CONTENTS

FOREWORD

Thank you for purchasing the KOLIDA KTS440 (R)(L) series total station!
This manual is applicable for the KOLIDA KTS440 (R)(L) series total station!
KTS440 series Total Station is equipped with infrared optic-electronic distance meter.
KTS440L series Total Station is equipped with infrared laser optic-electronic distance meter.
KTS440R series Total Station is equipped with infrared laser (visible) reflectorless distance meter.
In this manual, the parts which are marked "☞" are only applicable to KTS440R.
Before operating the instrument, please read this manual carefully.

Note：Manufacturer keeps the right of changing technical parameters without pre-advice!

1. FEATURES

1. Complete Function

   KOLIDA KTS-440 provides complete surveying program, the functions of data record and parameter setting, is applicable for professional and construction survey.

2. Powerful Memory Management

   The program module with 16M internal memory is adopted so that the memory is up to 14,000 points of surveying data and coordinate data. Memory files may be managed conveniently and data can be added, deleted, modified or transferred easily.

3. Absolute Encoding Circle

   Absolute encode circle pre-assembled is used, start measuring directly after turning on the instrument every time. The direction angle will never be lose even you reset the battery during measuring.

4. Reflectorless Mode☞

   The reflectorless function of .KTS440R enables you to carry out long-distance and high-accuracy measurement directly towards objects of different materials and with different colors (like wall of buidling, telegraph pole, wire, cliff, mountain, clay, wooden stake, etc.) It's the best solution for difficult measurement for the objects not easy to reach or even unreachable.

5. Abundant Surveying Programs

Except for the basic surveying modes (angle, distance, coordinate measurement), KTS-440 provides special surveying programs, for example, REM, Offset, MLM, Staking-out, etc, to meet the demand of professional survey.

2. PRECAUTIONS

1. Never place KTS directly on the ground. Sand or dust may cause damage to the screw holes or the centering screw on the base plate.
2. Before operating, inspect the power, functions and indications of the instrument as well its initial setting and correction parameters.
3. When working in a sun-baked (rainy or wet) day, please use a surveying umbrella to avoid damage. Besides, do not aim the telescope at the sun without a filter.
4. When not using the instrument, place it in the case and avoid 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 fits the temperature of environment outside.
6. Clean its surface with a woolen cloth when finishing use. If wet, dry it immediately before turning on it.
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, remove the battery for separated store. The battery should be charged once a month.
9. Clean exposed optical parts with degreased cotton or lens tissue only!
10. During transporting should be placed in its carrying case, cushioned materiait is recommended to be used around the case for support.
11. Unless you are a maintenance specialist, do not attempt to disassemble the instrument by yourself even if you find it abnormal.
12. Never aim at eyes with the laser beam of KTS440R Series Total Station.

☞3. SAFETY GUIDE

Interior EDM（Visible Laser）

Warning:

The total station is equipped with an EDM of a laser grade of 3R/IIIa. It is verified by the following labels: On the vertical tangent screw sticks an indication label "CLASS III LASER PRODUCT". A similar label is sticked on the opposite side.

This product is classified as Class 3R laser product, which accords to 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.

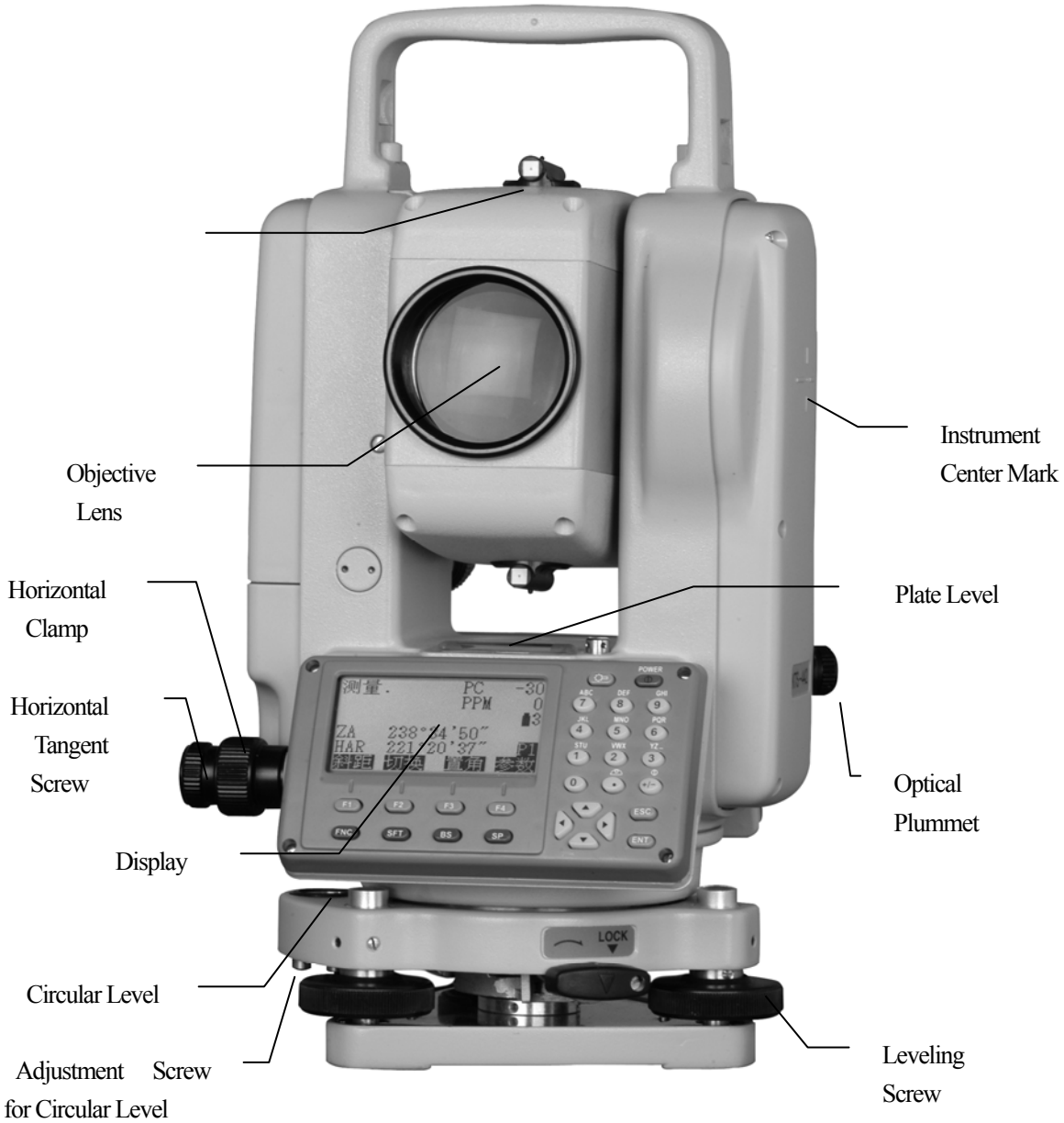
f) When the laser instrument is not in use, take care of it properly. The person who is not authenticated is not allowed to use.

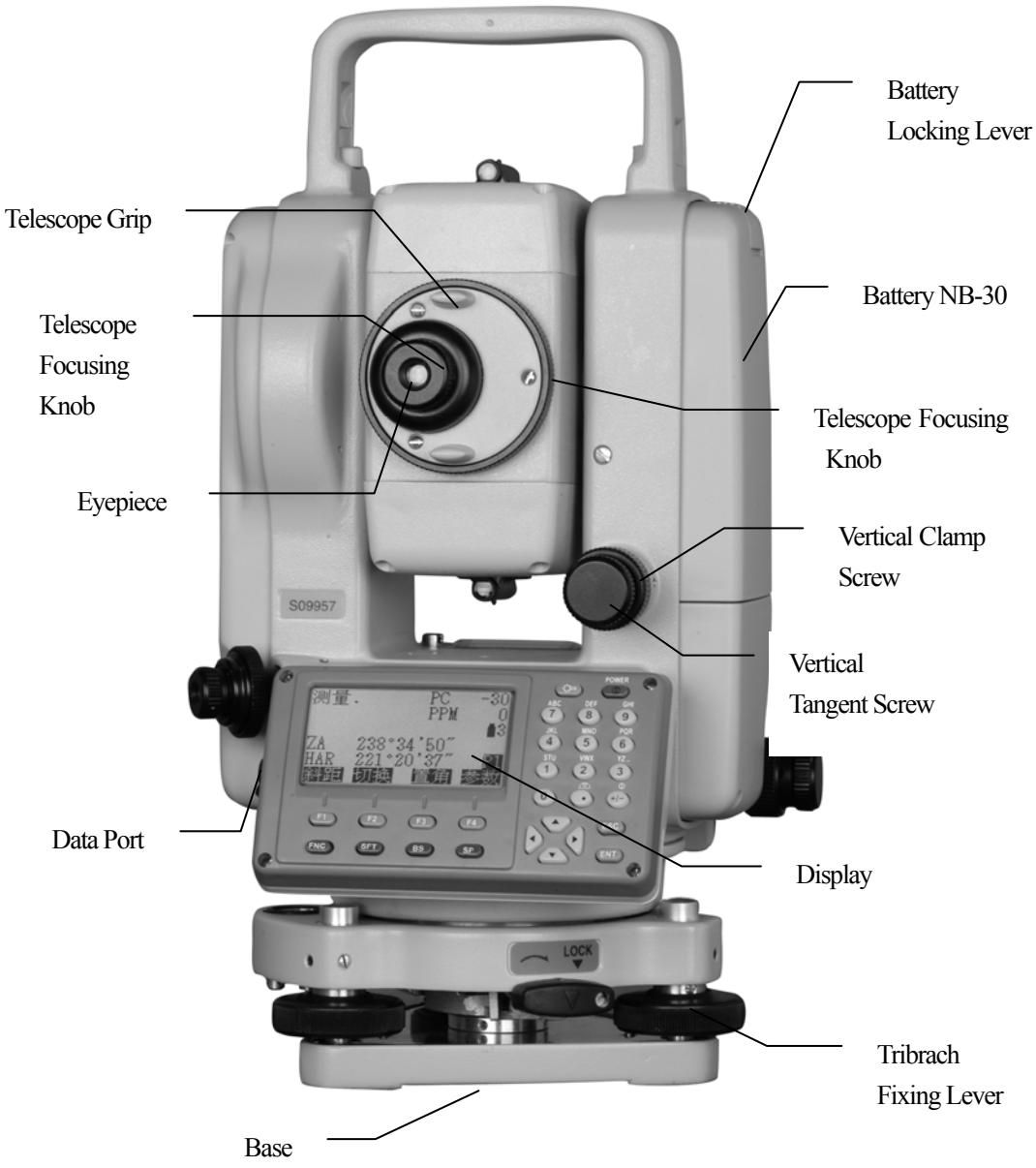
g) Prevent the laser beam from irradiating plane mirror, metal surface, window, etc., especially beware of the surface of plane mirror and concave mirror.

* 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.

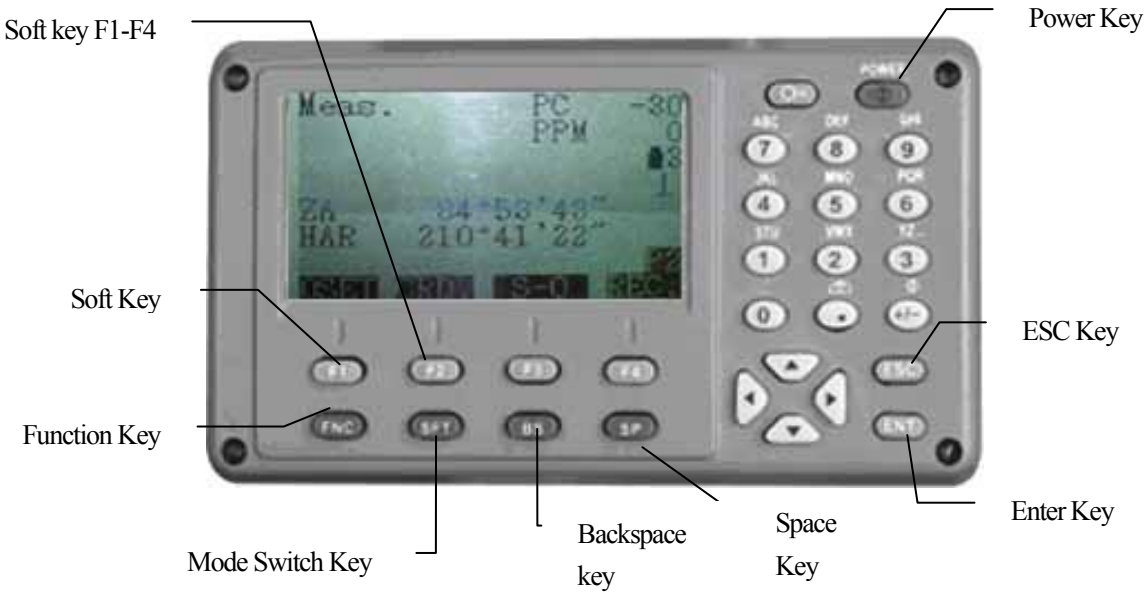
3. NOMENCLATURE




Battery
Locking Lever
Telescope Grip
Battery NB-30
Telescope
Focusing
Knob
Telescope Focusing
Knob
Eyepiece
Vertical Clamp
Screw
Vertical
Tangent Screw
Data Port
Display
Tribrach
Fixing Lever
Base

4. KEY FUNCTIONS

The KTS-440 (L)(R) has a 28-keys keyboard. The keys has a power switch key, an illumination key, 4 soft keys, 10 operating keys and 12 alphanumeric keys.



·Power ON / OFF Key

Power ON ： Press POWER

Power OFF ： Press POWER for 3 seconds

·Light Key

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-440, 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 circle to a required value
EDM	Distance measurement parameter setting

Page 2 ：

Name	Function
0SET	0 Set of horizontal angle
COORD	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 from MEAS mode to “Status Screen”
FNC	Change page of soft key display
SFT	Turn SHIFT mode ON or OFF
BS	Delete a blank left
SP	Input a blank
▲	Move cursor / select options up
▼	Move cursor / select options down
◄	Move cursor to the left / Select another options
►	Move cursor to the left / Select another options
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
1～9	Numerical input/Selection menu item
.	Input decimal point
+/-	Input minus

Alphanumeric keys with shift mode ON：

Name	Function
STU GHI 1 ～ 9	Alphabet input(one of the letters above each key is inputed when that key is pressed)
✉ .	Start the circular level display (See "7.8 Explanations : Leveling KTS-440 when the tilt angle display")
⏻ +/-	Start the return signal check (See"16.2 Return signal checking")

NOTE：Read the following section for detailed alphanumeric input instructions.

5. CHARACTER ENTRY

Job names, data numbers, codes, etc are entered to KTS-440 (L)(R) 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 alphabet input mode. Three letters are assigned to each key. Each time a key is pressed, one of the three letters is displayed at the cursor position. When the letter which must be entered is displayed, press ▶ to move the cursor to the position where the next letter will be entered.	Alpha Key + ▶	Mem. Character Entry Code： JOB_ S

(2) Press SFT to enter numeral input mode.	SFT	Mem. CharacteEntry Code: JOBM2
(3) When the entry is finished, press ENT. The original screen is restored.	ENT	Mem. Character 1、 Character Entry 2、 Delete Character 3、 View Character 4、 Delete All

6. DISPLAY SYMBOLS

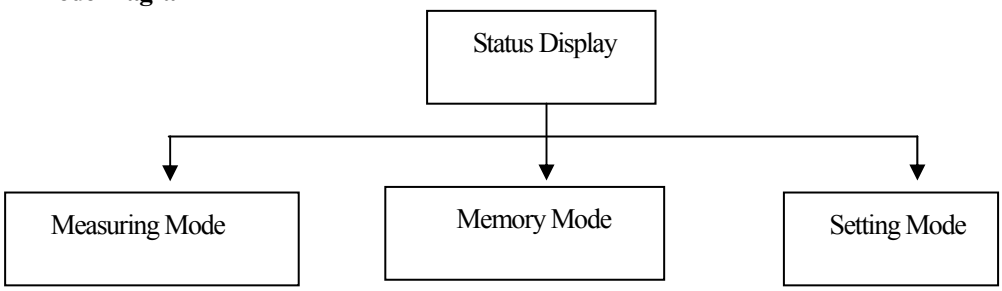
Some symbols are used in MEAS mode. Their meanings are presented below.

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

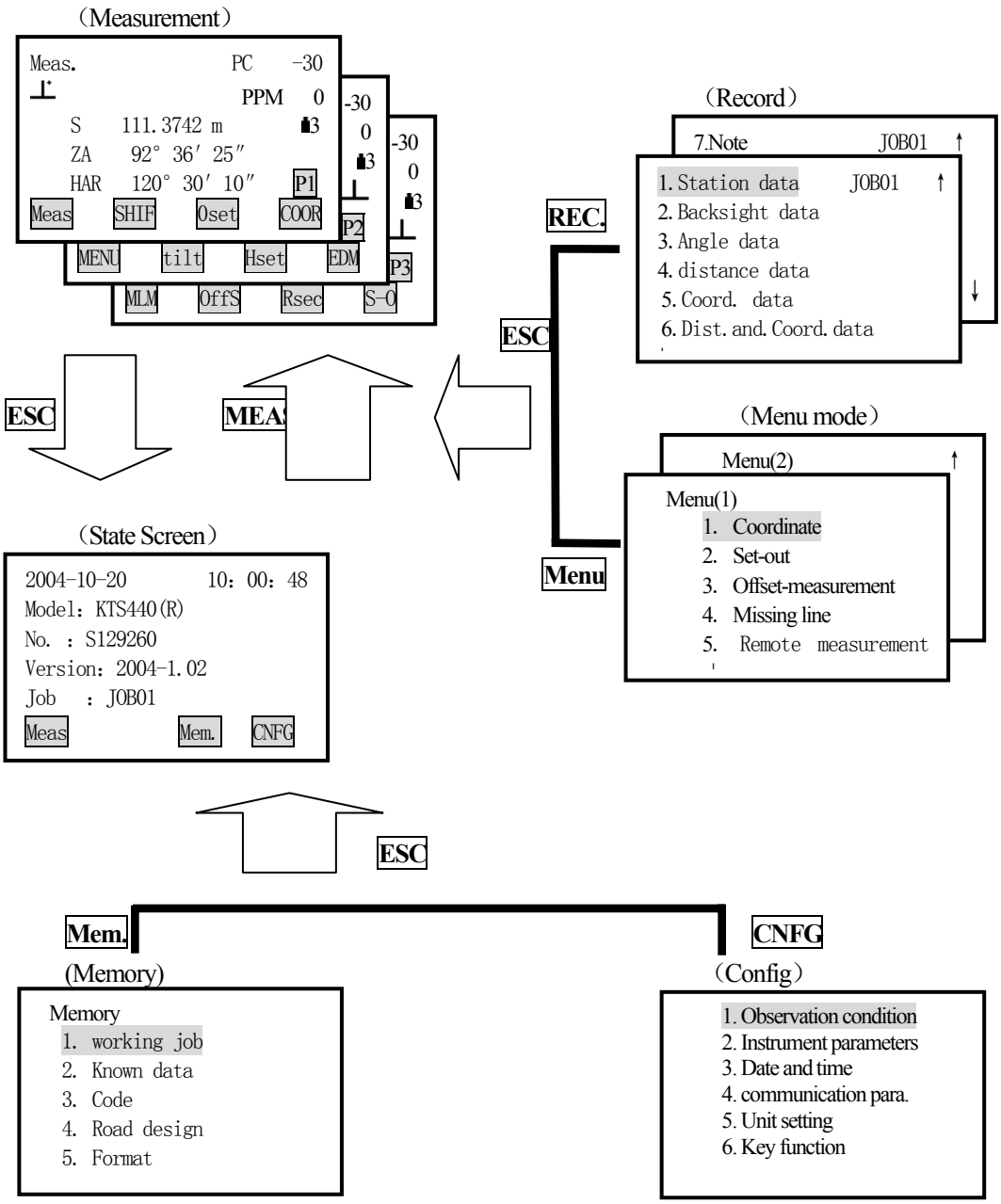
7. MODE CONFIGURATION

KTS440(R)(L) 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. Mode Diagram



2. Menu Table ：

① MEAS mode menu

Name	Function
_DIST	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
F/M	Switch between meters/feet
D-OUT	Output measurement result to external equipment

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
Road design	Design of road date
Format	Memory format

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.

