 VT AL Import 7 Receive HZ AL 8 Receive VT AL 9 Delete HZ AL 10 Delete VT AL
(2) When "Alignment delete?" is displayed, press YES, the data will be deleted, the screen restore the Roads screen. To exit, press NO.	YES	HZ Alignment Delete ? NO YES

19.1.10 Deleting Vertical Curve

The alignment data in memory can be deleted.

▶PROCEDURE

Operating Procedure	Operation	Display
(1) Select "10. Delete VT AL" in the "Roads" screen.		Define road(2) 6 VT AL Import 7 Receive HZ AL 8 Receive VT AL 9 Delete HZ AL 10 Delete VT AL

(2)When "Vertical curve delete?" is displayed, press YES, the data will be deleted, the screen restore the Roads screen. To exit, press NO.	YES	VT Alignment Delete? NO YES

19.2 Road Setting-out

It is possible to perform alignment setting-out for the designated point by using the chainage and offset which is ensured in road design.

For and alignment setout a horizontal alignment must have been uploaded (Refer to 19.1.5 Reiceiving alignment) or entered manully (Refer to 19.1.1 Define alignment).

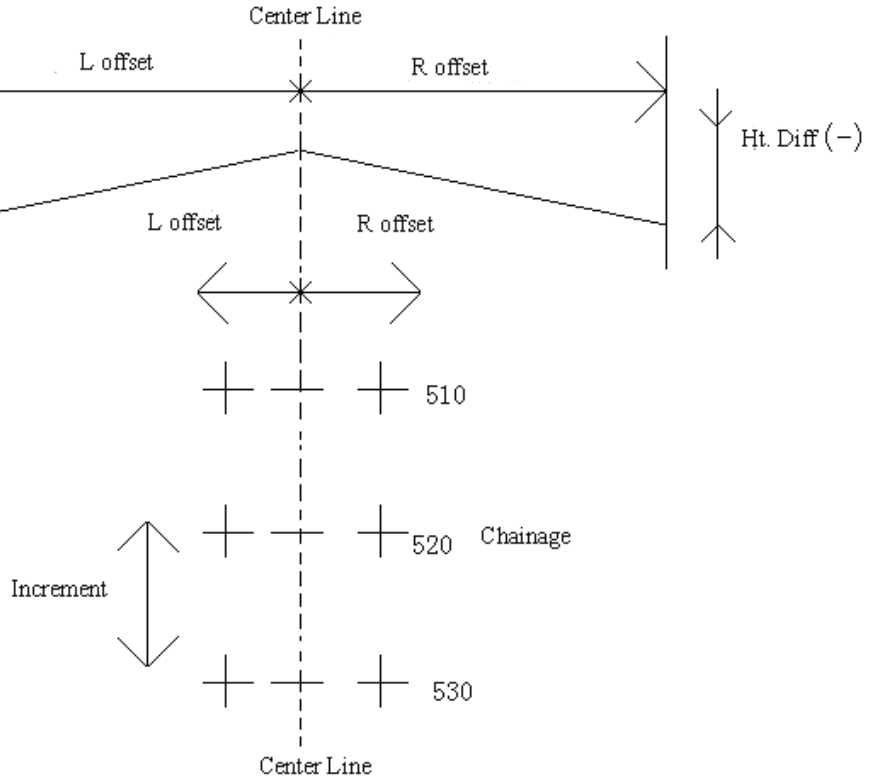
The vertical alignment is optional, but is required to compute cut and fill.

Rule:

Offset left: the horizontal distance from the left stake point to the center line.

Offset right: the horizontal distance from the right stake point to the center line.

Elevation difference: Left (right) is the elevation difference between left (right) stake and the center line point.



19.2.1 Set Station Point

It allows you to set station point by reading from memory (N, E, Z coordinate) or entering manually by keyboard (chainage and offset).

▶ **PROCEDURE**

Operating Procedure	Operation	Display
(1) From the "Roads" menu select "2. Set-Out Roads". Then select "1. Stn data."	Select"1. Stn data"	Roads 1. Define Roads 2. Set-Out Roads Set out roads 1. Stn data 2. Angle 3. Coord. 4. Set-Out 5. EDM
(2) The "Stn data" screen is displayed.		Stn data CH 0.000 Offs 0.000 m Inst .H 0.000 m READ OK
(3) A: Enter the chainage, offset, instrument height of the station point. B: To read in coordinate data from memory, press READ. ↑ view the last data ↓ view the next data ← view the last page → view the next page	Enter the chainage, offset, instrument height READ	A: Stn data CH 1000.000 Offs 20.000 m Inst. H 1.560 m READ OK B: Pt 1 Pt 2 Pt 3 Pt 4 VIEW SRCH

(4) A: The point coordinate is calculated on the basis of the entered chainage and offset. It the vertical curve data of the chainage is existed in memory, the elevation of the point will be displayed. If the curve is not existed, the elevation display with 0. B: The coordinate of the read point is displayed. To check the coordinate data in memory, press VIEW.		A: N0: 1000.000 E0: 1000.000 Z0: 0.000 m Pt. 100.000 Inst. H 1.560m SAVE READ OK B: N: 100.253 E: 120.027 Z: 21.045 PT. : 2 Tgt. H: 2.000m TOP LAST P1
(5) Press OK to finish the setting and return to the "Set-Out Screen."	OK	Set out roads 1. Stn data 2. Set H angle 3. Set Back Sight Pt 4. Set Out 5. EDM

19.2.2 Setting Backsight Point

Program provides two methods for setting backsight point: Entering it manually, setting it by using coordinate.

1）Setting backsight point by using angle

▶PROCEDURE

Operating Procedure	Operation	Display
(1)Select "2. Angle" from the "Set Out Roads" menu.	Select "2. angle"	Set out roads 1. Stn data 2. Angle 3. Coord 4. Set Out 5. EDM

(2)Enter the bearing angle and press OK.	Enter bearing angle	Set Azimuth HAR: 0.0000 OK
(3) Press YES to record the data		Set Azimuth Sight BS Point HAR 0° 00'00" NO YES
(3) Press OK, the screen restore the "Set Out Roads Screen."	OK	Set out roads 1. Stn data 2. Angle 3. Coord 4. Set Out 5. EDM

2) Setting backsight point by using coordinate

It allows you to set backsight point by reading from memory (N, E, Z coordinate) or entering manually by keyboard (chainage and offset).

▶PROCEDURE

Operating Procedure	Operation	Display
(1) Select "3. Coord." in the "Set Out Roads Screen."	Select "3. Coord."	Set out roads 1. Stn data 2. angle 3. coord 4. Set Out 5. EDM
(2) The "Set Back Sight Pt Screen" is displayed.		Set Back Sight Pt Chain 0.000 Offs. 0.000 m READ OK

(3) A: Enter the chainage, offset of the backsight point. B: To read in coordinate data from memory, press READ.	Enter the chainage, offset READ	A: Set Back Sight Pt Chain 1000.000 Offs. 20.000 m READ OK B: Read data Pt 1 Pt 2 Pt 3 Pt 4 Crd. 4 Stn 1 ↓ VIEW SRCH
(4) A: The point coordinate is calculated on the basis of the entered chainage and offset. It the vertical curve data of the chainage is existed in memory, the elevation of the point will be displayed. If the curve is not existed, the elevation display with 0. B: The coordinate of the read point is displayed.。		A: Set Back Sight Pt NBS: 80.436 m EBS: 217.326 m ZBS: 10.090 m READ OK B: N: 102.253 E: 110.027 Z: 21.045 PT. : 1 Tgt.h. : 2.000m TOP LAST P1
(5) To accept the bearing angle, press YES , to reset the angle press NO.	YES	Set H angle Sight ? HAR: 332°23′45″ NO YES

(6) Return to set-out road s menu.		Set out roads 1. Stn data 2. angle 3. coord 4. Set Out 5. EDM

19.2.3 Setting Out

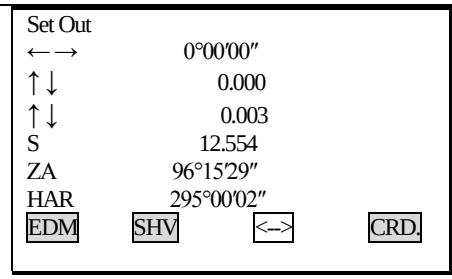
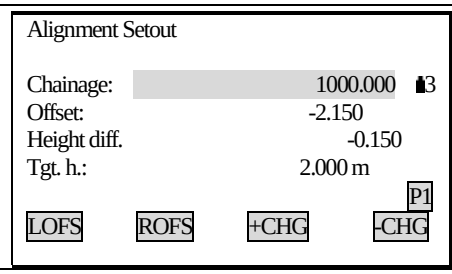
After Setting station point and backsight point, it is possible to perform Setting Out measurement.

▶PROCEDURE

Operating Procedure	Operation	Display
(1)Select "4. Set Out" in the "Set Out Roads Screen."	Select "4. Set Out"	Set out roads 1. Stn data 2. Set H angle 3. Set Back Sight Pt 4. Set Out 5. EDM
(2)Enter the start stake number, increment, the horizontal distance from side stake points to center line (Offset L: the horizontal distance from left stake point to center line. Offset L: the horizontal distance from left stake point to center line.) and the height difference from the side stake to center line.		Alignment Setout StartC 0.000 Incre. 0.000 Offs. L 0.000 m Offs. R 0.000 m HtDi.L 0.000 m HtDi.R 0.000 m OK
(3) Press ENT, the chainage and offset screen is displayed.	ENT	Alignment Setout Chain: 1000.000 3 Offs: 0.000 HtDi: 0.000 Tgt.h: 0.000 m P1 LOFS ROFS +CHG -CHG SLOPE (Main set out screen)

(4) Press LOFS(orROFS) to set out the left (or right) side stake, the corresponding chainage, offset, height difference will be displayed in the screen. It is possible to enter the chainage and offset manually. Offset is minus: the offset point is at the left side of center line. Offset is positive: the offset point is at the right side of center line.		Alignment Setout Chain: 1000.000 m3 Offs: -2.150 HtDi: -0.150 Tgt.h: 2.000 m P1 LOFS ROFS +CHG -CHG
(5) When the required chainage and offset is displayed, press ENT to confirm them. When the cursor is in the bottom of the screen, press ENT, the coordinate of the point to be set out is displayed, press OK.		Alignment Setout Np: 8.888 m Ep: 199.200 m Zp: 80.000 m OK
(6) When the "Set Out screen" is displayed, sightthe prism, press SHV key to display the CRD key. SO.H: the distance to the point to be set out dHA : the horizontal angle difference to the point to be set out	SHV	Set Out SO.H m H-0 m ZA 96°15′29″ HAR 331°14′35″ dHA -36°14′35″ REC SHV <--> HD
(7) Sight the prism and press CRD. When the measurement is finished, the "Setting-Out Obsevation screen" is displayed.	CRD	Set Out Set Out PSM = 0 PPM = 0 Fine's' STOP Set Out SO. N -2.369 E 8.044 Z -79.672 ZA 96°15′29″ HAR 331°13′46″ dHR -36°14′35″ REC. SHV <--> CRD.

<table>
<tr>
<td>(8) Press <--> then press CRD. To display the "SetOut guide screen."
The angle value which displays on the seond line is the difference of the measured angle value and the required set-out value. The arrow indicates the instrument should be turned to which direction.
The distance value which displays on the third line is the difference between the measured value and the required distance setout value. The arrow indicates the direction which the prism should be moved to.
The height difference of the point to be set out is displayed on the fourth line, The arrow indicates the direction which the prism should be moved to.
(If to show the values in coordinates format, press <--> when the measurement is finished.</td>
<td><-->
+
CRD.</td>
<td>Set Out
← -36°13′46″
↓ -7.882
↑ -79.672
S-A 2.131 m
ZA 96°15′29″
HAR 331°13′46″
REC. SHV <--> CRD.</td>
</tr>
<tr>
<td>(9) Rotate the EDM part of the instrument to make the displayed value to be 0 °(the second line). When the difference of the measured angle value and the required value is within ±30″, there are two arrows displayed on screen.
·The meaning of arrows:
←: Move the prism to left.
→: Move the prism to right.
·Restore the "Set-Out Observation Screen": <--></td>
<td></td>
<td>Set Out
←→ 0°00′00″
↓ -7.882
↑ -79.672
S-A 2.131 m
ZA 96°15′29″
HAR 295°00′02″
REC. SHV <--> CRD.</td>
</tr>
<tr>
<td>(10) Place a prism on the sight direction and sight it.
Press CRD. to start distance set-out measurement.
Press SHV to select the Set-Out measurement mode.</td>
<td>CRD.</td>
<td>Set Out
Set Out PSM = 0
PPM = 0
Fine's'
STOP</td>
</tr>
<tr>
<td>(11) Move the prism to make the displayed value which is displayed on the third line be 0 m, press CRD. to start measuring.
When the difference value between the distance set-out value and the measured value is within ±1cm, there are two arrows displayed on the screen. (When the distance measuring mode is repetition or tracking measurement, it is possible to display the results directly after</td>
<td></td>
<td>Set Out
←→ 0°00′00″
↑↓ 0.000
↑ -79.672
S-A 12.234 m
ZA 96°15′29″
HAR 295°00′02″
REC. SHV <--> CRD.</td>
</tr>
</table>

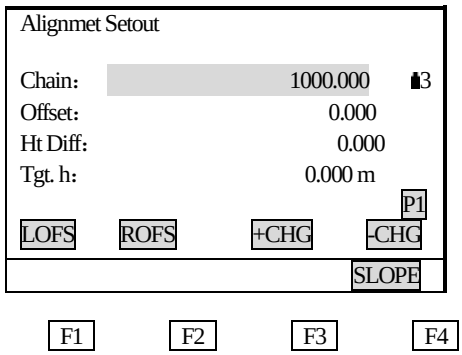
sighting the prism.) ↓: Move the prism to the station point direction. ↑: Move the prism away to the station positon.		
(12) Press CRD, move the prism up or down to make the displayed height difference value to be 0 m(When the value is near to 0 m, there are 2 arrows displayed on the screen). When all the values which display on the 2nd, 3rd , 4th lines are 0, the current position is the required position. The meaning of the arrow: ↑: Move the prism up ↓: Move the prism down		
(13)Press [ESC] key to the "Chainage and Offset Setting Screen", set out the next point from step 4.		

Note:

Any time press [ESC] key to the "Chainage and Offset Setting Screen", it is possible to input a new point and perform setting-out. To return to previous screen, press [ESC] key on the "Point Number Screen."

It allows to change Target Height by pressing the key FNC.

Explanation for the main set out screen:



SLOPE: The key is used in slope set out. (Press FNC key)

LOFS: The key is use in setting out the left side stake. Press it to display the offset and the height difference

of the left side stake.

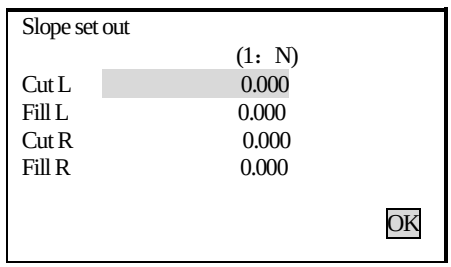
ROFS: The key is use in setting out the right side stake. Press it to display the offset and the height difference of the right side stake.

+CHG: The key is use in increasing the chainage.

-CHG: The key is use in discreasing the chainage.

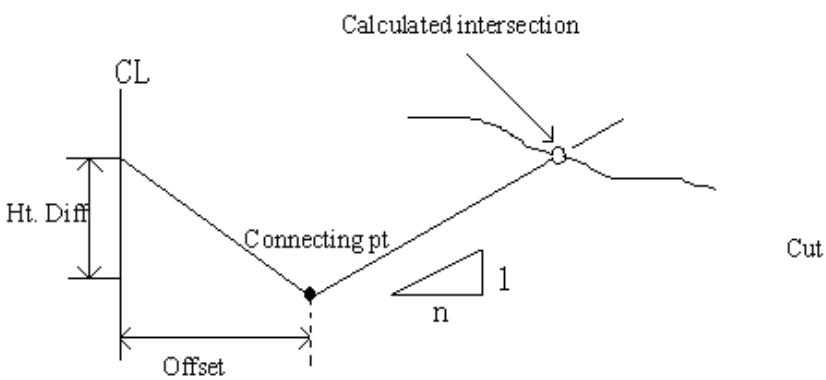
19.2.4 Slope Setout

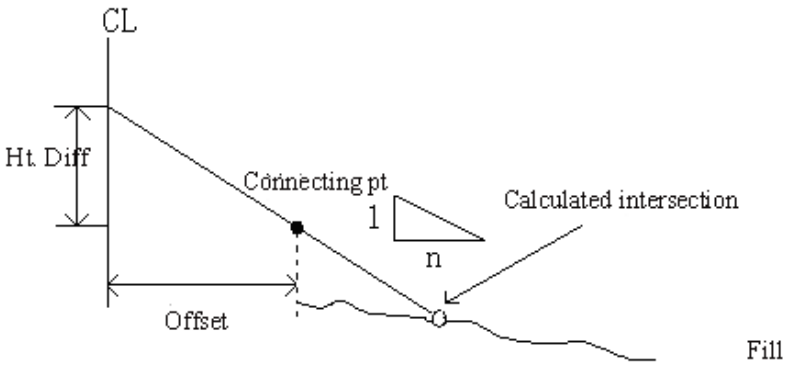
Slope setting-out can be performed as part of the Alignment setout option. After defining vertical curve and horizontal alignment in the "Define Roads Menu", it is possible to perform slope setting-out. Press F4 (SLOPE) key, Slope Setout will be displayed.



