DE Series Electronic Theodolite
Service Manual

Changzhou Dadi Surveying Science & Technology Co., Ltd.

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1. Brief Description

The angle measurement section of the DE series Chinese electronic theodolite adopts either a grating incremental or absolute encoding digital angle measurement system. It utilizes microcomputer technology for multiple functions such as measurement, calculation, and display. It can simultaneously display measurement results including horizontal angle, vertical angle, slope distance or horizontal distance, and height difference, and supports various modes of measurement such as angle and slope.

The DE series Chinese electronic theodolite can be used for engineering surveys in railways, highways, bridges, water conservancy, and mines. It can also be used for construction, large-scale equipment installation, cadastral surveying, topographic surveying, and various other engineering surveys.

This service manual applies to DE series Chinese electronic theodolites including DE2A, DE2A-L, DE2B, DE5A, DE5B, DE10A, and DE10B. Among them, 2, 5, 10 represent the angle measurement accuracy (in arcseconds); A indicates the inclusion of a compensator, and B indicates without a compensator.

2. Safety Precautions for Using the Service Manual

1. When the instrument malfunctions, it must be inspected, analyzed, and debugged step-by-step according to the procedures and diagrams outlined in this service manual. The company assumes no responsibility for instrument damage resulting from maintenance operations that violate the requirements of this manual.
2. If functional faults involve core components—such as the electronic main circuit board, grating disk, reading head modules, tilt compensator sensor, telescope optical path, or LCD modules—the entire sub-assembly must be replaced. Independent component disassembly repair is strictly prohibited.
3. When performing component replacements during maintenance, please strictly follow the steps and diagrams in this manual. If a specific component's repair procedure is not covered in this manual, do not disassemble it without authorization; it must be returned to the manufacturer for factory maintenance.
4. After replacing components during service, the entire instrument's technical indicators must be completely re-calibrated and debugged. The instrument may only be put back into field use after verifying that all individual parameters are qualified.
5. Electronic theodolites are high-precision measurement instruments. If you lack professional maintenance training or standard calibration equipment, do not attempt to dismantle or service the instrument, to prevent permanent structural damage.
6. This maintenance manual is authorized exclusively for servicing DE series electronic theodolites manufactured by Changzhou Dadi Surveying Science & Technology Co., Ltd. If any uncertainties arise during servicing, contact the technical support department directly.

3. Instrument Introduction

3.1 External Component Identification (Front View)

The front-facing component arrangement of the DE2A-L system is specified below:

• Instrument Center Mark: Optical axis alignment point.	• Telescope Focusing Ring: Sharpens focus.
• Handle Securing Screw: Locks the carrying handle.	• Left Standard Cover Plate: Protects vertical module.
• Laser Pointer Assembly: Coaxial pointing beam.	• Laser Downward Plummet: Ground centering emitter.
• Telescope Eyepiece Shroud: Eyepiece focus shell.	• LCD Panel Assembly: Displays active tracking data.
• Telescope Eyepiece Ring: Crosshair diopter focusing.	• Circular Leveling Vial: For coarse leveling checks.
• Horizontal Tangent Screw: Fine horizontal adjustments.	• Tribrach Base Plate: Ground support platform.

3.1 External Component Identification (Back View)

The back-facing structural components of the instrument are specified below:

• **Carrying Handle**: Top transport frame.	• **Battery Box Release Catch**: Ejects battery box.
• **Objective Lens Sun Shroud**: Blocks ambient lens glare.	• **Battery Box Housing**: Holds the internal power pack.
• **Telescope Objective Lens**: Main light gatherer.	• **Vertical Clamp Screw**: Locks vertical rotation.
• **Optical Peep Sight**: Coarse targeting sight.	• **Vertical Tangent Screw**: Fine vertical adjustments.
• **Instrument Serial Plate**: Factory registration tag.	• **Right Standard Cover Plate**: Seals right structure.
• **Plate Vial Adjusting Screw**: Bubble calibration screw.	• **Tribrach Base Locking Claw**: Secures body base.

3.2 Display Screen and Operation Panel Introduction

a. **Screen Characteristics:** The display screen uses a graphical LCD matrix capable of tracking angles, characters, dates, and live timestamps. Upon system boot-up, the instrument enters the main angle tracking measurement screen interface shown below:

```
[ Repetition ▲ ] [ ON / OFF ] Date: 11-12-30 09:20
[ Distance ◆ ] [ Light ☼ ]
Vertical Circle : b-OUT
Horizontal Circle: 137°  56’ 14″
-------------------------------------------------------
[ L / R ] [ Lock ] [ Slope ] [ Clear 0 ]
[ Angle ▼ ] [ Enter ]
```

Panel Layout Configurations: There are ten operational buttons on the keypad. The red switch controls system power. Under the standard Angle Measurement screen interface, key map definitions are assigned as follows:

- **L/R (左右):** Switches horizontal angle tracking increments between Clockwise (HA-R) and Counter-Clockwise (HA-L) modes.
- **Lock (锁定):** Freezes the current horizontal angle reading on screen.
- **Slope (坡度):** Toggles vertical reading row between angular degrees and percentage slope grade formats.
- **Clear 0 (置零):** Resets the horizontal angle value to reference 0° 00’00″.
- **Combination [☀] + [▲]:** Activates the main coaxial pointing laser beam. Press again to turn off.
- **Combination [☀] + [▼]:** Turns on the downward laser plummet centering beam. Press again to turn off.
- **Combination [☀] + [♦]:** Toggles graphical LCD panel backlight illumination. Press again to turn off.
- **Combination [☀] + [Enter]:** Enters internal menu parameters setup interface. Press Enter again to save modifications and exit.

b. System Display Icons Glossary

Icon Symbol	Functional System Meanings
(Clock Icon)	Auto Power-Off protocol enabled flag.
(Battery Gauge)	Real-time voltage capacity supply level bars.
(Star Icon)	Special combination command shift mode active flag.
%	Percent slope grade metrics active.
b-OUT	Vertical circle axis tilt compensation exceeds electronic range.
OUT	Current slope gradient exceeds maximum mathematical tracking threshold of ±100%.
m	Unit metrics tracking in meters.
° ’ ″	Standard sexagesimal angular formatting units.