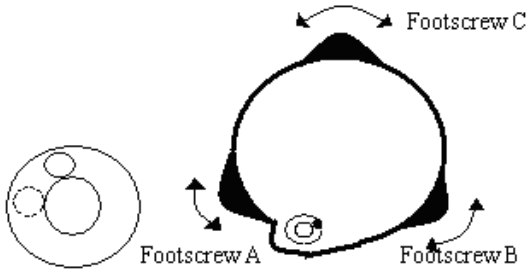
2. **Installing the instrument on the tripod**

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.

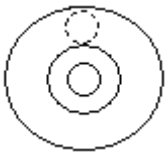
3. **Roughly leveling the instrument by the circular level**

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.



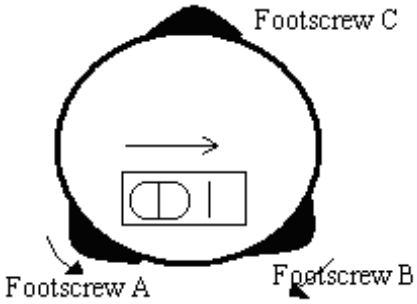
①Turn the leveling screw A and B to move the bubble in the circular level, in which case the bubble is located on a line perpendicular to a line running through the centers of the two leveling screw

being adjusted.

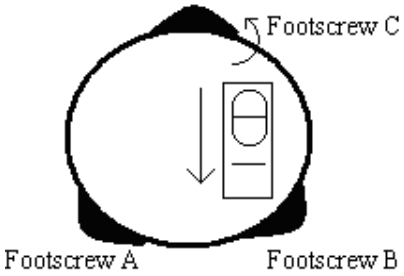


4. **Leveling by the plate level**

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 90º(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 90º (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.

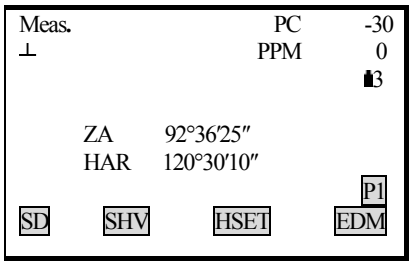
▶PROCEDURE Inserting the battery

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

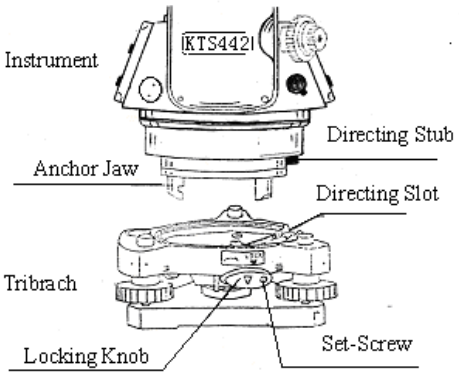
During distance measurement, a reflector prism needs to be placed at target place. Reflector systems come with single prism and triple prisms, which can be mounted with tribrach on a tripod, or mounted on a prism pole. Unique Mini prism systems allows to be set up at corners that are hard to reach.

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

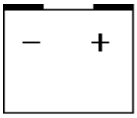
▶**PROCEDURE** ·Power ON

Operation	Display	Note
Press POWER	Initializating.	After power on, instrument process self-check as left.
	Meas. PC -30 PPM 0 S 111.374 m 5 ZA 92°36′25″ HAR 120°30′10″ P1 SD SHIF Hset	Self-check ok.

·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"single 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.

KTS440(R)(L) 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 ZA 92°36′25″ HAR 120°30′10″ P1 SD SHV HSET EDM
(2) Press ESC to enter status screen.	ESC	2004-01-01 10：00：48 KTS-440 No.S09996 Ver.2004-1.02 2004-1.02 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 crn", use ◄or► to set the tilt correction method. Then press ENT to finish set. There are two options about tilt correction: "No, Yes(V)"	"1. Obs. Condition" + ENT + ▲or▼ + ◄or►	Condition C&R crn.: No V. obs : Zenith Tilt crn. : 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

☆ For other settings, refer to "21.1 Changing Instrument Parameters."

If the instrument is not leveled, it is possible to see any 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.		Tilt sensor [X-ON] X: 0°09′22″ OFF X-ON
(2) Rotate tribrach foot screw, centering electronic bubble, the tilt amount is within ±3.5′. Press OFF , tilt correction will be off..		Tilt Sensor [X-ON] X: 0°00′22″ OFF X-ON
(3) When the electronic bubble be 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 *
		Single 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	1″ *
		5″
	Read- in JOB	Enter the read-in JOB

Table 2 ：

Screen Setting	Parameter	Options（*：Factory Setting）
Comms Setup	Baud rate	1200 b/s * ， 9600 b/s
		38400 b/s ， 115200 b/s
	Data length	8 Bits *
		7 Bits
	Parity	None *
		ODD
		EVEN
	Stop bit	1bit *
		2bits
	Check sum	No *
		Yes
	Xon/Xoff	No *
		Yes

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

▶PROCEDURE

Operating Procedure	Operation	Display
(1) From Status Mode Press [Config] to enter config mode.	[Config]	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.	"2. Instrument constant" + [ENT]	Instr. const: Instr. const: 30 mm
(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.

7.6 Setting LCD Contrast

·From "7.5 Setting Instrument Constant", set the contrast of LCD.

▶PROCEDURE

Operating Procedure	Operation	Display
(1) From Status Mode Press [Config] to enter config mode.	[Config]	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 Config to enter config mode.	Config	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: Aug 9, 2003 : 20030809 2 : 30 : 17 p.m : 143020	"3. Date & time" + ENT	Date & Time : Date : 2003-08-09 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 parallax

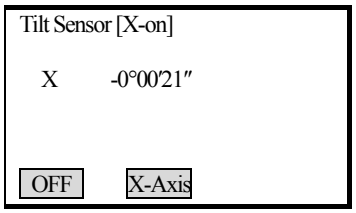
Parallax is the relative displacement of the target image with respect to the reticle when the observer's head is moved slightly up and down or to the sides while looking through the telescope. Parallax will introduce reading errors and must be eliminated before observations are taken. Parallax can be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

▶ Power-saving automatic cut-off

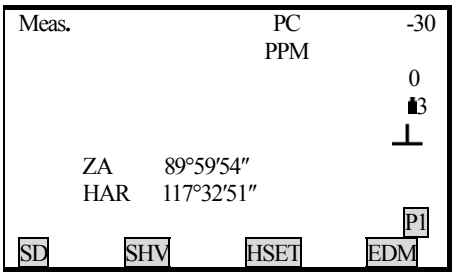
To save power, power to the KTS-440 is automatically cut off if it is not operated for 30 minutes. It is possible to turn the automatic power cut-off function ON or OFF function. Refer to "21 Changing Instrument parameters".

▶ 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.

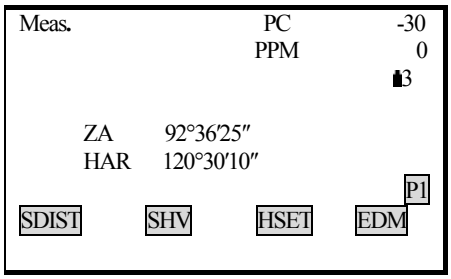


PART 2 BASIC MEASUREMENTS

· 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 "19. 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.

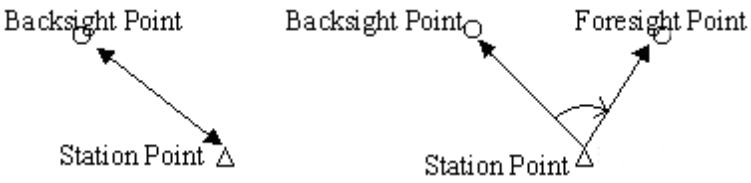
8.1 Measuring the Horizontal Angle Between Two Points（Horizontal Angle 0）

·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 0SET 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 SD SHV 0SET EDM

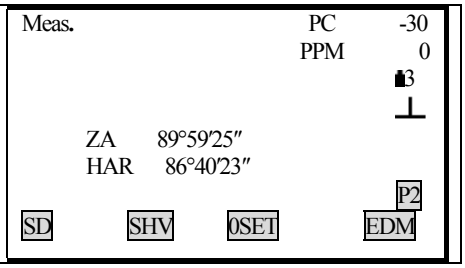
8.1.1 Example Measuring the Horizontal Angle Between Two Points



(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 SD SHV 0SET EDM

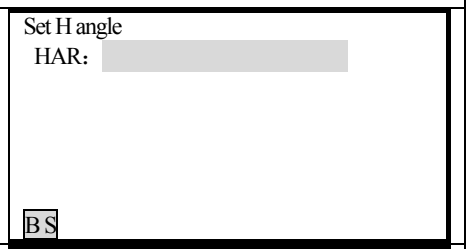
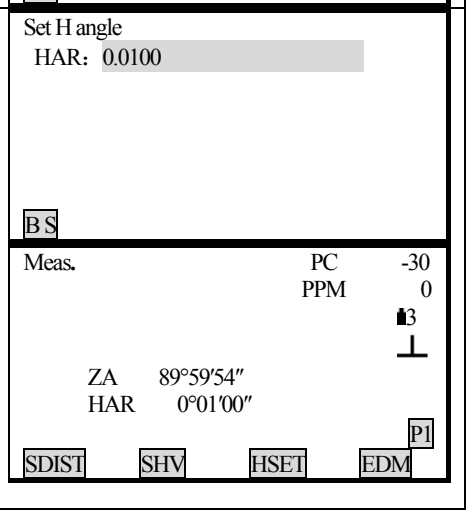
(2) Sight the foresight point, the displayed (HAR) value is the included angle between 2 points.	Sight Foresight Point	

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 direction value and press ENT	

☆ Entry Rules

When you wish to enter 90°30′20″, input 90.3020.

When 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")

8.2.2Use 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	Meas. PC -30 PPM 0 ZA 89°59′54″ HAR 90°01′00″ P1 SDIST SHV HOLD EDM
(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	Meas. PC -30 PPM 0 ZA 89°59′54″ HAR 0° 0′00″ P1 SDIST SHV HOLD EDM
(3) Sight the target and press HOLD to unlock the angle, set the sighting direction to the required direction value.	HOLD	Meas. PC -30 PPM 0 ZA 89°59′54″ HAR 0° 0′00″ P1 SDIST SHV HOLD EDM

8.3 Horizontal Angle Display Selection（Right /Left）

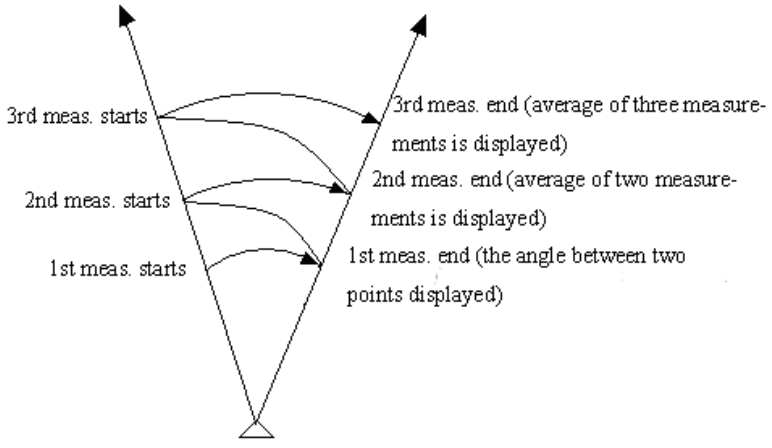
· It is possible to switch between Right Angle (horizontal angle clockwise) display and Left Angle (horizontal angle counterclockwise) display.
· In advance allocate the function keys to display [R/L]. Refer to "18.1.1 Key Function Allocation".

▶ **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 PPM -30 0 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 PPM -30 0 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 "18.1.1 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, repeat step 4 and step 5. · When the repetition measurement is completed, press ESC.	Sighting foresight point + OK	Repetition Hah 80°00′00″ Reps 2 Ave 40°00′00″ HAh 0°00′00″ Take BS C E OK

· 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-440 allows to displays the gradient as a %.
·In advance allocate the function keys to display [ZA/%]. Refer to "18.1.1 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 VA 89°59′54″ HAR 17°31′50″ P1 SD SHV ZA/% EDM
(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 V% 0.00 % HAR 17°31′50″ P1 SD SHV ZA/% EDM

☆ 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 KTS440(R)(L) 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 "22.10 REFLECTORLESS EDM")

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

Accurate measurements to prisms should be made with the standard program (infrared mode).

☞**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 "22.10 REFLECTORLESS EDM").

Make sure the additive constant belongs to the selected target (reflector).

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 After setting these, press ENT.	Temp ： 20 ℃ Press ： 1013.0 hPa PPM ： 0 PC ： -30 Mode： Fine" s" 0PPM

· 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: -30°～ +60°(step length 1℃) or –22 ～ +140℉（step length 1℉）

Pressure entry range: 560 ～ 1066hPa (step length 1hPa) or 420 ～ 800mmHg (step length 1mmHg) or 16.5 ～ 31.5inchHg (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：KTS440R 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.KTS440 series Total Station has the infrared distance measurement function only, and the prism should match with the prism constant.

9.2 Returned Signal Checking

· Check to make sure that sufficient reflected light is returned by the reflective prism sighted by the telescope. Checking the returned signal is particularly useful when performing long distance measurements.

· The instrument can be switched to returned signal checking at any time except the following times:

During distance measurement
During resection calculation
During circular level display

▶PROCEDURE

Operation	Display	Note
Accurately sight the reflecting target, and press SFT, +/- in any screen.	Aiming Signal: [ ] * BEEP DIST	[ ]: No signal [■]: Too much signal [■]: Measurement possible [■]: Measurement possible [■]: Measurement possible The more "■" displayed, the greater the quantity of reflected light. If "*" is displayed, only enough light for the measurement is returned. It is possible to make a buzzer sound at the same time the [*] appears when distance measurement is possible by pressing BEEP, press BEEP to shut off the buzzer.
Press ESC, check completed.	Meas. PC -30 PPM 0 3 S 111.3742 m ZA 92°36′25″ HAR 120°30′10″ P1 SD SHV HSET EDM	Press SDIST, when "*" is not displayed, either resight the target, or in case of long distance measurement, increase the number of prisms. ·When "[■]" is displayed persistently, contact us.

NOTE: When the light intensity is sufficient even though the center of the reflective prism and the reticle are slightly misaligned (short distance etc), [*] will be displayed in some cases, but in fact, accurate measurement is impossible. Therefore make sure that the target center is sighted correctly.

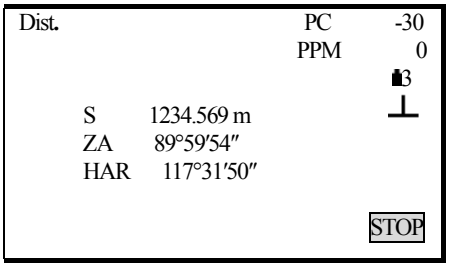
9.3 Distance and Angle Measurement

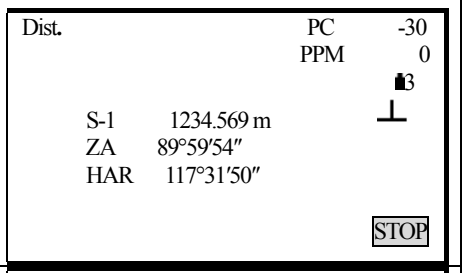
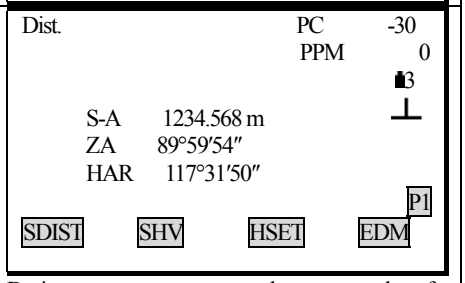
· KTS-440 allows to do angle measurement and distance measurement at the same time.
· When recording measurement data, see "17. Recording Distance Measurement Data".
· Check the following once more before measuring a distance:

1 The KTS-440 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 "18.11 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
(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 "20.1.1 Key Function Allocation."

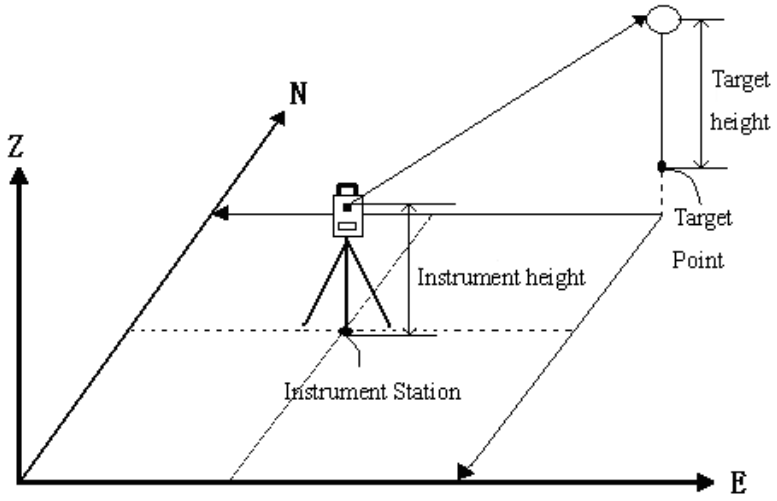
▶PROCEDURE

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 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.



· 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 the backsight station to be measured.

· 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".

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 "18.1 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 COORD in the second page of the "MEAS mode screen", the **Coordinate Measurement Menu Screen** is displayed.	COORD	Coord 1. Observation 2. Stn data 3. Set h angle
(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 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 REC to record instrument station data. For the method of setting each item, see "17.4 Recording Instrument Station Data", press OK to record in JOB.	Enter the station data + ENT	N0 : 1234.688 E0 : 1748.234 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.	OK	Coordinate 1. Observation 2. Stn data 3. Set h angle

NOTE：Coordinates input range

-9999999.999 to +9999999.999 (m) or -9999999.999 to +9999999.999 (ft)

Instrument height input range

-9999.999 to + 9999.999 (m) or –9999.999 to +9999.999 (ft)

Target height input range

-9999.999 to +9999.999 (m) or –9999.999 to +9999.999 (ft)

☆ 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"19.1 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

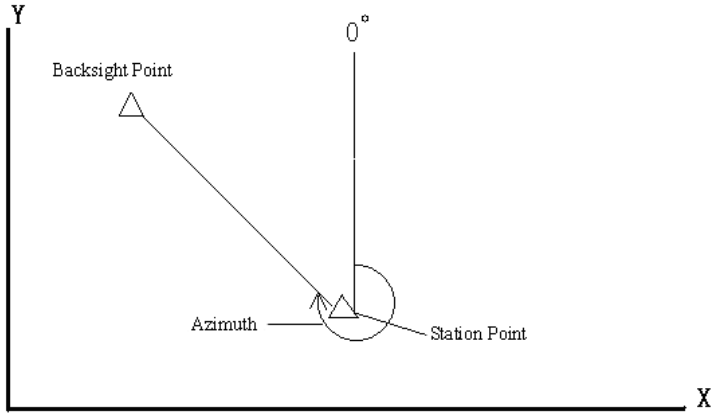
Operating Procedure	Operation	Display
(1) Press READ in the "Instrument Station Setting Screen", the "Coordinate Data Point Number Display screen" is displayed. Stn or Crd ： Coordinate data saved in the job which has been selected,	READ	Read data Pt 1 Stn 1 Stn 2 Crd 1 ↓ -P TOP LAST SRCH
(2) Press ▲or▼ 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]. ·Changing the cursor movement method: -P When –P is displayed, the cursor moves one line at a time. When –P is displayed， the cursor moves one page at a time. Pt name： The point name of the coordinate data which saved in memory.	SRCH	Read data Pt ： 1

(3) Press ENT to read in the selected point and display the coordinate data.	ENT	N0 : 1234.688 E0 : 1748.234 Z0 : 5121.579 Inst. h : 1.600 m Tgt. h : 2.000 m READ REC OK
(4) Press OK, the coordinate Measurement screen is displayed.	OK	Coordinate 1. OBS 2. Stn Data 3. Set H Angle
(5)Press ok, display comes back to coordinate measurement screen.	确定	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"后按 ENT (or press 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: 0°00′00″ NO YES
(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 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.		Coordinate 1. Observation 2. Stn data 3. Back sight data

NOTE: Read coordinate value from memory.