The left and right slopes may be entered for both cut and fill. Enter the required slopes using positive numbers for both cut and fill. The software selects the appropriate slope from the table depending on whether the situation is on the left or right and in cut or fill.

Cut or fill is determined by the estimated level at the offset of the hinge point. If the level is above the level of the hinge then the cut slope is used, otherwise the fill slope is used.





▶PROCEDURE

Operating Procedure	Operation	Display
(1) Press SLOPE in the screen of alignment setting-out chainage and offset.	SLOPE	Alignment Setout Chain: 1000.000 3 Offset: -2.150 HT. Diff: -0.150 Tgt.H : 2.000 m P2 LOFS ROFS +CHG SLOPE
(2) Input cut/fillslope, and press ENT. After inputting slope, press OK to save the data.	Input slope + OK	Slope Setout (1: N) Cut L : 0.000 Fill L : 0.000 Cut R : 0.000 Fill R : 0.000 OK
(3) Choose LEFT or RIGHT using function keys.	L or R	Slope Setout Choose (L) or (R) Cut L: 2.150 Fill L: 0.000 Cut R: 2.150 Fill R: 0.000 LEFT RIGHT
(4) Enter the screen of slope setting-out.		Slope Setout 3 S m ZA 96°15'29" HAR 295°00'02" MEAS STOP

<table>
<tr>
<td>(5) Sight the point that to be intercepted near the slope, press MEAS to start slope setting-out. It chooses proper slope from the data input in previews PROCEDURE. Supposes the height of target point is level benchmark, and calculate the point to be intercepted. The offset from measured point to calculated point is displayed.
The indication of arrow:
↓: Move prism towards station point.
↑: Move prism away from station point.
←: Seeing from station point，move prism to the left.
→: Seeing from station point，move prism to the right.</td>
<td></td>
<td>Setout

Setout PSM = 0
PPM = 0
Fine “S”

STOP

Slope Setout

↑ 7.670
← -1.001
S 2.341 m
ZA 96°15′29″
HAR 295°00′17″
MEAS STOP</td>
</tr>
<tr>
<td>(6) Move prism according to the indication of screen, press MEAS. When 2 arrows are shown in the third and fourth line of the screen, it means the setting-out point is found.</td>
<td>Move prism + MEAS</td>
<td>Slope Setout
↑↓ 0.000
←→ -0.001
S 2.341 m
ZA 56°10′29″
HAR 95°20′17″
MEAS STOP</td>
</tr>
<tr>
<td>(7) Press ESC to return to the screen of choosing slope.
Set out the next point fron STEP 4.</td>
<td></td>
<td>Slope Setout
Choose (L) or (R)
Cut L: 2.150
Fill L: 0.000
Cut R: 2.150
Fill R : 0.000
L R</td>
</tr>
</table>

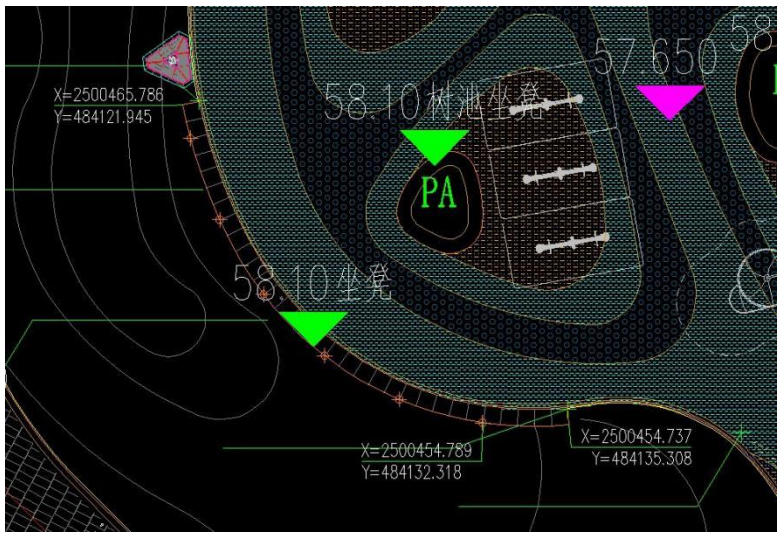
1) An intersection can not be computed if the ground surface passes through the hinge point.
2) The cut is not displayed because the cut at the computed point is zero.

19A: SETTING OUT ARC

You can define an arc by inputting the start point, end point, radius of the arc, then input Arc Length and Offset to calculate the setout point coordinate and perform a setout.

Please see a sample data as below:

	N	E
Start Point	2500454.737	484135.308
End Point	2500461.017	484123.613
Verification Point (arc length 3m)	2500454.789	484132.318
Radius of the Arc	11.707 m	



Operating Procedure	Operation	Display
(1) Choose "10. Setting-out arc" in the 2nd page of MENU screen.	Choose 10. Setting-out Arc	Menu (2) 6. Resection 7. Repetition 8. Area 9. Roads 10. Setting-out arc
2) Choose "4. Define ref. arc"	4. Define Ref.arc	Setting-out arc 1. Stn data 2. Back sight data 3. Set-out 4. Define ref. arc 5. EDM
(3) Input start point coordinate then press F4 OK, it goes to end point input screen. Or press F1 to read from memory	Input Coord. + F4 OK	Start pt SPN: 2500454.737 SPE: 484135.308 SPZ: 0.000 READ OK

(4) Input end point coordinate then press F4 OK. It goes to Radius input screen.	Input Coord. + F4 OK	End pt SPN: 2500461.017 SPE: 484123.613 SPZ: 0.000 READ OK
(5) Input Arc Radius then press F4 OK. It goes back to setout screen.	Input Radius + F4 OK	Input arc r Arc r: 11.707 m READ OK
(6) In "Setting-out Arc" screen, set Station and Backsight point, choose "3. Set-out". It goes to Setout Point input screen.	Move prism + MEAS	Setting-out arc 1. Stn data 2. Back sight data 3. Set-out 4. Define ref. arc 5. EDM
(7) Input Arc Length and Offset, press OK. *1 *2	Input Arc Length + OK	Input pt. position Arc L: 0.000 m Offset: 0.000 m OK
(8) The screen shows setout point coordinate, press F4 OK to start setout. For the procedures you can refer to coordinate setout. If you need to record setout point, press F1 REC.		Set-out (1) Np: 2500454.791 Ep: 484132.317 Zp: 0.000 Tgt.h.: 0.000 m REC. READ OK

*1. When you input only Arc Length, keep Offset value be 0, the setout point will be on the arc. Arc Length is distance from start point to setout point. It is part of the arc, not straight line.

Arc Length can be positive or negative. Under the designed coordinate system:
If the arc from the start point to end point turn to right, it is positive (counter clockwise)
If the arc from the start point to end point turn to left, it is negative (counter clockwise)

*2. When you input both Arc Length and Offset. The setout point is on the line from "center of the circle" to the "Arc Length Point". Offset is the distance from "center of the circle" to setout point.

Offset can be positive or negative. Under the designed coordinate system:

If the setout point is on the direction from "center of the circle" to the "Arc Length Point", Offset value is positive.

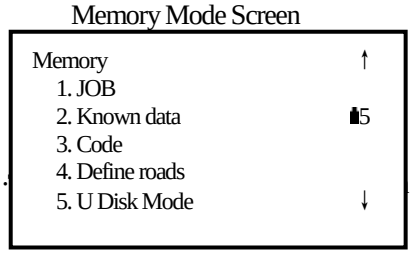
If the setout point is on the negative direction of above, Offset value should be negative.

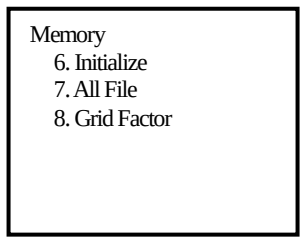
PART 4 DATA RECORDING

This section explains JOB or memory settings which can be performed in Memory Mode and data recording methods which can be performed in Record Mode.

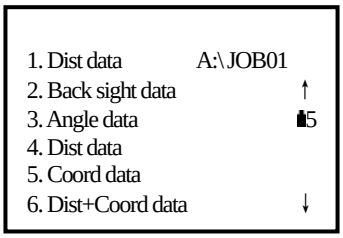
·Press MEM in Date/ time Screen to enter Memory Storage screen.

Memory Mode Screen



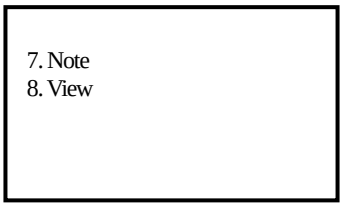


Record Mode Screen



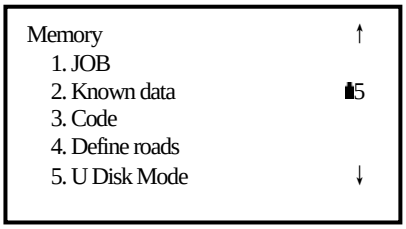
·To enter Record Mode, press REC in "MEAS Mode Screen".

·Press ESC to return to previous screen.



20 SETTING IN MEMORY MODE

Memory Mode Screen



·To enter Memory Mode, press MEM in the "Status Screen"

· In Memory Mode, it is possible to perform settings concerning JOB and memory.

·JOB selection

·Deleting a JOB

·Registering Coordinate Data in Memory

Clearing Coordinate Data from Memory

·Reviewing Coordinate data

·Inputting codes

·Reviewing codes

·Outputting JOB data to the computer

20.1 JOB Selection

20.1.1 Current JOB Selection

Before recording data, select the JOB in which it is to be recorded. The following data can be recorded in JOB.

·Measurement results ·Instrument station data ·Notes

▶PROCEDURE

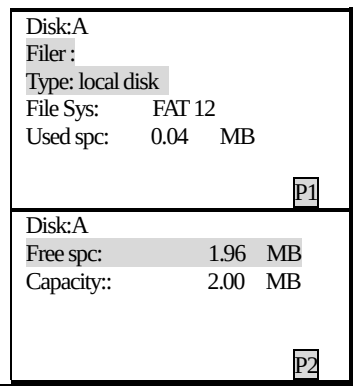
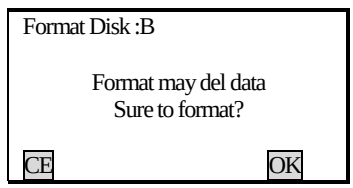
Operating Procedure	Operation	Display
(1) Select "1. JOB" in the "Memory Mode Screen" and press ENT (or press numeric key 1), the "JOB Management Screen" is displayed.	"1. JOB" + ENT	Mem./ JOB 1. JOB selection 2. Coord read JOB 3. JOB Export 4. Coord . import 5. comms output
(2) Select "1. JOB Selection" then press ENT (or press numeric key 1).	"1. JOB Selection" + ENT	JOB selection Job : J0B1 LIST OK

(3) imput the file name then press F4 OK. Or press F1 LIST to choose an existed job. Press ENT to confirm Note: when you input file name, press SFT to switch between number and alphabet.	▲ or ▼ + List	JOB selection Job : J0B2 LIST OK * JOB01 [JOB] * JOB02 [JOB] ATTR SRCH EXIT P1
(4) Finish the imputting and return to previous menu	ENT	Mem./ JOB 1. JOB selection 2. Coord read JOB 3. JOB Export 4. Coord . import 5. comms output

20.1.2 Check Memory Status and Format the Disk

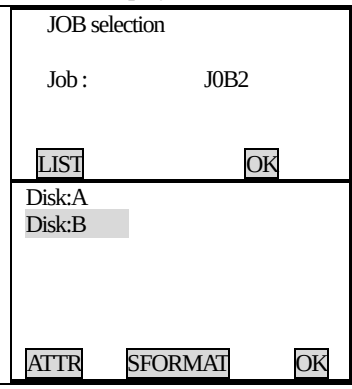
Below operations are to check memory size, free space, data format.

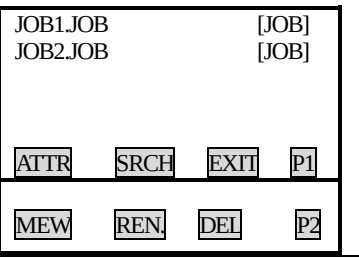
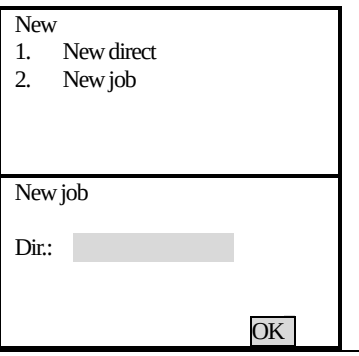
Operation	key	display
(1) Enter "job selection" Screen.		JOB selection Job : J0B2 LIST OK
(2) LIST Enter disk list **Disk: A** local disk **Disk: B** SD card (does not support file name or directory name in Chinese). When operating the data file in the SD card, please do not put out the SD card, otherwise the surveying data may be lost or be damaged.	LIST	Disk:A Disk:B ATTR FORMAT OK

(3) ATTR to check the disk space ESC to return to previous menu		
(4) FORMAT Enter the interface for formatting OK Start formatting (the data will not be recovered forever) CE **Cancel** the operation for formatting		

20.1.3 Create new working job

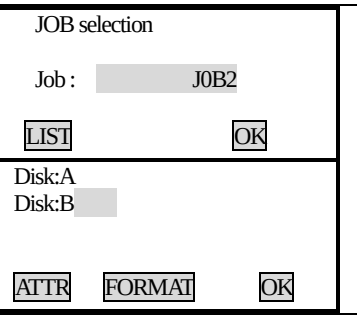
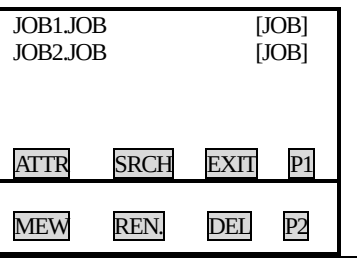
To creat a new working job, the Job name can be from A-Z, or 0-9. The first character can not be **Space**. Using an exsited job name is not allowed.

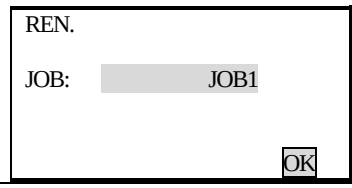
Procedure	Key	Display
(1) Enter the "Job Selection" screen. Press LIST to enter disk list. Choose a disk for creating new job. Press OK to enter job list	LIST OK	

(2) Press P2 to enter the second page. Press NEW to create new list.		
(3) Select "2 New job" to create new file OK Finish the creation for new job and return to previous menu. The user can create new job in local disk and SD card.		

20.1.4 Change Job name

Job name can be edited through the below operation.

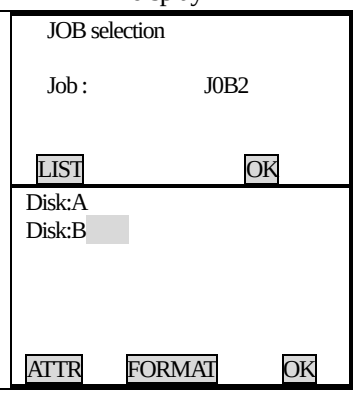
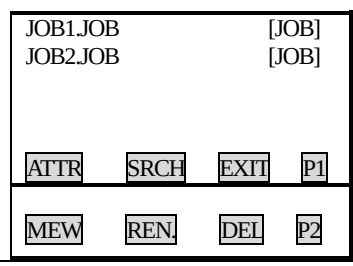
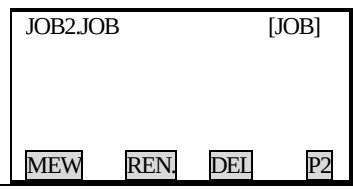
Procedure	Key	display
(1) Enter the "Job Selection" screen. LIST Enter disk list and choose a disk for creating new job. OK Enter job list.	LIST OK	
(2) Enter " page 2" by pressing P1		

(3) Press REN. to enter the screen for changing job name. OK Finish the operation and return to previous menu		

20.1.5 Delete Job

This function is to clear the data in working job.

If the data in JOB file was deleted, the filename which have been changed will restore to its default name automatically.

Procedure	Key	display
(1) Enter the "Job Selection" screen. LIST Enter disk list and choose a disk for creating new job. LIST Enter job list.	LIST OK	
(2) Enter " page 2" by pressing P1		
(3) Press DEL it displays the selected job. Confirm for delete it.	DEL	
(4)Press OK to finish deletion and turn back to previous menu.	OK	

20.1.6 Coordinate Selection

Coordinates can be selected through below operation.