4. Inspection and Calibration of Common Technical Indicators

4.1 Plate Vial Inspection and Calibration

a. Mechanical Inspection Procedure:

(1) Secure the base tribrach of the theodolite firmly onto a structurally stable testing platform or a heavy-duty tripod, and lock the central tie-down connecting screw.

(2) Perform initial coarse leveling. Release the horizontal clamp screw and turn the alidade table until the long plate level vial is positioned perfectly parallel to an imaginary line bridging tribrach footscrews A and B. Turn footscrews A and B simultaneously in opposing directions until the bubble rests perfectly inside the central graduation lines.

(3) Rotate the instrument alidade table exactly 90° . Turn footscrew C until the bubble rests inside the center lines. Then, spin the instrument alidade table exactly 180° from this position and lock it. Observe the displacement of the bubble. If the bubble remains centered, the plate vial is accurate and needs no adjustment. If the bubble drifts past the tolerance boundaries, calibrate the vial.

b. Mechanical Calibration Procedure:

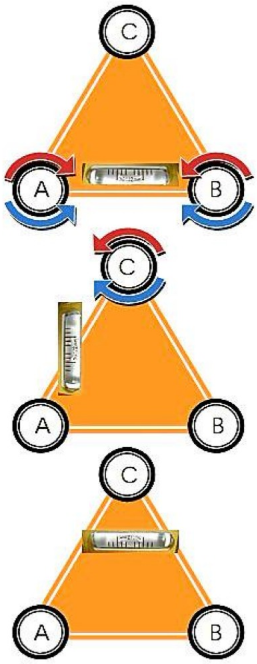
(1) Secure the instrument onto the verification stand or tripod frame and perform coarse leveling.

(2) Turn the alidade until the plate vial is parallel to a line bridging footscrews A and B. Turn footscrews A and B in opposing directions (either both inward or both outward, as shown by the arrows) to bring the bubble to the center.

(3) Rotate the alidade table exactly 90° until the plate vial is perpendicular to footscrews A and B. Turn footscrew C to center the bubble. Repeat steps (2) and (3) until the bubble remains centered at both orthogonal positions.

(4) Rotate the instrument alidade exactly 180° around its vertical axis and let the bubble stabilize. Insert the adjustment pin tool into the mechanical calibration screw at the tip of the plate vial housing. Turn the screw to move the bubble back toward the center by exactly **half** of its total observed error drift distance.

(5) Turn the standard tribrach footscrews to correct the remaining half of the bubble error distance. Repeat steps (2), (3), and (4) in sequence until the bubble remains perfectly centered no matter which direction the alidade is rotated around the horizontal circle.



4.2 Circular Vial Inspection and Calibration


a. Inspection Procedure:

(1) Secure the instrument base firmly onto the verification stand platform.

(2) Level the theodolite precisely using the long plate level vial.

(3) Check the position of the bubble in the circular level vial. If the bubble rests exactly inside the inner target ring circle, no calibration is needed. If the bubble drifts outside the target circle, calibrate it.

b. Calibration Procedure:

(1) Keep the instrument locked on the stand and leveled precisely via the plate vial.

(2) Locate the two circular level vial calibration screws underneath the mounting bracket base ring.

(3) Insert the calibration pin tool and carefully turn the two screws to drive the bubble into the exact center of the target ring.

Notice: Do not over-tighten or force the calibration screws. Keep the relative tension between the two screws balanced to ensure long-term mechanical stability.

4.3 Optical Downward Plummet Inspection and Calibration

a. Inspection Procedure:

(1) Mount the theodolite onto a tripod and set a clear crosshair target mark on the floor directly beneath the vertical axis of the instrument.

(2) Turn the tribrach footscrews to align the optical plummet reticle center mark with the floor crosshair target.

(3) Rotate the alidade table exactly 180° around its vertical axis. Look through the plummet eyepiece and check the reticle center. If it matches the floor target exactly, no adjustment is required. If it shifts away from the target, calibrate the plummet reticle.

b. Optical Downward Plummet Calibration Procedure:

(1) Turn the three tribrach footscrews to realign the optical plummet reticle center mark with the floor crosshair target.

(2) Rotate the alidade table exactly 180°. Unscrew the protective cover cap from the plummet eyepiece barrel to expose the four orthogonal adjustment screws. Use the pin tool to adjust these screws to shift the reticle center crosshair toward the ground mark by exactly **half** of the error distance.

(3) Repeat steps (1) and (2) in sequence until the reticle center mark remains centered on the floor target throughout a full 360° rotation of the instrument.

Notice: Keep the final tension on all four adjustment screws uniform and snug. Do not over-tighten them.

4.4 Laser Downward Plummet Inspection and Calibration

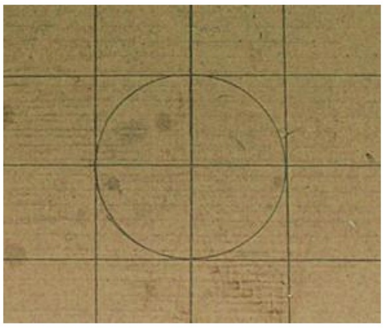
a. Inspection Procedure:

(1) Set up the instrument on a tripod and fix a clear target sheet on the floor directly beneath it.

(2) Power on the instrument and turn on the laser downward plummet module. Adjust the beam focus ring until the red laser spot on the target sheet is sharp and distinct.

(3) Turn the tribrach footscrews to align the center of the red laser spot exactly with the intersection line mark on the target sheet.

