

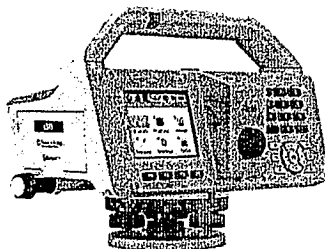
ANNEXURE I

PRECISION LEVELLING

1 EQUIPMENT AND ACCESSORIES

Leica LS-15 Digital Level with high accuracy, offers short measurement cycles and fast, highly accurate EDM for monitoring and managing the displacement of natural and man-made structure on the surface and underground.

1.1 Leica LS15 Digital Level

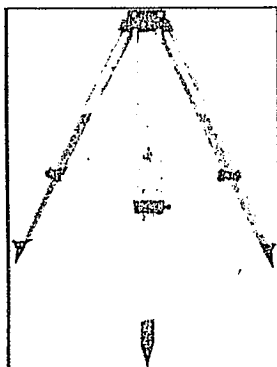


Leica LS-15 Digital Level is high accuracy instrument of 0.2 mm that alleviate demanding levelling tasks on any site. It has automated functions and touchscreen displays with clean lay out that makes the entire measurement process more efficient.

1.2 Accessories

Following are the equipment and accessories used for monitoring purpose:

- Tripod



Tripod is has three extending legs that can be locked in any position and height stability under load and the minimal horizontal drift. Their weight in relation to load-bearing capacity.

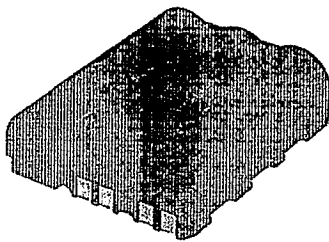
- Data Transfer Cables



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The data transfer cables are used for transfer of data over the cable from and to the instrument making it extremely reliable and secure, even in extreme heat, cold, snow and rain.

- **Battery**



Exchangeable Lithium-ion internal battery GEB331

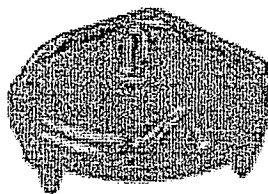
With battery life of 10 -12 hours

- B. Levelling staff**



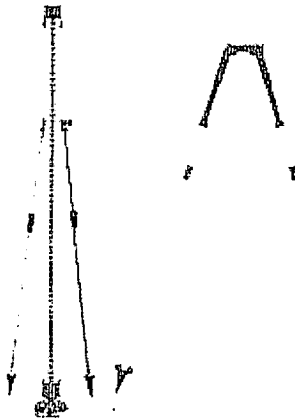
Levelling staff are made up of aluminum and distinguish themselves through a minimal thermal expansion coefficient. They are high precision staff and used to determine differences in elevation.

- C. Levelling base plate**



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D. Levelling Bipod



Levelling bipod is a device to support the levelling staff and maintaining the vertical bubble level of the staff.

2 DESCRIPTION OF THE SYSTEM

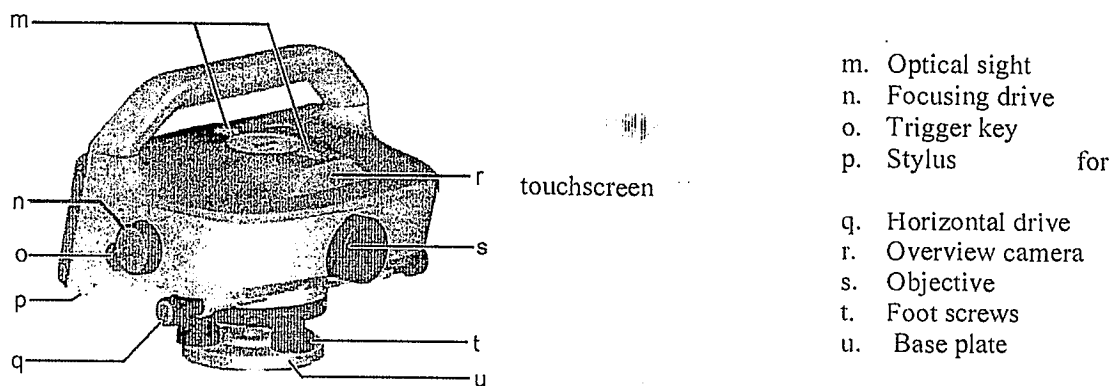
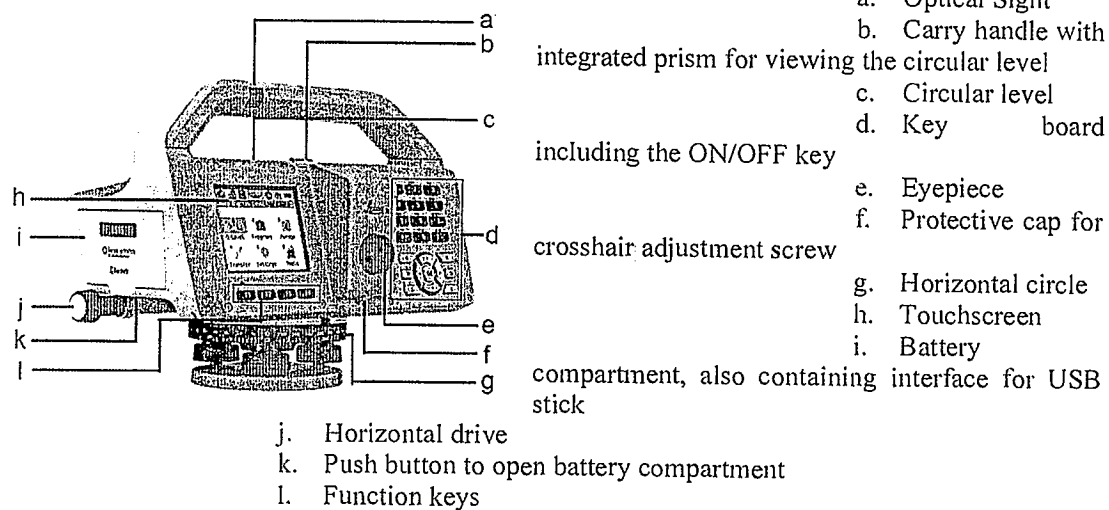
2.1 System Components