▶PROCEDURE

Operating Procedure	Operation	Display
(1) Select "1. JOB" in the "Memory Mode Screen" and press ENT (or press numeric key 1), the "JOB Management Screen" is displayed.	"1. JOB" + ENT	Mem./ JOB (1) 1 JOB selection 2. Coord. read JOB 3. JOB Export 4. Coord. import 5. Comms Output
(2) Select "2. Coord read JOB" then press ENT (or press numeric key 2).	2. Coord read JOB " + ENT	Coord. Read JOB Job : J0B1 LIST OK
(3) Input the filename to be selected. Press ▲or ▼key to move the cursor onto the file needs to be changed, press LIST key. All jobs will be displayed in 4 pages, the numbers on right side show the record amount.	▲ or ▼ + LIST	JOB selection Job : J0B2 LIST OK * JOB01 20 * JOB02 8 ATTR SRCH EXIT P1
(4) Finish the imputting and return to previous menu	ENT	Mem./ JOB (1) 1. JOB selection 2. Coord. read JOB 3. JOB Export 4. Coord. Import 5. Comms output

20.1.7 Job Export

This operation requires USB pen drive. It is to export working job from local disk to USB pen drive. The exported file will be transformed to .txt, SDR, CSV format.

▶PROCEDURE

Operating Procedure	Operation	Display
(1) Select "1. JOB" in the "Memory Mode Screen" and press ENT (or press numeric key 1), the "JOB Management Screen" is displayed. Insert a USB pen drive to total station USB port.	"1. JOB" + ENT	Mem./ JOB (1) 1 JOB selection 2. Coord. read JOB 3. JOB Export 4. Coord. import 5. Comms Output
(2) Select "3. JOB Export" then press ENT (or press numeric key 3).	"3. JOB Export" + ENT	Select a job Job : J0B1 LIST OK
(3) Then input the filename. Or press LIST to enter Job list and choose job. Then press ENT.	▲ or ▼ + LIST	File output Job: JOB2 LIST OK * JOB01 20 * JOB02 8 ATTR SRCH EXIT P1
(4) The operation as right		Job Export From A\job. Job To B:\JOB. TXT EXIT Finishing
(5)Finish the imputting and return to previous menu		Mem./ JOB (1) 1 JOB selection 2. Coord. read JOB 3. JOB Export 4. Coord. import 5. Comms Output

20.1.8 Coordinate Import

It is to transfer coordinate data from USB pen drive to total station memory.

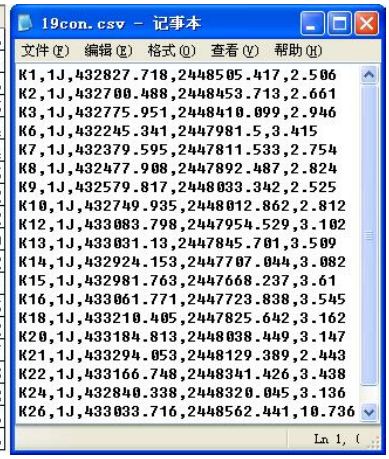
It is not allowed to transfer between two jobs which are all exisited in Local disk.

▶PROCEDURE

Operating Procedure	Operation	Display
(1) Select "1. JOB" in the "Memory Mode Screen" and press ENT (or press numeric key 1), the "JOB Management Screen" is displayed. Insert a USB pen drive which is loaded with known coordinates.	"1. JOB" + ENT	Mem./ JOB (1) 1 JOB selection 2. Coord. read JOB 3. JOB Export 4. Coord. import 5. Comms Output
(2) Select "4. Coord . import" then press ENT (or press numeric key 4) Imput the filename. Or press LIST to enter Job list and choose job. Then press ENT.	"4. Coord . import" + ENT	Select a job Job : J0B1 LIST OK
(3) Choose the CSV file from the USB pen drive.		JOB1. TXT JOB1. SDR JOB1. CSV EXIT
(4) The operation as right		Coord. Import From B: \ JOB1. CSV From A \ job1. Job EXIT Finishing
(5)Finish the imputting and return to previous menu		Mem./ JOB (1) 1 JOB selection 2. Coord. read JOB 3. JOB Export 4. Coord. import 5. Comms Output

* 1. The data format to import should be: point name, code, E, N, Z, see sample below:

	A	B	C	D	E
1	K1	1J	432827.718	2448505.417	2.506
2	K2	1J	432700.488	2448453.713	2.661
3	K3	1J	432775.951	2448410.099	2.946
4	K6	1J	432245.341	2447981.5	3.415
5	K7	1J	432379.595	2447811.533	2.754
6	K8	1J	432477.908	2447892.487	2.824
7	K9	1J	432579.817	2448033.342	2.525
8	K10	1J	432749.935	2448012.862	2.812
9	K12	1J	433083.798	2447954.529	3.102
10	K13	1J	433031.13	2447845.701	3.509
11	K14	1J	432924.153	2447707.044	3.082
12	K15	1J	432981.763	2447668.237	3.61
13	K16	1J	433061.771	2447723.838	3.545
14	K18	1J	433210.405	2447825.642	3.162
15	K20	1J	433184.813	2448038.449	3.147
16	K21	1J	433294.053	2448129.389	2.443
17	K22	1J	433166.748	2448341.426	3.438
18	K24	1J	432840.338	2448320.045	3.136
19	K26	1J	433033.716	2448562.441	10.736



* 2. You can edit data by Microsoft Office (Excel) , then save as .CSV format. File name can be with number and alphabet.

20.1.9 Comms output

It allows to output working jobs from instrument to computer.

▶PROCEDURE

Operating Procedure	Operation	Display
(1) Select "1. JOB" in the "Memory Mode Screen" and press ENT (or press numeric key 1), the "JOB Management Screen" is displayed.	"1. JOB" + ENT	Mem./ JOB (1) 1 JOB selection 2. Coord. read JOB 3. JOB Export 4. Coord. import 5. Comms Output
(2) Select "5. Comms output" then press ENT (or press numeric key 5)	"5. comms output" + ENT	Select a job Job : J0B1 LIST OK

(3)Choose the job name and press ENT to start output.		Comms output Transfer: USB Job: A:\ Job1. JOB Sending STOP Finishing
(5)Finish the imputting and return to previous menu		Mem./ JOB (1) 1 JOB selection 2. Coord. read JOB 3. JOB Export 4. Coord. import 5. Comms Output

20.1.10 Comms input

It allows user to transfer data from computer to total station and restore it in working jobs.
First, edit the coordinate data by KOLIDA data transmission software in the computer
Second, set the data communication parameters in total station and computer.

Operating Procedure	Operation	Display
(1) Select "1. JOB" in the "Memory Mode Screen" and press ENT (or press numeric key 1), the "JOB Management Screen" is displayed. Enter page 2.	"1. JOB" + ENT	Mem./ JOB (1) 1 JOB selection 2. Coord. read JOB 3. JOB Export 4. Coord. import 5. Comms Output Mem./ JOB (2) 6. Comms input 7. Key in Coord.
(2) Select "6. Comms input" then press ENT (or press numeric key 6).	"6. Comms input" + ENT	JOB selection Job : J0B1 LIST OK

(3)Choose the job name and press ENT to start input.		Comms input Transfer: USB Job: A \ job. Job Receiving STOP
(4)Finish the imputting and return to previous menu		Mem./ JOB (2) 1 Comms input 2. Key in Coord.

20.1.11 Transfer coord data to job

User can imput coordinate data into working job.

Operating Procedure	Operation	Display
(1) Select "1. JOB" in the "Memory Mode Screen" and press ENT (or press numeric key 1), the "JOB Management Screen" is displayed. Enter page 2	"1. JOB" + ENT	Mem./ JOB (1) 1 JOB selection 2. Coord. read JOB 3. JOB Export 4. Coord. import 5. Comms Output Mem./ JOB (2) 6. Comms input 7. Key in Coord.
(2) Select "7. Key in Coord." then press ENT (or press numeric key 7).	"7. key in coord" + OK	Select a job Job : LIST OK
(3) Choose a Job name or Create a new job name. (or press LIST to choose from local disk or SD card). OK to Confirm.	OK	Select a job Job : J0B1 LIST OK

(4)All the coordinates are listed now.. Press ADD to enter the Coordinate Data input screen.	ADD	Pt 101 Pt 102 Pt 103 VIEW SRCH DEL ADD
(5)Input the coordinates value N E Z, point name, and code.		N: 0.000 m E: 0.000 m Z: 0.000 m Pt.: 001 Code: KOLIDA REC. CODE
(6)After finish the imput, press REC. to record the known point. Press ESC to return to previous menu. ADD to continue imputing new point.		N: 100.000 m E: 10.000 m Z: 1.000 m Pt.: 001 Code KOLIDA REC CODE

20.2 Known point Data Import

·It is possible to register coordinate data in memory in advance. The coordinate data which has been registered can be output during setting for use as instrument station, backsight station, known point, and setting-out point coordinate data.

·Coordinate data is stored in a part of the memory separated from JOB data.

·There are two registration methods: key entry and entry from an external instrument.

20.2.1. Input coordinate of known point

▶PROCEDURE

Operating Procedure	Operation	Display
(1) Select "2. Known data" in "Memory Mode Screen" and press ENT (or press numeric key 2), the "Known Point Menu Screen" is displayed.	"2. Known data" + ENT	1. Key in coord 2. coord import 3. coord export 4. comms input 5. comms output 6. clear

(2) Select "1. Key in coord" and press ENT, the "Coordinate Data Entry Screen" is displayed. Press ADD to set the following items: N, E, Z coordinate values, point name, code. After each entry press ENT.	"1. Key in coord" + ENT + ADD	N: 110.000m N: 100.000m N: 10.000m Pt.: 001 Code: KOLIDA REC
(4) Press REC to record the coordinate value into memory, next it is possible to enter other coordinate data. After the registration of all the coordinate data has been completed, press ESC to return to the "Known Point Menu Screen". Maximum point number size: 14 characters	REC + ESC	1. Key in coord 2. coord import 3. coord export 4. comms input 5. comms output 6. clear

NOTE: Coordinates input range: -99999999.999 to +99999999.999 (m)

20.2.2 Known Coordinate data import

It is to import data (.txt file) from SD card to a specified file in Local Disk.

▶PROCEDURE

Operating Procedure	Operation	Display
(1) Select "2. Known data" in "Memory Mode Screen" and press ENT (or press numeric key 2), the "Known Point Menu Screen" is displayed.	"2. Known data" + ENT	Mem./ Known 1. Key in coord 2. coord import 3. coord export 4. comms input 5. comms output 6. clear
(2) Select "2. Coord import" and press ENT, to enter the display for coord import, input or import the data job name. (or press LIST to choose the .txt file in SD card). Press OK.	"2. coord import" + ENT	File import Job LIST OK
(2) Import starts now.		Import cood From B:\ JOB1.TXT To A: \ coord.PTS QUIT Data import accomplihed

20.2.3 Known Coordinate data export

It realizes the data transmission from local disk to the ".TXT file" in SD card.

PROCEDURE

Operating Procedure	Operation	Display
(1) Select "2. Known data" in "Memory Mode Screen" and press ENT (or press numeric key 2), the "Known Point Menu Screen" is displayed.	"2. Known data" + ENT	1. Key in coord 2. coord import 3. coord export 4. comms input 5. comms output 6. clear
(2) Select "3. coord export" and press ENT, to enter the display for coord output, input or import the data job name. (or press LIST to choose the .txt file in SD card). Press OK.	"3.Coord export" + ENT	File output Job LIST OK
(3) After the export of all the coordinate data has been completed, it returns to the "Known Point Menu Screen".		Job Export From A:\ Coord.PTS To B:\ JOB1.TXT ESC Data export accomplished.

20.2.4 Entering coordinate data from computer

The format of the coordinate data is the SDR33. There are two formats, see below:

1. /Dg 123.456, -1234.123, 12.345, BE122 CODE[SUM]CRLF

a b c d e f

Data identification code

N coordinate

E coordinate

Z coordinate

2. The coordinate format which is provided by KOLIDA software.

Point number,, E, N, Z CRLF

First, edit coordinate format with KOLIDA communication software on computer.

Second, set communication parameters on total station. (Refer to "23.1Changing Instrument Parameters")

Operating Procedure	Operation	Display
(1) Select "2. Known data" in the "Memory Mode Screen" and press ENT to show the "Known Point Menu Screen".	"2. Known data" + ENT	1. Key in coord 2. coord import 3. coord export 4. comms input 5. comms output 6. clear
(2) Select "4. Comms input" and press ENT, the "Data Format Display Screen" is displayed. Press ENT again, start data reception. The received data amount is showed on the bottom of the screen.	"4.Comms input" + ENT	Comms input Transfer: USB Job: A:\COORD. PTS Receiving STOP
(4) Data input finished, display returns toknow data screen.		1. Key in coord 2. coord import 3. coord export 4. comms input 5. comms output 6. clear

☆ **Note：** Before performing communication between KTS and other equipments, make sure that their communication parameters should be equal.（Refer to "23.1 Changing Instrument Parameters"）

20.2.5 Sending known point data to computer

Operation Procedure	Key	Display
(1) Under memory mode choose "2. Known data"and press ENT to enter known point screen.	"2. Known data" + ENT	1. Key in coord 2. coord import 3. coord export 4. comms input 5. comms output 6. clear
(2) Choose"5. Comms output"and press ENT.The machine starts sending known data,then sending data amount shows in the bottom of the screen.	5. comms output + ENT	Comms output Transfer: USB Job: A:\COORD. PTS Sending STOP
(4) Data output finished, display returns toknow data screen.		1. Key in coord 2. coord import 3. coord export 4. comms input 5. comms output 6. clear

20.2.6 Clearing Coordinate Data from Memory

This operation is for deleting all coordinate data in internal memory.

Operation Procedure	Key	Display
(1) Under memory mode choose "2. Known data"and press ENT to enter known point screen.	"2. Known data" + ENT	1. Key in coord 2. coord import 3. coord export 4. comms input 5. comms output 6. clear
(2) Choose"6. clear "and press ENT. To enter the display for data clearing. YES to delete, NO to cancel.	6. clear + ENT	Known data Clear confirm ? NO YES
(4) data clear, display returns to known data screen.		1. Key in coord 2. coord import 3. coord export 4. comms input 5. comms output 6. clear

20.3 Input Codes

- It is possible to save codes in memory.
- It is possible to read in codes registered in memory when recording instrument station data or observation data.

▶PROCEDURE

Operating Procedure	Operation	Display
(1) Select "3. Code" in the "Memory Mode Screen" and press ENT (or press numeric key 3), the "Code menu screen" is displayed.	"3. Code" + ENT	Mem./Code 1. Key in code 2. Code import 3. receive code 4. Clear list
(2) Select "1. Key in code" and press ENT (or press numeric key 1).	"1. Key in code" + ENT	VIEW SRCH DEL ADD

(3) ADD to input code OK to record the code. ESC to finish inputing The max. length is 16 characters	ADD OK	Mem./Code 1. Key in code 2. Code import 3. receive code 4. Clear list

20.3.1 Code import

▶**PROCEDURE**

Operating Procedure	Operation	Display
(1) Select "3. Code" in the "Memory Mode Screen" and press ENT (or press numeric key 3), the "Code menu screen" is displayed.	"3. Code" + ENT	Mem./Code 1. Key in code 2. Code import 3. receive code 4. Clear list
(3) Select "2. Code import " and press ENT (or press numeric key 2).	2. Code import + ENT	File import Job: LIST OK

20.3.2 Receive code

Receive the data from computer and save in specified working job.

▶**PROCEDURE**

Operating Procedure	Operation	Display
(1) Select "3. Code" in the "Memory Mode Screen" and press ENT (or press numeric key 3), the "Code menu screen" is displayed.	"3. Code" + ENT	Mem./Code 1. Key in code 2. Code import 3. receive code 4. Clear list
(2) Select ". 3. receive code " and press ENT (or press numeric key 1).	3. receive code + ENT	Mem./Code 1. Key in code 2. Code import 3. receive code 4. Clear list USB initializating…….

(3)When the transfer is finished. The screen return back to previous menu automatically		Receive code Transfer:USB Job:A:\ PCDDE. LIB Receiving STOP

20.3.3 All clear

All code data in memory can be deleted by this operation

▶PROCEDURE

Operating Procedure	Operation	Display
(1) Select "3. Code" in the "Memory Mode Screen" and press ENT (or press numeric key 3), the "Code menu screen" is displayed.	"3. Code" + ENT	Mem./Code 1. Key in code 2. Code import 3. receive code 4. Clear list
(2) Select "4. Clear list" and press ENT (or press numeric key 4).	4. Clear list + ENT	Code deletion Clear list ? NO YES
(3) YES Confirm for deletion NO Undo the previous operation	YES	Mem./Code 1. Key in code 2. Code import 3. receive code 4. Clear list

Road design

The designs for road data also can be carried out in memory moder, for the operation, please take chapter"19. Road design" as reference

20.4 Memory mode

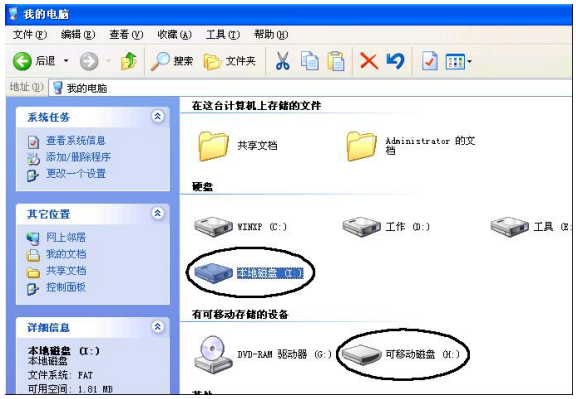
In this mode, user can manage the transferring and editing of file by PC

▶PROCEDURE

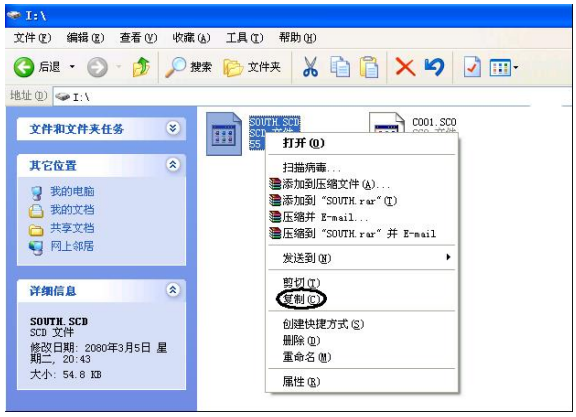
Operating Procedure	Operation	Display
(1) Select "5 U Disk Mode" in the "Memory Mode Screen" and press ENT (or press numeric key 5)	5. U Disk Mode + ENT	Momory(1) 1 JOB 2 Knowm data 3 code 4 define roads 5 U Disk Mode

(2)Enter the display for connecting		U Disk Mode Connected to PC…….. EXIT	

(3)Double click "my computer", you see the local disk I (total station) and mobile disk H (SD card).