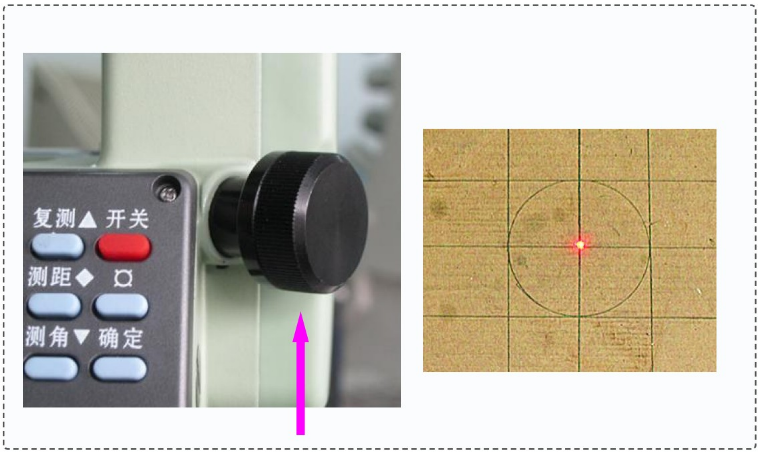
(4) Rotate the alidade table exactly 180° and let it stabilize. Observe the position of the laser spot relative to the target sheet mark. If the spot center stays on the target mark, no calibration is needed. If it shifts away, calibrate the laser alignment.



b. Laser Downward Plummet Calibration Procedure:

(1) Turn the tribrach footscrews to realign the red laser spot center with the target sheet mark.

(2) Rotate the instrument alidade exactly 180° . Remove the protective cover ring from the plummet housing to expose the four orthogonal laser adjustment screws. Use the pin tool to adjust these screws to shift the laser spot back toward the target mark by exactly **half** of the error distance.



(3) Repeat steps (1) and (2) in sequence until the red laser spot remains centered on the target mark throughout a full 360° rotation of the instrument.

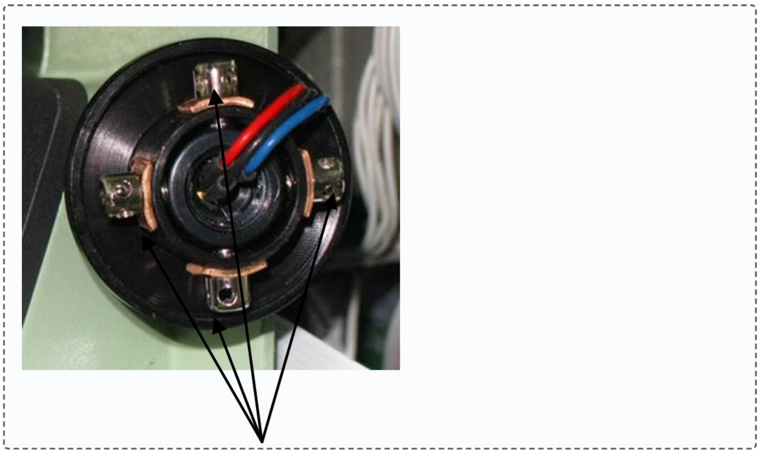
c. Downward Laser Tube Replacement Procedure:

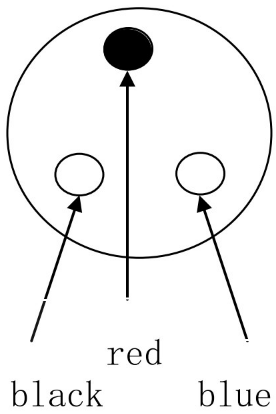
(1) If the laser beam fails to turn on and you have ruled out operational errors or disconnected wire leads, replace the laser diode tube assembly.

(2) Turn the downward plummet shroud cylinder counter-clockwise to unscrew and remove it.

(3) Use the pin tool to unscrew and remove the four adjustment screws around the module frame, then gently pull out the laser focusing barrel assembly.

(4) Insert fine tweezers into the slot tracks inside the lens barrel. Turn counter-clockwise to unscrew the focusing module cap, then desolder the three electrical lead wires from the laser tube pins to remove the old tube.





- **Pin Lead Map**: Top Lead = **Red Wire**; Left Lead = **Black Wire**; Right Lead = **Blue Wire**.

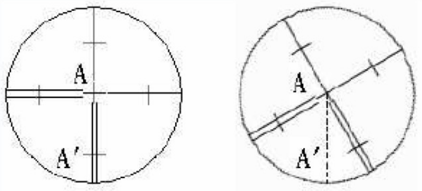
4.5 Telescope Reticle Vertical Hair Inspection and Calibration

a. Inspection Procedure:

(1) Mount the instrument securely onto a tripod and level it precisely.

(2) Set up a sharp, clear point target A at a distance of approximately 50 meters from the instrument.

(3) Aim the telescope at target point A. Turn the vertical tangent screw to move the telescope up and down vertically. Observe target A's path relative to the reticle vertical hair line. If target A tracks perfectly along the vertical hair line, no adjustment is required. If it drifts sideways off the line, calibrate the reticle orientation.



b. Calibration Procedure:

(1) Aim at target A at 50 meters. Remove the protective cover plate from the telescope eyepiece barrel to expose the four reticle adjustment screws.

(2) Use the pin tool to slightly loosen all four adjustment screws. Gently rotate the entire eyepiece reticle assembly until the vertical hair line aligns perfectly with target point A's vertical movement path. Tighten all four screws securely.

(3) Re-verify the vertical tracking alignment by moving the telescope vertically. Repeat the procedure if any deviation remains.

4.6 Laser Upward Pointing Emitter Inspection and Calibration

a. Inspection Procedure:

(1) Mount the theodolite securely onto a tripod and set up a clear crosshair target mark on a wall or screen exactly 50 meters away.

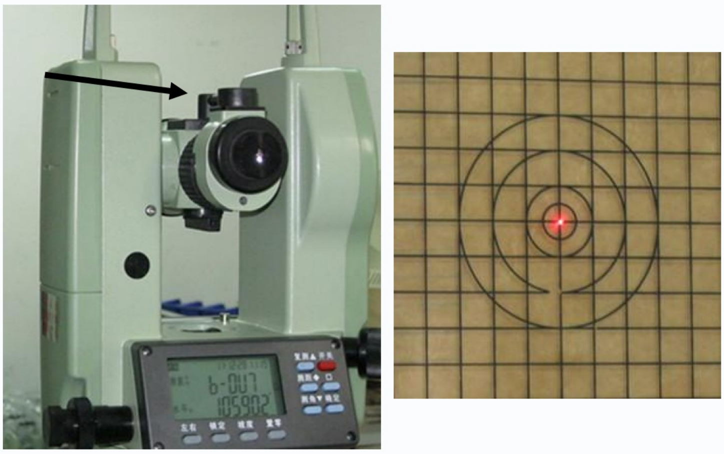
(2) Turn on the coaxial pointing laser and adjust the focus ring until the red laser spot centers exactly on the crosshair intersection of the target screen.