Components	Description
Leica LS-15 Digital Level	✓ Accuracy in height measurement of 0.2 – 0.3 mm. ✓ Highly suited for measurement tasks such as height measurements, line levelling jibs, adjustment of point heights or staking out heights.
Features	✓ Height and Distance measurement ✓ Magnetically damped compensator ✓ 32x Magnification telescope ✓ Auto and manual focus ✓ Overview camera ✓ Compass ✓ Mechanical bubble ✓ Electronic or Tilt check bubble ✓ Bluetooth

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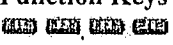
	✓	Internal flash memory for 30,000 measurement
Display and Keyboard	✓	QVGA (320 x 240 pixels) , color touch 3.6' screen
	✓	28 keys including 4 function keys and 12 alphanumeric keys.
Communication	✓	communicate through SD card and USB port for USB stick
Power supply	✓	internal battery GEB331
	✓	battery life of 10-12 hours
Infinity software	✓	An office software consisting of a suite of standard and extended programs for the viewing, exchanging, managing and post processing pf data.
Data storage	✓	30,000 measurement Internal memory
Weight	✓	3.9 kg

2.2 Instrument components



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3 USER INTERFACE

Key	Function
Touch screen 	Area on which images and data's are displayed.
ON/OFF key 	ON/OFF key to switch the instrument on or off or to set it into standby mode.
Alphanumeric key 	To type text and numerical values.
Function Keys 	Assigned to the variable functions displayed at the bottom of the screen.
Home key 	Returns to the Main Menu.
Page key 	Displays the next screen when several screens are available.
User key 1 	Programmable with a function from the Favorites menu.
Navigation keys 	Control the focus bar within the screen and the entry bar within a field.
Enter key OK	Confirms an entry and continues to the next field.
User Key 2 	Programmable with a function from the Favorites menu.
ESC key 	Deletes any change and restores the previous value.
Favorites key 	Quick-access to measurement supporting functions.

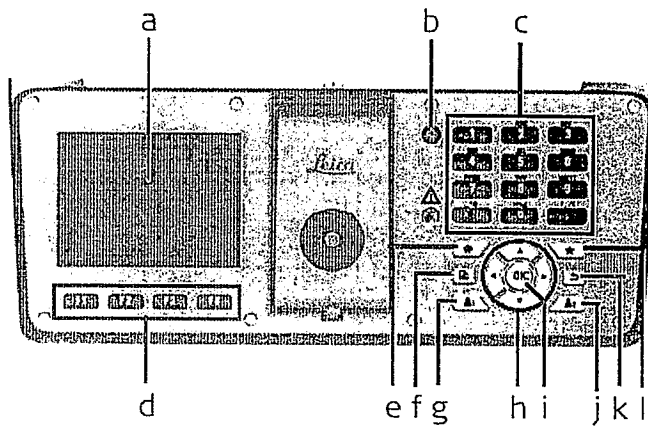
3.1 Operating principles

The alphanumeric keypad is used to enter the characters directly into editable fields.

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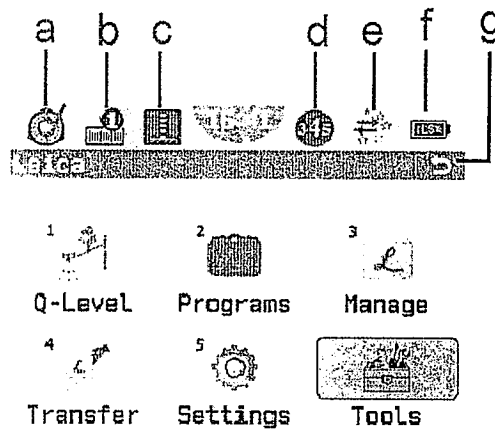
- **Numeric fields:** Can only contain numerical values
- **Alphanumeric fields:** Can contain numbers and letters.