(4)Double click local disk I or removable dick H, then choose the file data that you want to edit, right click it and select the "copy command" in the popup menu.



(5)Enter removable disk H, paste the file to removable disk by selecting the copied item in the popup menu. Moveover, the popup menu also supports the deleting and editing of file data. By pessing [ESC] on the keyboard of KTS-442UT, disconnects the computer and returns to data communication menu.

20.5 Initialization

This operation restores instrument parameters to factory default settings and clear all data.

Below settings will be restored by initialization.

① Observation condition:

Atmosphere correction, vertical angle format, tilt correction, measurement type, auto power off, coordinate unit, minimim angle display, minimum distance display, keyboard buzzer, same (or different) result of coordinate measurement by measuring with face left/ right.

②Communication setting:

Baud rate, data bit, parity, stop bit, check sum, flow control.

③Unit:

Temperature, air pressure, angle and distance unit.

④Distance measurement setting:

Temp., pressure, atmosphere correction factor (PPM), prism constant correction value (PC), distance measurement mode.

⑤Key function:

Factory setting for key function.

Below data will be initialized

1. data in all jobs
2. data in interior memory.
3. code in interior memory.

Operating Procedure	Operation	Display
(1) Select "6. initialize "and press ENT (or press numeric key 6),	"6.initialize" + ENT	Memory (1) 1. JOB 2. known data 3. code 4. define roads 5. U disck mode Memory (2) 6. initialize 7. all file 8. grid factor
(2) YES :Confirm for initialization. NO: Cancel initialization.	YES	Initialize Restore factory set Are you sure ? NO YES
(3)Finish initialization and return to previous menu.		Initialize partameter Initializing …….. Please waiting …….

20.6 All documents

Operating Procedure	Operation	Display
(1) Select "7. All file " in Memory Mode Screen" and press ENT (or press numeric key 7),	7. All file + ENT	Memory (1) 1. JOB 2. known data 3. code 4. define roads 5. U disck mode Memory (2) 6. initialize 7. all file 8. grid factor
(2) OK:enter the display for all file.	OK	Disk:A Disk:B ATTR Format OK

(3)Show file list PCODE. LIB code fixed file COORD. PTS known data Those two files are system file , which could not be deleted or changed. JOB1.JOB job file JOB1.HAL horizontal alignment file JOB1.VCL vertical curve file JOB1.TXT text file		PCODE. LIB [CODE] COORD. PTS [Know] JOB1.JOB [JOB] JOB1.HAL [HZAL] JOB1.JVCL [VTAL] ATTR SRCH EXIT P1

20.7 Setting for Grid Factor

When calculating coordinates, measured horizontal distance should be multiplied by scale factor. The raw data will not be changed by scale factor.

Formula:

1. Height factor = $\frac{R}{R + ELEV}$

R ：the average radius of the earth

ELEV：the average height of sea level

2. Scale factor

Scale factor：the scale factor of station point

3. Grid factor

Grid factor = height factor ×scale factor

Distance calculation

1. Grid distance

HDg = HD ×grid factor

HDg：Grid distance

HD ：ground distance

2. Ground distance

HD = HDG/ grid factor

Note： 1. Input range of scale factor: 0.990000 ～ 1.010000 Default value: 1.00000.

2. The input range of average altitude：-9999.8 ～ 9999.8.

Average altitude keeps 1 digit after radix point, default value is 0.

Operation procedure	Key	Display
(1)Select "8. Grid factor" in Memory Mode Screen" and press ENT (or press numeric key 8).	"8. Grid factor" + ENT	Memory (1) 1. JOB 2. known data 3. code 4. define roads 5. U disck mode Memory (2) 6. initialize 7. all file 8. grid factor
(2) It displays current setting. Input elevation and scale factor, press ENT key.	Input elevation + ENT Input scale factor + ENT	Grid Factor =1.000000 Elevation: 1.000m Scale : 1.000000 5 OK
It gets grid factor., returns to the previous screen.		Memory (2) 6. initialize 7. all file 8. grid factor

21. DATA RECORDING IN RECORD MODE

Record Mode Screen

1. Stn data A:\JOB01
2. back sight data
3. angle data
4. dist data
5. Coord data
6. dist+ coord data

7. Note A:\JOB01 ↑
8. view
↓

To enter Record Mode, press REC in the "MEAS Mode Screen."

Operations concerning the regarding of data can be performed in Record Mode.

Recording Distance Measurement Data.

Recording Angle Measurement Data.

Recording Coordinates Data.

Recording Station Point Data.

Recording backsight point Data.

Recording notes.

Reviewing JOB data.

21.1 Recording Instrument Station Data

It is possible to record instrument station data in a JOB.

The items which can be recorded are the instrument coordinates, point number, codes, instrument height, operator,

date, time, weather, wind, temperature, air pressure, atmospheric correction factor, target type, prism constant correction value, and distance measurement method.

▶PROCEDURE

Operating Procedure	Operation	Display
(1) Press REC in the second page of MEAS Mode. The "Record Mode Screen" is displayed.	REC.	1. Stn data A:\JOB01 2. back sight data 3. angle data 4. dist data 5. Coord data 6. dist+ coord data
(2) Select "1. Stn data" and press ENT (or press numeric key 4), the present instrument station data is displayed, there are a total of 4 pages. Enter the following data items: Instrument station coordinates Point number Code Instrument height Operator Date and time Weather Wind Distance measurement method Temperature Air pressure Atmospheric correction factor Prism constant correction value	"1. Stn data" + ENT	N0 10.364 E0 234.897 Z0 49.098 Pt. : POINT2000 Inst. h: 1.65 m ↓ SAVE READ OK Code ↑ : Name: : ↓ SAVE CODE OK Date: 2010-08-07 Time: 10: 14: 52 Weat: Fine Wind: Calm Mode: Fine [S] ↓ SAVE OK Temp.: 20 ℃ Press.: 1013.0 hPa PPM : 0 PC : -30 SAVE 0PPM OK
(3) After entering all data, press OK to record the station data and restore the "Record Mode Screen."	OK	1. Stn data A:\JOB01 2. back sight data 3. angle data 4. dist data 5. Coord data 6. dist+ coord data

·Movement of the cursor between items：▲ ▼

·Entry rules：

Read in coordinate：READ

Pt. ： 14 numerals and letters

Code: 16 numerals and letters

Read in code：CODE

Time：pm 3：33：37 enter 153337

Date：Year 2010 month 8 day 7 enter 20100807

·Setting methods and content：

Weather：Press ◀ ▶ to select (clear, cloudy, light rain, rain, snow)

Wind：Press ◀ ▶ to select (calm, gentle, light, strong, very strong)

Mode：Press ◀ ▶ to select (Fine[r], Fine AVG [n], Fine[s], Tracking)

·To set the atmospheric correction factor to 0 ppm: 0PPM

21.2 Recording backsight data

It allows you to record backsight point data by 2 ways：

set backsight point by angle

set backsight point by coordinate

21.2.1 Set backsight point by Angle

It allows you to set backsight azimuth angle by inputting angle value directly.

▶ **Steps**

▶ Operation procedures	Key	Display
(1) Under coordinate measurement screen, usd▲▼ to select "2. Back sight data" p etting(or press numeric key 2), displays as right, choose"1. angle".	"1.Angle"	Back Sight Data 1. Angle 2. Coord.
(2) Input Azimuth and press OK key.	Input angle value + OK	Set Azimuth HAR: OK
(3) Sight at backsight point and press YES.	YES	Set Azimuth Sight BS point HAR: 0°00′00″ NO YES

(4) Finish azimuth z ettingand returns to previous menu		1.Stn data A:\JOB01 2. back sight data 3. angle data 4. dist data 5. Coord data 6. dist+ coord data

21.2.2 Set backsight point by coordinate

You can set backsight azimuth angle by inputting backsight coordinate, the machine calculates azimuth angle by station point coordinate and backsight coordinate.

Operation Procedure	Key	Display
(1) In backsight setting menu, choose "2.coord.".	"2 Coord"	Backsight data 1. Angle 2. Coord.
(2) After inputting backsight point coordinate NBS, EBS, ZBS, after each entry press ENT, then press OK. To use value in memory, press Read Key.	Input backsight point coordinate + ENT + OK	Back sight point NBS : 1382.450 EBS : 3455.235 ZBS : 1234.344 READ OK
(3) the machine calculates backsight azimuth by station point coordinate and backsight point coordinate, screen shows as right.(HAR is the backsight azimuth)		Set Azimuth Sight BS Point HAR: 40°00′00″ NO YES
(4) Sight at backsight point, press YES, finish setting and returns to coordinate measurement menu screen.	YES	1. Stn data A:\JOB01 2. back sight data 3. angle data 4. dist data 5. Coord data 6. dist+ coord data

21.3 Recording Angle Measurement Data

It is possible to record angle measurement data only in a JOB after entering Record Mode.

Once the data has been recorded. REC can not be displayed in order to prevent double recording.

It is convenient to use AUTO to perform automatic operation from angle measurement to recording.

The items which can be recorded are the vertical angle, horizontal angle, point number, code, and target height.

PROCEDURE

Operating Procedure	Operation	Display
(1) Press REC on the second page of the "MEAS Mode Screen".	REC	1. Stn data A:\JOB01 2. back sight data 3. angle data 4. dist data 5. Coord data 6. dist+ coord data
(2) Select "3. Angle data" and press ENT (or press numeric key 3), the "Angle Measurement Data Recording Screen" is displayed.	"3. Angle data" + ENT	REC/Angle ZA 45°18′23″ HAR 87°23′09″ Pt. : POINT2000 ANGLE AUTO
(3) Sight the target and press ANGLE, the measurement results are displayed on line3 and 4 (lines indicated by *) of the "Measurement Data Display Screen". Values with no * are the angle measurement values displayed in real time.	ANGLE	REC/Angle *ZA 76°34′17″ *HAR 64°22′10″ Pt. : POINT2000 REC ANGLE AUTO
(4) Press REC to record the angle measurement data indicated by the "*". Set the following items: point number, code, target height. After each entry press ENT. Maximum point number size: 14(alphanumeric) Maximum code size: 16 (alphanumeric)	REC	*ZA 76°34′17″ *HAR 64°22′10″ Pt. : k2009 Code: KOLIDA Tgt. h: 1.67 m SAVE CODE
(5) Press SAVE to record data. Because the same data can not be recorded a second time. REC is not displayed after recording.	SAVE	REC/Angle Pt.: POINT2000 ZA 45°18′23″ HAR 87°23′09″ ANGLE AUTO
(6) ANGLE :measure the angle again.	ANGLE	REC/Angle *ZA *HAR Pt.: POINT2001 REC ANGLE AUTO

(7) Press ESC to restore the "Record Mode Screen."	ESC	1. Stn data A:\JOB01 2. back sight data 3. angle data 4. dist data 5. Coord data 6. dist+ coord data

··Perform distance measurement to record automatically by pressing a single key: AUTO.

When this key is used, it is unnecessary to perform distance measurement in MEAS Mode. Press AUTO on the "Record Mode Screen" to perform distance measurement and automatically record the results. When this is done, the point number automatically increases from that displayed when the KTS entered Record Mode and the code that was displayed is used unchanged. After measurement has been completed, the results are display for 2 seconds and the screen displayed before AUTO was pressed is restored.

21.4 Recording Distance Measurement Data

- It is possible to record the most recently measured distance measurement data in a JOB. And it is possible to perform and record distance measurements, offset measurements, etc. after entering Record Mode.
- Once the data has been recorded, REC can not be displayed in order to prevent double recording.
- It is convenient to use AUTO to perform automatic operation from distance measurement to recording.
- The items recorded are slope distance, vertical angle, horizontal angle, point number, codes, and target height.

▶ **PROCEDURE**

Operating Procedure	Operation	Display
(1) Perform coordinate measurement in the "MEAS Mode Screen."		Meas. PC -30 ⊥ PPM 0 S 1234.789 m ZA 89°59′54″ HAR 90°01′00″ P2 SD SHV HSET EDM
(2) Press REC on the second page of MEAS Mode.	REC	1. Stn data A:\JOB01 2. back sight data 3. angle data 4. dist data 5. Coord data 6. dist+ coord data

(4) select ". 4. dist data" and press ENT (or press numeric key 4), the measurement results are displayed on lines 2 to 4. (Lines indicated by "*")	"4. Dist data" + ENT	REC/Dist. *S 10.364 m *ZA 76° 34′ 17″ *HAR 64° 22′ 10″ Pt. : 2000 REC OBS OFFS AUTO
(4) Press REC to record the measurement data indicated by the "*". Enter following items: point number, code, target height R.HT. ·KTS automatically increments the last input number by 1 and display it. This point number can be used to record data in the memory or can be changed. Codes registered in advance can be read in by pressing CODE	REC	S 10.364 m ZA 76°34′17″ HAR 64°22′10″ Pt. : 2000 code kolida SAVE R.HT CODE
(5) Check the data and press SAVE. The data is recorded and the number of registrations possible declines by 1. Because the same data can not be recorded a second time. REC is not displayed after recording.	SAVE	REC/Dist. S m ZA 45° 18′ 23″ HAR 87° 23′ 09″ Pt. : 2001 OBS. OFFS AUTO
(6) Press OBS. to measure the distance again in Record Mode.	OBS.	REC/Dist. Dist PC = -30 PPM = 0 Fine "S" STOP
(7) Press ESC to restore the "Record Mode Screen."	ESC	1. Stn data A:\JOB01 2. back sight data 3. angle data 4. dist data 5. Coord data 6. dist+ coord data

·Perform distance measurement to record automatically by pressing a single key: AUTO.

When this key is used, it is unnecessary to perform distance measurement in MEAS Mode. Press AUTO on the "Record Mode Screen" to perform distance measurement and automatically record the results. When this is done, the point number automatically increases from that displayed when the KTS entered Record Mode and the code that was displayed is used unchanged. After measurement has been completed, the results are display for 2 seconds and the screen displayed before AUTO was pressed is restored.

Offset measurement in Record Mode: OFFSET

It is possible to advance through "Offset/Dist" and "Offset/Angle" by pressing OFFSET. See "12. Offset

Measurement" for the procedure.

21.5 Recording Coordinates Data

It is possible to record codes and the measured coordinates data only in a JOB after entering Record Mode.
Once the data has been recorded. REC can not be displayed in order to prevent double recording.
It is convenient to use AUTO to perform automatic operation from angle measurement to recording.
The items which can be recorded are the vertical angle, horizontal angle, point number, code, and target height.

▶PROCEDURE

Operating Procedure	Operation	Display
(1) Perform coordinate measurement in the "MEAS Mode Screen."		Meas. PC -30 ⊥ PPM 0 S 1234.789 m ZA 89°59′54″ HAR 90°01′00″ P2 0SET CRD. S-O REC.
(2) Press REC in the second page of the "MEAS Mode Screen." The "Record Mode Screen" is displayed.	REC	1. Stn data A:\JOB01 2. back sight data 3. angle data 4. dist data 5. Coord data 6. dist+ coord data
(3) Select "5. Coord. data" and press ENT, the measurement results are displayed on lines 2 to 4 (lines indicated by *) of the "Measurement Data Screen."	5. Coord data + ENT	REC/Coord. *N 10.364 *E 234.897 *Z 49.098 Pt. : POINT2000 REC OBS. OFFS AUTO
(4) Press REC to record the measurement data with *. Enter following data: Point number, code, target height.	REC	N 10.364 E 234.897 Z 49.098 Pt. : POINT2000 Code: KOLIDA SAVE R.HT CODE
(4) When the self checking is finished, Press SAVE to record data. System will creates a new point number by adding "1" on the base of last point number. user can use this number directly or create another number by himself In order to avoid duplicate record , the function key REC will not show up until a new measurement happens.	SAVE	REC/Coord. *N *E *Z Pt.: POINT2000 OBS. OFFS AUTO

(6) Press OBS to measure the coordinates again in Record Mode.	OBS.	Coordinates Coord. PC = 0 PPM = 0 Fine "S" STOP
(7) Press ESC to restore the "Record Mode Screen."	ESC	1. Stn data A:\JOB01 2. back sight data 3. angle data 4. dist data 5. Coord data 6. dist+ coord data

Perform distance measurement to record automatically by pressing a single key: AUTO.