(3) Look through the telescope eyepiece and check if the reticle crosshair intersection aligns exactly with the red laser spot center. If it matches perfectly, no calibration is required. If there is any offset or misalignment, calibrate the laser emitter alignment.

b. Laser Upward Pointing Emitter Calibration Procedure:

(1) Turn the telescope focusing wheel and eyepiece diopter ring until both the reticle crosshairs and the distant target screen are sharp and clear.

(2) Use a screwdriver to adjust the four calibration screws located around the laser emitter mounting housing block. Look through the eyepiece while adjusting to watch the movement of the red laser spot.



(3) Adjust the screws until the center of the red laser spot aligns perfectly with the intersection of the telescope reticle crosshairs. Ensure all four screws are tightened evenly when finished.

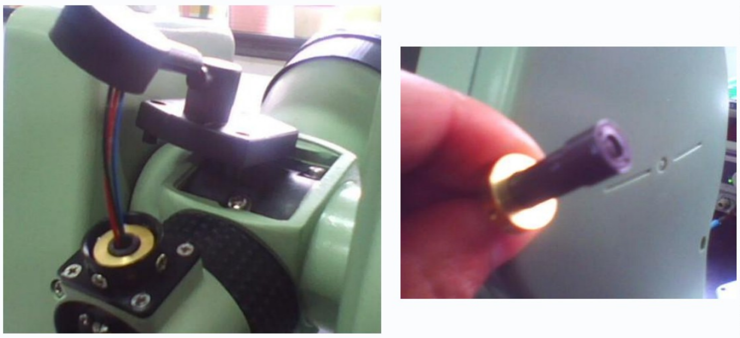
c. Upward Laser Tube Replacement Procedure:

Notice: The upward pointing laser module operates at a higher power output rating than the downward plummet module. Do not mix up or swap the two laser tubes.

(1) If the laser pointer fails to turn on and you have ruled out wiring or switch issues, replace the laser tube.

(2) Use a screwdriver to unscrew and remove the three M2×12 retaining screws counter-clockwise, then remove the protective laser module cover plate.

(3) Unscrew and remove the four M2×5 structural assembly screws to remove the internal focusing lens barrel cylinder.



(4) Insert tweezers into the slots inside the lens barrel. Turn counter-clockwise to unscrew the focusing module cap, then desolder the three electrical lead wires from the laser tube pins to remove the old tube.

(5) Install the new laser tube, matching the wire leads to their correct pins (Red, Black, Blue) as shown in the pin layout map. Reassemble the module in reverse order and verify laser operation.

4.7 Instrument Collimation Error (C) Inspection and Calibration

a. Inspection Procedure:

(1) Mount the theodolite onto a heavy-duty tripod or a stable calibration stand and level it precisely.

(2) Aim the telescope at a clear collimator reticle crosshair or a sharp, distant point target. Take a horizontal angle reading in the Face Left position, recorded as H_L.

(3) Flip the telescope vertically and rotate the alidade table to the Face Right position. Aim at the exact same target point and record the horizontal angle reading as H_R. Calculate the total Collimation Error (C) using the following formula:

$$C = (H_L - H_R \pm 180^\circ) / 2$$

If $\lvert C \rvert \le 10''$, the instrument meets accuracy standards and needs no adjustment. If $\lvert C \rvert > 10''$, calibrate the collimation alignment.

b. Mechanical Calibration Procedure:

Example Calculation: If Face Left reading $H_L = 0^\circ 00' 00''$ and Face Right reading $H_R = 180^\circ 00' 40''$, then:

$C = (0^\circ 00'00'' - 180^\circ 00'40'' + 180^\circ 00'00'') / 2 = -20''$. This exceeds tolerance limits and must be adjusted.

Calculate the target calibration angle value: $H_R' = H_R + C = 180^\circ 00' 20''$.

(1) While keeping the instrument in the Face Right position, turn the horizontal tangent screw until the horizontal circle reading matches your calculated target value exactly ($H_R' = 180^\circ 00' 20''$).

(2) Remove the protective cover ring from the telescope reticle adjustment window. Use the pin tool to adjust the left and right reticle screws to shift the vertical crosshair until it intersects perfectly with the target point.

(3) Repeat the entire inspection procedure to recheck the readings. Continue adjusting until the residual collimation error meets the standard ($\lvert C \rvert \le 10''$).

4.8 Checking 2C Indicators via Horizontal Software Program Adjustment

This procedure checks and calibrates the horizontal collimation error electronically through the system software firmware.

(1) Mount the theodolite onto a stable calibration stand or tripod and level it precisely.

(2) Press and hold the [Slope] key while powering on the instrument. Release the key when the system software diagnostic screen initializes and displays the calibration interface layout.

```
DIAGNOSTIC INDEX MODE
STEP-1 INITIALIZE REFS
[OSET] TO SECURE ZERO
```

(3) Aim the telescope in the Face Left position at a collimator reticle or a sharp distant target located near the horizontal plane (within $\pm 10°$ vertical inclination). Press the [Clear 0] key once to store the reference value. The screen changes to show the next step.

```
DIAGNOSTIC INDEX MODE
STEP-2 INVERT TARGET DATA
[OSET] TO SECURE SET
```

(4) Flip the telescope vertically and rotate the alidade table to the Face Right position, then aim back at the exact same target. Press the [Clear 0] key once to capture the inverted reference data.

(5) Return the instrument to the Face Left position and aim at the target once more. Press the [Clear 0] key again. The system will automatically reset the horizontal angle reading to a calibrated baseline of 0° 00′00″.

```
CALIBRATION COMPLETION
HA-R VALUE MATRIX ZEROED
SYS-STATUS: VERIFIED STANDARD
```

(6) Switch the instrument to the Face Right position again, aim at the target, and read the horizontal angle value displayed on screen, recorded as value X.