3.2 Keyboard



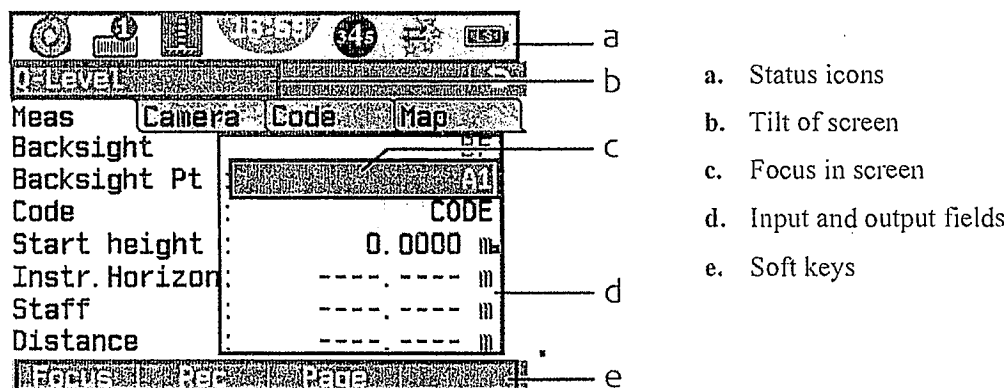
- a. Touchscreen
- b. ON/OFF key
- c. Alphanumeric keypad
- d. Function keys F1 to F4
- e. Home key
- f. Page key
- g. User key 1
- h. Navigation keys
- i. Enter key
- j. User key 2
- k. ESC key
- l. Favorites key

3.3 Screen



- a. Tilt check
- b. Measurement mode
- c. Staff orientation and status of Earth Curvature Correction
- d. Keypad mode
- e. Interface setting
- f. Battery
- g. backspace

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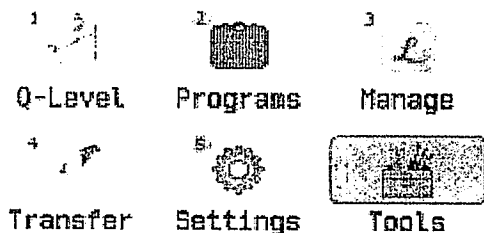
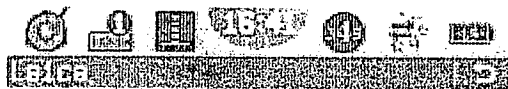
Icon	Description
Tilt Check	
	Tilt Check is off. Tap the icon to open the Level & Tilt Check screen.
	The instrument is levelled and Tilt Check is on.
	Instrument needs to be levelled before a measurement can be performed.
Measurement Mode	
	Measurement mode is set to Single. Tap the icon to open the Mode setting screen.
	Measurement mode is set to Mean.
	Measurement mode is set to Mean S.
	Measurement mode is set to Median.
	Measurement mode is set to Tracking.
Orientation of Staff and Status of Earth Curvature Correction	
	The orientation of the staff is set to upright . It is only possible to take measurements with the 0-mark at the bottom of the staff. The earth curvature correction is set to Off .
	The orientation of the staff is set to inverse . The earth curvature correction is set to Off .
	The orientation of the staff is set to upright . The earth curvature correction is set to On .

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	The orientation of the staff is set to inverse . The earth curvature correction is set to On .
Keypad Mode	
	Keypad is set to numeric mode. Tap the icon to switch to alphanumeric mode or use the soft key ABC.
	Keypad is set to alphanumeric mode. Tap the icon to switch to numeric mode or use the soft key 123.
Interface Setting	
	RS232 communication port is selected.
	Bluetooth communication port is selected, but inactive.
	Bluetooth communication port is selected and active.
	Either Mini USB communication port is configured and connected.
	Either Mini communication port is configured but disconnected.
System Status	
	The battery symbol indicates the level of the remaining battery capacity, 100% full shown in the example.

4 APPLICATION

4.1 Main Menu



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Function	Description
 Q-Level	A line levelling program to start right away. Each time you access Q-Level, a new Line is started and ended when you exit the application.
 Programs	To select and start the programs Basic Level, Line Level and Line Adjust.
 Manage	To manage jobs, data, code lists and formats in the internal memory as well as files stored on the USB memory stick
 Transfer	To export and import data.
 Settings	To change Work or Regional settings and to select communication parameters. To change general instrument settings such as measurement modes and interface settings.
 Tools	To access instrument-related tools such as check and adjust, personal startup settings, PIN code settings, license keys, system information and firmware upload.

Job and Data application is for managing the points, importing and exporting the saved data in different formats

5 CHECK AND ADJUSTMENT

The equipment can be affected by a number of factors like temperature changes, vibrations, shock and stress which leads to decrease the accuracy. Therefore it is recommended to compensate for these changing conditions before processing the work. This can be done in the field any levelling by running through specific measurement procedures.

Check & Adjust Menu contains tools to be used for the electronic adjustment of the line of sight, for the alignment of the camera crosshair and for the compass calibration of the instrument.

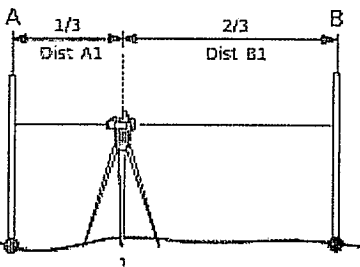
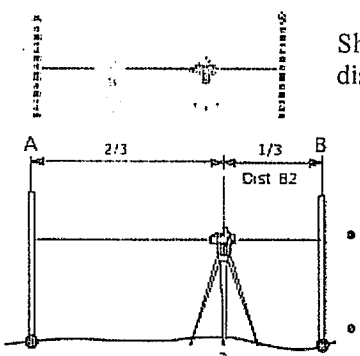
Check & Adjust screen contains following adjustment options.

Menu	Description
F1 Line of Sight	To check and adjust the line of sight.
F2 Camera Crosshair	To align the camera crosshair.
F3 Digital Compass	To calibrate the digital compass.
F4 Level Bubble	To adjust the electronic level of the instrument.