When this key is used, it is unnecessary to perform distance measurement in MEAS Mode. Press AUTO on the "Record Mode Screen" to perform distance measurement and automatically record the results. When this is done, the point number automatically increases from that displayed when the KTS entered Record Mode and the code that was displayed is used unchanged. After measurement has been completed, the results are display for 2 seconds and the screen displayed before AUTO was pressed is restored.

·Offset measurement in Record mode: OFFSET

It is possible to advance through "Offset/Dist" and "Offset/Angle" by pressing OFFSET. See "12. Offset Measurement" for the procedure.

21.6 Recording distance and coordinate data.

The function can measure distance and coordinate at the same time then record distance data and coordinate data seperately in working jobs.

Under record mode, distance measurement data and coordinate data can be saved in working jobs.

To avoid recording data repeatedly, after recording each measured data, before measuring new data, it will not show the REC. function.

Following distance measurement data will be saved： vertical angle, horizontal angle,code, target height.

Following distance measurement data will be saved: N, E, Z coordinate value, point name, target height, code.

Operation Procedure	Key	Display
(1) In REC. menu choose "6. Dist+ Coord. data".	"6. Dist+ Coord data" + ENT	1. Stn data JOB01 ↑ 2. Back sight data 3. Angle data 4. Dist data 5. Coord data 6. Dist+ coord data ↓

(2) Press F4 AUTO, the screen shows as right diagram, the line 2,3,4 (with"*") are measured data. System will creates a new point number by adding "1" on the base of last point number. user can use this number directly or create another number by himself	F4 AUTO	Dist+ Coord 1201 rec *N 100.364 *E 234.897 *Z 49.098 Pt.: SS20004 OBS. OFFS AUTO
Note: If you need to change Target Height (R.HT) / point name/ code, then sight at target point and press F2 OBS. When the measurement is finished, press F1 REC., input the new information. Press ENT after input all data. Press F1 SAVE to save data.		Dist+ Coord 1201 rec *N 100.364 *E 234.897 *Z 49.098 Pt.: SS20004 REC. OBS. OFFS AUTO *N 100.364 ↑ *E 234.897 *Z 49.098 Pt.: SS20004 CODE: ↓ SAVE R.HT CODE
(3) Press ESC to return to record mode screen.	ESC	1. Stn data JOB01 ↑ 2. Back sight data 3. Angle data 4. Dist data 5. Coord data 6. Dist+ coord data ↓

measure coordinate and record distance and coordinate data automatically: AUTO

By using AUTO key, it allows you to measure coordinate and record the result under record mode. The point number will be original number plus 1, codes remain the same.After recording the result will be displayed for 2 seconds and it returns to the previous screen before pressing AUTO.

Offset measurement under Rec. mode: OFFS

(Refer to"12. offset measurement")

21.7 Recording Notes

This procedure prepares note data and records it in the JOB which is selected.

▶PROCEDURE

Operating Procedure	Operation	Display
(1) Press REC in the second page of MEAS Mode. The "Record Mode Screen" is displayed. Enter Page 2.	REC	7. note 8. view

(2) Select "7. Note" and press ENT (or press numeric key 7), the "Note Entry Screen" is displayed and the final note data prepared is displayed.	"7. Note" + ENT	REC./Note KOLIDA SAVE
(3) Enter the note and press SAVE to restore the "Record Mode Screen." Maximum note length: 60 characters	SAVE	7. note 8. view

21.8 Reviewing JOB Data

It is possible to display the data within the JOB which is selected.

In advance allocate the function key to display VIEW. Refer to "22. Key Function Allocation."

It is possible to search for data within the JOB to be displayed by point number, but the note data can not be searched.

▶PROCEDURE

Operating Procedure	Operation	Display
(1) Press REC in the second page of MEAS Mode. The "Record Mode Screen" is displayed.	REC	7. note 8. view
(2) Select "8. view" and press ENT, the "Point Number Display Screen" is displayed. Cursor up or down: ▲or▼ Page previous or next ◀or▶ SRCH Checking by point number DEL Delete point number ADD Add new coordinate	"8. view" + ENT	Pt 101 Pt 102 Pt 103 Pt 104 VIEW SRCH DEL ADD
(3) press VIEW and enter the display as the picture on right. TOP Show the first data LAST Show the last data	VIEW	N 10.364 E 100.145 Z 10.756 Pt. : 1 Code: KOLIDA TOP LAST P1

(4) Press ESC to return to previous menu	ESC	Pt 101 Pt 102 Pt 103 Pt 104 VIEW SRCH DEL ADD
(5) Press ESC again to restore the "Record Mode Screen."	ESC	7. note 8. view

PART 5 MEASUREMENT OPTIONS SELECTION

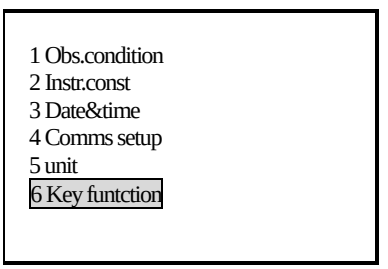
·This section explains the setting of keys functions of KTS-442UT, the setting of parameters, etc.

22. KEY FUNCTION ALLOCATION

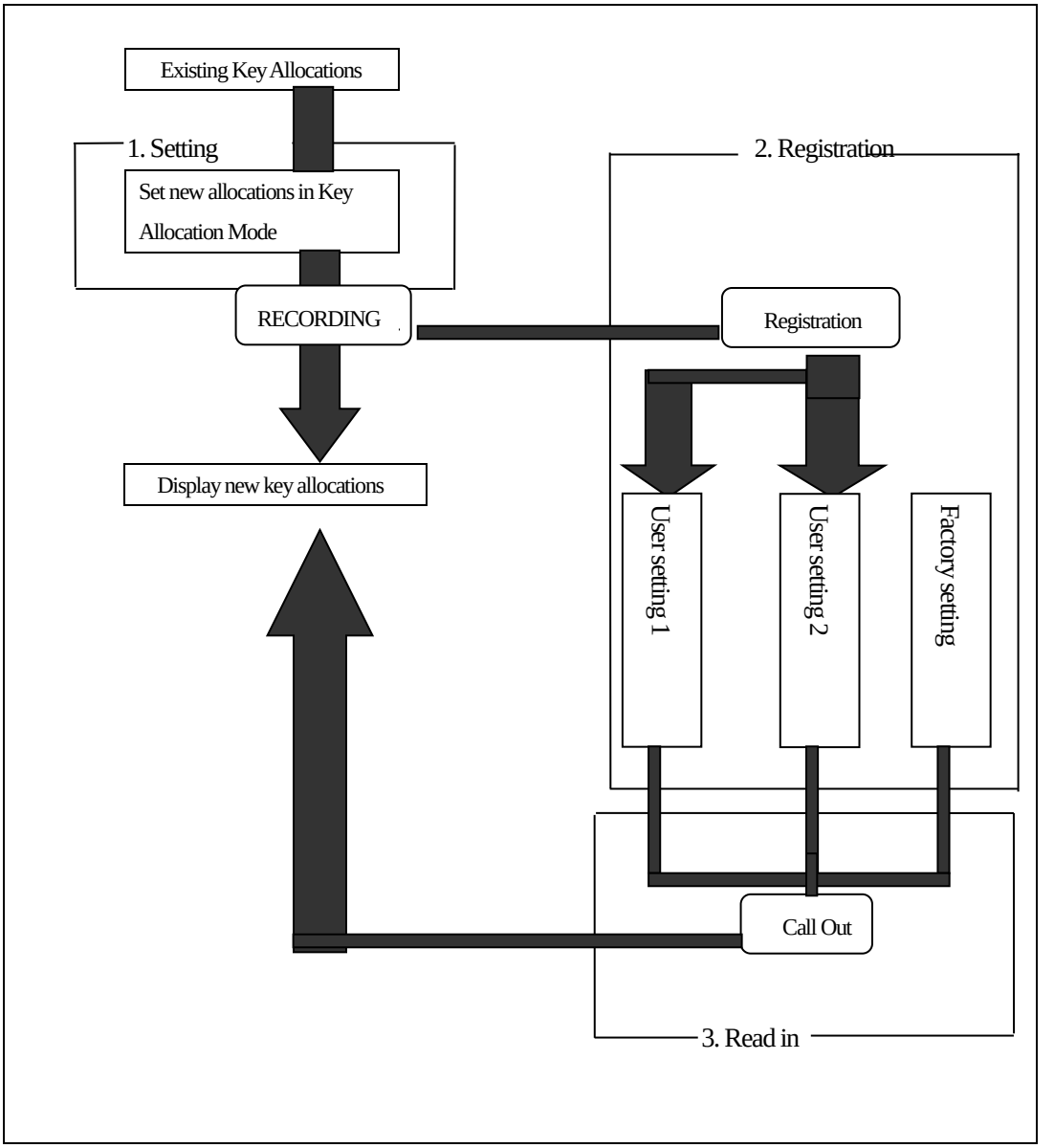
·With the KTS-442UT, it is possible to allocate the soft keys in MEAS Mode to meet measurement conditions. The current soft key allocations are retained forever until they are revised again, even when the power is cut off. Two register locations are available in Internal memory card for users: user setting 1 and user setting 2. User setting keys registered could be resumed at any time.

· It is definite to operate the KTS-442UT efficiently because unique soft key allocations can be preset to suit various applications and the ways that different operators handle the instrument.

·Press CNFG in the "Status Screen," the "setting mode screen" is displayed. Select "6. Key Function" and press either ENT or numeric key 6, to enter the "Key Setting Screen."
The following operations can be performed in the "Key Allocation Mode."



·Key allocation
·Registration of the allocation
·Recalling the allocation



22.1 Allocation and Registration

·It is possible to set new key allocations in the "Key Allocation Screen."
When new key allocations are set, the content of the function keys in MEAS Mode are displayed. This allocation is recorded in the instrument until they are set again.
It is possible to register two kinds of allocations: User setting 1 and User setting 2.

NOTE: When soft key allocations are recorded and registered, the previously recorded settings are cleared.

It is possible to allocate the functions displayed in the "Setting Mode Screen" to the soft keys. The following functions can be allocated to the soft keys.

1) SD, HD, VD: Distance measurement.
2) SHV: Select distance mode (slope distance, horizontal distance, height difference)
3) 0set: Set horizontal angle to 0
4) H. ANG: Set required horizontal angle
5) R/L: Select horizontal angle right/Left
6) REP: Repetition Measurement
7) HOLD: Hold horizontal angle/ release horizontal angle
8) ZA/% : Switch between zenith angle/ slope in %
9) HT: Set the instrument height and target height
10) REC: Data recording
11) REM: REM measurement
12) MLM: Missing line measurement
13) RCL: Display final measurement data
14) View: Display observation data for the selected JOB
15) EDM: Distance measurement parameters setting (Atmospheric correction, prism constant correction, distance measurement mode)
16) COORD: Coordinates measurement
17) S-O: Setting-out measurement
18) OFFSET: Offset measurement
19) MENU: To Menu Mode
20) RESEC: Resection measurement
21) DOUT: Output measurement results to external instrument
22) F/M: Switch between meters/feet
23) AREA: Area calculation
24) ROAD: Road measurement
25) PROJ: Point Projection
26) LINE: Straght line setout

·The following are the soft key allocations when the KTS-442UT was shipped from factory.

Page 1: SD, SHV, HSET, EDM

Page 2: 0set, COORD, S-O, REC

Page 3: MLM, RESEC, MENU, HT

22.1.1 Allocating functions

·It is possible to freely allocate up to 12 kinds of functions to the soft keys. The allocated key array is saved until it is revised again, even when the power is cut off.

It is possible to allocate the same keys on each page (example 1). The same function can be allocated to more than

one key on the same page (example 2). And it is also possible to allocate a function to only one key (example 3).

Example 1

P1 DIST, SHV, H. ANG, EDM

P2 DIST, SHV, H. ANG, EDM

Example 2

P1 DIST, SHV, H. ANG,, DIST

Example 3

P1 DIST, SHV, ----, ----

▶PROCEDURE

Operating Procedure	Operation	Display
(1) In Setting Mode Screen, select "6. Key Function," press [ENT] (or press numeric key 6), the "Key Setting Menu Screen" is displayed.	"6. Key Function" + [ENT]	Key Func. 1. Define 2. Registration 3. Recall
(2) Select "1. Define" and press [ENT] (or press numeric key 1), the "Allocation Screen" is displayed.	"1. Define" + [ENT]	P1 DIST SHV DIST ↑ HSET EDM SHV P2 0SET CRD, 0SET S-O REC HSET P3 MLM RESE R/L ↓ MENU HT OK
(3) Align the cursor with the keys on the left half of the screen whose allocation is changed using ◀ or ▶.	◀ or ▶	Key Func. P1 DIST SHV DIST ↑ HSET EDM SHV P2 0SET CRD, 0SET S-O REC HSET P3 MLM RESE R/L MENU HT OK ↓
(4)Align the cursor with the keys on the right half of the screen which are to be allocated using ◀ or ▶.	▲ or ▼	P1 DIST SHV DIST ↑ HSET R/L SHV P2 0SET CRD, 0SET S-O REC HSET P3 MLM RESE R/L MENU HT OK ↓

(5) Press ENT to allocate the functions designated in step 4 to the positions designated in step 3.	ENT	P1 DIST SHV DIST ↑ HSET R/L SHV P2 0SET HOLD 0SET S-O REC HSET P3 MLM RESE R/L MENU HT OK
(6) Repeat steps 3 to 5 only as many times as necessary. Press OK to record the allocations and to restore the "Key Setting Screen."	OK	Key Func. 1. Define 2. Registration 3. Recall

☆ **NOTE:** When DIST is allocated to key, it will display SD, HD or VD. Press SHV key to change among them.

22.1.2 Registering an allocation

It is possible to register two soft key arrays allocated in the "Allocation Screen" as User Registration 1 and User Registration 2.

The registered soft key arrays can be called and used as needed (See "18.2 Recalling Allocation")

▶PROCEDURE

Operating Procedure	Operation	Display
(1) In Setting Mode Screen, select "6. Key Function," press ENT (or press numeric key 6), the "Key Setting Menu Screen" is displayed.	"6. Key Function" + ENT	Key Func. 1. Define 2. Registration 3. Recall
(2) Select "2. Registration" and press ENT (or press numeric key 2), the "Allocation Registration Screen" is displayed.	"2. Registration" + ENT	Key func. 1. User's 1 2. User's 2
(3) Select either "user'1" or "user'2" as the soft key array to be registered and press ENT.	"1.user'1"or"2. User'2" + ENT	Key func. Registered to 1 Press any key
(4) Press any key to restore the "Allocation Registration Screen." and return to "Key Setting Screen".	Press any key	Key Func. 1. Define 2. Registration 3. Recall

22.2 Recalling an Allocation

It is possible to recall the soft key arrays registered for User 1 and User 2 as necessary.

NOTE: When an array is recalled, the key array is changed to the key array which has been recalled, clearing the previous key array.

▶PROCEDURE

Operating Procedure	Operation	Display
(1) In Setting Mode Screen, select "6. Key Function," press ENT (or press numeric key 6), the "Key Setting Menu Screen" is displayed.	"6. Key Function" + ENT	Key Func. 1. Define 2. Registration 3. Recall
(2) Select "3. Recall" and press ENT to show the "Allocation Recall Screen."	"3. Recall" + ENT	Key Func. 1. User's 1 2. User's 2 3. Default
(3) Select "1. User's 1" or "2. User's 2" or "3. Default" and press ENT to restore key functions. T This displays the functions in the recalled array in the "MEAS Mode Screen".	"1. User's 1" + ENT	Key Func. 1. Define 2. Registration 3. Recall

23. INSTRUMENT PARAMETERS SETTING

·This section explains the parameters which are set in Setting Mode. The set parameters are recorded until they are revised.

23.1 Changing Instrument Parameters

·The following are the items set and their parameters.