(7) Calculate the residual error: $\Delta C = 180° - X$. If $\lvert \Delta C \rvert \le 8''$, the software calibration is successful and within tolerance limits. If it exceeds 8″, restart the procedure. If the error cannot be resolved through software calibration, return the instrument to the factory for service.

4.9 Vertical Circle Index Error (I) Inspection and Electronic Calibration

(1) Set up the instrument on a stable calibration stand and level it precisely using the plate vial.

(2) Turn on the instrument. Press the [☀] shift key followed by [Enter] to open the menu options. Use the [Dist] key to select parameter register SET-2. Press the [Angle] key to toggle the option to ON, setting the vertical circle reference to Zenith 0°. Press [Enter] to save the change, then press the power key to turn off the instrument.

```
MENU SELECTION CONFIG
REG ID: SET-2 REG VALUE: ON
V-CIRCLE ZERO: ZENITH BASE
```

(3) Press and hold the [L/R] key while powering on the instrument. Release the key when the vertical index calibration screen initializes and displays STEP-1.

(4) Aim the telescope in the Face Left position at a collimator crosshair target or a sharp distant point target within ±10° vertical inclination. Press the [Clear 0] key once to store the data.

```
V-INDEX BOOTSTRAP CAL
STEP-1 FACE-LEFT TARGET
VAL-DATA: 90° 00'14" [OSET]
```

(5) Flip the telescope vertically and rotate the alidade table to the Face Right position, then aim back at the exact same target point. Press the [Clear 0] key once. The screen will display STEP-2 and record this vertical value as angle V_R.

```
V-INDEX BOOTSTRAP CAL
STEP-2 FACE-RIGHT TARGET
VAL-DATA: 270° 00'07" [OSET]
```

(6) Turn the instrument back to the Face Left position, aim at the target point again, and record the vertical angle reading as angle V_L.

(7) Calculate the Vertical Index Error (I) using the following formula:

$$I = (V_L + V_R - 360^\circ) / 2$$

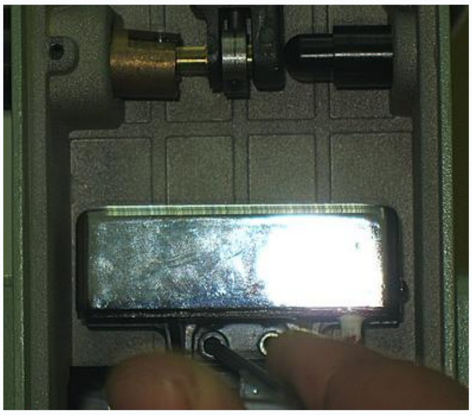
(8) If index error $\lvert I \rvert \le 15''$, it meets the standard. If it exceeds 15″, restart the calibration procedure. If electronic calibration cannot resolve the error, return the instrument to the factory for service.

4.10 Vertical Circle Tilt Compensator Installation, Calibration, and Compensation Adjustments

a. Compensator Installation and Calibration

(1) Set up the instrument on a heavy-duty tripod or a stable testing stand, level it precisely, and turn the alidade until the plate level vial faces you.

(2) Position the dual-axis liquid tilt compensator module inside the instrument housing. Secure it using two pairs of M3×8 hex socket screws and size 3 split-ring spring washers, then connect the circuit wiring plug to the main board socket as shown below.



(3) Power on the instrument and enter the menu options. Select parameter register SET-1 and press the arrow key to toggle the value to ON to activate the tilt compensator circuit. Press [Enter] to save the setting.

```
MENU SELECTION CONFIG
REG ID: SET-1 REG VALUE: ON
COMPENSATOR STATUS: SYSTEM ACTIVE
```

(4) Press the [☀] shift key followed by [L/R] to open the real-time tilt compensator diagnostic readout screen.

```
LIVE TILT SENSOR DIAGNOSTICS
ANGLE VALUES OFFSET: -0° 02'36″
STABILIZATION WINDOW ACTIVE
```

(5) Use a non-marring adjustment tool (such as a small plastic hammer or a tool with a wooden handle) to gently tap the side of the compensator module frame to align it. Watch the diagnostic readout screen while doing this. When the displayed offset value drops below 20″, tighten the module mounting screws firmly. Record this Face Left offset reading as value $BC1$. Then, rotate the alidade exactly 180° and record the Face Right offset reading as value $BC2$.

(6) Adjust the module position using the tapping method until the total combined offset error satisfies the following condition: $BC1 + BC2 < 30″$.

b. Linear Compensation Calibration Procedure

This procedure calibrates the response accuracy of the tilt compensator module across its operational measurement range.

(1) Mount the theodolite onto a stable verification stand or tripod and level it precisely.

(2) Press and hold down both the [Clear 0] and [Angle] keys while powering on the instrument. Release the keys when the factory diagnostics calibration screen initializes.

```
FACTORY MAINTENANCE ENTRY
CAL MODS SELECTION MATRIX
[L/R] -> F1L-SET [LOCK] -> F20-SET
```

(3) Press the [L/R] key to select the linear compensation option F1L-SET from the options menu. The screen changes to display the linear tracking layout.

```
REG SELECTION: F1L-SET
V-CIRCLE INCLINE RUN ACTIVE
STEP CURRENT REFERENCE VALUE: 0° 03'13″
```

(4) Aim the telescope in the Face Left position at a clear collimator reticle target or a sharp distant point target. Target value tracking configuration: Turn vertical tangent screw to add exactly +3' angular inclination to target value reference data point, secure alidade, capture and save value as data point $X1$.

(5) Turn the vertical tangent screw downward to change the vertical angle reading by exactly -6' from its current position (which sets it to exactly -3' below the original baseline value). Turn the tribrach footscrews to realign the telescope with the target, and press the [Clear 0] key once to store this data point as value $X2$.