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

Reading 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 coordinate: (N0, E0, Z0)

Instrument height

Prism height

Height difference: Z

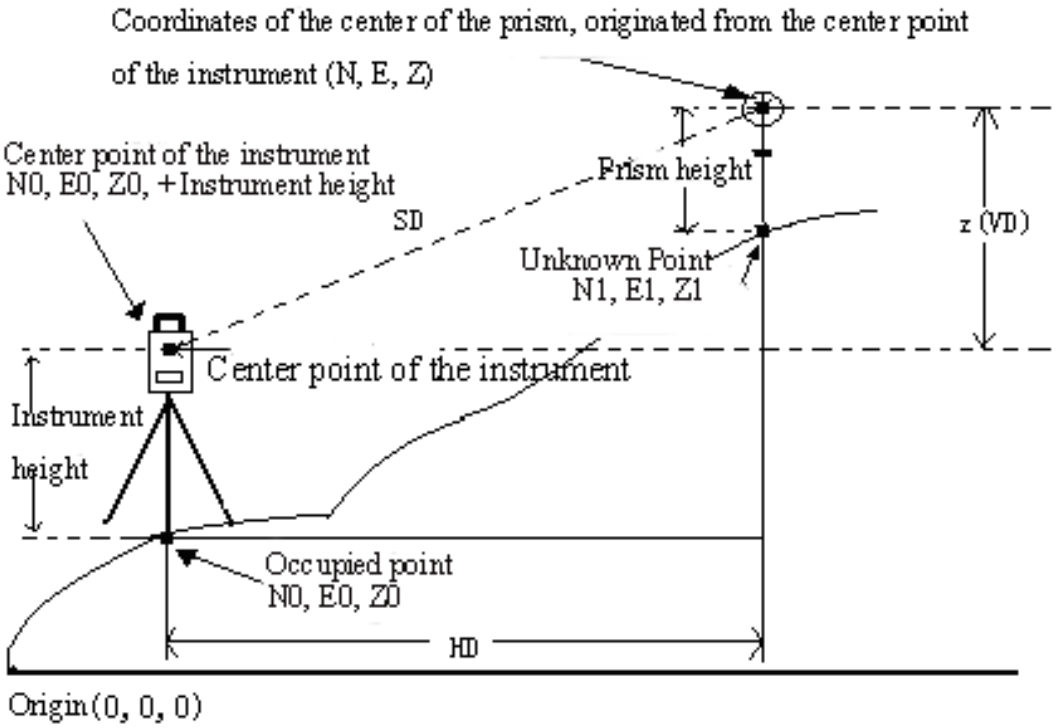
The coordinate difference from the instrument center to prism center: (n,e,z)

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 "16.1JOB selection".

· Check the following once more before measuring.

1. The KTS-440 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 the target center point, select "1. OBS" 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
(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.)		N : 1534.688 E : 1048.234 Z : 1121.579 S : 1382.450 m HAR: 12°34'34" STOP N : 1534.688 E : 1048.234 Z : 1121.579 S : 1382.450 m HAR: 12°34'34" REC OCC OBS
(3) To record the coordinate data in the JOB, press REC. Enter the following items: 1. Point number: target point number 2. Code: Codes or notes. After each entry press ENT · When the cursor is on the code line, press [↑]or[↓] to display and select the codes which is stored in memory. Press OK to record data.	REC + OK	N : 1534.688 E : 1048.234 Z : 1121.579 Pt. : 6 Ht : 1.600 m OK Code : OK ⇓ ⇑
(4) Sight next target point and press OBS to begin measuring. Press STN 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.	OBS	N : 1534.688 E : 1848.234 Z : 1821.579 S : 482.450 m HAR: 92°34'34" STN OBS

(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 14 characters.

☆ To enter codes in advance, see Explanation "18.10 Inputting 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

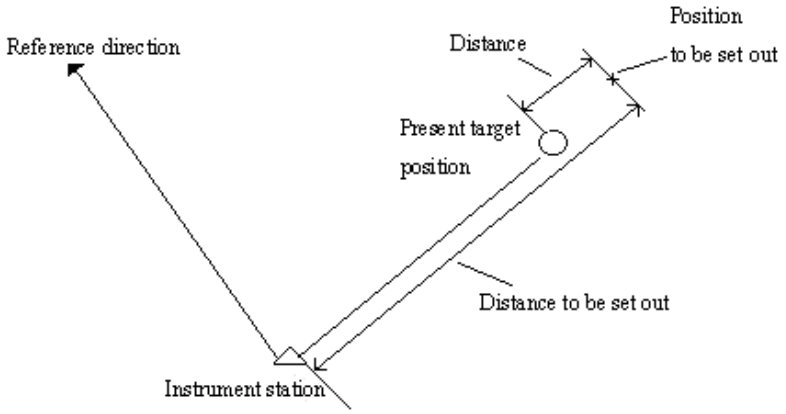
There is two method：

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.

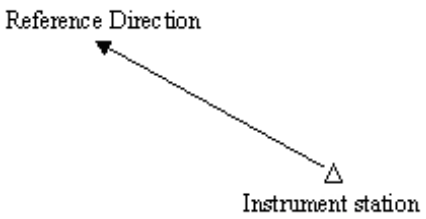
11.1 Distance Setting-Out Measurement

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

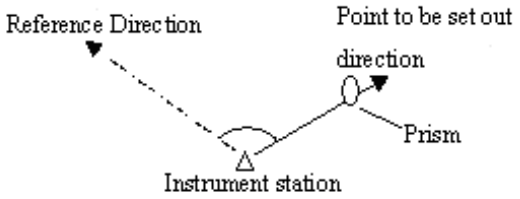


· From the menu mode, selecting "2. S-O" also can perform setting-out measurement.

▶PROCEDURE



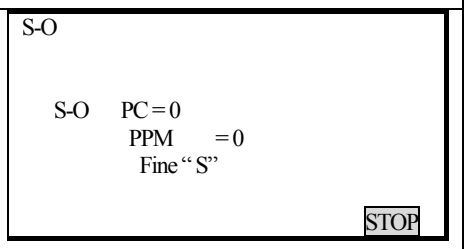
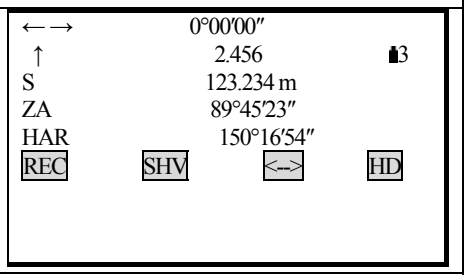
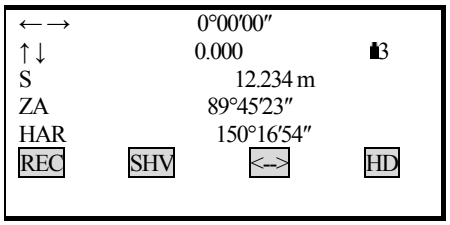
(1)



(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. S-O data 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′08″ 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		←→ 0°00′00″ S 6.324 m ZA 89°45′23″ HAR 150°16′54″ REC SHV <--> HD

instrument station. · Restore the setting-out observation screen: <-->		
(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	
(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.		
(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	

⑽ 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
⑾ 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)

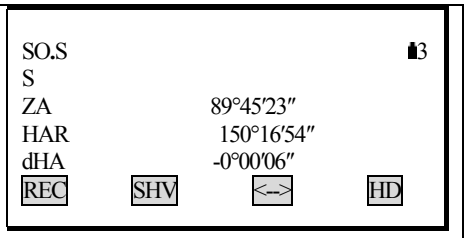
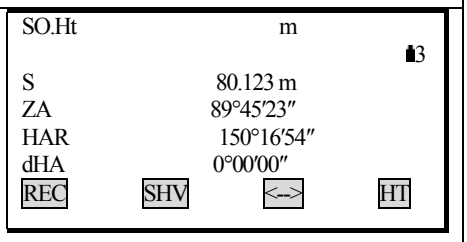
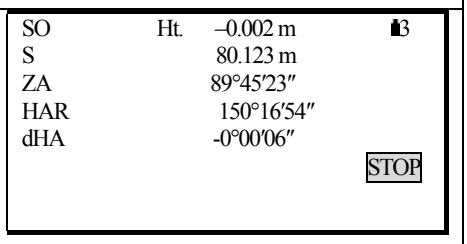
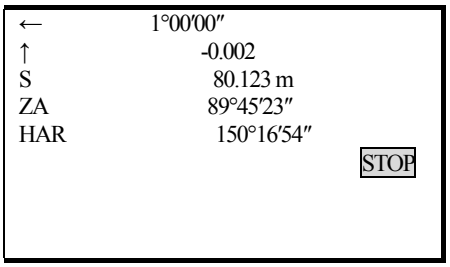
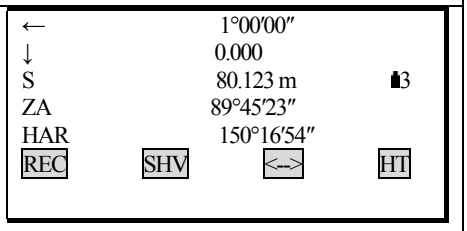
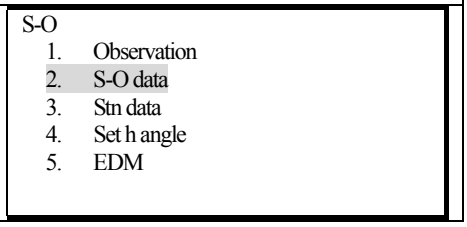
Note: It is possible to perform SD setting-out measurement, VD setting-out measurement, REM setting-out measurement, only after inputting setting-out distance directly.

11.2 REM Setting-Out Measurement

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

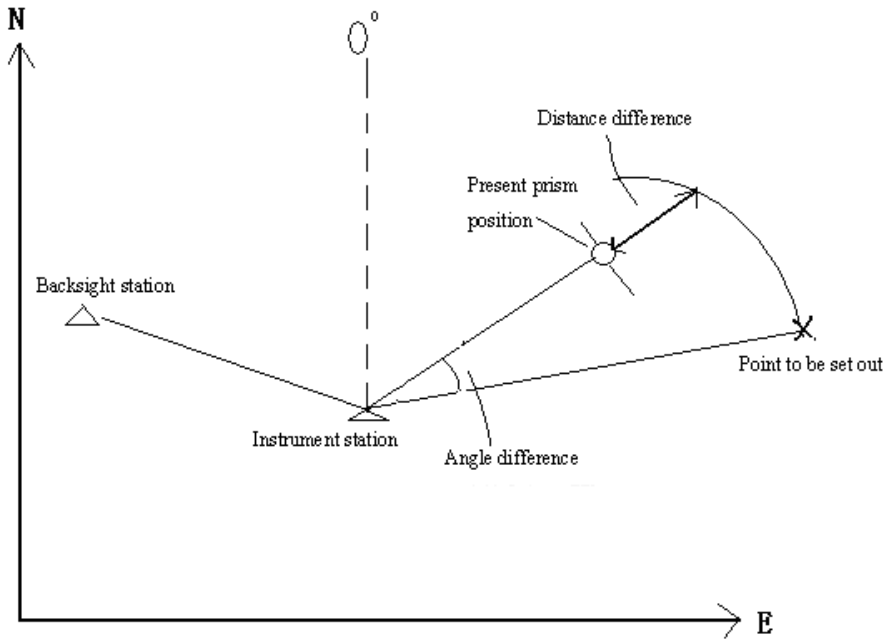
▶PROCEDURE

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	S-O 1. Observation 2. S-O data 3. Stn data 4. Set h angle
(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

<table>
<tr><td>(5) Press OK.</td><td>OK</td><td> 
</td></tr>
<tr><td>(6) Press SHV, HT is displayed on the bottom line of the screen.</td><td>SHV</td><td> 
</td></tr>
<tr><td>(7) Press HT 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.</td><td>HT</td><td> 
</td></tr>
<tr><td>(8) After pressing <-->, then press HT, 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.</td><td><-->
+
HT</td><td> 
</td></tr>
<tr><td>(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.</td><td></td><td> 
</td></tr>
<tr><td>(10) Press ESC to end measurement and return to setting-out measurement menu screen.</td><td>ESC</td><td> 
</td></tr>
</table>

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, the "Setting-out Measurement menu screen" is displayed.	S-O	S-O 1. Observation 2. S-O data 3. Stn data 4. Set h angle 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. Set h angle" 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. Set h angle" + ENT	S-O 1. Observation 2. S-O data 3. Stn data 4. Set h angle 5. EDM
(4) Select "2. S-O data" 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. S-O data" + 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 H-A 0.043m ZA 89°45′23″ HAR 150°16′54″ dHA -0°00′06″ REC SHV <--> HT
(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 COORD. Press COORD to begin Elevation Setting-out Measurement.	SHV + COORD	SO. N 0.001 E -0.006 Z 5.321 HAR 150°16′54″ dHR 0°00′02″ REC SHV <--> COORD

<table>
<tr>
<td>(7) When the measurement is completed, the “Setting-out Observation Screen” is displayed. Press <--->, then press COORD 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.</td>
<td><--->
+
COORD</td>
<td>← 0°00′00″
↓ -0.006 3
↑ 0.300
ZA 89°45′20″
HAR 150°16′54″
REC SHV <---> COORD</td>
</tr>
<tr>
<td>(8) Press COORD, 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 bottom of the pole is found.
Meaning of arrows:
↑: Move upwards ↓ : Move downwards</td>
<td>COORD</td>
<td>←→ 0°00′00″
↑↓ 0.000 3
↑↓ 0.003
ZA 89°45′20″
HAR 150°16′54″
REC SHV <---> COORD</td>
</tr>
<tr>
<td>(9) Press ESC to return “Setting-Out” measurement menu screen”.
To find the next point to be set out, repeat the procedure from step 7.</td>
<td>ESC</td>
<td>S-O
1. Observation
2. S-O data
3. Stn data
4. Set h angle
5. EDM</td>
</tr>
</table>

☆ **NOTE:** When the setting-out distance is bigger than 9999.999 m, the displayed setting-out distance value and the horizontal angle value is 0.000 m and 00°00′00″, be careful.

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 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)

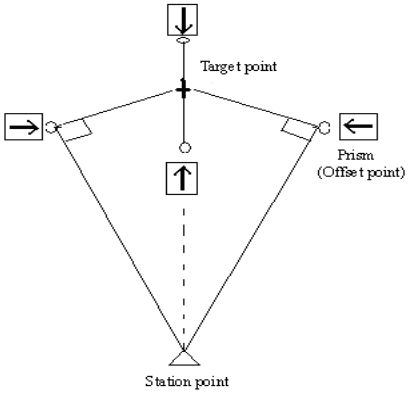
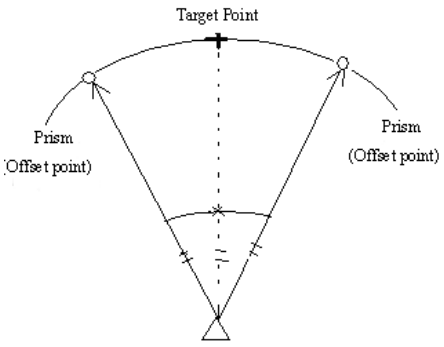
Prism constant input range: -99mm ～ +99mm (Foot length 1mm)

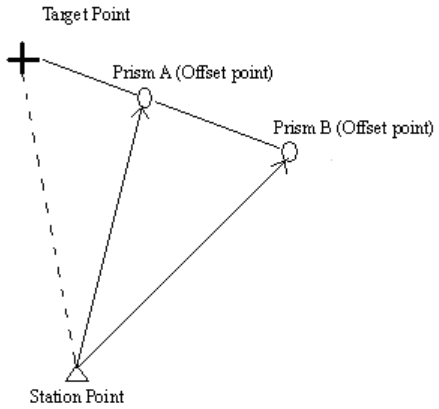
☞Reflector type：KTS440R series Total Station can be set infrared laser distance measurement and unvisible infrared distance measurement ，The reflector includes prism,non-prism and reflector sheet. You can set by yourself according to your need.KTS440 series Total Station has the infrared distance measurement 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.

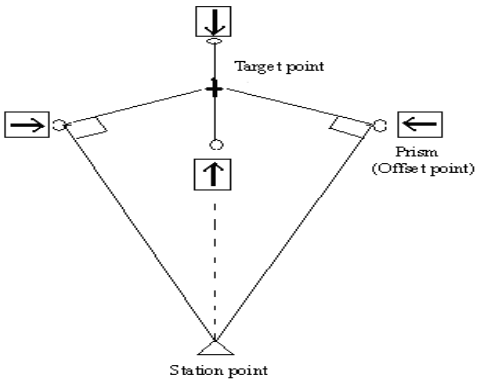
·In advance allocate the function keys to display OFFSET. For the method, see "18.1.1 Key Function Allocation."