5.1 Adjusting Line-of-Sight Error/ Collimation Error

Step	Description
1.	Main Menu: Tools 

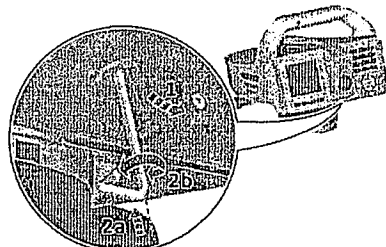
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2	Select Adjust from the Tools Menu. An information page is displayed. Select Cont to display the Check & Adjust Menu.
3	Select F1 Line of Sight .
4	On the General page, the current collimation error is displayed in arc seconds. Select AxBx method and press F4 or Cont.
5	AxBx Method. For AxBx adjustment method, the distances to the staffs have a ratio of 1:2 for each position of the instrument. First position (Station 1) First Position the instrument at 1/3 of the distance between staff A and B.  • The distance between staff A and B should be approximately 45m-60m. • Aim at staff A and carry out a measurement and then aim at staff B and carry out the measurement. • Store the measurements for station 1. A x x B method  Press F4 or Cont.
6	Second Position (Station 2) Shift the instrument to second position at 2/3 of the distance between staff A and B.  • This time, aim at staff B first and carry out the measurement • Then, aim at staff A and carry out the

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	measurement. Store the measurements for station 2.
7	On the Result page, the results of the adjusted procedure are displayed. Press Set in order to set the determined collimation error and apply it to all subsequent measurements. Result Collim error old: 0.0 " Collim error new: 4.4 " Difference : 4.4 " Reticle : 2.0003 "

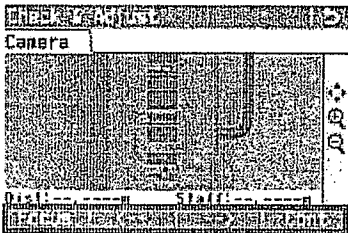
5.2 Adjusting the Optical Crosshair

Step	Description	
➤	The need for optical crosshair adjustment is determined by the Reticle value displayed in the Result screen after the line of sight adjustment. Result Collim error old:0.0 " Collim error new:4.4 " Difference:4.4 " Reticle:2.0003 "	Take an optical height reading and check if the value corresponds with the Reticle value of the Result screen. If the Optical height reading doesn't corresponds with the Reticle value, it indicates the need of Optical Crosshair adjustment.
1	The crosshair adjustment screw is underneath the eyepiece and is covered by a protective cap. Pull out the cap about 1cm and slightly press it to the side.	
2	Using an Allen key, turn the adjustment screw to move the optical crosshair until the optical crosshair corresponds with the Reticle value on the screen.	
3	Gently remove the Allen key and put the protective cap back in place.	

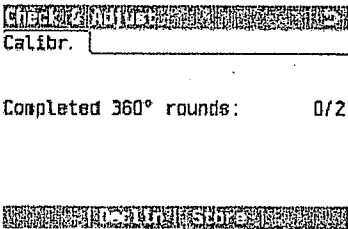
5.3 Aligning the Camera Crosshair

Step	Description
1	Main Menu: Tools
2	Tools Menu: Adjust
3	From the Check & Adjust screen, select F2 Camera Crosshair

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5	An information message is displayed. Aim accurately at the staff by using the optical crosshair and press Cont.  Focus: To focus the optics onto the staff distance. <-- : To move the vertical indicator to the left. --> : To move the vertical indicator to the right.
6	Press Cont.
7	An information page is displayed. Press Cont to accept the new position of the camera crosshair and to close the Check & Adjust screen. Press Reset to reset the crosshair to the default and to return to the Check & adjust screen.

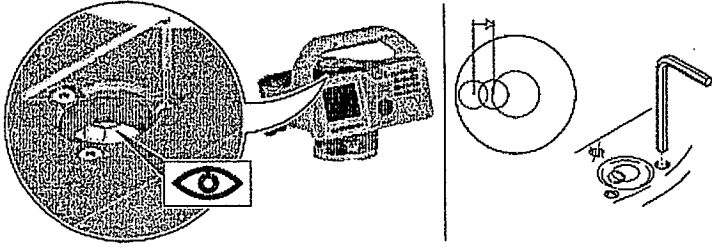
5.4 Calibrating the Digital Compass

Step	Description
1	Main Menu : Tools
2	Tools menu : Adjust
3	Check & Adjust screen : F3 Digital Compass and press F4 (Cont).
4	Following screen is displayed.  Rotate the instrument 360° at least two times and press F4 (Cont).
5	A message is displayed on the screen to inform whether the compass calibration has been successful. To accept the calibration, press F4 (Cont) .

5.5 Adjusting the Circular level of the instrument

Step	Description
1	Place and secure the instrument into the tribrach and onto a tripod.
2	Using the tribrach foot screws, level the instrument with the Circular level.
3	Turn the instrument by 180°/200 gon and observe the bubble of the circular level. • If after turning the instrument, the bubble is still centered no adjustment is need.