(6) Press the shift key followed by [L/R] to check the residual error calculations. Turn the tribrach footscrews until the displayed error offset metrics read exactly 0° 00'00″, then press the [Clear 0] key once to save the data point as value $X3$.

```
LINEAR MOD CALIBRATION DONE
X3 STABILIZED RUN VAL: 0° 00'00″
SAVING COEFFICIENTS TO MEMORY EPROM
```

(7) Find the maximum value (X_{max}) and the minimum value (X_{min}) among the three recorded data points ($X1$, $X2$, $X3$). Calculate the total linear variation range: $\Delta X = X_{max} - X_{min}$. When $\Delta X < 6''$, the module linearity meets standard constraints.

c. Zero-Position Compensation Calibration Procedure

This procedure calibrates the electronic zero-point reference of the tilt compensator module.

(1) Mount the instrument onto a stable verification stand or tripod and level it precisely.

(2) Press and hold down both the [Clear 0] and [Angle] keys while powering on the instrument. Release the keys when the factory diagnostics calibration screen initializes.

(3) Press the [Lock] key to select the zero-position compensation option F20-SET from the options menu. The screen changes to show the zero calibration layout.

```
REG SELECTION: F20-SET
ZERO SENSOR POSITION CAPTURE
VA CURRENT MEASURED VAL: 0° 00'15"
```

(4) Aim the telescope in the Face Left position at a clear collimator reticle target or a sharp distant point target, and press the [Clear 0] key once to capture the data point.

(5) Flip the telescope vertically and rotate the alidade table to the Face Right position, then aim back at the exact same target point. Press the [Clear 0] key once to capture the inverted data point.

(6) Press the shift key followed by [L/R] to open the calibrated zero offset values screen.

```
ZERO REFERENCE SAVED
Y VALUE OFFSET METRICS: 0° 00'04"
SYS CORRECTION LEVEL FACTOR COMPLETED
```

Observe the recorded offset values for Face Left ($Y1$) and Face Right ($Y2$) positions. Calculate the total residual zero-position error: $\Delta Y = Y1 + Y2$. If $\Delta Y < 30″$, the compensator zero alignment meets the required standards. If $\Delta Y \ge 30″$, restart both the linear and zero calibration procedures until the error is within tolerance.

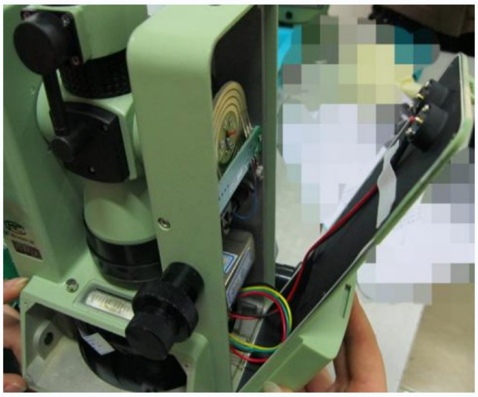
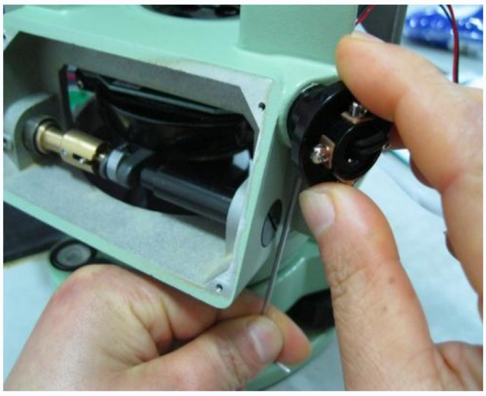
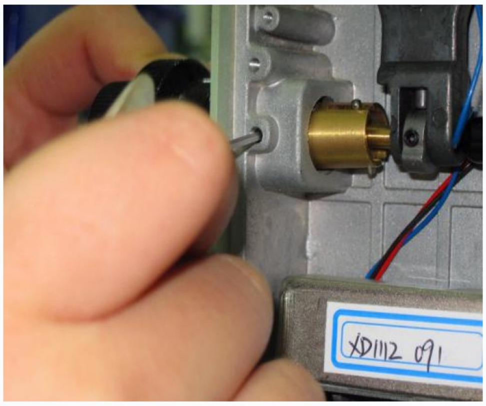
5. Instrument Mechanical Dismantling Procedures

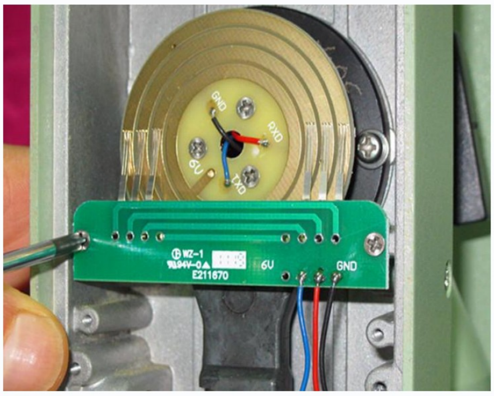
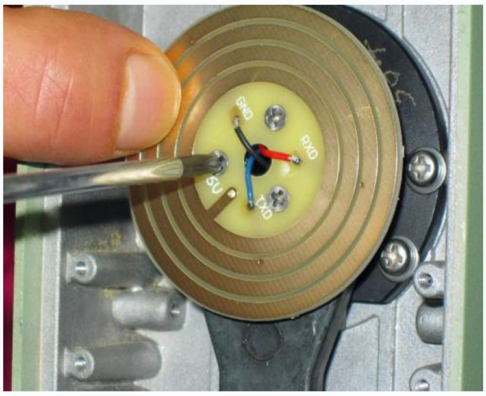
Always disconnect the power supply and remove the battery box pack before dismantling any mechanical or electronic components. Follow the breakdown sequence below:

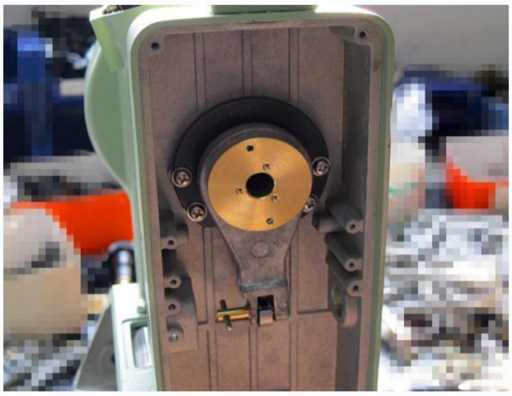
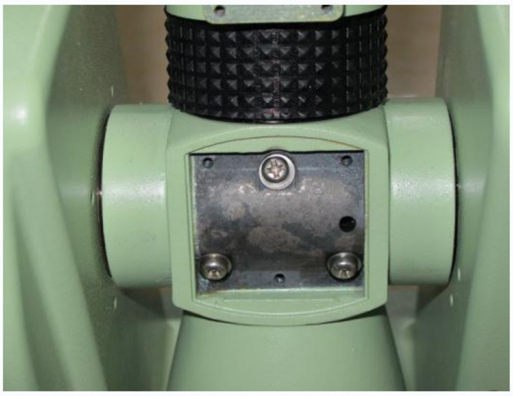
Dismantling Steps & Mechanical Guidelines	Assembly Diagrams & Callouts
(1) Removing the Carrying Handle: Turn the handle locking screws counter-clockwise until they are completely unscrewed, then lift the carrying handle straight up and remove it from the top frame.	
(2) Removing the Battery Box Pack: Press down firmly onto the top battery box spring latch catch, then tilt and extract the battery pack outward away from the housing frame.	
(3) Removing the Standard Left Cover Plate: Locate the five M2.5×10 phillips structural screws on the left standard cover housing. Turn them counter-clockwise to unscrew and remove them.	

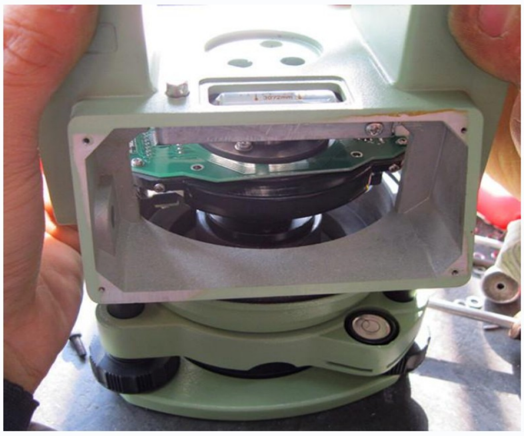
Dismantling Steps & Mechanical Guidelines	Assembly Diagrams & Callouts
(4) Disconnecting the Internal Buzzer Lead: Carefully lift the left standard cover plate away from the frame. Use fine tweezers to gently unplug the buzzer wire lead plug from its main board circuit socket, then remove the cover plate assembly completely.	
(5) Removing the Main Circuit Processor Board Screws: Locate the six M2×6 phillips retaining screws on the main circuit board frame. Turn them counter-clockwise to unscrew and remove them.	
(6) Removing the Circuit Cable Connectors: Use fine tweezers to gently open the ribbon cable sockets on the main circuit board. Disconnect all flat ribbon cables and wire lead plugs from their sockets, then remove the main board from the instrument frame.	

Dismantling Steps & Mechanical Guidelines	Assembly Diagrams & Callouts
(7) Removing the Operation Panel Frame: Locate the four M2×10 panel assembly screws around the corners of the keypad faceplate frame. Turn them counter-clockwise to unscrew and remove them.	
(8) Removing the LCD Screen Assembly: Disconnect the flat ribbon display cable that links the graphic LCD module to the main circuit board, then remove the LCD screen assembly from the panel frame. Use the same procedure to remove the operation panel on the opposing side.	
(9) Removing the Battery Side Panel Base Screws: Locate the four flat-head M2.5×6 screws and the single round-head M2.5×6 retaining screw on the inner side of the battery compartment housing. Turn them counter-clockwise to unscrew and remove them.	

Dismantling Steps & Mechanical Guidelines	Assembly Diagrams & Callouts
(10) Removing the Right Standard Cover Housing: Disconnect the battery terminal power supply wire leads from the main circuit board connector socket, then remove the battery side plate standard cover assembly completely from the instrument frame.	
(11) Removing the Laser Plummet Module: Use a hex key wrench to turn the flat-end M3×4 set screw counter-clockwise to loosen it. Unplug the laser plummet module power supply wire lead from its circuit connector socket on the main board, then slide the plummet module out of its mounting collar.	
(12) Removing the Vertical Tangent Assembly: Use a hex key wrench to turn the flat-head M3×4 socket screw counter-clockwise to unscrew and remove it, then pull the vertical tangent and clamp micro-drive screw assembly out of the standard frame.	

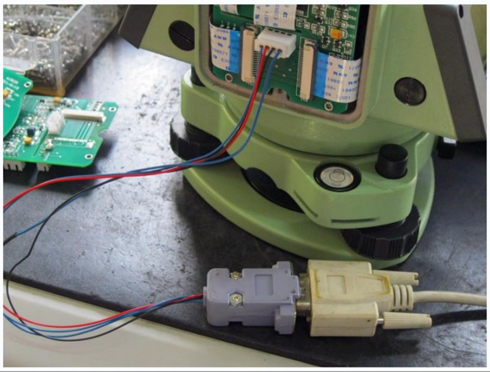
Dismantling Steps & Mechanical Guidelines	Assembly Diagrams & Callouts
(13) Removing the Horizontal Tangent Assembly: Use a hex key wrench to turn the flat-end M3×4 set screw counter-clockwise to unscrew and remove it, then pull the horizontal tangent and clamp micro-drive screw assembly out of the lower base casting.	
(14) Removing the Ground Terminal Solder Pads and Contact Brushes: Use a phillips screwdriver to turn the two M2×5 flat-head screws counter-clockwise to remove them. Desolder the Blue, Red, and Black wire connections from their solder pads, then remove the contact brush assembly.	
(15) Removing the Slip Ring Assembly: Use a phillips screwdriver to turn the three M2×5 screws counter-clockwise to remove them. Desolder the Blue, Red, and Black wire connections from their terminal joints, then lift the slip ring out of the center core sleeve axis.	