·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

·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 positioned in front of or behind the target point, install 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. The measurement results can be distance or coordinate. The upper picture is the result from distance measurement. To see coordinate result, press COORD to show nether picture. Press DIST to show the distance result screen again.	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 "17.1 Recording Distance Measurement data." 1. Point number (Target point number) 2. Code 3. Target height After each entry press ENT. · Maximum point number size: 14 (alphanumeric) · Maximum code size input: 14(alphanumeric)	REC	S 10.865 m ZA 87°58′38″ HAR 112°34′23″ Code: AD Tgt.h: 1.570 m OK N 2.345 E 1.234 Z 0.569 Code: AD Tgt.h: 1.570 m OK
(7) Press OK to return to Offset Menu Screen. · To return to Offset Measurement Menu screen press ESC	OK	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

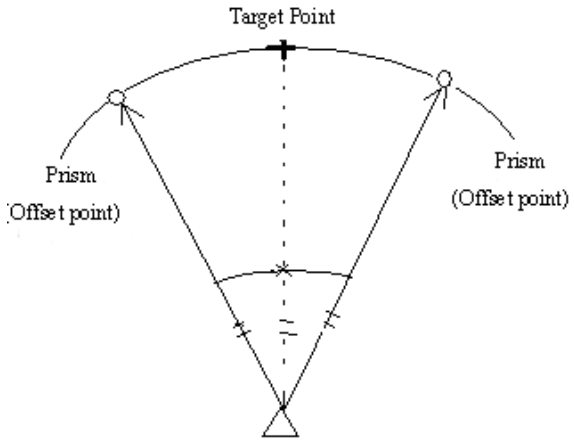
↑ offset point in the front of the target point

↓ 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

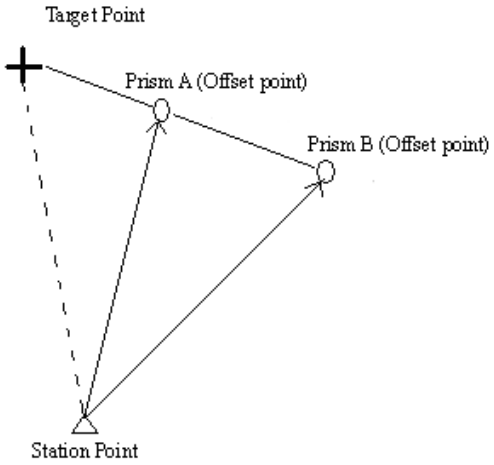
Operating Procedure	Operation	Display
(1) Sight the target of the offset points and press SD in Meas mode.	SD	Dist Dist PC = 0 PPM = 0 Fine "S" STOP
(2) When observation is completed or after the measurement values are displayed during continuous measurement, press STOP to restore the "MEAS Mode Screen." 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 HSET EDM

(3) In MEAS mode, display the screen in which OFFSET is registered. Press OFFSET, the "Offset Menu Screen" is displayed.	OFFSET	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. There will be different contents under different measurement mode. The measurement results can be angle or coordinate. The upper picture is the result from distance measurement. To see coordinate result, press COORD to show nether picture. Press ANGLE to show the distance result screen again.	OK + COORD (or ANGLE)	Offset/Angle. S 22.200 m ZA 76°42′05″ HAR 156°34′23″ REC COORD Offset/Angle. N 2.345 E 1.234 Z 0.569 REC DIST
(6) Press REC to record measurement result. (See "17.1 Recording Distance Measurement.")	REC	S 10.865 m ZA 87°58′38″ HAR 112°34′23″ Pt.: PT0 Tgt. h: 1.570 m OK N 2.345 E 1.234 Z 0.569 Pt.: PT0 Tgt. h: 1.570 m OK

(7) Press OK to return to the Offset Measurement Menu Screen.	OK	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 OFFSET is registered. Press OFFSET to display the "Offset Measurement Menu Screen."	OFFSET	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″ OK
(3) Sight prism 1, press OK to begin measurement.	OK	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 Confirm ? NO YES
(5) Press YES, the "2 nd Target Observation Screen" is displayed. (If to re-observe prism 1, press NO)	OK	Offset/2D Take 2 nd point. ZA 89°47′23″ HAR 150°16′12″ OK

(6) Sight prism 2 and press OK to begin measurement.	OK	Dist. Dist PC = 0 PPM = 0 Fine "S" STOP
(7)When observation has been completed or after the measurement values are displayed during repeat measurement, 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 Confirm ? 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
(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 ROBS EXIT
(10) Press EIXT to return to the "Offset Measurement Menu screen."	EXIT	Offset 1. Offset/Dist 2. Offset/Angle 3. Offset/2D 4. Stn data

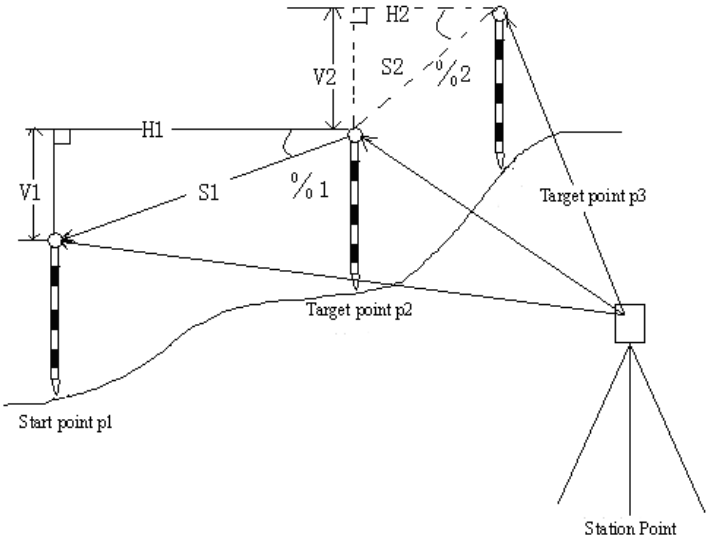
· Offset distance entry range: ±9999.999 m Minimum entry unit: 0.001 m

· Discard the data and observe again: press NO

· Record the result in JOB: REC (See "17.1 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.



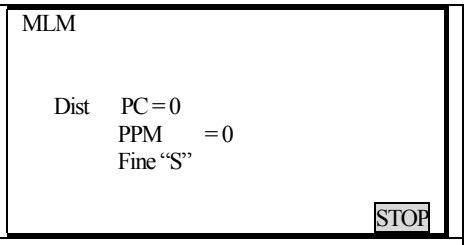
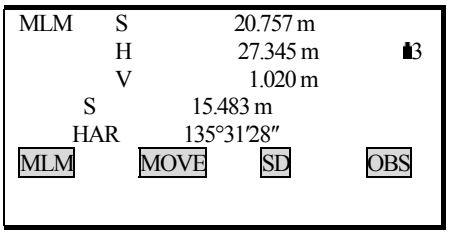
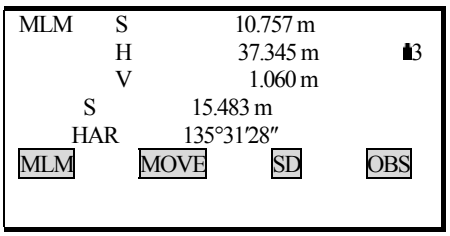
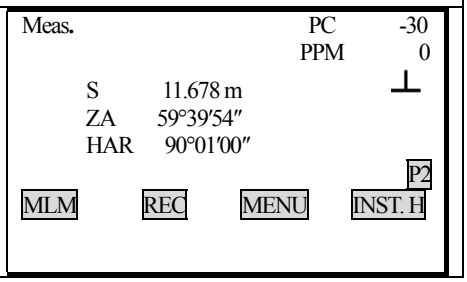
· To find the height difference between 2 points, use a pole to make the target height of all the targets identical.

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. When the observation has been completed or during repeat measurement, 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	
(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	

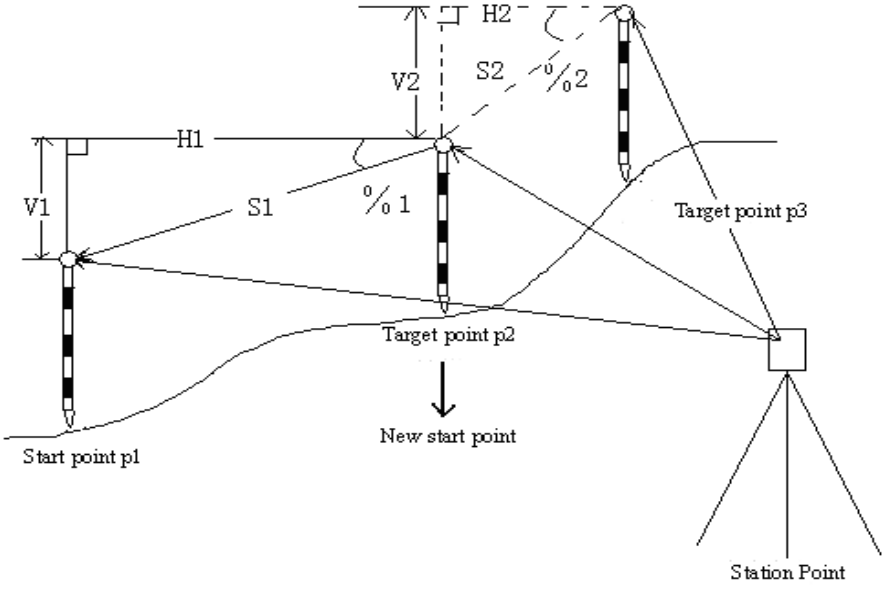
13.1.2 Slope in between 2 points

·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/%	MLM S 46.755% H 37.345 m V 1.060 m S 15.483 m HAR 135°31′28″ MLM MOVE S/% OBS
(2) Press SD again, returns to the original screen.	SD	MLM S 10.757 m H 37.345 m 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.

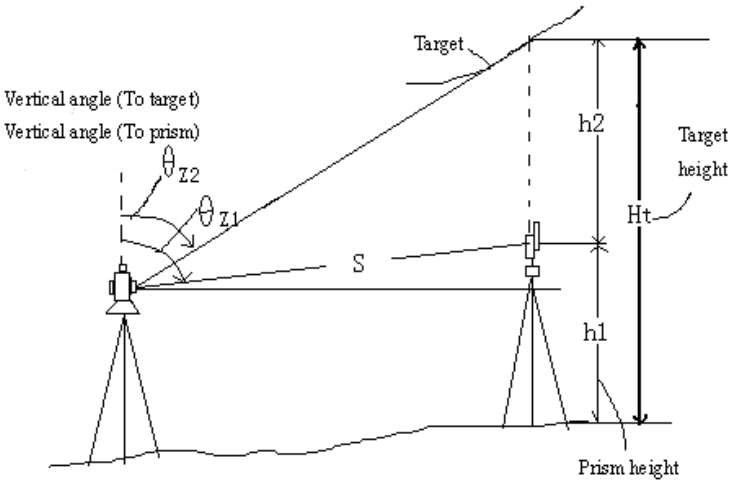


▶**PROCEDURE**

Operating Procedure	Operation	Display
(1) Observe the starting position and target following the steps 1 to 3 in "PROCEDURE 13.1.1 Measuring the distance between multiple targets."		MLM S 46.755% H 37.345 m 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.

$Ht = h1 + h2$

$h2 = Sin\theta z1 \times Ctg\theta z2 - Scos\theta z1$

· 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 "18.1.1 Key Function Allocation."

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

▶PROCEDURE

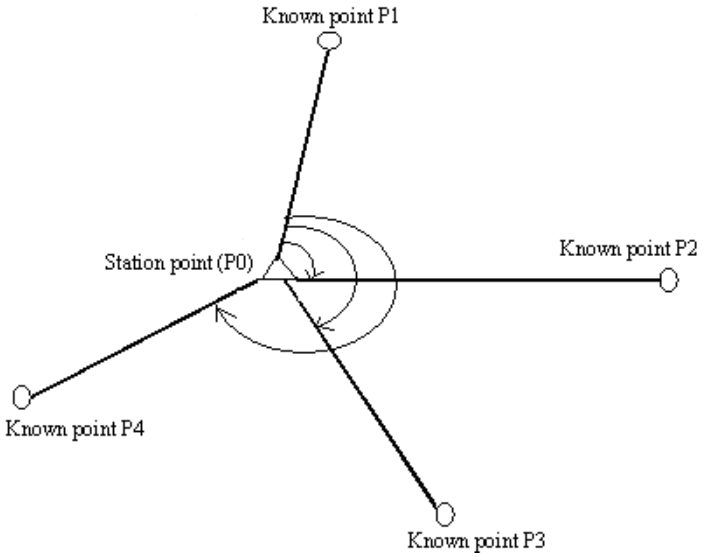
Operating Procedure	Operation	Display
(1) Set the prism directly under or directly over the object and measure the target height with a tape measure. Press HT on the third page of "MEAS Mode Screen". The "Height Setting Screen" is displayed.	[HT]	Height Tgt.h. : 1.650 m Inst. h. : 2.000 m [OK]
(2) Enter 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 7.) · 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	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-440 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 there is even one point which can not be measured, at least known points are required.

NOTE: Angle and distance can not be used crossways. When angle is in measuring, the known point direction should be clockwise or anticlockwise, the angle between near 2 points should be within 180°.

· 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 RESEC in the third page of Meas Mode. Enter coordinate values for the 1 st known point and press ENT. · Stopping an entry in progress: ESC · Reading in data: READ · Record data: REC	RESEC	Resection Pt. 1 N 0.000 m E 0.000 m Z 0.000 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 enter the coordinates of all the known point.	Enter coordinate values	Resection Pt. 2 N 0.000 m E 0.000 m Z 0.000 m MEAS READ REC OK
(3) When all required known points have been set, press MEAS.	MEAS	Resection N 4456.343 E 4321.890 Z 215.557 Sight Pt. 1 ANG DIST
(4) Sight the 1 st known point, press ANG for angle measurement only. Or press DIST for angle and distance measurement. When DIST is selected, the "Observation Start Screen" is displayed.	DIST	Resection Dist PC = 0 PPM = 0 Fine "S" STOP
(5) When the measurements are completed, of 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 Pt. 1 S 353.324 m ZA 21°34′50″ HAR 78°43′12″ Tgt. h : 1.560 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 YES 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 Pt. 3 S 153.324 m ZA 61°14′50″ HAR 98°40′12″ Tgt. H : 1.560 m CALC NO YES

<table>
<tr>
<td>(7) Calculate the station point coordinate, when it is finished, the result is displayed.

·When distance resection is performed, upper screen is displayed.
dHD(The horizontal distance between 2 known points) = measured value – calculated value
dZ=(the coordinate of new point Z which is calculated from the known point A) - (the coordinate of new point Z which is calculated from the known point B)

·When angle resection is performed, nether screen is displayed.
@N,@E are the difference between “the coordinate which calculated from point 1, 2, 3” and “the coordinate which calculated from point 1, 2, 4”, Z0 coordinate is 0.</td>
<td></td>
<td>N0 56.343
E0 21.890
Z0 15.557
dHD 0015 mm
dZ 0012 mm
RE_OBS ADD REC OK

N0 56.343
E0 21.890
Z0 0.000
@N 0015 mm
@E 0012 mm
RE_OBS ADD REC OK</td>
</tr>
<tr>
<td>(8) Press OK to adopt measuring result, the result is recorded as station coordinate. It restores “the Bearing Angle Setting Screen.”</td>
<td>OK</td>
<td>Take the third point.

Set bearing angle
HAR 98°40′12″

NO YES</td>
</tr>
<tr>
<td>(9) Press YES to set bearing angle and return to measurement screen.</td>
<td>YES</td>
<td>Meas. PC -30
PPM 0
S 1234.456 m
ZA 34°45′09″
HAR 126°31′23″
P1
DIST SHV HSET EDM</td>
</tr>
</table>

·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“17.1 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 RE_OBS.	RE_OBS	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

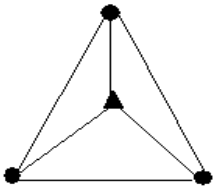
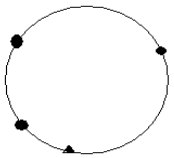
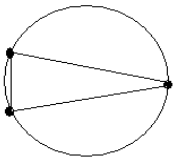
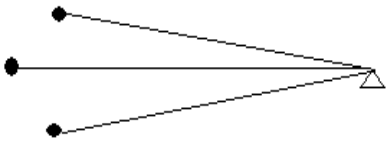
▶**PROCEDURE**

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

▶EXPLANATION Precaution when performing resection

·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
	·It is sometimes 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.

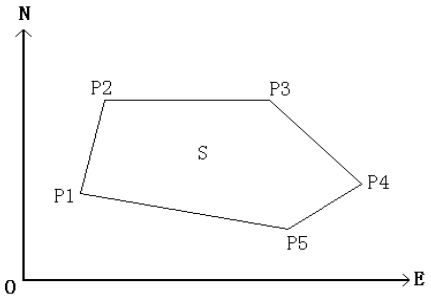
Coordinates(Known value)：P1 (N1, E1)　　Area (calculated value)：S

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 Calculation".		Menu(2) ↑ 8. Area Calculation 9. Set-out Line 10. Point Projection 11. Roads

<table>
<tr>
<td>Every point use during calculation can be gotten by measuring or reading from memory.

For example
Measuring point 1:
(2) Sight the first point on the line enclosing the area and press MEAS to start measuring. The result will be displayed.</td>
<td>Sight
Point 1
+
Meas</td>
<td>Area Calculation
01:
02:
03:
04:
05:
06:
READ MEAS

Area Calculation
N: 40.028 m
E: -10.002 m
Z: 0.076 m
S-A 2.043 m
ZA: 333°28′54″
HAR: 20°45′22″
OK MEAS</td>
</tr>
<tr>
<td>(3) Press OK to enter the value of point 1 in “pt_01”.</td>
<td>OK</td>
<td>Area Calculation
01: pt_01
02:
03:
04:
05:
06:
MEAS</td>
</tr>
<tr>
<td>(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.</td>
<td>READ</td>
<td>Area Calculation
01: pt_01
02:
03:
04:
05:
06:
READ MEAS

Read data
Pt 1
Crd 2
Crd 3
Crd 4
Crd 5
Stn 6 ↓
-P TOP LAST SRCH</td>
</tr>
</table>

(5) In the known points list, select the point number which corresponding for point 2 and press ENT to read the point in.	ENT	Area Calculation 01：pt_01 02：6 03： 04： 05： 06： READ MEAS
(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.		Area Calculation 01：pt_01 02：6 03：pt_03 04： 05： 06： READ CALC MEAS
(7) Press CALC to calculate and display the result.	CALC	Area Calculation Points： 5 Area： 0.338 m. sq 0.0000 ha 3.64 ft. sq 0.0001 acre NEXT END
(8) Press END to end calculation and return to menu screen. Press NEXT to re-enter area calculation.	END	Menu(2) 8. Area Calculation 9. Set-out Line 10. Point Projection 11. Roads

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 "18.1.1 Key function allocation".

17. 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.

17.1 Road Design

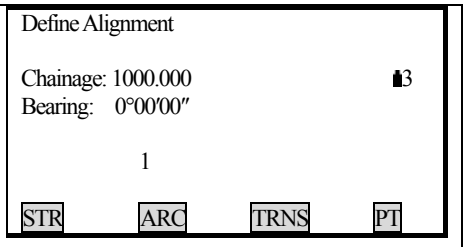
The Road Design menu contains the alignment design functions.

17.1.1 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

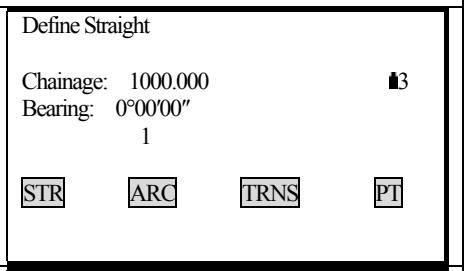
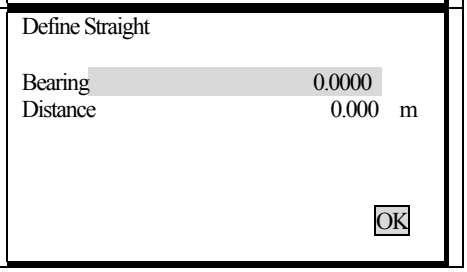
Operating Procedure	Operation	Display
(1) From page 2 on MENU, select "11. Roads."	MENU +"11. Roads"	Menu(2) ↑ 8. Area calculation 9. Set-Out line 10. Point Projection 11. Roads
(2) Slect "1. Define Roads" in the "Roads Menu" and select "1. Define Alignment."	Select"1.Define Alignment"	Roads 1. Define Roads 2. Set-Out Roads Roads(1) 1. Define Alignment 2. Edit Alignment 3. Define VC 4. Edit VC 5. Receive Alignment 6. Receive VC ↓
(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	Define Start Point Chain: 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.		 (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.