Table 1:

Screen Setting	Parameter	Options（*: Factory Setting）
	Atmospheric Correction	None *
		K=0.14
		K=0.2
		Zenith 0 °*

OBSERVATION CONDITION	Vertical angle format	Horizontal 0 °
		Horizontal 0 ° ±90 °
	Tilt correction	None*
		Dual-axis
		Single axis
	Distance measurement mode	SD *
		HD
		VD
	Automatic power cut off	Auto cut off after 30 Minutes *
		Switch on/off by key
	Coordinates format	N-E-Z *
		E-N-Z
	Minimum angle value	1″ *
		5″
	Read-in JOB	Enter the Read-in JOB

Table 2:

Screen Setting	Parameters	Options（*: Factory setting）
Communication Setup	Baud rate	1200 b/s * ， 2400b/s
		4800 b/s * ， 9600b/s
		19200 b/s ， 38400b/s
		57600b/s ， 115200b/s
	Data length	8 bits *
		7 bits
	Parity	None *
		Even
		Odd
	Stop bit	1 bit *
		2 bits
	Check sum	Off *
		On
	Transfer	USB*
		COM

Table 3:

Screen Setting	Parameters	Option（*：Factory setting）
Unit	Temperature	℃ *
		℉
	Air pressure	hPa *
		mmHg
		inHg
	Angle	DEG *(360 degrees)
		GON (400 gons)
		MIL
	Distance	M *
		Ft

▶PROCEDURE

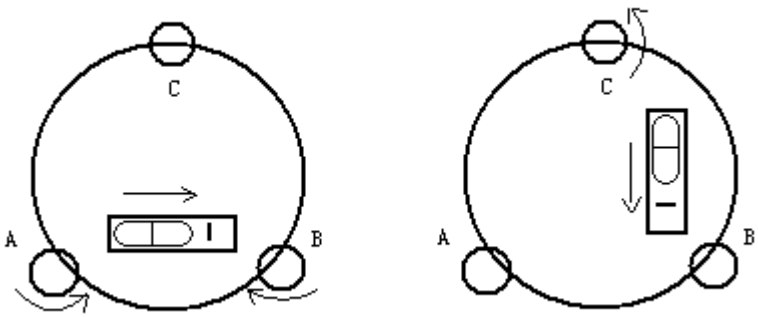
Operating Procedure	Operation	Display
(1) In Measurement screen, press ESC to show the status screen.	ESC	2020-01-01 10：00：48 KTS-442UT No.S19996 Ver.2020-1.02 Job: JOB01 MEAS MEM CNFG
(2) Press CNFG under the status screen, the Setting Mode Screen is displayed.	CNFG	Config (1). 1. Obs. condition 2. Instr. const 3. Date & time 4. Comms setup 5. Unit
(3) Select "1. Obs. condition" and press ENT to show "Observation Condition Setting Screen". It is possible to check and change the parameter settings. When "↑" or "↓" is displayed, there are items above or below, use ▲or▼ to scroll the screen. It is possible to change the parameter setting of the current line by using ◀or▶ key. The following are the selected conditions. (Those marked by an [*] are values set at the factory)	"1. Obs. condition" + ENT	Condition (1) C&R crn: No V. obs : Zenith 0 Tilt crn. : Yes(H&V) Dist mode: SD ↓ Power off: off Condition (2) Coord: E-N-Z Ang. Reso. : 5″ ↑ Coord. Search JOB: JOB01

(4) Align the cursor with the final item after setting is complete and press ENT. The "Setting Mode Screen" is displayed.	ENT	Config (1). 1. Obs. condition 2. Instr. const 3. Date & time 4. Comms setup 5. Unit
(5)Select "4. Comms setup" and press ENT to show the "Communication Conditions Setting Screen". It is possible to check and change the parameter settings. The following are the selected conditions. (Those marked by an [*] are values set at the factory)	ENT	Baud rate: 1200b/s Data bits: 8bits Parity : Not set Stop bit : 1 bit Check sum: off X on/X off : No
(6) Align the cursor at the final item after setting is completed and press ENT to return to the "Setting Mode Screen."	ENT	Config (1). 1. Obs. condition 2. Instr. const 3. Date & time 4. Comms setup 5. Unit
(7) Select "5. Unit" and press ENT. It is possible to check and revise the parameter settings. The following are the selected conditions.	ENT	Unit Temp. : ℃ Press. :mmHg Angle : DEG Dist :m
(8) Press ENT after setting is completed, the "Setting Mode Screen" is restored.	ENT	Config (1). 1. Obs. condition 2. Instr. const 3. Date & time 4. Comms setup 5. Unit

PART 6 CHECKING AND ADJUSTMENT

The instrument has been checked and adjusted strictly in the factory and can meet the quality requirement. But the long distance transportation and the change of the environment will have great influence on internal structure of the instrument. So before using, the instrument should be checked and adjusted according the items of this section.

24.1 Plate Vial



Inspection

Refer to 2. Setting Up the instrument §4. "**Leveling by using the plate level**".

Adjustment

1. If the bubble of the plate level moves from the center, bring it half way back to the center by adjusting the leveling screw, which is parallel to the plate level. Correct the remaining half by adjusting the screw of plate level with adjusting pin.
2. Confirm whether the bubble is in the center by rotating the instrument 180 º. If not, repeat Procedure (1).
3. Turn the instrument 90 ºand adjust the third screw to center the bubble in the plate level.

Repeat inspection and adjustment steps until the bubble remains in center with the plate level in any direction.

24.2 Circular Level

Inspection

No adjustment is necessary if the bubble of the circular level is in the center after inspection and adjustment of the plate level.

Adjustment

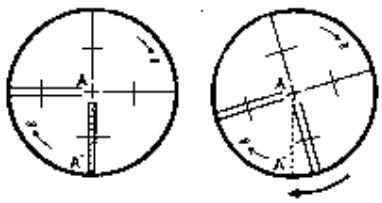
If the bubble of the circular level is not in the center, bring the bubble to the center by using the adjusting pin or hexagon wrench to adjust the bubble adjusting screw. Firstly loosen the screw opposite to the offset side, and then tighten the other adjusting screw on the offset side, bringing the bubble to the center. After the bubble stays in the center, keep the tightness of the three screws in uniform.

24.3 Inclination of Reticle

Inspection

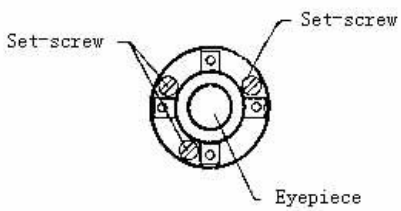
1. Aim at object A through the telescope and lock the horizontal and vertical clamp screws.
2. Move object A to the edge of the field of view with the vertical tangent screw (point A′)
3. No adjustment is necessary if object A moves along the vertical line of the reticle and point A′ still in the vertical line.

As illustrated， A′offsets from the center and the cross hair tilts, then need to adjust the reticle.



Adjustment

1. First remove the eyepiece cover to expose the four reticle adjusting screws.
2. Loosen the four reticle adjusting screws uniformly with an adjusting pin. Rotate the reticle around the collimation axis and align the vertical line of the reticle with point A′.
3. Tighten the reticle adjusting screws uniformly， Repeat the inspection and adjustment to see if the adjustment is correct.
4. Replace the eyepiece cover.

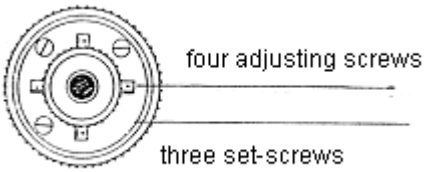


24.4 Perpendicularity of Collimation Line to Horizontal Axis (2c)

Inspection

1. Set object A at a far distance the same height as the instrument, then level and center the instrument and turn on the power (horizontal angle L=10°13′10″).
2. Aim at object A in left position and read the horizontal angle value (horizontal angle R= 190°13′40″).
3. Loosen the vertical and horizontal clamp screws and rotate the telescope. Aim at object A in right position and read the horizontal angle value.

4. 2 C=L-R±180°-30″≥± 2 0″, adjustment is necessary.



Adjustment

A: Adjustment by on-board program:

Operation procedure	KEY	Display
(1) After levelling the machine, power on, press CNFG under date/ time screen, as right diagram shows.	CNFG	2020-09-10 10：00：48 Type：KTS－442UT No. ： S112926 Ver.：20.09.10 Job ： JOB01 MEAS MEM CNFG
(2) Press ▼ key to choose"2. Instr. Const."and press ENT key(or press numeric key 2),enter the instrument constant setting screen.	" 2 . Instr. Const." + ENT	1. Obs. condition 2. Instr. Const. 3. Date& time 4. Comms setup 5. Unit 6. Key function
(3) press ▼ key to choose "3. collimation", then press ENT key(or press numeric key3), enter collimation error adjustment function.	"3. collimation" + ENT	1. V0/Axis const. 2. V0/ Adjustment 3. Collimation 4. horizontal axis 5. Instr. Const. 6. Contrast ADJ.
(4) At positive position (Face left) sight at target, press OK.	Face left, sight at target + OK	Collimation <Step-1> Front ZA 0°21′39″ HAR 185°47′57″ OK
(5) Rotate telescope. At the reverse position (face right) sight at the same target precisely, press OK.	Face right and sight at target + OK	Collimation <Step-2> Reverse ZA 179°38′17″ HAR 5°50′57″ OK
(6) After adjustment, it shows "set" on the screen, the display returns to Instrument constant menu screen.		1. V0/Axis const. 2. V0/ Adjustment 3. Collimation 4. horizontal axis 5. Instr. Const. 6. Contrast ADJ.

B：Optical adjustment (Only for professional service technician)

1. Use the tangent screw to adjust the horizontal angle reading,
2. Take off the cover of the reticle between the eyepiece and focusing screw. Adjust the two adjusting screws by loosening one and tightening the other. Move the reticle to aim at object A exactly.
3. Repeat inspection and adjustment until $|2C| < 20''$.
4. Replace the cover of reticle.

24.5 Vertical Index Difference Compensation

Inspection

1. Mount and level the instrument and make the telescope parallel with the line connecting the center of the instrument to any one of the screws. Lock the horizontal clamp screw.
2. After turning on the power, zero the vertical index. Lock the vertical clamp screw and the instrument should display the vertical angle value.
3. Rotate the vertical clamp screw slowly in either direction about 10mm in circumference, and the error message "b" will appear. The vertical axis has been increased to more than 3´ at this time and exceed the designated compensation range.

Rotate the above screw to its original position, and the instrument display screen will show the vertical angle again, meaning that the vertical index difference compensation function is working.

Adjustment

If the compensation function is not working, send the instrument back to the factory for repair.

24.6 Adjustment of Vertical Index Difference (i angle) and Vertical Angle 0 Datum

Inspect this item after finishing the inspection and adjustment of Item 24.3 and 24.5.

Inspection

1. Power on after leveling the instrument. Aim at object A facing left and read the Vertical angle value L.
2. Rotate the telescope. Aim at object B facing right and read the Vertical angle value R.
3. If the vertical angle is 0° in zenith, $i = (L + R - 360°)/2$

If the vertical angle is 0° in horizon, $i = (L + R - 180°)/2$ or $(L + R - 540°)/2$

4. If $|i| \geq 10''$ shall set the Vertical Angle 0 Datum again.

Adjustment

Operation procedure	Key	Display

(1)After levelling the machine, power on, press CNFG under date/ time screen, as right diagram shows.	CNFG	2020-09-10 10：00：48 Type：KTS－442UT No. ： S112926 Ver.：20.09.10 Job ： JOB01 MEAS MEM CNFG
(2) Press ▼ key to choose"2. Instr. Const."and press ENT key(or press numeric key 2),enter the instrument constant setting screen.	" 2 . Instr. Const." + ENT	1. Obs. condition 2. Instr. Const. 3. Date& time 4. Comms setup 5. Unit 6. Key function
(3)press ▼ key to choose "2.V0/ Adjustment", then press ENT key(or press numeric key2), enter collimation error adjustment function.	"2. V0/ Adjustment" + ENT	1. V0/Axis const. 2. V0/ Adjustment 3. Collimation 4. horizontal axis 5. Instr. Const. 6. Contrast ADJ.
(4)At positive position (Face left) sight at target, press OK.	Face left, sight at target + OK	V0 adjustment <Step-1> Front ZA 0°21′49″ HAR 185°47′42″ OK
(5)Rotate telescope. At the reverse position (face right) sight at the same target precisely, press OK.	Face right and sight at target + OK	V0 Adjustment <Step- 2> Reverse ZA 179°38′30″ HAR 5°50′15″ OK
(6) After adjustment, it shows "set" on the screen, the display returns to Instrument constant menu screen.		1. V0/Axis const. 2. V0/ Adjustment 3. Collimation 4. horizontal axis 5. Instr. Const. 6. Contrast ADJ.

4 Repeat the inspection steps to measure the Index Difference (i angle). If the Index Difference can not meet the requirement, you should check whether the three steps of the Adjustment are right, the sight is right and etc. Then set again according to the requirement.

5 If Index Difference can not still meet the requirement after the repeated operation, the instrument should be returned to factory for inspection and repair.

NOTE: The vertical angles shown in the Vertical Angle 0 Datum are only for reference.

24.7 The adjustment of horizontal axis error correction

As the horizontal axis error only affects the angle of sight line, it can be only confirmed through observing the target of which height is obviously lower or higher than the instrument.

To avoid the influence of collimation axis error, user must have an associated adjustment before adjusting collimation axis.

It is unnecessary to collimate the prism or the target plane to decide the horizontal axis error. Therefore user is enabled to launch this adjustment at any time. Select a recognizable point which is rather far away from the instrument, and much higher or lower than the instrument, with an aim to precisely collimate the point twice.

Operation Procedure	Key	Display
(1) Under Instrument constant setting functions, choose "4. Horizontal axis" and press ENT key (or press numeric key 4), enter horizontal axis error correction menu.	"4. Horizontal axis" + ENT	1. V0/Axis const. 2. V0/ Adjustment 3. Collimation 4. horizontal axis 5. Instr. Const. 6. Contrast ADJ.
(2) The screen shows as right diagram, at the front position (face left) sight at the target precisely (The obliquity is among ±10 °~ ±45 °), press SET 10 times.	Face left and sight at target + SET 10 times	Horizontal axis <Step-1> Front ±10 °< level < 45 ° ZA 337°19′00″ HAR 186°42′41″ INPUT [00/10] SET
(3) Rotate telescope. At the reverse position (face right) sight at the same target precisely, press SET 10 times.	Face right and sight at target + SET 10 times	Horizontal axis <Step-2> Reverse ±10 °< Level < 45 ° ZA 202°41′09″ HAR 6°45′38″ INPUT [10/10] SET
(4) Setting finished, screen shows "set!", it returns to instrument constant screen.		1. V0/Axis const. 2. V0/ Adjustment 3. Collimation 4. horizontal axis 5. Instr. Const. 6. Contrast ADJ.

24.8 Optical Plummet

Inspection

1. Set the instrument on the tripod and place a piece of white paper with two perpendicular lines, then intersect drawn on it directly under the instrument.

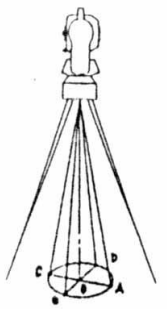
2. Adjust the focus of the optical plummet and move the paper so that the intersection point of the lines on the paper comes to the center of the field of view.

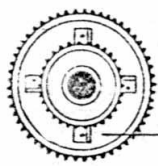
3. Adjust the leveling screws so that the center mark of the optical plummet coincides with the intersection point of the cross on the paper.

4. Rotate the instrument around the vertical axis and at every 90 °observe whether the center mark position coincides with the intersection point of the cross.

5. If the center mark always coincides with intersection point, no adjustment is necessary.

Otherwise, the following adjustment is necessary.





Plummet adjusting srews (4 pieces)

Adjustment

1. Take off the protective cover between the optical plummet eyepiece and focusing knob.

2. Fix the paper. Rotate the instrument and mark the point of fall of the center of optical plummet on the paper at every 90°. As illustrated: Point A, B, C, D.

3. Draw lines that attach AC and BD and mark the intersection point of the two lines as O.

4. Adjust the four adjusting screws of the optical plummet with an adjusting pin until the center mark coincides with Point O.

5. Repeat the inspection and adjusting steps to be sure the adjustment is correct.

6. Replace the protective cover.

24.9 Instrument Constant（K）

Instrument constant has been checked and adjusted in the factor, K=0. It seldom changes and it is suggested to check one or two times every year. The inspection should be made on the base line, also can be made according to the following method.

Inspection

1. Mount and level the instrument on Point A in a plain place. Use the vertical hair to mark Point B and Point C on the same line with the distance of 50m on the same line, and set the reflector accurately.

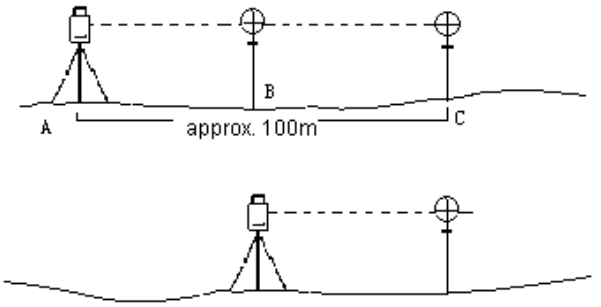
2. After setting temperature and air pressure in the instrument, measure the Horizontal Distance of AB and AC accurately.

3. Set the instrument on Point B and center it accurately, measure the Horizontal Distance of BC accurately.

4. Then you can get the Instrument Constant：

$$K = AC - (AB + BC)$$

K should be closed to 0, If $|K| > 5mm$, the instrument should be strictly inspected in the standard baseline site, and adjusted according the inspection value.



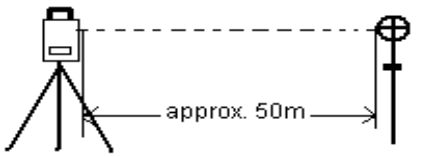
Adjustment

If strict inspection approves that the Instrument Constant K has changed and is not closed to 0. If the operator wants to adjust, should set Stadia Constant according the Constant K.

●Set the direction by using the Vertical Hair to make Point A,B,C on the same line strictly. On Point there must be fixed and clear centering mark.

●Whether the prism center of Point B coincides with the Instrument Center is the important tache to inspect the accuracy. So on Point B Tripod or tribrach compatible should be used. That will decrease the difference.