Dismantling Steps & Mechanical Guidelines	Assembly Diagrams & Callouts
(17) Removing the Horizontal Axis Retaining Ring: Insert a tool into the slot hole on the horizontal axis collar ring and turn counter-clockwise to unscrew the locking nut cap, then remove the horizontal axis retaining block.	
(18) Removing the Horizontal Axis Bearing Sleeve: Use a screwdriver to turn the four M3×9 structural screws counter-clockwise to remove them, then slide the horizontal axis bearing sleeve off the instrument frame standard.	
(19) Releasing the Telescope Axis Clamps: Use a screwdriver to turn the three M3×8 screws counter-clockwise to loosen them. Turn the telescope focusing wheel clockwise until it stops to retract the internal focusing lens barrel completely.	

Dismantling Steps & Mechanical Guidelines	Assembly Diagrams & Callouts
(21) Releasing the Alidade Housing Assembly Fasteners: Remove the rubber protective plugs from the access holes on the frame. Insert a screwdriver into the access holes and turn the three M4×12 structural base bolts counter-clockwise to unscrew and remove them.	
(22) Separating the Alidade Housing from the Base: Lift the main alidade housing straight up off the vertical axis spindle, sliding it smoothly up along the center axis track.	

6. Electronic Circuit System Checks and Calibration

6.1 Signal Debugging Software Tools



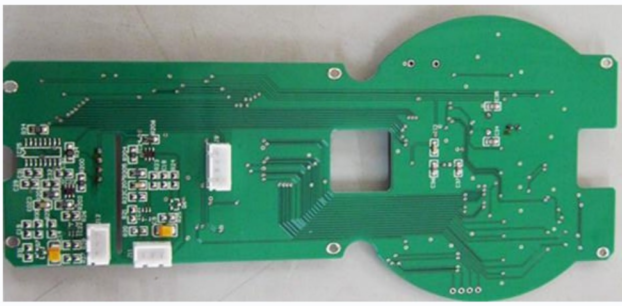
6.2 Waveform Diagnostics and Calibration

Oscilloscope Parabolic Sensor Signal Run

Connect the instrument to the computer and open the diagnostic software, using the default communication settings. Check the photo-electronic sensor parameters for both the horizontal and vertical axes sequentially, scrolling through channels CCD_0 to CCD_3. Capture and analyze the live signal waveform graphs displayed on the screen.

Waveform Acceptability Criteria: The signal waveform envelope curve must follow a smooth, continuous parabolic trajectory. The peak-to-peak amplitude variation across any segment within the central tracking zone must not exceed a maximum threshold of **350mV**. The signal must display a clean, stable harmonic oscillation pattern that is completely free of high-frequency noise spikes, signal spikes, jagged data dropouts, or sudden phase shifts. Any waveform that fails to meet these criteria indicates a sensor module error.

6.3 Main Processor Board Terminal Map



7. Troubleshooting and Fault Rectification Guide

7.1 Troubleshooting Common Hardware Faults

(1) Horizontal or Vertical Axis Rotation Jammed or Stiff: Mechanical resistance within the main bearing spindle arrays. *Notice: Spindle housing adjustments require factory recalibration and must be returned to the manufacturer for service.*

(2) Tangent and Clamp Drive Screw Failure: Follow the dismantling procedures in Section 5 to remove the tangent drive module. Check the condition of the drive cam, inspect internal components for wear or thread stripping, re-align the drive mechanism, and reinstall it. If tangent screw operation remains uneven after adjustment, replace the entire micro-drive sub-assembly.

(3) Index Error Consistently Exceeds Tolerance: If the vertical index error remains outside tolerance limits and cannot be resolved through electronic calibration steps, open the menu and disable the automatic tilt compensator function. If the index error continues to drift, it indicates a physical failure within the liquid compensator sensor module. Return the instrument to the factory for module replacement.

(4) LCD Panel Character Segment Fading or Missing Lines: View the LCD panel from an angle to check for faint, ghosted character segments. If segments are ghosting, check if any keypad buttons are stuck down inside the faceplate bezel. If all buttons bounce back normally, use a multimeter to inspect the bias resistor array connected to the LCD driver lines, and verify that the display ribbon cable plug is fully seated in its main board socket. If no character segments are visible even when viewed from an angle, first check that the LCD module power supply connector pins are making secure contact. Next, verify main microcontroller operation by using an oscilloscope to check for a stable clock signal across the crystal oscillator pins. If the crystal oscillator is dead, replace it.

7.2 System Error Codes Matrix Diagnostics

When internal diagnostic checks detect a hardware failure, the system microcomputer displays a specific error code on the LCD screen. Use the diagnostic matrix below to isolate and service the faulty module:

Error Code	Detected Hardware Failure	Required Field Service Action
E-302	Vertical circle angle tracking signal failure (Absolute or Incremental encoder channel fault).	Clean or replace vertical circle glass grating disk; adjust reading head alignment or replace sensor board.
E-303	Horizontal circle angle tracking signal failure (Near-end encoder matrix channel fault).	Clean or replace horizontal circle glass grating disk; adjust reading head alignment or replace sensor board.
E-304	Horizontal circle angle tracking signal failure (Far-end encoder matrix channel fault).	Clean or replace horizontal circle glass grating disk; adjust reading head alignment or replace sensor board.
E-305	Dual-axis angle tracking signal tracking synchronization error.	Check for physical axis binding; replace main angle sensor board or main board sub-assembly.
E-108	Tilt compensator out of range or sensor hardware failure.	Re-level instrument; check compensator module wiring connections, or replace compensator module sub-assembly.
E-08	Repetitive angle measurement variation exceeds maximum allowed software tolerance ($\lvert \text{Current} - \text{Average} \rvert > 30″$).	Check stability of tripod setup; smooth out horizontal tangent movement, or restart repetitive measurement session.
E-09	Repetitive measurement session counter has exceeded maximum limit of 9 sets.	Press reset button to clear session history counter and start a new measurement session.

⚠️ SERVICE REMINDER: If you encounter an error code that cannot be resolved through field adjustments, or if component replacements fail to clear the system error, return the instrument to the factory for professional diagnosis and repair.