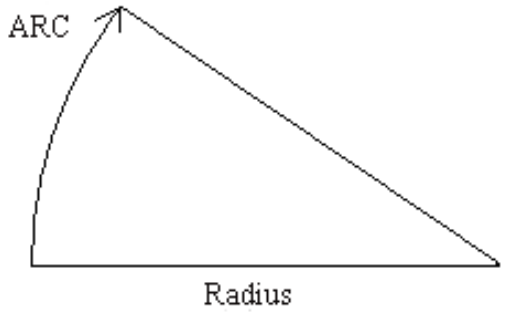
Straight line

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	
(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	

(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 Alignment Chainage: 1020.000 3 Bearing: 4°25′00″ 2 STR ARC TRNS PT

Circular Curve

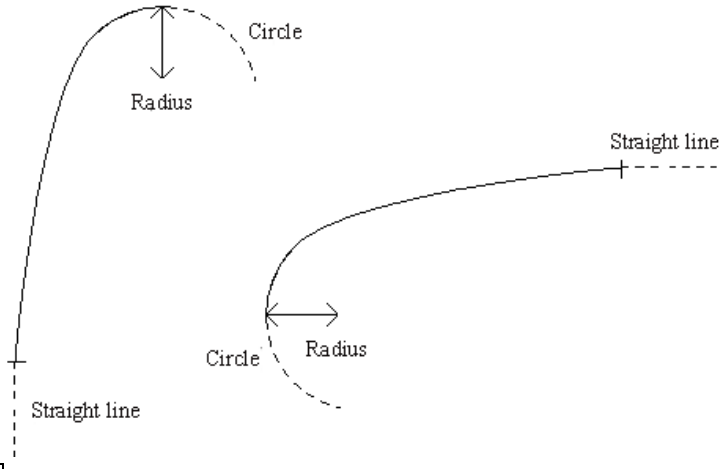


Press ARC key in the "Main line Input Screen", the circular curve can be defined. Circular curve consists of Arc length and Radius. The rule of radius value: along the forward direction of the curve.When the curve rotates to right, the radius value is positive. When the curve rotates to left, the radius 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 Alignment Chainage: 1000.000 3 Bearing: 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	Define Arc Radius: 0.000 m Arc: 0.000 m OK

(3) Press OK to record the alignment data.	OK	Define Alignment Chainage: 1020.000 3 Bearing: 75°37′11″ 2 STR ARC TRNS PT

Transition curve



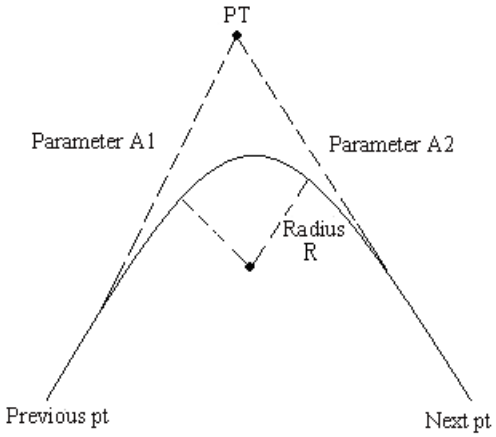
Press TRNS key in the "Main Line Input Screen", the transition curve can be defined. Transition curve consists of the minimum radius and arc length. The rule of radius value: along the forward direction of the curve.When the curve rotates to right, the radius value is positive. When the curve rotates 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."	ARC	Define Alignment Chainage: 1000.000 3 Bearing: 0°00′00″ 1 STR ARC TRNS PT

(2) Enter the minimum radius and arc length of transition curve, and press ENT.	Enter the minimum radius and arc length + ENT	Define Transition Radius: 0.000 m Arc 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 Alignment Chaingage: 1028.000 3 Bearing: 83°15′32″ 2 STR ARC TRNS PT

PT (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 alignment Chainage:1000.000 3 Bearing: 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	Define point 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 alignment Chainage: 1046.000 Bearing: 153°15′32″ 2 STR ARC TRNS PT

[NOTE]： 当 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.

17.1.2 Edit Alignment

To edit the alignment select Edit Alignment from the menu.

▶PROCEDURE

Operating Procedure	Operation	Display
(1) Select "2 Edit alignment" from the "ROADS" menu.		Roads(1) 1. Define Alignment 2. Edit Alignment 3. Define VC 4. Edit VC 5. Receive Alignment 6. Receive VC ↓

(2) The first alignment data in memory is displayed.		Edit Start Chain ： 1046.000 N ： 201.000 m E ： 102.000 m PREV NEXT SRCH P1
(3) Press PREV or NEXT to find the alignment data to be edited.		Edit Straight Bearing: 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.		Edit Straight Bearing: 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	Edit start Chain: 1046.000 N ： 200.000 m E ： 100.000 m PREV NEXT SRCH P1

<table>
<tr>
<td>(2) Enter the required chaiage.</td>
<td>Enter the chainage</td>
<td>Search alignment
Chain: 1111.561</td>
</tr>
<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.

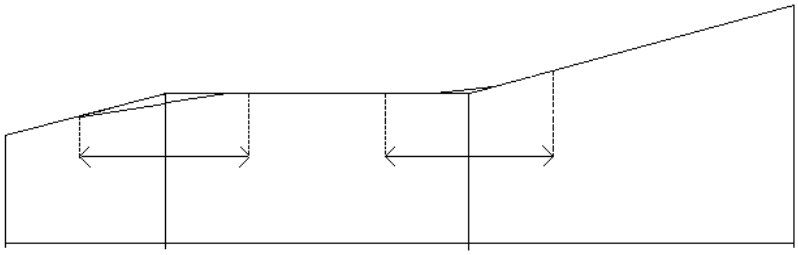
B:
If the entered chainage is existed in memory, its information will be displayed.</td>
<td></td>
<td>A:
Search alignment
Invalid chainage !

Edit start
Chian: 1046.000
N : 200.000 m
E : 100.000 m
PREV NEXT SRCH P1
B:
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>

17.1.3 Define Vertical Curve (Maximum 100 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 VC" from Roads menu.	Select "3. Define VC"	Roads(1) 1. Define Alignment 2. Edit Alignment 3. Define VC 4. Edit VC 5. Receive Alignment 6. Receive VC ↓
(2) Enter chainage, elevation and curve length.	Enter chainage, elevation and curve length.	Define VC Chainage: 1000.000 m3 Elevation: 50.000 m Curve length: 0.000 m OK
(3) Press OK to record the data. Then enter next data.	OK	Define VC Chainage: 1000.000 m3 Elevation: 50.000 m Curve length: 0.000 m OK

17.1.4 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 VC" from Roads menu.		Roads(1) 1. Define Alignment 2. Edit Alignment 3. Define VC 4. Edit VC 5. Receive Alignment 6. Receive VC ↓
(2)The first curve data in memory is displayed.		Edit curve Chain: 1000.000 3 Elevation: 50.000 m Curve length: 0.000 m PREV NEXT SRCH P1 STRT END READ P1
(3) Press PREV or NEXT to find the required curve data.		Edit curve Chain: 1106.000 3 Elevation: 200.000 m Curve length: 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 curve Chain: 1100.000 3 Elevation: 200.000 m Curve length: 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 VC" screen.	SRCH	Edit curve Chain: 1000.000 ∎3 Elevation: 50.000 m Curve length: 000.000 m PREV NEXT SRCH P1
(2) Enter the chainage of the required curve.	Enter the chainage	Search curve 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: Edit curve Chain: 1000.000 ∎3 Elevation: 50.000 m Curve lengt: 000.000 m PREV NEXT SRCH P1 B: Edit curve Chain: 1100.000 ∎3 Elevation: 50.000 m Curve length: 200.000 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

17.1.5 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[，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 "Receive alignment" in the "Roads" screen.		Roads(1) 1. Define Alignment 2. Edit Alignment 3. Define VC 4. Edit VC 5. Receive Alignment 6. Receive VC ↓
(2) 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 alignment Overwrite file? NO YES
(3)Start the receiving software in computer, when the KTS displays "Ready? ", press OK.	OK	Receive alignment Ready? OK
(4) Start receiving. To stop receiving, press STOP.		Receive alignment Receive 0 Data STOP
(5) When "Receiving finished" is displayed, the screen will restore the Roads menu.		Receive alignment Receiving finished!

17.1.6 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 "6. Receive VC" in the "Roads" screen.		Roads(1) 1. Define Alignment 2. Edit Alignment 3. Define VC 4. Edit VC 5. Receive Alignment 6. Receive VC ↓
(2)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 3.	YES	Receive VC Overwrite file? NO YES
(3)Start the receiving software in computer, when the KTS displays "Ready? ", press OK.	OK	Receive VC Ready? OK

(4)Start receiving. To stop receiving, press STOP.		Receive VC Receive 0 Data STOP
(5)When "Receiving finished" is displayed, the screen will restore the Roads menu.		Receive VC Receiving finished!

17.1.7 Deleting Horizontal alignment Data

The alignment data in memory can be deleted.

▶PROCEDURE

Operating Procedure	Operation	Display
(1)Select "Delete alignment" in the "Roads" screen.		Roads(2) ↑ 7. Delete Alignment 8. Delete VC
(2) When "Alignment delete?" is displayed, press YES, the data will be deleted, the screen restore the Roads screen. To exit, press NO.	YES	Alignment Delete? NO YES

17.1.8 Deleting Vertical Curve

The alignment data in memory can be deleted.

▶PROCEDURE

Operating Procedure	Operation	Display
(1)Select "8. Delete VC" in the "Roads" screen.		Roads(2) ↑ 7. Delete Alignment 8. Delete VC
(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	Vertical curve Delete? NO YES

17.2 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).

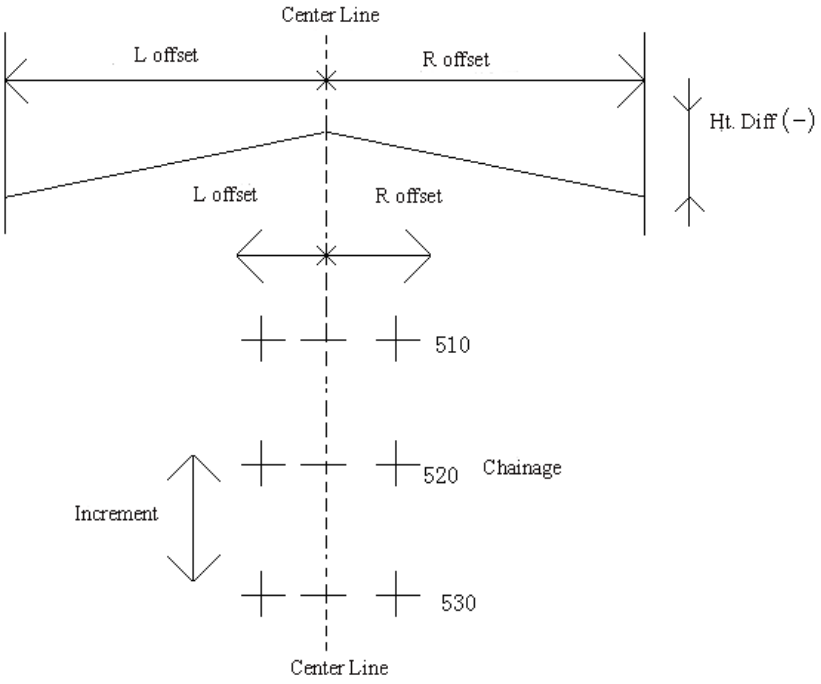
The vertical alignment is optional, but is required to compute cut and fill.

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.



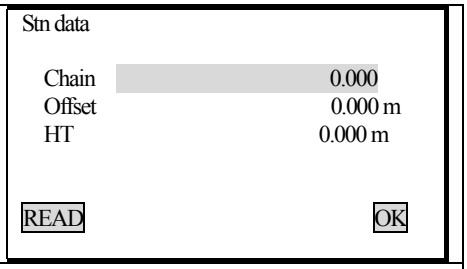
19-2

17.2.1 Set Station Point

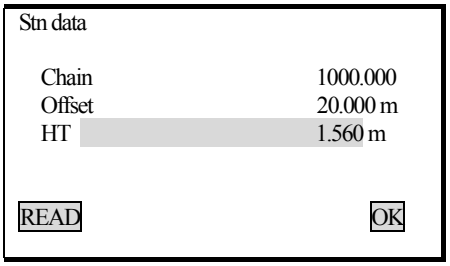
It allows you to set station point by reading from memory (N, E, Z coordinate) or entering manually by keyboard (chainage and offset).

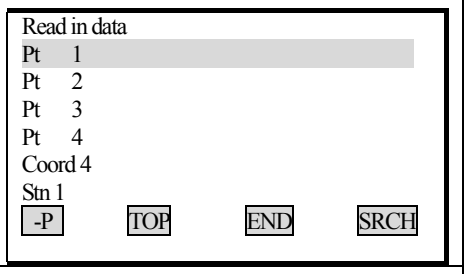
▶ **PROCEDURE**

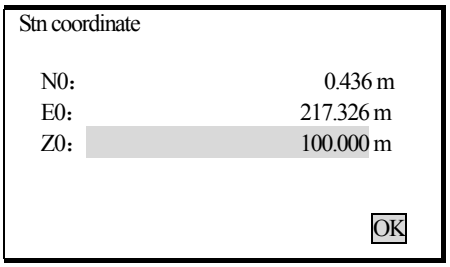
Operating Procedure	Operation	Display
(1) From the "Roads" menu select "2. Set-Out Roads". Then select "1. Stn data."	Select"1. Stn data"	Roads 1. Define Roads 2. Set-Out Roads Set out roads 1. Stn data 2. Set H angle 3. Set Back Sight Pt 4. Set Out Data 5. EDM

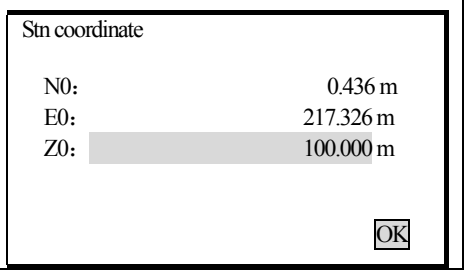
<table>
<tr>
<td>(2) The “Stn data” screen is displayed.</td>
<td></td>
<td> 
</td>
</tr>
<tr>
<td>(3)
A:
Enter the chainage, offset, instrument height of the station point.

B:
To read in coordinate data from memory, press READ.</td>
<td>Enter the chainage, offset, instrument height

READ</td>
<td>A:
 

B:
 
</td>
</tr>
<tr>
<td>(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.</td>
<td></td>
<td>A:
 

B:
 
</td>
</tr>
</table>

(5) Press OK to finish setting and retore 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

17.2.2 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. Set H angle" from the "Set Out Roads" menu.	Select "2. Set H angle"	Set out roads 1. Stn data 2. Set H angle 3. Set Back Sight Pt 4. Set Out 5. EDM
(2) Enter the bearing angle.	Enter bearing angle	Set H angle HAR: 0.0000 OK
(3) Press OK, the screen restore the "Set Out Roads Screen."	OK	Set out roads 1. Stn data 2. Set H angle 3. Set Back Sight Pt 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. Set Back Sight Pt" in the "Set Out Roads Screen."	Select "3. Set Back Sight Pt"	Set out roads 1. Stn data 2. Set H angle 3. Set Back Sight Pt 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.	Enter the chainage, offset	A: Set Back Sight Pt Chain 1000.000 Offs. 20.000 m READ OK
B: To read in coordinate data from memory, press READ.	READ	B: Read data Pt 1 Pt 2 Pt 3 Pt 4 Crd. 4 Stn 1 -P TOP LAST SRCH

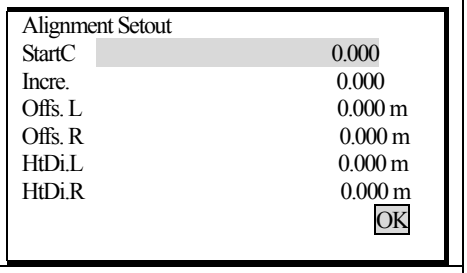
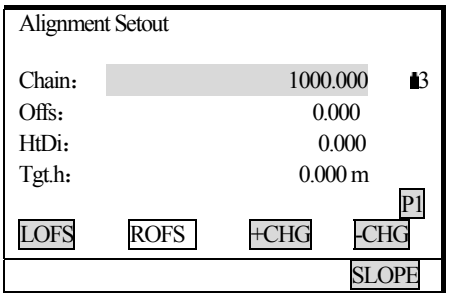
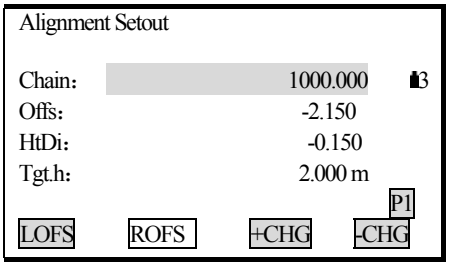
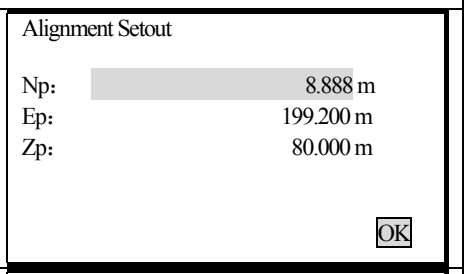
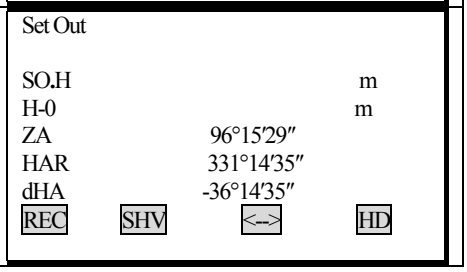
(4) A: The point coordinate is calculated on the basis of the entered chainage and offset. It the vertical curve data of the chainage is existed in memory, the elevation of the point will be displayed. If the curve is not existed, the elevation display with 0. B: The coordinate of the read point is displayed.。		A: Set Back Sight Pt NBS: 80.436 m EBS: 217.326 m ZBS: 10.090 m OK B: Set Back Sight Pt NBS: 400.436 m EBS: 17.326 m ZBS: 150.000 m OK
(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

17.2.3 Setting Out

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

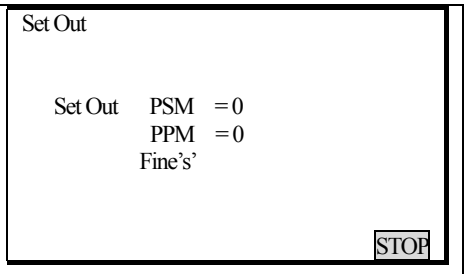
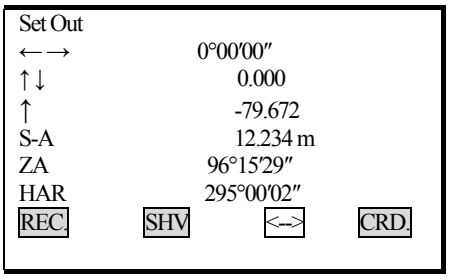
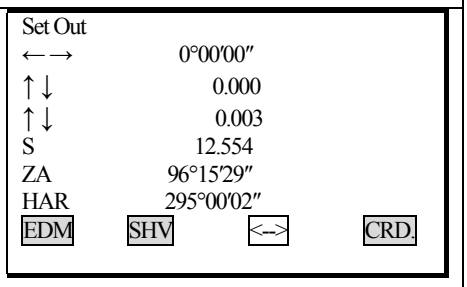
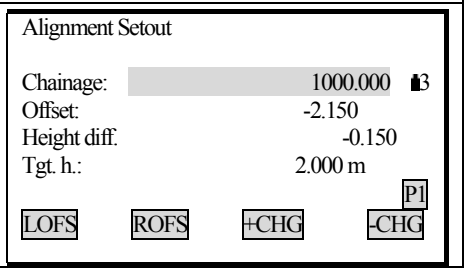
▶PROCEDURE

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.		
(3) Press ENT, the chainage and offset screen is displayed.	ENT	 (Main set out screen)
(4) Press LOFS (or ROFS) 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.		
(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.		
(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	

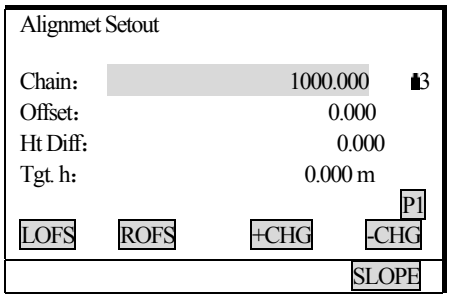
(7) Sight the prism and press CRD. When the measurement is finished, the "Setting-Out Obsevation screen" is displayed.	CRD	Set Out Set Out PSM = 0 PPM = 0 Fine's' STOP Set Out SO. N -2.369 E 8.044 Z -79.672 ZA 96°15′29″ HAR 331°13′46″ dHR -36°14′35″ REC. SHV <--> CRD.
(8) Press <--> then press CRD. To 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.	<--> + CRD.	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.
(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": <-->		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.

<table>
<tr>
<td>⑽ 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> 
</td>
</tr>
<tr>
<td>⑾ 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 sighting the prism.)
↓ : Move the prism to the station point direction.
↑ : Move the prism away to the station positon.</td>
<td></td>
<td> 
</td>
</tr>
<tr>
<td>⑿ 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</td>
<td></td>
<td> 
</td>
</tr>
<tr>
<td>⒀Press [ESC] key to the "Chainage and Offset Setting Screen", set out the next point from step 4.</td>
<td></td>
<td> 
</td>
</tr>
</table>

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."