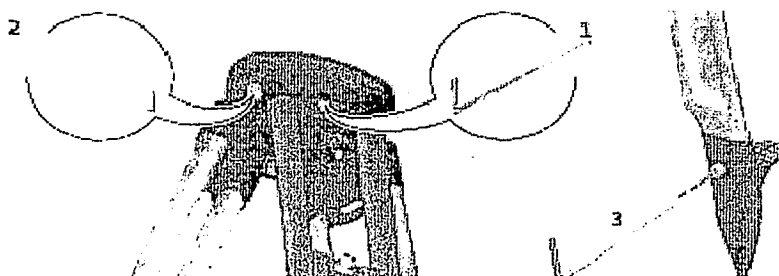
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4	If after turning the instrument, the bubble is not centered. Use the Allen key to bring the bubble to the center by moving the adjustment screws. 
5	Turn the instrument again by 180° / 200 gon and observe the bubble.
6	If necessary, repeat the step 3 to 5 until the bubble is centered correctly.

5.6 Adjusting the Electronic Level

Step	Description
1	Main Menu: Tools.
2	Tools Menu: Adjust.
3	Check & Adjust screen: F4 Level Bubble.
4	Use the mechanical circular level to precisely level the instrument and press Cont (F4) .
5	Turn the horizontal circle of the instrument to 0gon / 0deg.
6	Press the trigger key and wait until the next screen is displayed.
7	Then turn the horizontal circle of the instrument to 200 gon / 180 deg.
8	Press the trigger key. Then the message " Level Bubble is Calibrated " is displayed.
9	Press Cont (F4) to complete the calibration.

5.7 Servicing the Tripod



The connections between metal and timber components must always be firm and tight

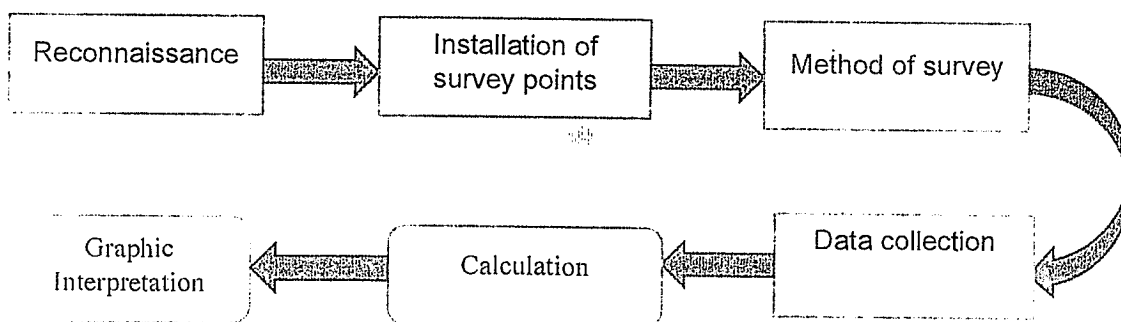
Step	Description
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1	Tighten the leg cap screws moderately, with the supplied align key
2	Tighten the articulated joints on the tripod head enough to keep the tripod legs open when lifting the tripod off the ground.
3	Tighten the allen screws of the tripod legs.

6 SURVEY METHODOLOGY

Survey methods, principle and procedures adopted for carrying out the survey involves preliminary planning in the office, choice of instrument selection, field operation and data collections as shown in the work flow figure 7.1



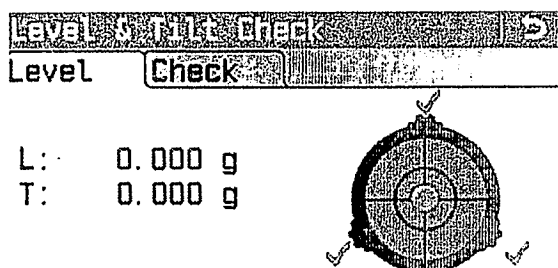
6.1 To setup and level the Leica Digit level LS 15

- i. Gather the survey equipment and accessories
 - ii. Set up the instrument
- E. Set the tripod on the stable ground. While holding the tripod, loosen the tripod leg clamps and extend the tripod up to a height you are comfortable to do survey. Tighten the leg clamps.
- F. Spread out the tripod legs evenly, about two to three feet for each leg on instrument point from where the monitoring readings are taken. The top of your tri-pod should be mostly level and parallel with a horizontal plane.
- G. Remove the Digital level from the carrying case and secure it to the top of the tripod. The tribrach features a level bubble and leveling screws to adjust the tripod's level as necessary. With your foot, apply equal pressure along each tripod leg to ensure a stable connection with the ground.
- H. Viewing the level bubble, adjust the height of two tripod legs so that the bubble is close to center. Then use the tribrach leveling screws for a more precise bubble level. Alternate

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back-and-forth between the optical plummet and level bubble to gain the most center and level position.

- I. To fine level the instrument, turn the Digital Level so that its face-plate is parallel with two tribrach leveling screws. These two screws will be used to adjust the trunnion (left and right) and the sighting (forward and back).



J. Keep the Tilt compensator ON so that the tilt of the vertical axis can easily be leveled.

K. Horizontal correction should be ON so that the horizontal axis error can be corrected.

L. L: Level of the instrument

M. T: Tilt of the instrument

Now that the instrument has been successfully leveled, press the accept button.