24.10 Parallel Between Collimation line and Emitting Photoelectric Axis



Inspection

1. Set the reflector prism 50m from the instrument.
2. Sight the center of the reflector prism with reticle.
3. Power on and enter Distance Measurement Mode. Press [MEAS] to measure.

Rotate the Horizontal Tangent Screw and Vertical Tangent Screw, to do electric collimation and make the light route of EDM unblocked. In the bight zone find the center of emitting photoelectric axis.

4. Check whether the center of reticle coincides with the center of emitting photoelectric axis. If so, the instrument is up to grade.

Adjustment

If there is great difference between the center of reticle and the center of emitting photoelectric axis, the instrument needs repairing.

☞24.11 Reflectorless EDM

The red laser beam used for measuring without reflector is arranged coaxially with the line of sight of the telescope, and emerges from the objective port. If the instrument is well adjusted, the red measuring beam will coincide with the visual line of sight. External influences such as shock or large temperature fluctuations can displace the red measuring beam relative to the line of sight.

●The direction of the beam should be inspected before precise measurement of distances, because an excessive deviation of the laser beam from the line of sight can result in imprecise distance measurements

Warning

Looking straight at the laser beam should be always considered as hazardous.

Precautions:

Do not stare at the beam or point it to the other people. Measuring result might also available even the laser pass through body.

Inspection:

A target plate is provided. Set it up between five and 20 meters away with the grey reflective side facing the instrument. Move the telescope to face II. Switch on the red laser beam by activating the laser-point function. Use the reticle to align the instrument with the centre of the target plate, and then inspect the position of the red laser dot on the target plate. Generally speaking the red spot cannot be seen through the telescope, so look at the target plate from just above the telescope or from just to the side of the target plate.

If the spot illuminates the cross, the achievable adjustment precision has been reached; if it lies outside the limits of the cross, the direction of the beam needs to be adjusted.

●If the spot on the more reflective side of the plate is too bright (dazzling), use the white side instead to carry out the inspection.c

24.12 Tribrach Leveling Screw

If the leveling screw becomes flexible, adjust the two adjusting screws in the leveling screw to tighten the screw appropriately.

24.13 Related Parts for Reflector

1. The Tribrach and Adapter for Reflector

The plate level and optical plummet in the adapter and tribrach should be checked, refer to Chapter 24.1 and 24.7.

2. Perpendicularity of the prism pole

As illustrated, mark '+' on Point C, place the tine of the prism pole on the Point C and do not move

it during the inspection. Place the two feet tine of Bipod on Point E and F on the cross lines. Adjust the two legs to make the bubble on the prism pole centered.

Set and level the instrument on Point A near the cross. Sight tine of Point C with the center of reticle, and fix the Horizontal Clamp Screw. Rotate the telescope upward to make D near the horizontal hair. Flex the prism pole Leg e to make the D in the center of reticle. Then both Point C and D are on the central line of reticle.

Set the instrument on Point B on another cross lines. With the same way flexing the Leg f to make Point C and D are on the central line of reticle.

Through the inspection by the instrument on Point A and B, Prism pole has been perpendicular. If then the bubble offset from the center, adjust the three screws under circular vial to make the bubble centered, refer to Chapter 20.2. Check and adjust again until the bubble is in tche center of the vial from both directions.

25. SPECIFICATION

TYPE	KTS-442UT	
	Red visible laser	
External Memory Storage	USB Pen drive	
Plummet	Laser Plummet	
EDM type	Coxial	
Minimum display	0.1mm	
Laser facula (only on KTS-442/5(R))	Non-reflector	About 7×14 ㎜ / 20m
	With-reflector	About 10×20 ㎜ / 50m
Weather correction	Manually input, Auto correction	
Atmosphere reflection and earth curve correction	Manually input, Auto correction	
Prism constant correction	Manually input, Auto correction	
Distance unit	meter /us.feet/international feet/feet-inch	
Digit display	Max：99999999.999 m Min 0.1 mm	
Average measuring times	The average value of 2- 9 times	
Accuracy		
Below is only for KTS-442UT		
With reflector		
Distance measurement	Standard difference of accu.	Measuring time
Prism fine	±(2mm＋2ppm Ð)	＜1.8s
Non-reflector		
Distance measurement	Standard difference of accu.	Measuring time
Non-prism fine	±(3mm＋2ppm Ð)	＜1.2s

Measuring range		
Below is only for KTS-442UT		
With reflector		
Air condition	Standard prism	Sheet
5km	5000m	800m
20km	8000m	1000m
Non-reflector		
Air condition	Non-prism（white）※	Non-prism grey 0.18
Cloudy or objective under shadow	1000m or more	1000m
※※ Kodak Grey Card used with exposure meter for reflected light		

☞Other parameters

	KTS-442UT
Angle measurement	
Angle measurement type	Continuous, absolute
Diameter of disc	79mm
Min. display	1″/ 5″ choosable
Accuracy	2″
Detection method	Horizontal：Dual Vertical：Dual
Telescope	
Image	Erect
Length of Obj. lens	154mm
Effective aperture	Observation：45mm, measurement：50mm
Magnification	30 X
View field	1° 30’
Min. focusing distance	1m
Resolution power	3″
Tilt sensor	
System	Dual Axis Liquid-electric Detection/plate vial
Working range	±3′
Accuracy	6″
Vial	
Plate vial	30″ / 2mm
Circular vial	8′ / 2mm

Optical plummert (optional by special order)	
Image	Erect
Magnification	3×
Focusing range	0.5m～∝
View field	5°
Display part	
Type	6 lines, dual sides
Data communication	
Port	USB, Bluetooth
On-board battery	
Power supply	Rechargable Lithium battery 3100mAh
Voltage	DC 7.4V
Continuously work-time	10 Hours
Size and weight	
Size	160×150×330mm
weight	5.7 KG

26. ERROR DISPLAYS

Error message	Error explanation	Operation
Calc. Error	Error data inputting, can not be calculated	Input correct data
Memory is full!	There is no more room to enter data.	Download the data to computer, and delete it in memory.
Not found!	The required data is not found	Confirm that data is existed, and search again
Out of range	The tilt error of instrument exceeds 3′	precisely level the instrument
Circular Error	3 known points on a dangerous circle	Select the known point again
Range Error!	The direction of known point error.	Check the known point again
Error 01-08	Angle measurement system error	If these error messages are continuously showed, send the instrument to KOLIDA agents.

NOTE: If error still persists after dealing with them, contact KOLIDA or KOLIDA distributors.

27. ACCESSORIES

● Case	1 pc
●Main body	1 set
●On-board battery	1 pc
●Charger	1 pc
●Plummet	1 pc
●Correction pin	2 pcs
●Fur brush	1 pc
●Screwdriver	1 pc
●Hexagon wrench	2 pcs
●Cloth	1 pc
●desiccant	1 bag
●Operating manual	1 pc
●Exequatur	1 pc

☞ reflector sheet（20×20 ， 30×30,40×40,60×60）different size one for each

APPENDIX A BIDIRECTIONAL COMMUNICATION

Bidirectional communication command divides into 3 kinds: QP output command, input command, setting command.

Note: Communication command will be available only in status mode or measurement mode.

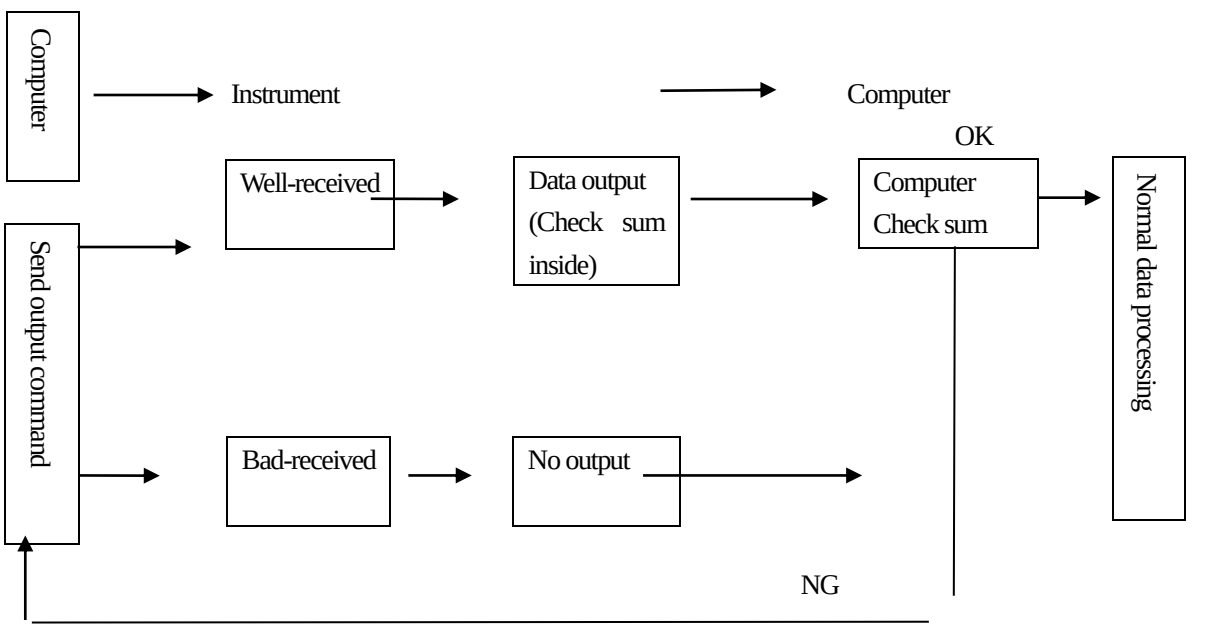
1.1 Outputting Commands

Following commands are used in sending data from instrument to computer, relative data format will be sent with commands, " " means space (20H)

When "Check sum" in "Communication parameters setting" is set to "ON", there are 2 bytes check sum added in the output data.

Sending command and outputting data

Output command is send from computer to instrument.



·Standard command format

Check sum

The calculation of check sum starts with the first data info and ends the space before the check sum. The result comes from the summation of hexadecimal ASCII Code of each such separate valid data, the last two significant figures of the gained sum is check sum.

For example: 1234567 1234567 1234567 A4 CRF

Calculation: 31H + 32H + 33H + 34H + 35H + 36H + 37H + 20H … 20H = 4A4H

When check sum parameter is set "ON", the check sum "A4" in above example will be output as a part of the data.

1） 13H (angle data request), 11H (slope distance and angle data request)

1999999 1999999 199999 [SUM] CRLF

a b c d

a) Slope distance value

b) Vertical angle value

c) Horizontal angle value

d) Check sum

Note: If there are some errors occured in angle and distance measurement result, "Exxx" will be output in a), b), c).

Other command formats

Check sum

The calculation method is same as standard command.

For example：A–KTSxxx, 123456, 4100, 2506, 39CRF

Calculation：41H + 20H + 53H + 45H + 54H … 2CH = 539H

When check sum parameter is set to "ON", the check sum "39" in above example will be output as a part of the data.

1） Instrument mark output command (A）

A KTS440, S03456 , 4100[,SUM]e CRLF

a b c d

a) Data identification

b) Instrument name

c) Instrument series number (8 digits)

d) Instrument ROM version (4digits)

2) Instrument parameters output command (B)

B 0, 0, 0, -30, 0, 0, 0, 0, 0, 0, 0, 0[,SUM]CRLF

a b c d e f g h i j k l m

a) Data identification

b) Distance unit (0：meter/1：foot)

c) Temperature and pressure unit 0: ℃ and hpa
1: ℃ and mmHg
2: ℃ and inchHg
3: ℉ and hPa
4: ℉ and mmHg
5: ℉ and inchHg

d) Earth curvature and atmospheric refraction correction constant
0: None
1： Correction (K=0.142)
2: Correction (K=0.20)

e) Prism constant (-99 ～ 99mm)

f) Angle unit 0：360 degree
1：400Gon
2：Mil

g) Minimum angle display 0：1″
1：5″

h) Vertical angle display 0：Zenith 0 °
1：Horizontal 0 °
2：Horizontal 0 °±90 °

i) Always be "0"

j) Tilt correction 0：None
1：Single axis

k) Always be "0"

l) Coordinates format 0：N，E，Z
1：E, N, Z

m) Always be "0"

3) Instrument station coordinate output command (Da)

Da 1234.567, -1234.567, -9999999.999[,SUM]CRLF

a b c d

a) Data identification code

b) Instrument station point N coordinate value

c) Instrument station point E coordinate value

d) Instrument station point Z coordinate value

4）Distance and angle setting-out data output command（Db）

Db -1234.567, 359.5959[,SUM]CRLF

a b c

a) Data identification code

b) Distance Setting-out value

c) Horizontal angle setting-out value

5) Backsight point coordinate output command (Dd)

Dd -123.567, -1234.567, -1.999[,SUM]CRLF

a b c d

a) Data identification code

b) Backsight point N coordinate value

c) Backsight point E coordinate value

d) Backsight point Z coordinate value

6）Instrument height, target height, temperature, pressure and ppm output command (De)

De 12.245, 1.500, -20, 1015, -39[,SUM]CRLF

a b c d e f

b) Data identification code

c) Instrument height

d) Target height

e) Temperature

f) Pressure

g) ppm

7）Coordinate setting-out data output command (Df)

Df 1234.567, -12.345, 9.182[,SUM]CRLF

a b c d

a) Data identification code

b) N coordinate setting-out value

c) E coordinate setting-out value

d) Z coordinate setting-out value

8）Slope distance and angle value output command (Ea)

Ea 0000, 0, 1.500, -199, 999, 89.5959, 359.5959[,SUM]CRLF

a b c d e f g h

a) Data identification code

b) State data

The first unit indicates distance unit:

0：Meter

1：Feet

The second unit indicates angle unit:

0：360 Degree

1：400 Gon

2：Mil

The third unit indicates vertical angle format:

0：Zenith 0 °

1：Horizontal 0 °

2：Horizontal 0 °±90 °

The fourth unit indicates horizontal angle format:

0: right angle

1: left angle

a) Always be "0"
b) Target height
c) ppm
d) Height difference value
e) Zenith value (Vertical angle value)
f) Horizontal angle value

9）Horizontal distance and angle value output command (Eb)

Eb 0000, 0, 1.500, -199, 99.999, 89.5959, 359.5959 [,SUM]CRLF

a b c d e f g h

g) Data identification code
h) State data (same as Ea)
i) Always be "0"
j) Target height
k) ppm
l) Height difference value
m) Zenith value (Vertical angle value)
n) Horizontal angle value

10）Height difference and angle date output command (Ec)

Ea 0000, 0, 1.500, -199, 99.999, 89.5959, 359.5959 [,SUM]CRLF

a b c d e f g h

o) Data identification
p) State data (same as Ea)
q) Always be "0"
r) Target height
s) ppm

t) Height difference value

u) Zenith value (Vertical angle value)

v) Horizontal angle value

11）Coordinate data output command (Ed)

Ed 0000, 0, 1.500, -199, 123.456, 234.567, 1.234[,SUM]CRLF

a b c d e f g h

a) Data identification code

b) State data (same as Ea)

c) Always be "0"

d) Target height

e) ppm

f) N coordinate value

g) E coordinate value

h) Z coordinate value

12) Angle and angle of inclination data input command (Ee)

Ee 0000, 0, 1.500, -199, 89.5959, 359.5959, -0.0032, 0.0216[,SUM]CRLF

a b c d e f g h I

a) Data identification

b) State data (same as Ea)

c) Always be "0"

d) Target height

e) ppm

f) Zenith value (vertical angle value)

g) Horizontal angle value

h) X angle of inclination

i) Y angle of inclination

13）REM data output command (Ef)

Ef 0000, -299, 45.1234, 25.623[,SUM]CRLF

a b c d e

a) Data identification

b) State value(as Ea)

c) ppm

d) Zenith value (vertical angle value)

e) REM data

14）MLM measurement data output command (Eg)

Eg 0000, -299, 123.450, 123.456, -1.234[,SUM]CRLF

a b c d e f

a) Data identification code

b) State data (same as Ea)

c) ppm Slope distance value between two points

d) Horizontal distance value between two points

e) Height difference value between two points

15）Slope distance setting-out data output command (Ga)

Ga 123.456, 999.999[,SUM]CRLF

a b c

a) Data identification code

b) Slope distance setting-out value

c) Slope distance measured value

16）Horizontal distance setting-out data output command (Gb)

Gb 123.456, 777.777[,SUM]CRLF

a b c

a) Data identification code

b) Horizontal distance setting-out value

c) Horizontal distance measured value

17）Height difference setting-out data output command (Gc)

Gc 123.456, 666.666[,SUM]CRLF

a b c

a) Data identification code

b) Height difference setting-out value

c) Height difference measured value

18）Coordinate setting-out data output command (Gd)

Gd -378.902, -248.908, -99.999, -278.902, -149.908, 0.003[,SUM]CRLF

a b c d e f g

a) Data identification code

b) N coordinate setting-out value

c) E coordinate setting-out value

d) Z coordinate setting-out value

e) N coordinate measured value

f) E coordinate measured value

g) Z coordinate measured value

19）REM setting-out data output command (Gf)