Explanation for the main set out screen:



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

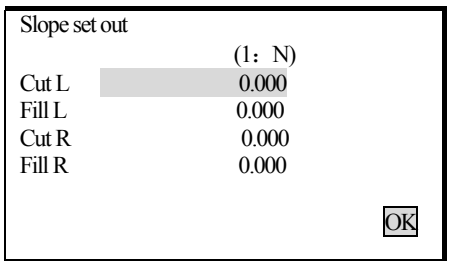
ROFS: The key is use in setting out the right side stake. Press it to display the offset and the height difference of the right side stake.

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

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

17.2.3-1 Slope Setout

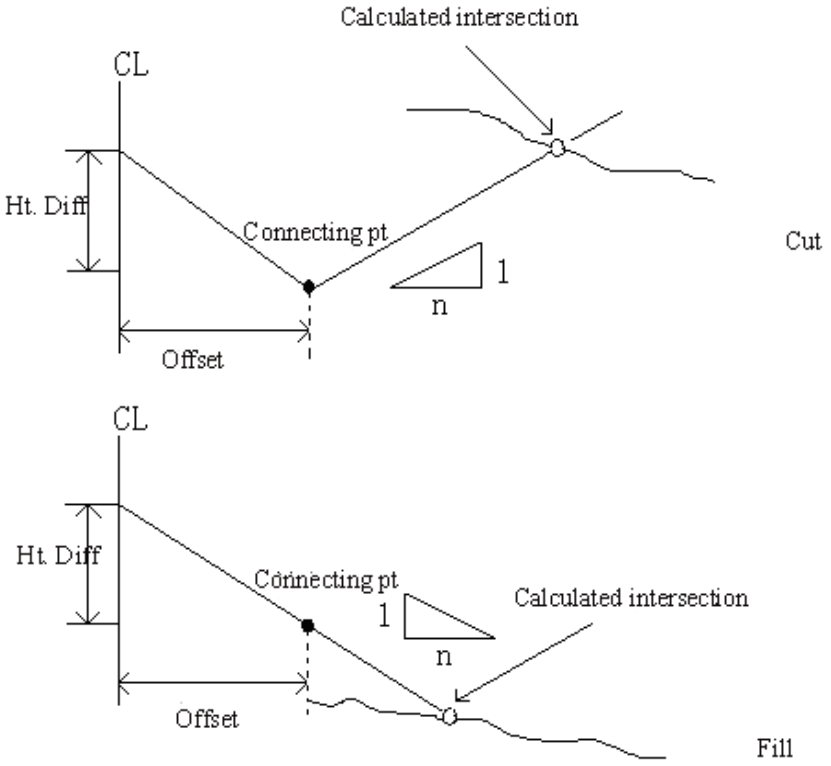
Slope setting-out can be performed as part of the Alignment setout option. After defining vertical curve and horizontal alignment in the "Define Roads Menu", it is possible to perform slope setting-out. Press F4 (SLOPE) key, Slope Setout will be displayed.



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.

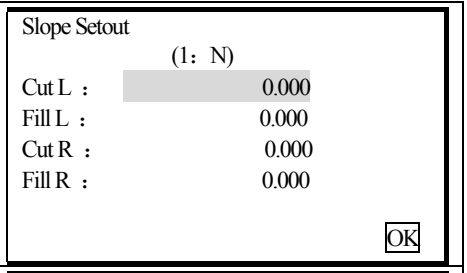
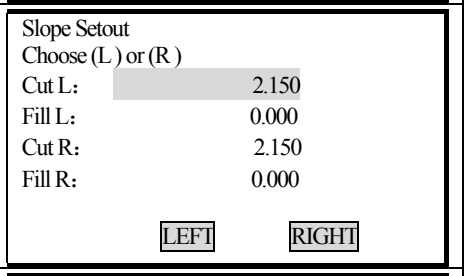
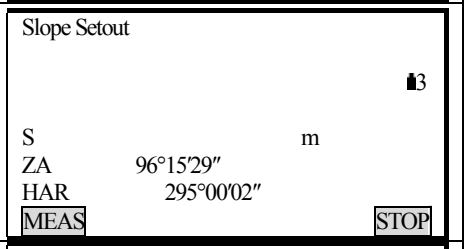
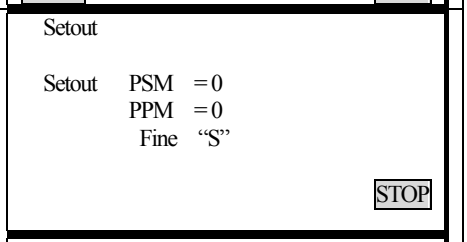
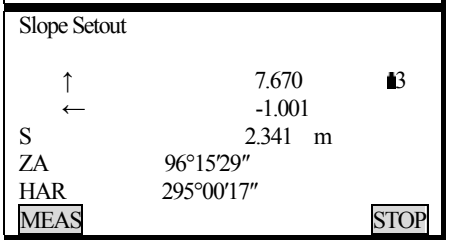
Cut or fill is determined by the estimated level at the offset of the hinge point. If the level is above the level

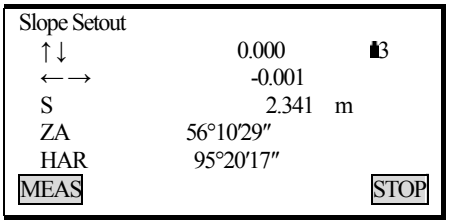
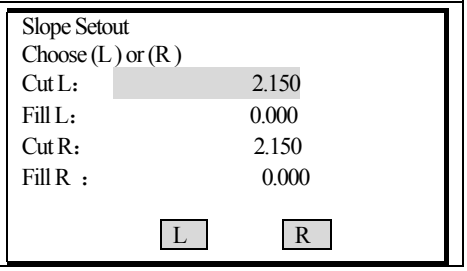
of the hinge then the cut slope is used, otherwise the fill slope is used.



▶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	
(3) Choose LEFT or RIGHT using function keys.	L or R	
(4) Enter the screen of slope setting-out.		
(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.		 

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

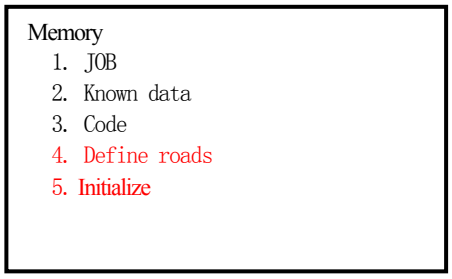
1) An intersection can not be computed if the groun surface passes through the hinge point.

2) The cut is not displayed because the cut at the computed point is zero.

PART 4 DATA RECORDING

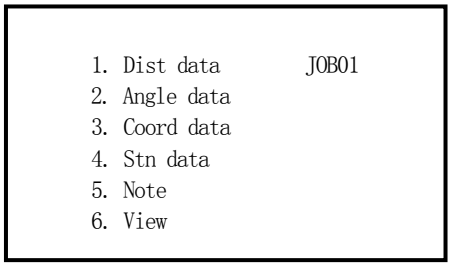
·This section explains JOB or memory settings which can be performed in Memory Mode and data recording methods which can be performed in Record Mode.

Memory Mode Screen



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

Record Mode Screen

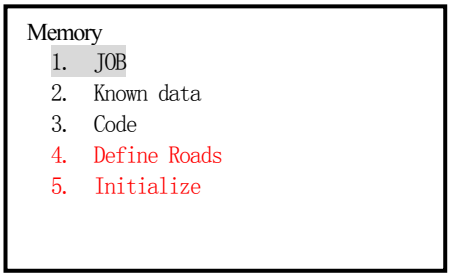


· To enter Record Mode, press REC in "MEAS Mode Screen".

·Press ESC to return to previous screen.

18 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

18.1 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

· A total of 24 JOBs have been prepared, and JOB01 was selected when your KTS-440 was shipped from the factory.

· A total of 100,000 data items, which includes data stored in all JOBs and the coordinate data in the memory, can be stored inside the instrument. Storage space for 2 items is required to store 1 item of instrument station data.

▶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. JOB deletion 3. Comms output
(2) Select "1. JOB Selection" then press ENT (or press numeric key 1). The 24 JOBs are divided among four pages, The numbers to the right represent the number of data items in each JOB.	"1. JOB Selection" + ENT	Mem./ JOB * JOB01 20 * JOB02 8 JOB03 10 JOB04 0 ↑↓P TOP LAST EDIT
(3) There are 2 kinds of working jobs in system: current working job and read coordinate file. 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 * JOB01 20 * JOB02 8 JOB03 10 JOB04 0 ↑↓P TOP LAST EDIT JOB selection * JOB01 20 * JOB02 8 JOB03 10 JOB04 0 ↑↓P TOP LAST

(4) Align the cursor with the desired JOB and press ENT. •Move cursor: ▲or▼ •Changing the cursor motion unit: -P •When –P is displayed, the cursor moves from line to line. •When -P is displayed, the cursor moves from page to page. •Display top of JOB list: TOP •Display end of JOB list: LAST	ENT	Mem./JOB 1. JOB selection 2. JOB deletion 3. Comms output 4. Comms input 5. Key in coord.

18.1.1 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) In"Job Selection"function press S.F.,enter setting screen of grid factor.	S.F.	Current Job JOB01 S.F.: 1.000000 ▮5 Coord. Search Job: JOB01 LIST S.F.
(2) It displays current setting. Input height and scale factor, press ENT key.	Input height + ENT Input scale factor + ENT	S.F. Elevation: 1.000m Scale : 1.000000 ▮5
(3) It returns to the previous scree, gets grid factor.		Current Job JOB01 S.F.: 0.999997 ▮5 Coord. Search Job: JOB01 LIST S.F.

18.1.2 Changing JOB name

Operating Procedure	Operation	Display
(1) Perform steps 1 and 2 in "JOB Selection" to display the "JOB Selection Screen."		Mem./ JOB * JOB01 20 * JOB02 8 JOB03 10 JOB04 0 ↑↓P TOP LAST EDIT
(2) Align the cursor with the JOB to be changed, then press EDIT to access the "JOB Name Change Screen."	EDIT	Mem./ JOB JOB : JOBM1
(3) Enter the new JOB name with the alphanumeric keys, then press ENT. The "Job Selection Screen" is restored.	ENT	Mem./ JOB * JOBM1 20 * JOB02 8 JOB03 10 JOB04 0 ↑↓P TOP LAST EDIT

18.2 Deleting a JOB

· It is possible to clear the data within a designated JOB.
· It is not possible to clear a JOB until external output (transmission to the host computer or output to a printer) has been completed.
An "*" beside a JOB name indicates that the data in that JOB has not been output.
· After the data has been cleared, the JOB name returns to the name allocated when the KTS was shipped.

▶ **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. JOB deletion 3. Comms output
(2) Select "2. JOB deletion" and press ENT, the JOB names are displayed in a table.	"2. JOB deletion" + ENT	JOB deletion * JOB01 20 * JOB02 8 JOB03 10 JOB04 0 ↑↓P TOP LAST EDIT
(3) Select the JOB whose data is to be deleted and press ENT, the "JOB Deletion Confirmation Screen" is displayed.	ENT	JOB deletion JOB. JOB01 Deletion Confirm? NO YES
☆If the selected JOB data is not sent, it will recommend you to send the JOB out, Press ESC to exit, output the JOB and delete it.	ESC	JOB deletion Send first Press ESC key

(4) Press YES, the data within the JOB which is displayed and the "JOB Management Screen" is restored.	YES	Mem./ JOB 1. JOB selection 2. JOB deletion 3. Comms output

18.3 Outputting JOB Data to Computer

·It is possible to output the data within the JOB to the computer in JOB unit.

►PROCEDURE

Operating Procedure	Operation	Display
(1) Select "1. JOB" on the "Memory Mode Menu Screen" and press ENT (or press numeric key 1), the "JOB Management Screen" is displayed.	"1. JOB" + ENT	Mem./JOB 1. JOB selection 2. JOB deletion 3. Comms output
(2) Select "3. Comms output" and press ENT (or press numeric key 3), the "JOB Management Screen" is displayed. The "JOB Selection Screen" is displayed. ··Move item: ▲or▼ ·Changing the cursor motion unit: ↑↓P ·When ↑↓P is displayed, the cursor moves from line to line. ·When ↑↓P is displayed, the cursor moves from page to page. ·Display top of JOB name: TOP ·Display end of JOB name: LAST	"3.Comms output" + ENT	Comms output * JOB01 20 * JOB02 8 JOB03 10 JOB04 0↓ ↑↓P TOP LAST
(3) Select the job name to be output and press ENT to start output.	ENT	Comms output Format：SDR33 Job：JOB01 Sending 10

(4) When output is completed, the "Output JOB Selection Screen" is restored. It is possible to select and output another job.		Comms output JOB01 20 * JOB02 8 JOB03 10 JOB04 0↓ ↑↓P TOP LAST

18.4 Receiving coordinate Data

KTS440(R)(L) total station allows sending data from computer to total station, restore in relevant working jobs.

·Edit coordinate data by KOLIDA communication software (on computer).

·Setting communication parameters.（Refer to"21.1Changing Instrument Parameters"）

Operation	Key	Display
(1) Under memory mode, choose "1. JOB"then press ENT(or press numeric key 1), enter JOB management screen.	"1. Job" + ENT	Mem./ JOB 1. JOB selection 2. JOB deletion 3. Comms output 4. Comms input 5. Key in coord.
(2) Choose"4. Comms input"and press ENT (or press numeric key 4), enter comms input scree. It displays working job selection screen, as right display. ·Move cursor：▲ or▼ ·Changing cursor movement：↑↓P ·When it displays ↑↓P, cursor moves by line. ·When it displays ↑↓P, cursor moves by page. ·Cursor moves to the first job name：TOP ·Cursor moves to the last job name: LAST	"4. Comms input" + ENT	Comms Input * JOB01 20 * JOB02 8 JOB03 10 JOB04 0↓ ↑↓P TOP LAST
(3) Choose the job name to be receive coordinate data and press ENT to start receiving data.	ENT	Comms input Format：SDR33 Job ： JOB01 Receiving 20 STOP
(4) Finish data receiving, the screen returns to main screen of JOB selection		Mem./ JOB 1. JOB selection 2. JOB deletion 3. Comms output 4. Comms input 5. Key in coord.

18.5 Input coordinate data to current job

It allows user to input data to current working jobs.

Operation procedure	Key	Display
(1) Under memory mode, choose "1.JOB"then press ENT(or press numeric key 1), enter job management screen.	"1. JOB" + ENT	Mem./ JOB 1. JOB selection 2. JOB deletion 3. Comms output 4. Comms input 5. Key in coord.
(2) Choose current working job then select "5.Key in coord."then press ENT (or press numeric key 5), enter coordinate data input function. ·On left upper corner it shows current jobname, coordinate data quantity shows on right upper corner.	"5. Key in Coord." + ENT	JOB2 14Rec N: 0.000m E: 0.000m Z: 0.000m Pt.: KOLIDA REC. ↓
(3) Input N, E, Z value, point name,code information and press ENT key, press ▼key to show the second page of input screen. ·Press ↓or↑key to read code from code Library.	Input coordinate, point name and code + ENT	JOB2 14Rec Code: REC. ↓ ↑ ↑
(4) Input finished, press REC to record data, enter the next step of data input. Finish all data input, press ESC, it returns to job screen	REC.	JOB2 15Rec N: 0.000m E: 0.000m Z: 0.000m Pt. : KOLIDA REC. ↓

18.6 Registering Coordinate Data in Memory

· 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.

· It is possible to register 100,000 items of coordinate data, including the data inside the JOBs.

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

18.6.1Using the key entry method to register coordinate data

▶**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. Comms input 3. Deletion 4. View 5. Clear
(2) Select "1. Key in coord" and press ENT, the "Coordinate Data Entry Screen" is displayed. Set the following items: N, E, Z coordinate values, point number. After each entry press ENT. The "5039rec" means 5039 coordinates have been recorded.	"1. Key in coord" + ENT	Mem./ Known 5039rec N : 4567.098m E : 7856.545m 3 Z : 3445.091m Pt. : PT01 REC
(3) 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	Mem./ Known 1. Key in coord 2. Comms input 3. Deletion 4. View 5. Clear

NOTE：Coordinates input range

-9999999.999to +9999999.999 (m) or -9999999.999 to +9999999.999 (ft)

18.6.2 Entering coordinate data from an external instrument

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

1. /Dg 123.456, -1234.123, 12.345, 1234.678[,SUM]CRLF

a b c d e

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

·The communication conditions conform to the set communication conditions represented by parameters.
（Refer to "21.1Changing 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	Mem./ Known 1. Key in coord 2. Comms input 3. Deletion 4. View 5. Clear
(2) Select "2. 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.	ENT + ENT	Mem./ Known Format. SDR33 Receiving 25

☆ **Note：** Before performing communication between KTS and other equipments, make sure that their communication parameters should be equal.（Refer to "21.1 Changing Instrument Parameters"）

18.7 Sending known point data

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. Comms input 3. Comms output 4. Deletion 5. View 6. Clear
(2) Choose"3. Comms output"and press ENT.The machine starts sending known data,then sending data amount shows in the bottom of the screen.	"3. Comms output " + ENT	Comms Output Format：SDR33 Data：Known data Sending 20

(4) Data output finished, display returns toknow data screen.		1. Key in Coord 2. Comms input 3. Comms output 4. Deletion 5. View 6. Clear

18.8 Clearing Coordinate Data from Memory

· It is possible to clear coordinate data from memory. There are two methods:

1. Clear all coordinate data.
2. Clear designated data.

18.8.1 Clear all coordinate data at once (initialization)

·This procedure clears all registered coordinate data from memory at once.

Operating Procedure	Operation	Display
(1) Select "2. Known data" in the "Memory mode" and press ENT.	"2. Known data" + ENT	Mem./ Known 1. Key in coord 2. Comms input 3. Deletion 4. View 5. Clear
(2) Select "5. Clear" and press ENT. The "Data Initialization Screen" is displayed.	"5. Clear" + ENT	Mem./ Known Clear Confirm? NO YES
(3) Press YES, coordinate data is completely cleared and the "Known Point Menu Screen" is restored. ·Cancel of clearing: NO	YES	Mem./ Known 1. Key in coord 2. Comms input 3. Deletion 4. View 5. Clear

18.8.2 Deleting designated coordinate data

Select the point number of the coordinate data to delete data one item at a time.

Operating Procedure	Operation	Display
(1) Select "2. Known data" in the "Memory mode" and press ENT.	"2. Known data" + ENT	Mem./ Known 1. Key in coord 2. Comms input 3. Deletion 4. View 5. Clear
(2) Select "3. Deletion" and press ENT, the "Point Number Display Screen" is displayed.	"3Deletion" + ENT	Mem./ Known Deletion Pt. 1 Pt. 2 Pt. 3 Pt. A ↓ ↑↓P TOP LAST SRCH
(3) Select the point number to be cleared and press ENT. The point number to be cleared and its coordinate are displayed. Waiting for confirmation. ·Move item: ▲or▼ ·Changing the cursor motion unit: ↑↓P ·When ↑↓P is displayed, the cursor moves from line to line. ·When ↑↓P is displayed, the cursor moves from page to page. ·Display top of point number list: TOP ·Display end of point number list: LAST ·Searching for coordinate data: SRCH ·Display next data: NEXT ·Display last data: PREV	ENT	N : 4567.098m E : 7856.545m Z : 3445.091m Pt. : A Deletion Confirm? PREV NEXT NO YES
(4) Press YES to clear the point coordinate and restore the "Point Number Display Screen". Repeat above procedure to clear other points.	YES	Mem./ Known Deletion Pt. 1 Pt. 2 Pt. 3 Pt. A2 ↓ ↑↓P TOP LAST SRCH
(5) Press ESC to end deletion and restore the "Known Point Menu Screen".	ESC	Mem./ Known 1. Key in coord. 2. Comms input 3. Deletion 4. View 5. Clear

18.8.3 Clear designate coordinate data by SEARCH

·When it is necessary to search for a point number to be cleared using the procedure of "Deleting Designated Coordinate Data", search as explained below.