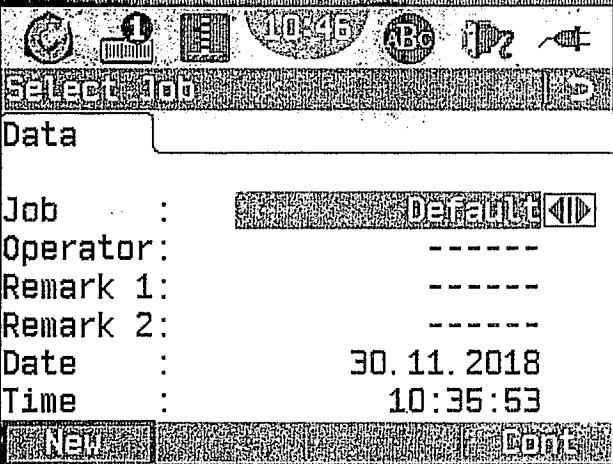
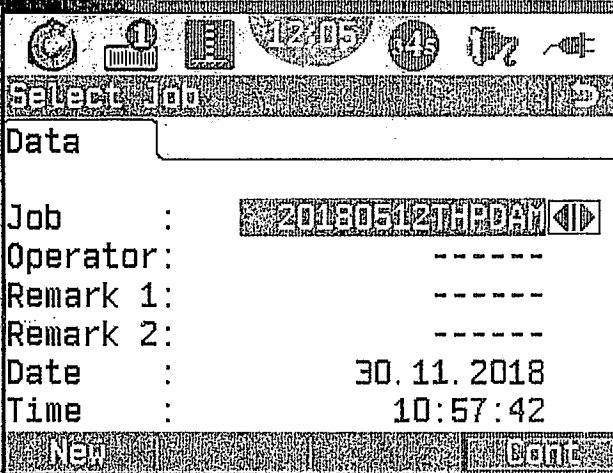
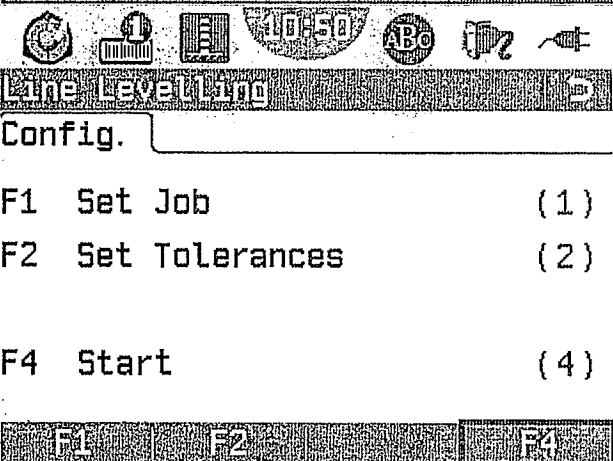
6.2 Survey Setup

Sl.No	Steps	Description
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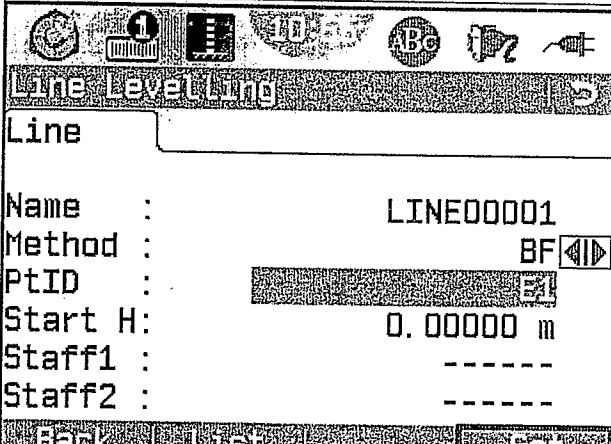
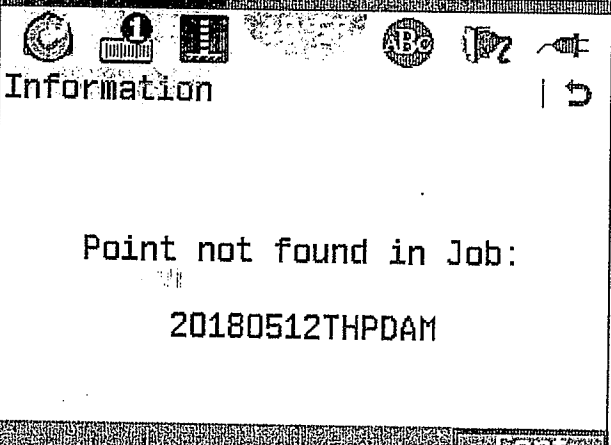
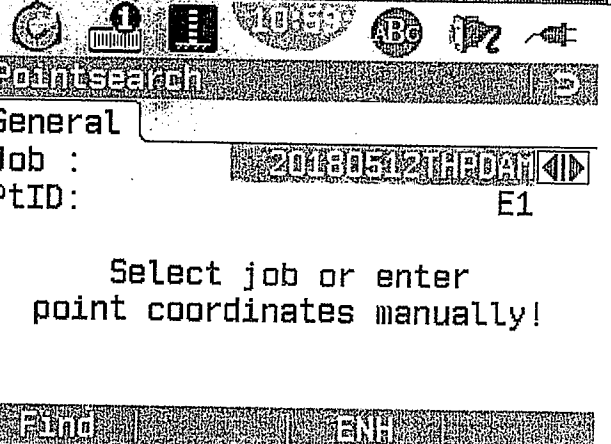
ANNEXURE I