Gf -453.903, 0.000[,SUM]CRLF

a b c

a) Data identification code

b) REM setting-out value

c) REM measured value

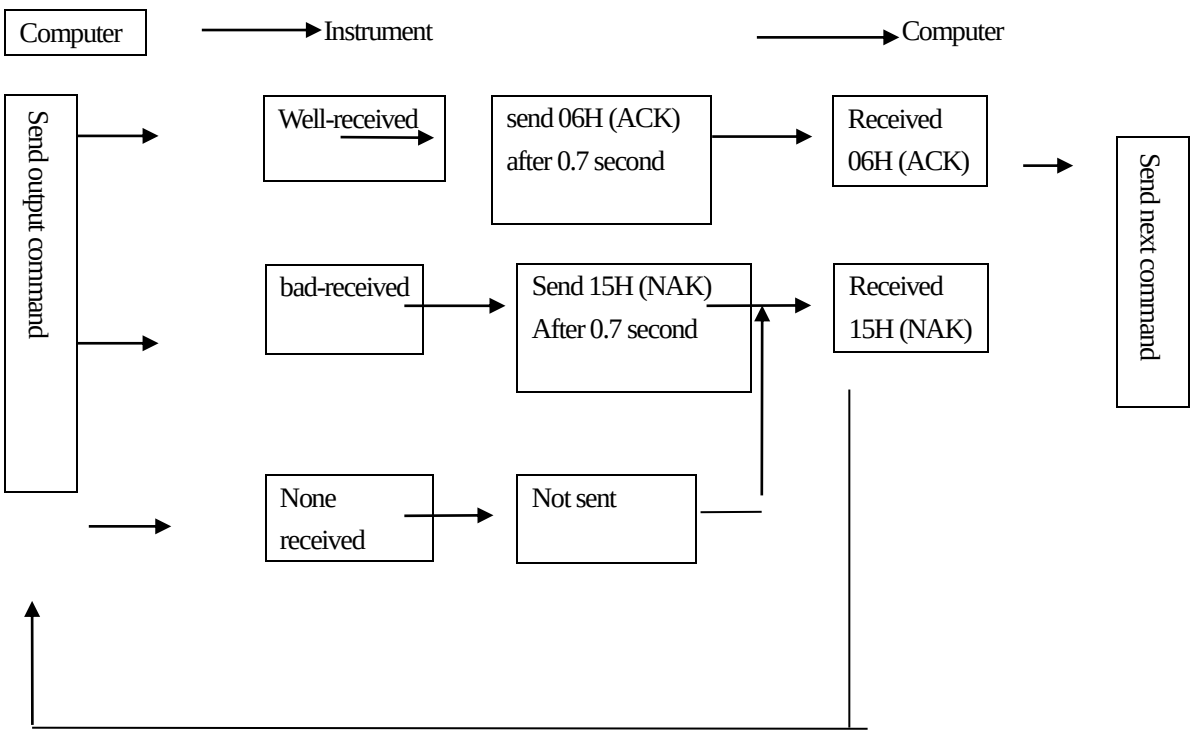
1.2 Entering Command

Following commands will be used in receiving data from computer, relative format will be given with commands, " " means space (20H).

·The input angle and distance value will be displayed in unit set.

·When entering angle value, the decimal should be behind integer value of angle.

For example: Angle value 359°59′59″ should be entered as 359.5959.



·Sending commands and outputting data

After computer sending input command (1) to instrument, instrument sends a receiving state code (ACK/NAK communication control)

1. 06H（ACK）：Data communicating succeeded, please send the next command.
2. 15H（NAK）：Data communicating failed, please send the command again.

Input command format:

1） Instrument parameters setting command (/B)

/B 0,0,0, 40,0,0,0,0,0,0,0,0[,SUM]CRLF

The format is same as input command B.

2） Station coordinate input command (/Da)

/Da 123.456,-123.456,-999.999[,SUM]CRLF

The format is same as input command Da.

3) Distance and angle setting-out data input command (/Db)

/Db -123.456, 359.5959[,SUM]CRLF

The format is same as input command Db.

4) Horizontal angle input command (/Dc)

/Dc 359.5959[,SUM]CRLF

a b

a) Data identification code

b) Horizontal angle value

5）Backsight coordinate input command (/Dd)

/Dd 123.456, _123.456, _999.999[,SUM]CRLF

The format is same as input command Dd.

6）Instrument height, target height, temperature, pressure input command (/De)

/De 12.345, 1.500, -20, 1015[,SUN]CRLF

a b c d e

a) Data identification code

b) Instrument height

c) Target height

d) Temperature value

e) Air pressure value

7) Coordinate setting-out data input command (/Df)

/Df 1234.567, _12.34, 9.182[,SUM]CRLF

The format is same as input command Df.

8) Coordinate data input commands (/Dg)

/Dg 123.456, -1234.123, 12.345, 12345678[,SUM]CRLF

a b c d e

a) Data identification code
b) N coordinate
c) E coordinate
d) Z coordinate
e) Point number

9）Property code input command (/Dh)

/Dh ABC.DEF, …, XYZ[,SUM]CRLF

a b

a) Data identification code
b) It is possible to enter 40 pieces of property codes which contains 14 characters length into instrument memory.

1.3 Set Command

After computer sending input command to instrument, a receiving state code will be send from instrument to computer. (ACK/NAK communication control)

1. 06H（ACK）：data communicating succeeded, send next command
2. 15H（NAK）：data communicating failed, resend command

Note：Please refer to "sending commend and outputting data" section.

Set command format

Following commands end with CRLF(0DH,0AH) or CR(0DH).

1. Xa: Set distance measurement mode to be fine single measurement.
2. Xb: Set distance measurement mode to be fine repeat measurement.
3. Xc: Set distance measurement mode to be fine N-times measurement.
4. Xe: Set distance measurement mode to be tracking measurement.
5. Xh: Set the horizontal angle to 0
6. Xd: Set the last measured coordinate to occupied coordinate.
7. Xi: Set coordinate bearing angle base on the coordinates of occupied point and backsight point
8. Xk: Set the horizontal angle to right angle (HAR)
9. XL: Set the horizontal angle to left angle (HAL)
10. XO: Change the start point in MLM measurement
11. Xr: Screen backlight on
12. Xs: Screen backlight off
13. Xt: Clear all the coordinate data in memory.
14. Xs: Switch off screen illumination.
15. Xt: Clear all coordinates data in memory.

【APPENDIX-B】CALCULATE ROAD ALIGNMENT

The road alignment stake-out program can stake out the alignment elements including straight, arc and transition curve..

NOTE:

1) Road alignment data can be uploaded from computer or can be entered manually.
2) Road alignment data is managed by chainage.

1.1 ROAD ALIGNMENT ELEMENTS

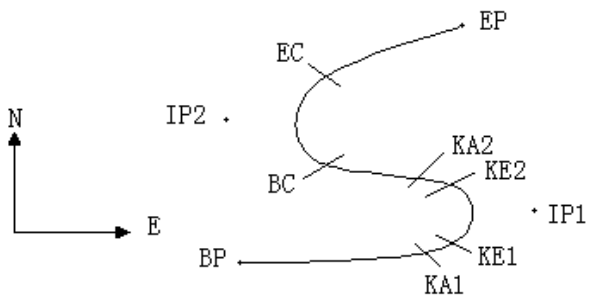
There are two ways to enter the alignment elements：

1) Download from PC.；
2) Manually input on the KTS-442UT series total station.

How to enter the alignment data is explained below.

Alignment Element	Parameter
Straight	Bearing, Distance
Transition Curve	Radius, Length of Transition Curve
Arc	Radius, Length of Arc
PT	N, E, radius, A1, A2

Note：When downloading from computer or selecting PT option, you do not have to calculate the Parameter.



Pt	North (N)	East (E)	Radius (R)	Transition curve A1	Transition curve A2
BP	1100.000	1050.000			
IP1	1300.000	1750.000	100.000	80.000	80.000
IP2	1750.000	1400.000	200.000	0.000	0.000
EP	2000.000	1800.000			

Example:

To enter the following data select DEF AL of ROADS in PROG menu:

Stake number	0
N	1100.000
E	1050.000

Press [ENT] and then press [F4] (PT), Enter the following data：

N	1300.000
E	1750.000
R	100.000
A1	80.000
A2	80.000

Enter the following data in the above way：

N	1750.000
E	1400.000
R	200.000
A1	0.000
A2	0.000

N	2000.000
E	1800.000
R	0.000
A1	0.000
A2	0.000

The format of the data above transmitted to computer is as follows：

START 0.000，1050.000，1100.000 CRLF

PT 1750.000，1300.000，100.000，80.000，80.000 CRLF

PT 1400.000，1750.000，200.000，0.000，0.000 CRLF

PT 1800.000，1800.000，2000.000 CRLF

1.2 CALCULATION OF ROAD ALIGNMENT ELEMENTS

(1) Calculation of the length of transition curve

$$L_{1.2}=\frac{A_{1.2}^2}{R}$$

$L_{1.2}$: Length of transitional curve

$A_{1.2}$: parameter of transitional curve

R : radius

$$L_1=\frac{A_1^2}{R}=\frac{80^2}{100}=64\text{ m} \qquad L_2=\frac{A_2^2}{R}=\frac{80^2}{100}=64\text{ m}$$

(2) Calculation of Deflection Angle

$$\tau=\frac{L^2}{2A^2}$$

$$\tau_1=\frac{64^2}{2\cdot 80^2}=0.32\text{ rad} \quad \Rightarrow \quad \text{deg} \quad \Rightarrow \quad 0.32\frac{180}{\pi}=18°20'06''$$

$$\therefore \quad \tau_1=-\tau_2$$

(3) Calculation of coordinate of points on transitional curve:

$$N=A\cdot\sqrt{2\tau}\ (1-\frac{\tau^2}{10}+\frac{\tau^4}{216}-\frac{\tau^6}{9360}....)$$

$$E=A\cdot\sqrt{2\tau}\ (\frac{\tau}{3}-\frac{\tau^3}{42}+\frac{\tau^5}{1320}-\frac{\tau^7}{7560}....)$$

$$N=80\cdot\sqrt{2\cdot 0.32}\ (1-\frac{(0.32)^2}{10}+\frac{(0.32)^4}{216}-\frac{(0.32)^6}{9360}....)$$

$$=64(1-\frac{0.01024}{10}+\frac{0.01048576}{216}-\frac{0.00107341824}{9360})$$

$$=64(1-0.01024+0.00004855-0.00000011)$$

$$=64*0.98981$$

$$=63.348$$

Similarly, the value of E is:

$$E=80\cdot\sqrt{2\cdot 0.32}\ (\frac{0.32}{3}-\frac{(0.32)^3}{42}+\frac{(0.32)^5}{1320}-\frac{(0.32)^7}{7560}....)$$

$$= 64(0.10666667 - 0.00078019 + 0.0000025 - 0)$$

$$= 6.777$$

The example is a symmetrical transitional curve. N1=N2，E1=E2

(4) calculate vector height ΔR

$$\Delta R = E - R(1 - \cos\tau)$$

$$\Delta R = 6.777 - 100(1 - \cos 18°20'06'')$$

$$= 1.700$$

In the symmetrical transitional curve $\Delta R_1 = \Delta R_2$

(5) calculate transitional point coordinate

$$N_m = N - R\sin\tau = 63.348\text{-}100\sin 18°20'06'' = 31.891$$

In the symmetrical transitional curve $N_{m1} = N_{m2}$

(6) Calculation of Tangent Distance

$$D_1 = R\tan(\frac{LA}{2}) + \Delta R_2 \cos ec(LA) - \Delta R_1 \cot(LA) + N_{m1}$$

$$LA = +111°55'47'', \qquad \cos ec = \frac{1}{\sin}, \qquad \cot = \frac{1}{\tan}$$

$$D_1 = 100 * \tan(111°55'47''/2) + 1.7(1/\sin 111°55'47'')$$

$$-1.7(1/\tan 111°55'47'') + 31.891$$

$$= 148.06015 + 1.8326 + 0.6844 + 31.891$$

$$= 182.468$$

$$D_1 = D_2$$

(7) Calculation of coordinate of point KA1

$$N_{KA1} = N_{IP1} - D_1 \cdot \cos\alpha_1$$

$$E_{KA1} = E_{IP1} - D_1 \cdot \sin\alpha_1$$

Bearing from BP to IP1 $\Rightarrow$ $\alpha_1 = 74°03'16.6''$

$$N_{KA1} = 1300 - 182.468 * \cos 74°03'16.6'' = 1249.872 \text{ m}$$

$$E_{KA1} = 1750 - 182.468 * \sin 74°03'16.6'' = 1574.553 \text{ m}$$

(8) Calculation of Arc Length

$$L = R(LA - \tau_1 + \tau_2)$$

$$= R(111°55'47'' - 2 * 18°20'06'')$$

$$= 100(75°15'35'' \frac{\pi}{180^\circ})$$

=131.353 m

(9) Calculation of the coordinate KA2

$$N_{KA2} = N_{IP1} - D_2 \cdot \cos\alpha_2$$
$$E_{KA2} = E_{IP1} - D_2 \cdot \sin\alpha_2$$

Bearing from IP1 to IP2 $\Rightarrow$ $\alpha_2 = 322°07'30.1''$

N_{KA2} = 1300 –(-182.468) * cos 322°07′30.1″= 1444.032 m

E_{KA2} = 1750 –(-182.468) * sin 322°07′30.1″= 1637.976 m

(10) calculate coordinate of feature point BC, EC of Arch length

Arch Length $CL = R \cdot IA$

IA= 95°52′11″

So

$$CL = 200 * 95°52'11'' * \frac{\pi}{180^\circ} = 334.648 \text{ m}$$

Tangent length

$$TL = R \cdot \tan(\frac{IA}{2}) = 200 * \tan(95°52'11''/2) = 221.615 \text{ m}$$

Calculate coordintes of each points:

$$N_{BC} = N_{IP2} - TL \cdot \cos\alpha_2$$
$$E_{BC} = E_{IP2} - TL \cdot \sin\alpha_2$$
$$N_{EC} = N_{IP2} - TL \cdot \cos\alpha_3$$
$$E_{EC} = E_{IP2} - TL \cdot \sin\alpha_3$$

Here:

α_2 (bearing from IP1 to IP2) = 322°07′30.1″

α_3 (Bearing from IP2 to EP) = 57°59′40.6″

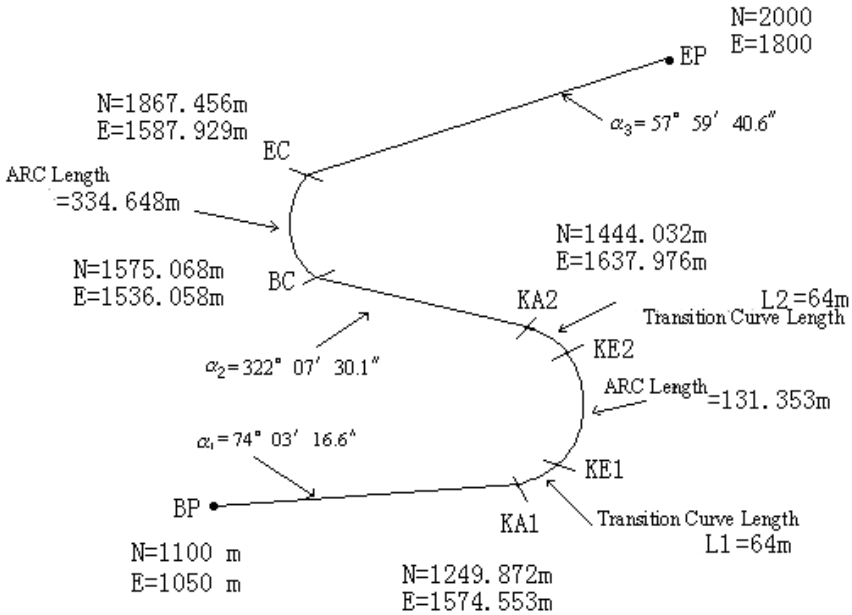
N_{BC} = 1750 - 221.615 * cos322°07′30.1″ =1575.068 m

E_{BC} = 1400 - 221.615 * sin322°07′30.1″ =1536.058 m

N_{EC} = 1750 –(-221.615) * cos57°59′40.6″=1867.456 m

E_{EC} = 1400 –(-221.615) * sin57°59′40.6″=1587.929 m

See below the calculation result:



The coordinates and the distance are calculated as below:

1） Compute the length of straight line

straight line

BP KA1= $\sqrt{(1249.872-1100.000)^2+(1574.553-1050)^2}=545.543$ m

straight line KA2 BC = $\sqrt{(1575.068-1444.032)^2+(1536.058-1637.976)^2}=166.005$ m

straight line EC EP = $\sqrt{(2000-1867.456)^2+(1800-1587.929)^2}=250.084$ m

Start point coordinate (BP)

N 1100.000 m

E 1050.000 m

straight line between BP and KA1

Bearing 74°03′16.6″

Distance 545.543 m

Transitional curve between KA1 and KE1

Radius -100 m ("-"sign is that curve turns left toward the end point)

Length 64 m

Arc between KE1 and KE2

Radius -100 m ("-"sign is that curve turns left toward the end point)

Length 131.354 m

Transitional curve between KA2 and KE2

Radius -100 m ("-"sign is that curve turns left toward the end point)

Length 64 m

Straight line between KA2 and BC

Bearing 322°07′30.1″

Distance 166.004 m

Arc between Bc and EC

Radius 200 (no sign means that curve turns left toward the end point)

Length 334.648 m

Straight line between EC and EP

Bearing 57°59′40.6″

Distance 250.084 m