Operating Procedure	Operation	Display
(1) Align the cursor with the top point number and press SRCH in the "Point Number Display Screen" Note: The point number following the point number indicated by the cursor becomes the object of the search.	SRCH	Mem./ Known Deletion Pt. 1 Pt. 2 Pt. 3 Pt. A ↓ ↑↓P TOP LAST SRC
(2) Enter the point number and press ENT.	Entering the point number + ENT	Mem./ Known Deletion Pt. : A
(3) When searching is completed, the "Data Clearing Screen" is displayed. When no point number has been searched, "Not found " is displayed on line 4.		N : 4567.098 E : 7856.545 Z : 3445.091 3 Pt. : A Deletion Confirm? PREV NEXT NO YES
(4) Press YES, the displayed coordinate data is cleared and the "Point Number Display Screen" is restored.	YES	Mem./ Known Deletion Pt. 1 Pt. 2 Pt. 3 Pt. A2 ↓ ↑↓P TOP LAST SRC

18.9 Reviewing Coordinate Data

·It is possible to display the coordinate data within the memory.

Operating Procedure	Operation	Display
(1) Select "2. Known data" in the "Memory mode" and press ENT.	"2. Known data" + ENT	Mem./ Known 1. Key in coord 2. Comms input 3. Deletion 4. View 5. Clear
(2) Select "4. View" and press ENT.	"4. View" + ENT	Mem./ Known View Pt. 1 Pt. 2 Pt. 3 Pt. A ↓ ↑↓P TOP LAST SRC
(3) Align the cursor with the point number to be viewed. Press ENT to display the coordinate. ·Move item: ▲or▼ ·Changing the cursor motion unit: ↑↓P ·When ↑↓P is displayed, the cursor moves from line to line. ·When ↑↓P is displayed, the cursor moves from page to page. ·Display top of point number list: TOP ·Display end of point number list: LAST ·Searching for coordinate data: SRCH ·Display next data: NEXT ·Display last data: PREV	ENT	Mem./ Known View N : 4567.098m E : 7856.545m 3 Z : 3445.091m Pt: 1 PREV LAST
(4) Press ESC to restore the "Point Number Display Screen."	ESC	Mem./ Known View Pt. 1 Pt. 2 Pt. 3 Pt. A ↓ ↑↓P TOP LAST SRC

(5) Press ESC again to restore the "Known Point Menu Screen."	ESC	Mem./ Known 1. Key in coord 2. Comms input 3. Deletion 4. View 5. Clear

18.10 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 deletion 3. Code view 4. Clear list
(2) Select "1. Key in code" and press ENT (or press numeric key 1).	"1. Key in code" + ENT	Key in code Code：M1 S
(3) Enter the code and press ENT to save the code and restore the "Code Menu Screen". ·Maximum code size 14(alphanumeric) (When the code can not be completely displayed, use ENT to display the remainder) ·Maximum number of codes registered: 40	ENT	Mem./Code 1. Key in code 2. Code deletion 3. Code view 4. Clear list

18.11 Deleting Codes

·It is possible to clear codes from memory.

▶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 deletion 3. Code view 4. Clear list
(2) Select "2. Code deletion" and press ENT (or press numeric key 2). The "Code deletion screen" is displayed.	"2. Code deletion" + ENT	Mem./Code ABCDEFGHIJKLMNO A001 TREE0LEET POINT1 ↓ ↑↓P TOP LAST DEL
(3) Align the cursor with the code to be deleted and press DEL to delete it. ·Move item: ▲or▼ ·Changing the cursor motion unit: ↑↓P ·When ↑↓P is displayed, the cursor moves from line to line. ·When ↑↓P is displayed, the cursor moves from page to page. ·Display top of code: TOP ·Display end of code: LAST Press ESC to end operating and restore to "Code Menu Screen."	DEL + ESC	Mem./Code 1. Key in code 2. Code deletion 3. Code view 4. Clear list

18.12 Reviewing Codes

·It is possible to display a list of codes in memory.

▶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 deletion 3. Code view 4. Clear list
(2) Select "3. Code view" and press ENT (or press numeric key 3). The "Code view screen" is displayed.	"3. Code view" + ENT	Code view ABCDEFGHIJKLMNO A001 TREE0LEET POINT1 ↓ ↑↓P TOP LAST
(3)Align the cursor with the code. ·Move item: ▲or▼ ·Changing the cursor motion unit: ↑↓P ·When ↑↓P is displayed, the cursor moves from line to line. ·When ↑↓P is displayed, the cursor moves from page to page. ·Display top of code: TOP ·Display end of code: LAST Press ESC to end operating and restore to "Code Menu Screen."	ESC	Mem./Code 1. Key in code 2. Code deletion 3. Code view 4. Clear list

●Road Design

Under memory mode it allows you to make road design, refer to "17.1 Road Design".

18.13 Initialization

·This operation restores instrument parameters to factory default settings and clear alldata.

·Below settings will be restored by initialization.

① Observation:

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.

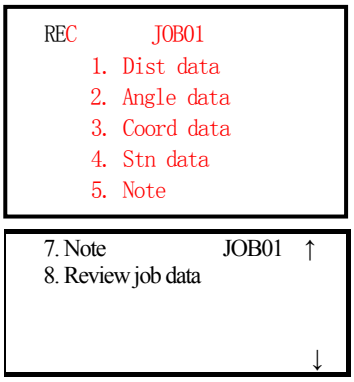
·Below data will be initialized

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

Operation Procedure	Key	Display
(1) Under memory mode choose "5. initialize"and press ENT (or press numeric key 5), enter initialization menu screen.	"5. Initialize" + ENT	Memory 1. JOB 2. Known data 3. Code 4. Define roads 5. Initialize
(2)Press YES key it will delete all data in memory,restores all setting to be factory default setting, or choose NO.	YES	Initialize Initialize data Are you sure ? NO YES
(3) Initialization is finished, returns to memory management screen.		Initializing..... Wait.....

19. DATA RECORDING IN RECORD MODE

Record Mode Screen



·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.

19.1 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. Dist data 2. Angle data 3. Coord data 4. Stn data 5. Note 6. View

<table>
<tr>
<td>(2) Select “4. 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</td>
<td>“4. Stn data”
+
ENT</td>
<td>N0 10.364
E0 234.897
Z0 49.098
Pt. : POINT2000
Inst. h: 1.65 m ↓
OK READ

Code
: K ↑
Name:
:
OK ⇑ ⇓

Date: 03-08-07
Time: 10：14：52
Weat: Fine
Wind: Calm
Mode: Fine [S] ↓
OK

Temp.: 20 ℃
Press.: 1013.0 hPa
PPM : 0
PC : -30
OK 0PPM</td>
</tr>
<tr>
<td>(3) After entering all data, press OK to record the station data and restore the “Record Mode Screen.”</td>
<td>OK</td>
<td>1. Dist data JOB01
2. Angle data
3. Coord data
4. Stn data
5. Note
6. View</td>
</tr>
</table>

·Movement of the cursor between items： ▲ ▼

· Entry rules：

Read in coordinate：READ

Pt. ： 14 numerals and letters

Code: 14 numerals and letters

Read in code：↑↓

Time：pm 3：33：37 enter 153337

Date：Year 2003 month 8 day23 enter 030823

·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

19.2 Recording backsight data

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

·set backsight point by angle

·set backsight point by coordinate

19.2.1 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"后按 ENT (or press 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： 0°00′00″ NO YES
(4) Finish azimuth zetting and returns to coordinate measurement screen.		Coordinate 1. Observation 2. Stn Data 3. Back sight data

19.2.2 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.		Coordinate 1. Observation 2. Stn data 3. Back sight data

19.3 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. Dist data JOB01 2. Angle data 3. Coord data 4. Stn data 5. Note 6. View
(2) Select "2. Angle data" and press ENT (or press numeric key 2), the "Angle Measurement Data Recording Screen" is displayed.	"2. Angle data" + ENT	REC/Angle 1200rec Pt. : POINT2000 ZA 45°18′23″ HAR 87°23′09″ 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 1200rec *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: 14 (alphanumeric)	REC	*ZA 76°34′17″ *HAR 64°22′10″ Pt. : POINT2000 Code: MB Tgt. h: 1.67 m OK
(5) Press OK to record data. Because the same data can not be recorded a second time. REC is not displayed after recording.	OK	REC/Angle 1201rec Pt.: POINT2000 ZA 45°18′23″ HAR 87°23′09″ ANGLE AUTO

(6) Press ANGLE to measure the angle again.	ANGLE	REC/Angle 1201rec *ZA *HAR Pt.: POINT2001 ANGLE AUTO
(7) Press ESC to restore the "Record Mode Screen."	ESC	1. Dist data JOB01 2. Angle data 3. Coord data 4. Stn data 5. Note 6. View

·· 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.

19.4 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
(2) Press REC on the second page of MEAS Mode.	REC	1. Dist data JOB01 2. Angle data 3. Coord data 4. Stn data 5. Note 6. View

(3) select "1. Dist data" and press ENT (or press numeric key 1), the measurement results are displayed on lines 2 to 4. (Lines indicated by "*")	"1. Dist data" + ENT	REC/Dist. 1200rec *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. After each entry press ENT · 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 ↑or↓.	REC	S 10.364 m ZA 76°34′17″ HAR 64°22′10″ Pt. : 2000 Tgt. H: 1.670 m ↓ OK
(5) Check the data and press OK. 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.	OK	REC/Dist. 1201rec S m ZA 45° 18′ 23″ HAR 87° 23′ 09″ Pt. : 2001 OBS OFFS AUTO
(6) Press SDIST 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. Dist data 2. Angle data 3. Coord data 4. Stn data 5. Note 6. View

· 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.

19.5 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 VD SHV HSET EDM
(2) Press REC in the second page of the "MEAS Mode Screen." The "Record Mode Screen" is displayed.	REC	1. Dist data 2. Angle data 3. Coord data 4. Stn data 5. Note 6. View

(3) Select "3. Coord dara" and press ENT, the measurement results are displayed on lines 2 to 4 (lines indicated by *) of the "Measurement Data Screen."	"3. Coord data" + ENT	REC/Coord. 1200rec *N 10.364 *E 234.897 *Z 49.098 Pt. : POINT2000 REC SDIST OFFSET AUTO
(4) Press REC to record the measurement data indicated by *. Enter following data: Point number, code, target height. After each entry press ENT	REC	N 10.364 E 234.897 Z 49.098 Pt. : POINT2000 Tgt. h: 1.67 m OK
(5)Press OK to record data. Because the same data can not be recorded a second time. REC is not displayed after recording.	OK	REC/Coord. 2001 rec *N *E *Z Pt.: POINT2000 SDIST OFFSET AUTO
(6) Press OBS to measure the coordinates again in Record Mode.	OBS	Dist. Dist. PC = 0 PPM = 0 Fine "S" STOP
(7) Press ESC to restore the "Record Mode Screen."	ESC	1. Dist data 2. Angle data 3. Coord data 4. Stn data 5. Note 6. View

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.

19.6 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) The screen shows as right diagram, the line 2,3,4 (with"*")are measuring data.		Dist+ Coord 1201 rec *N 100.364 *E 234.897 *Z 49.098 Pt.: SS20004 REC. OBS. OFFS AUTO
(3) Press REC. to record measured data with"*", the screen shows as right diagram. Input following data: point name, code, target height. Press ENT after input all data.	REC.	*N 100.364 ↑ *E 234.897 *Z 49.098 Pt.: SS20004 Tgt. H.: 1.670 m ↓ SAVE

(4) check the result and press SAVE , then on right upper screen the record amount will be plused with 1. To avoid recording data repeatedly, after recording each measured data, before measuring new data, it will not show the REC function.	SAVE	Dist+ Corrd 1202 rec *N *E *Z Pt.: SS20004 OBS. OFFS AUTO
(5) Under record mode, press OBS to measure distance again.	OBS	Dist. Dist. PC = 0 PPM = 0 Fine-S Stop
(7) 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")

19.7 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.	REC	1. Dist data JOB01 2. Angle data 3. Coord data 4. Stn data 5. Note 6. View

(2) Select "5. Note" and press ENT (or press numeric key 5), the "Note Entry Screen" is displayed and the final note data prepared is displayed.	"5. Note" + ENT	REC./Note 1200rec KOLIDA OK
(3) Enter the note and press OK to restore the "Record Mode Screen." ·Maximum note length: 70 characters	OK	1. Dist data JOB01 2. Angle data 3. Coord data 4. Stn data 5. Note 6. View

19.8 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 "18.1.1 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	1. Dist data JOB01 2. Angle data 3. Coord data 4. Stn data 5. Note 6. View
(2) Select "6. View" and press ENT, the "Point Number Display Screen" is displayed. ·Item motion: ▲or▼ ·Changing the cursor motion unit: ↑↓P ·When ↑↓P is displayed, the cursor moves from line to line. ·When ↑↓P is displayed, the cursor moves from page to page. ·Display top of JOB name: TOP ·Display end of JOB name: LAST ·Search for point number: SRCH	"6. View" + ENT	REC/View Pt. 1 ↑ Crd. 2 Pt. 3 Stn A ↓ ↑↓P TOP LAST SRCH

(3) Select the point number to be display in detail and press ENT, the select point data are displayed. ·Display next data: NEXT ·Display last data: PREV	ENT	SD 10.364 m ZA 76°34′17″ HAR 64°22′10″ Pt. : POINT2000 Inst. h: 1.65 m PREV NEXT
(4) Press ESC to restore the "Point Number Display Screen."	ESC	REC/View Pt. 1 ↑ Crd. 2 Pt. 3 Stn A ↓ -P TOP LAST SRCH
(5) Press ESC again to restore the "Record Mode Screen."	ESC	1. Dist data JOB01 2. Angle data 3. Coord data 4. Stn data 5. Note 6. View

PART 5 MEASUREMENT OPTIONS SELECTION

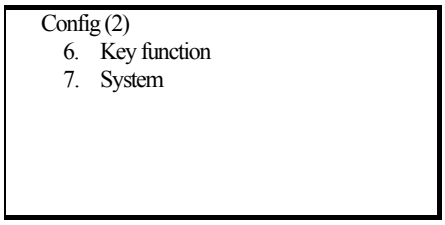
· This section explains the setting of keys functions of KTS-440, the setting of parameters, etc.

20. KEY FUNCTION ALLOCATION

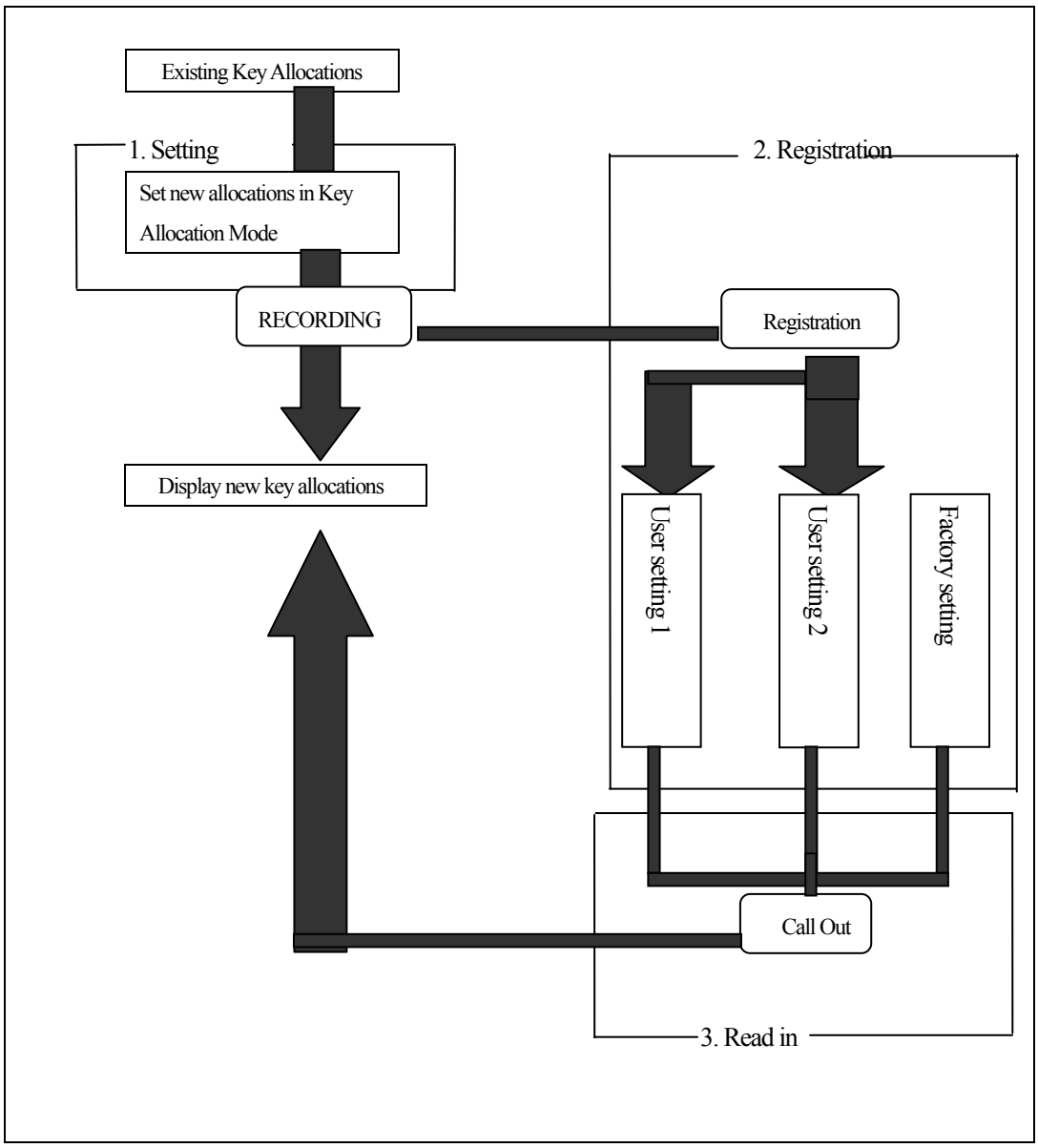
· With the KTS-440 (L)(R), it is possible to allocate the soft keys in MEAS Mode to meet measurement conditions. The current soft key allocations are retained forever until they are revised again, even when the power is cut off. Two register locations are available in Internal memory card for users: user setting 1 and user setting 2. User setting keys registered could be resumed at any time.