1	Select Programs	
2	Select Line level	
3	To create new job or to select job Tap F1 Set Job	

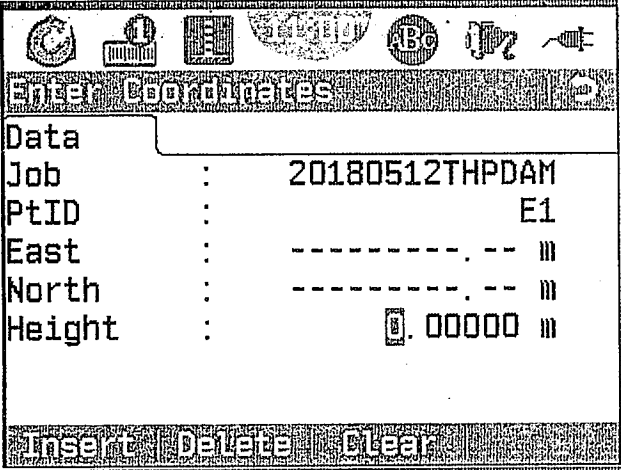
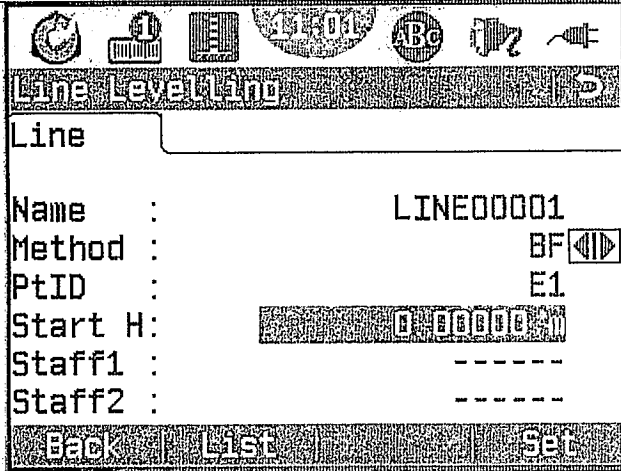
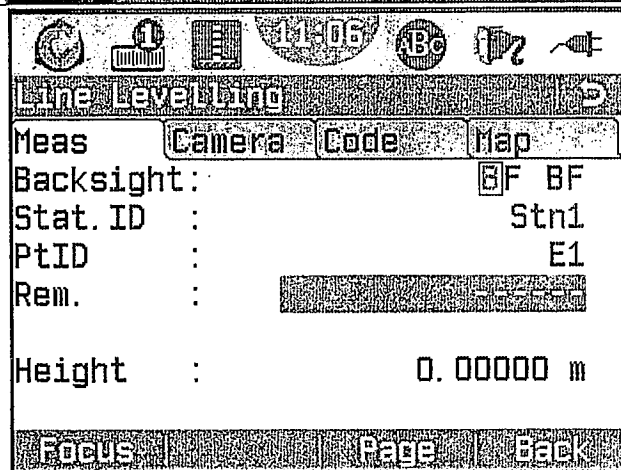
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4	Tap on NEW for creating new job Or Select the job with navigation key to select the existing job and continue :	
5	Enter the Job name, operator name, and additional remarks, Date and Time and Continue. A message will be displayed saying "Job set"	
6	Select F4 to set a line, method and continue	

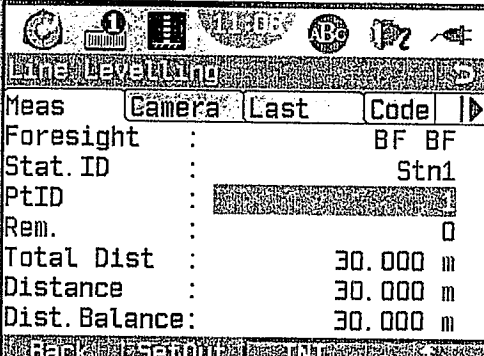
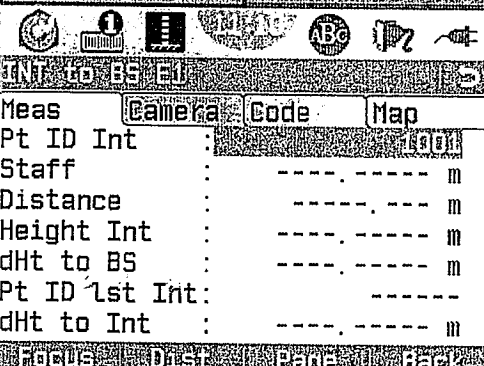
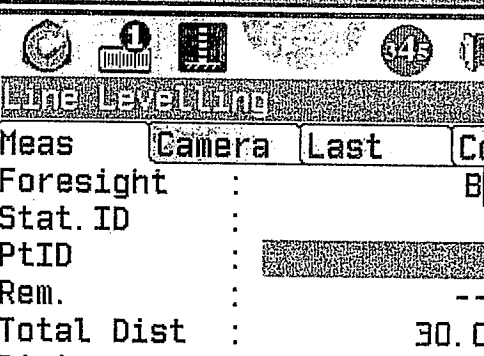
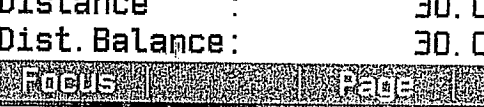
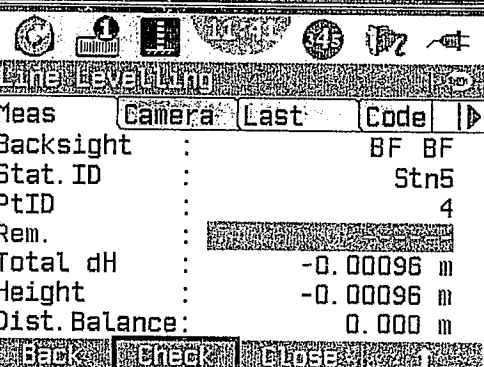
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7	Create new line using the BF levelling method Enter the point ID and press set.	 The screenshot shows the 'Line Levelling' screen. At the top is a toolbar with icons for back, forward, list, and other functions. Below the title bar, there's a 'Line' label and a text input field. The main area contains the following fields: 'Name' with value 'LINE00001', 'Method' with value 'BF' and a right arrow icon, 'PtID' with a greyed-out field and a right arrow icon, 'Start H' with value '0.00000 m', 'Staff1' with a dashed line, and 'Staff2' with a dashed line. At the bottom are three buttons: 'Back', 'List', and 'Set'.
8	Continue to create new point	 The screenshot shows the 'Information' screen. It has a toolbar at the top. The main text area displays the message: 'Point not found in Job:' followed by '20180512THPDAM'. At the bottom right, there is a 'CONTINUE' button.
9	Select ENH and input the coordinates of the new point	 The screenshot shows the 'Point Search' screen. It has a toolbar at the top. Below the title bar, there's a 'General' label and a text input field. The main area contains the following fields: 'Job' with value '20180512THPDAM' and a right arrow icon, and 'PtID' with value 'E1'. Below these fields is the instruction: 'Select job or enter point coordinates manually!'. At the bottom are two buttons: 'Find' and 'END'.

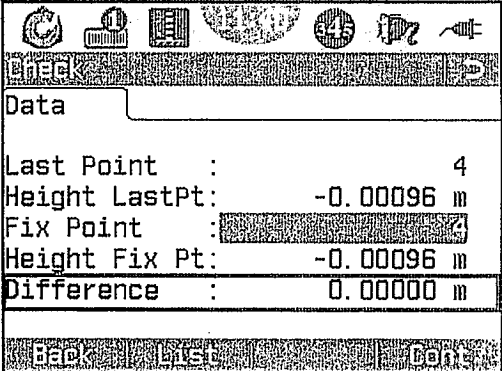
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10	Input the height of the point	
11	Set the selected line and continue with the program	
12	Take the back sight reading and focus the camera by pressing FOCUS. Take the measurement and record (REC).	

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13	Press on INT to survey the intermediate points.	 
14	Switch the recording to foresight and read the forward points.	 
15	Check the error by pressing on Check, if its within the acceptable limit at the end of the survey.	

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7 DATA STORAGE AND TRANSFER

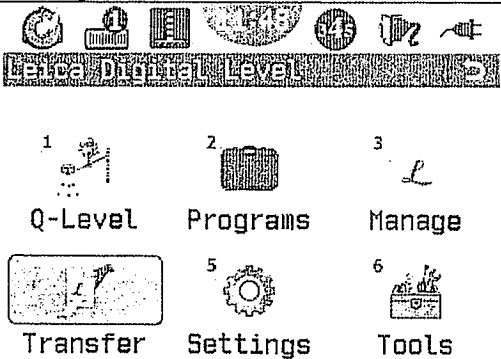
7.1 Data Storage

Data storage is the recording (storing) of information (data) in a storage medium. The digital level data are stored in internal memory.

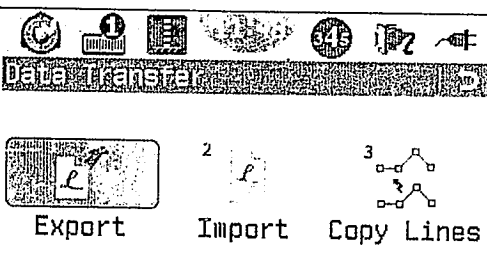
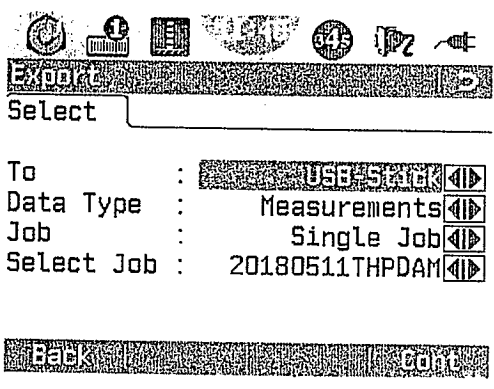
7.2 Transfer

Job data, format files, configuration sets and code lists can be exported from the internal memory of the instrument to **USB Memory Stick**.

Procedure

Sl.no	Step	Description
1	Go to Main Menu and Transfer	

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2	Select Export	 The screenshot shows a menu titled 'Data Transfer' with three options: 'Export', 'Import', and 'Copy Lines'. Each option is accompanied by a small icon representing its function.
3	• To: Destination of exported data • Data Type: Data type to be transferred. (Code, Format, Backup). • Job: Select whether to export all job-related data or single job data file. • Select Job: Select the particular job to be exported. And press Cont to complete the data transfer	 The screenshot shows the 'Export Select' screen with the following configuration: - To : USB Stick - Data Type : Measurements - Job : Single Job - Select Job : 20180511THPDAM At the bottom, there are 'Back' and 'Cont' buttons.