· It is definite to operate the KTS-440 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


Existing Key Allocations
1. Setting
Set new allocations in Key Allocation Mode
RECORDING
Display new key allocations
2. Registration
Registration
User setting 1
User setting 2
Factory setting
Call Out
3. Read in

20.1 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) ----: No functions set

· The following are the soft key allocations when the KTS-440 was shipped from factory.
Page 1: SD, SHV, HSET, EDM
Page 2: 0set, COORD, S-O, REC
Page 3: MLM, RESEC, MENU, HT

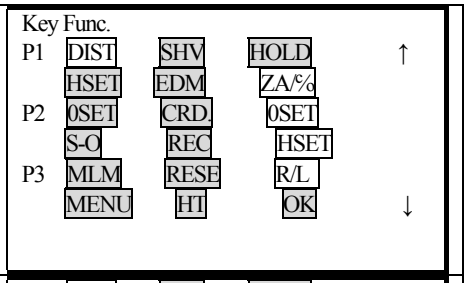
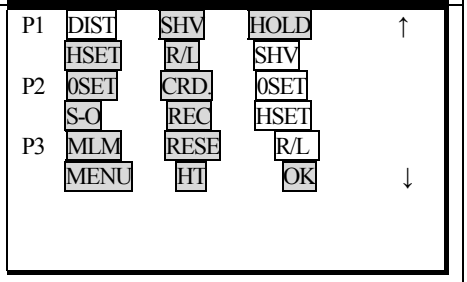
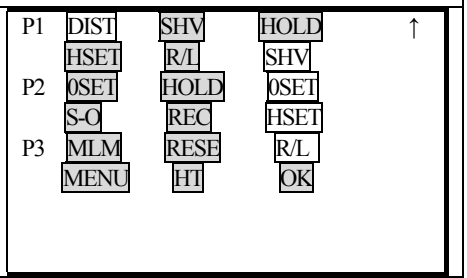
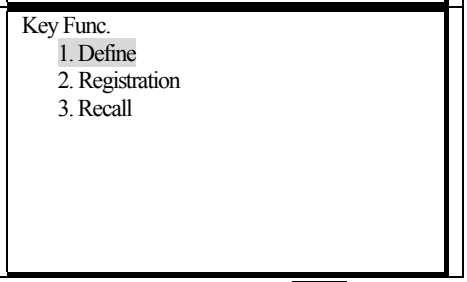
20.1.1 Allocating functions

· 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►	
(4)Align the cursor with the keys on the right half of the screen which are to be allocated using ◄or►.	▲or▼	
(5) Press ENT to allocate the functions designated in step 4 to the positions designated in step 3.	ENT	
(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	

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

20.1.2 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

20.2 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

21. INSTRUMENT PARAMETERS SETTING

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

21.1 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
	Vertical angle format	Zenith 0° *
		Horizontal 0°
		Horizontal 0° ±90°

OBSERVATION CONDITION	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 * ， 9600 b/s
		38400 b/s ， 115200 b/s
	Data length	8 bits *
		7 bits
	Parity	None *
		Even
		Odd
	Stop bit	1 bit *
		2 bits
	Check sum	Off *
		On
	Xon/Xoff	Off *
		On

Table 3：

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

▶PROCEDURE

Operating Procedure	Operation	Display
(1) In Measurement screen, press ESC to show the status screen.	ESC	2004-01-01 10：00：48 KTS-440 No.S09996 Ver.2004-1.02 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

21.2 Parameters and Data Initialization

· The operation restores the instrument parameters to factory settings and clears all data.

· Parameters initialization restores followings to factory settings:

①Observation conditions:

Atmospheric correction, vertical angle format, tilt correction, distance measurement mode, automatic cut off, coordinate format, minimum angle value, read-in JOB.

②Communication setup:

Baud rate, data bits, parity, stop bits, check sum, X on/off

③Unit:

Temperature, pressure, angle and distance unit.

④Distance measurement settings:

Temperature, pressure, atmospheric correction value (PPM), prism constant correction value (PC), distance measurement mode.

⑤Key allocation.

Factory set Key allocation.

· Initialize following data:

1, The data in all Jobs.

2, The data in internal memory.

3. The code value in internal memory.

▶PROCEDURE

Operating Procedure	Operation	Display
(1) Press CNFG in state mode.	CNFG	Config (2). 6. Key function 7. System

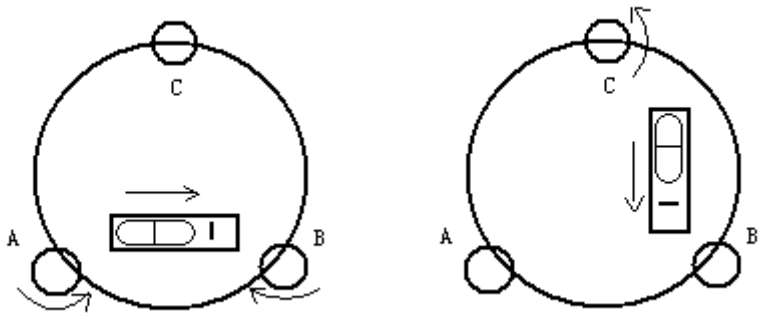
(2) Select "7. System" and press ENT (It also allows press numeric key directly).	"7. System" + ENT	System: 1. Initialize 2. VADJ SET 3. Input Inst. No.
(3) Select "1. Initialize" and press ENT (or press numeric key 1).	"1. Initialize" + ENT	Initialize ? No YES
(4) To restore parameters to factory settings and clear all data, press YES, otherwise, press NO to exit.	YES	Initialize……. Wait ……. NO YES
(5) When input is completed, return to setting screen.		System: 1. Initialize 2. VADJ SET 3. Input Inst. No.

☆ NOTE: Above "2. VADJ SET" and "3. HADJ SET" were well set in factory, don't revise these settings. Otherwise, the index difference must be re-adjusted.

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.

22.1 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 180º. If not, repeat Procedure (1).
3. Turn the instrument 90ºand 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.

22.2 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

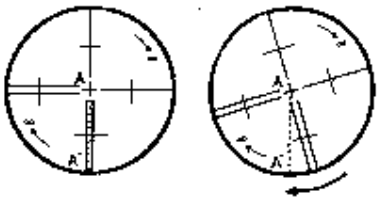
If the bubble of the circular level is not in the center, bring the bubble to the center by using the adjusting pin or hexagon wrench to adjust the bubble adjusting screw. Firstly loosen the screw opposite to the offset side, and then tighten the other adjusting screw on the offset side, bringing the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

20.3 Inclination of Reticle

·Inspection

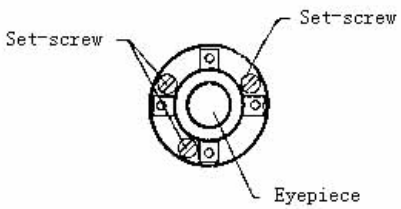
1. Aim at object A through the telescope and lock the horizontal and vertical clamp screws.
2. Move object A to the edge of the field of view with the vertical tangent screw (point A′)
3. No adjustment is necessary if object A moves along the vertical line of the reticle and point A′ still in the vertical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



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

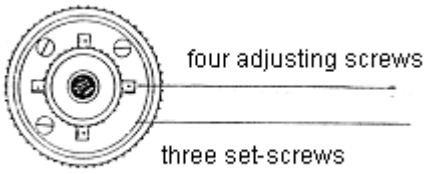
Inspection

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	2007-09-10 10：00：48 Type：KTS—440R No. ： S12926 Ver.：07.09.10 Job ： JOB01 MEAS MEM
(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.

22.5 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.

22.6 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 |≥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	2007-09-10 10：00：48 Type：KTS－440R No. ： S12926 Ver.：07.09.10 Job ： JOB01 MEAS MEM
(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.

22.7 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.

22.8 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.

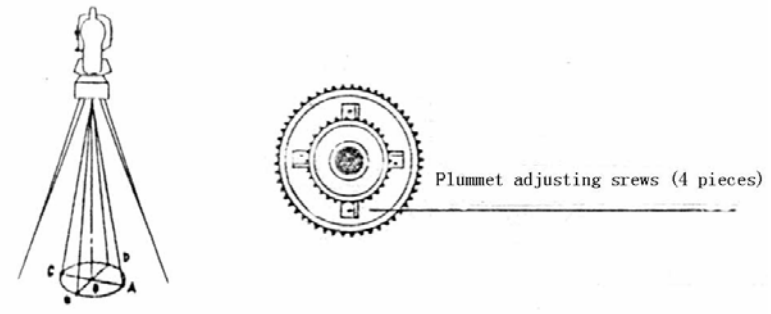
2. Adjust the focus of the optical plummet and move the paper so that the intersection point of the lines on the paper comes to the center of the field of view.

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.



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.

22.9 Instrument Constant（K）

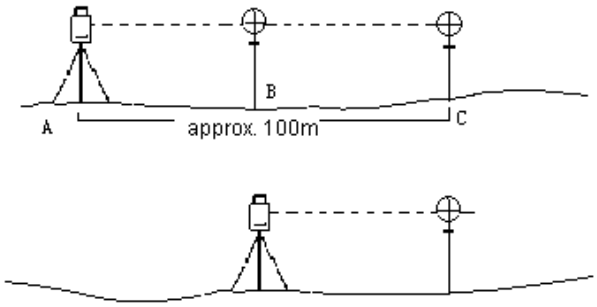
Instrument constant has been checked and adjusted in the factor, K=0. It seldom changes and it is suggested to check one or two times every year. The inspection should be made on the base line, also can be made according to the following method.

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



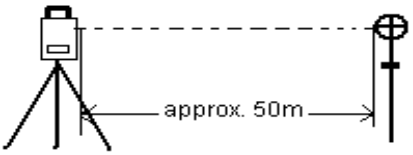
Adjustment

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.

22.10 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.

☞22.11 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

22.12 Tribrach Leveling Screw

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

22.13 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 the center of the vial from both directions.

23. SPECIFICATION

Distance measurement

TYPE	KTS-442/5 (R)	KTS-442/5 (L)	KTS-442/5
	Red visible laser	Laser	Infraed
carrier wave (only on KTS-442/5(R))	0.650 – 0.690 μm		
Measuring system	Basic frequency 60MHZ		
EDM type	Coxial		
Minimum display	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 1 mm	
Average measuring times		The average value of 2- 9 times	
Accuracy			
Below is only for KTS-442/5(R)			
With reflector			
Distance measurement		Standard difference of accu.	Measuring time
Prism fine		±(2mm+2ppm·D)	＜1.8s
Prism tracking		±(5mm+2ppm·D)	＜0.8s
IR sheet		±(5mm+2ppm·D)	＜1.2s
Non-reflector			
Distance measurement		Standard difference of accu.	Measuring time
Non-prism fine		±(5mm+2ppm·D)	＜1.2s
Non-prism tracking		±(10mm+2ppm·D)	＜0.8s
Below is only for KTS-442/5(L)			
Distance measurement		Standard difference of accu.	Measuring time
Prism fine		±(2mm+2ppm·D)	＜1.8s
Prism tracking		±(5mm+2ppm·D)	＜0.8s
Only for KTS-442/5		Prism fine ±(2mm+2ppm·D)	
Measuring range			
Below is only for KTS-442/5(R)			
With reflector			
Air condition		Standard prism	Sheet
5km		1000m	300m
20km		4000m	800m
Non-reflector			
Air condition		Non-prism（white）※	Non-prism grey 0.18
Objective strongly flashes under sunlight		160m	100m
Cloudy or objective under shadow		200m	120m
※※ Kodak Grey Card used with exposure meter for reflected light			
Below is for KTS-442/5(L) only			
		KTS-442(L)	KTS-445(L)
Max. range	1 prism	4.0 Km	4.0 Km

(good weather)	3 prism	5.0 Km	5.0 Km
Below is for KTS-442/5only			
		KTS-442	KTS-445
Max. range (good weather)	1 prism	2.0 Km	2.0 Km
	3 prism	2.6 Km	2.3 Km

☞Other parameters

	KTS-442 (R)(L)	KTS-445 (R)(L)
Angle measurement		
Angle measurement type	Continuous, absulute	
Diameter of disc	79mm	
Min. display	1″/ 5″ choosable	
Accuracy	2″	5″
Detection method	Horizontal：Dual	Vertical：Dual
Telescope		
Image	Erect	
Length of Obj. lens	154mm	
Effective aperture	Observation：45mm, measurement：50mm	
Magnification	30×	
View field	1°30′	
Min. focusing distance	1m	
Resolution power	3″	
Tilt sensor		
System	Liquid-electric detection/plate vial	
Working range	±3′	
Accuracy	6″	
Vial		
Plate vial	30″ / 2mm	
Circular vial	8′ / 2mm	
Optical plummert		

Image	Erect
Magnification	3×
Focusing range	0.5m～∝
View field	5°
Display part	
Type	6 lines
Data communication	
Port	ＲＳ－２３２Ｃ
On-board battery	
Power supply	Rechargable Ni-H battery
Voltage	DC ６Ｖ
Continuously work-time	8 Hours
Size and weight	
Size	160×150×330mm
weight	5.8 kg

24. 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 agents.

25. ACCESSORIES

● Case	1 pc
●Main body	1 set
●On-board battery	1 pc
●Charge	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.

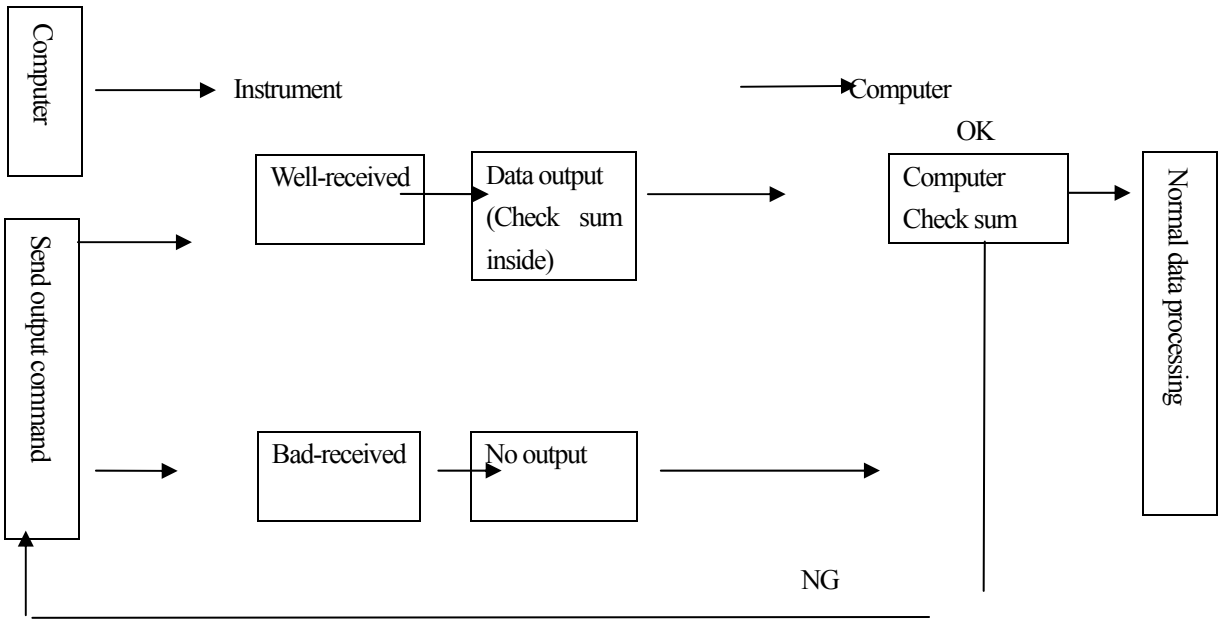
1.1 Outputting Commands

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

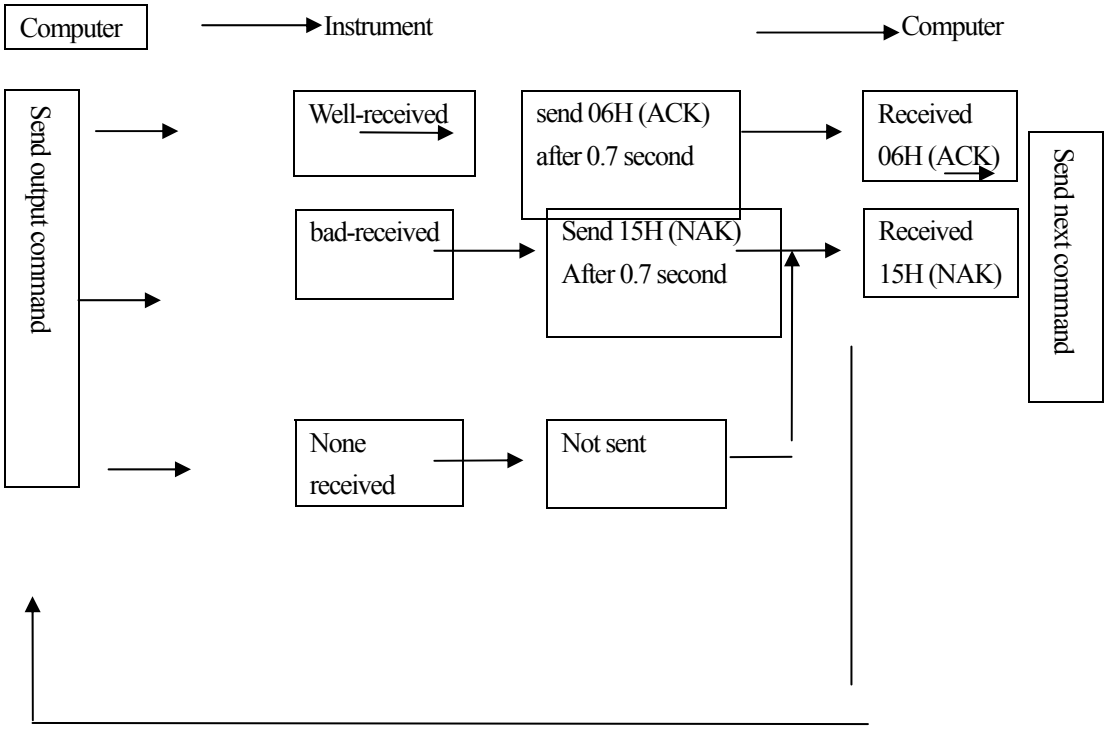
1.2 Entering Command

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, 40,0,0,0,0,0,0,0,0,0[,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

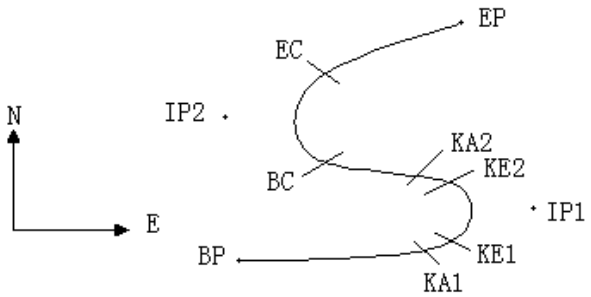
There are two ways to enter the alignment elements：

1) Download from PC.；
2) Manually input on the KTS440(R)(L) 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

$$N_m = N - R\sin\tau = 63.348 - 100\sin 18°20'06'' = 31.891$$

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 m

E_{KA1} = 1750 –182.468 * sin 74°03′16.6″=1574.553 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:

$$N_{BC} = N_{IP2} - TL \cdot \cos\alpha_2$$

$$E_{BC} = E_{IP2} - TL \cdot \sin\alpha_2$$

$$N_{EC} = N_{IP2} - TL \cdot \cos\alpha_3$$

$$E_{EC} = E_{IP2} - TL \cdot \sin\alpha_3$$

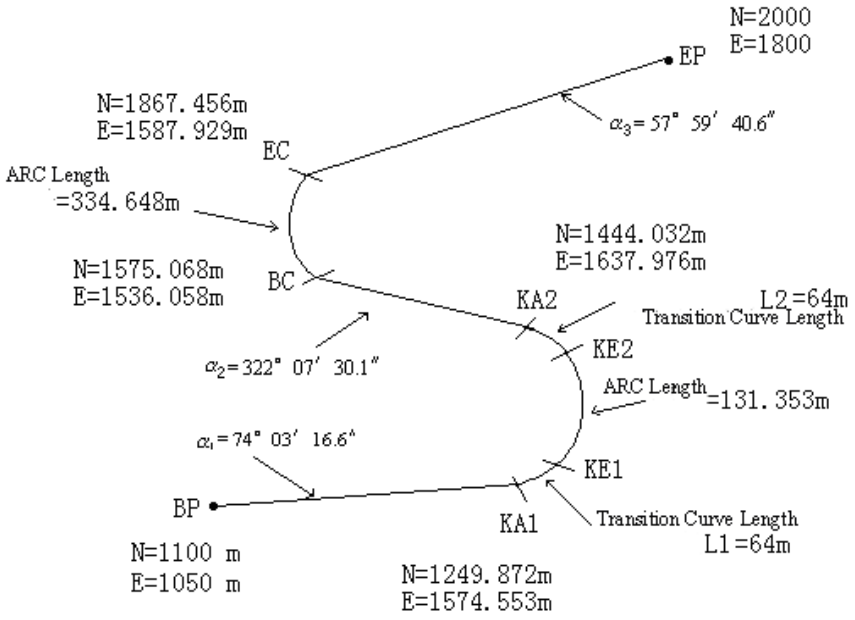
Here:

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