Terrameter LS 2
ELECTRICAL RESISTIVITY & IP
Based on UI version 2.6.2

ABEM

GUIDELINEGEO
Your guide to the subsurface

Quick guide for 4-cable 48 & 64 electrode systems

For more detailed and in-depth instructions regarding proper usage of the instrument, please consult the *ABEM Terrameter LS 2 User Manual.*

⚠ The current and voltage transmitted can be life threatening. **The red stop button must be engaged while working with connected cables and electrodes**. Before starting ANY measurements, ensure survey cables and electrodes are not being handled or touched.

Keep connectors dry and clean. **Poor connector handling and maintenance are the main causes of cable failure**. Always interconnect dust caps to keep them clean and dry during measurements (right).

LAYOUT PROCEDURE

A. Setting-up for survey

- **If cables are used at their full take-out spacing**, lay out the cables first, using the take-outs to locate electrodes.
- **If an alternative electrode spacing is required**, measure a straight line along the ground to position electrodes along the survey profile. Then place Take-out 1 of Cable 1 adjacent to the first electrode in the spread. Walk cable reel 1 along the survey line until all take-outs on the cable are aligned with an electrode.
- Electrodes should be hammered vertically into the ground to a depth of no more than 1/10th of the electrode spacing.
- Next, place Take-out 1 of Cable 2 at the next available electrode or measure the correct spacing for this point. Walk cable reels 2 - 4 along the survey line until all cables are out / all take-outs are aligned with an electrode.
- **Note:** If the electrode spacing is much smaller than the cable take-out spacing, avoid coiling and excessive overlapping of spare cable between the take-outs (right).
- Take-out numbers should always increase along the profile.
- **Tip:** To avoid confusion when processing results, profiles should run in southerly-to-northerly or westerly-to-easterly direction.
- Finally, place the ABEM Terrameter LS 2 instrument and external battery in the middle of the survey line (between Cable 2 and Cable 3).
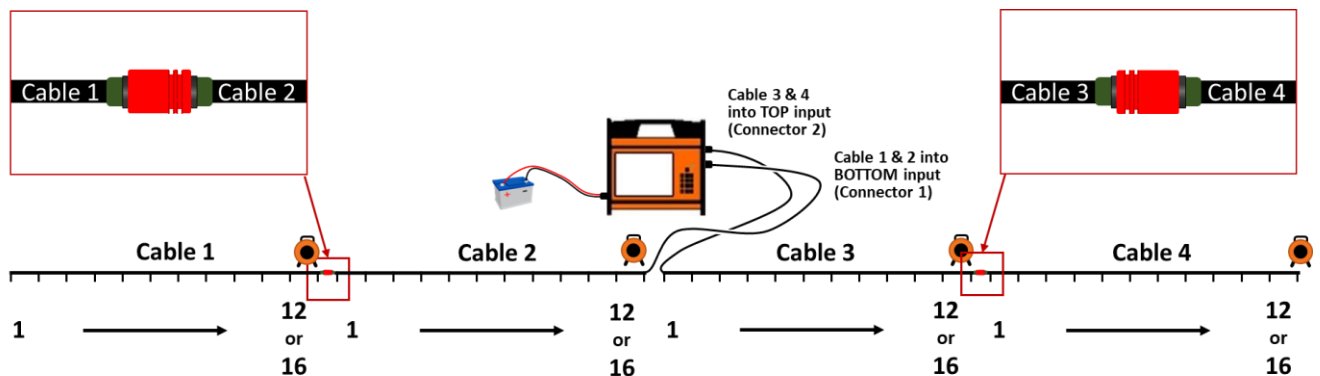
B. Connecting and powering the system

- Push the red stop button inward; this should be the case whenever handling cables and/or electrodes which are attached to the instrument.
- Connect jumper wires between cable take-outs and electrodes (preferably connected to upright section).
- Use cable joints to connect Cable 1 & 2 and Cable 3 & 4. **Important:** cable joints are directional and the ridges on the cable joints should be *towards* the instrument.
- Put Cable 2 into Connector 1, and Cable 3 into Connector 2 on the instrument end panel.
- Using the external power cable, connect the instrument to an external 12V car battery (>55Ah).
- Press the **Power** button on the instrument to start. Clicking noises will be audible during this start-up as the instrument exercises the relay matrix.

USER INTERFACE AND KEYBOARD FUNCTIONS

A. Welcome Page & Screen Features

Navigation Menu
When Menu Key is pressed, it displays four different menu options (Projects, Settings, Measure, Instrument) and their corresponding subitems/tabs, when expanded. **1**

Navigation Menu
- Projects
  - Welcome
  - Project List
  - Task List
  - Task Template List
- Settings
- Measure
- Instrument

Tabs
The tabs are the subitems of a selected menu. Tab icons also match their icons within the navigation menu. **2**

View
Displays the requested information in the screen layout. Change views by selecting a different tab or menu item. This is the 'Welcome View' which displays recent activities and instrument information. **4**

Status Bar
Shows measurement progress messages (when applicable) on the left and status icons on the right. During data collection, the left side will show how many data points have been written to the database versus the total number being collected in the current round of measurement, plus a summary of instrument activity. **7**

Welcome To ABEM Terrameter LS 2

Serial Number: LS219120557   Transmitter: 3.7.2
Software: 2.6.2-4-gf816d86b3f-d   eth0: 192.168.1.201
Available Channels: 12   tun0: 10.17.23.178

Recent Activities
< TaskName_1 >
< Show List of Projects >

Active Guidance
Press the "Guide" button for assistance on any tab, menu item, or command

Terrameter LS 2 Resources
Scan to access resources for this instrument

15:51

Project14
TaskName_1

Active Project/Task
Displays the project and task that is currently open. **3**

Instrument Information
Shows instrument serial number, the application software version, the number of measuring channels, and the transmitter firmware version. When applicable, the network IP address (for connecting locally) and the VPN tunnel address (for remote connection) are displayed. **5**

Guidance and resources
ABEM Active Guidance gives specific help on the current screen, menu item or command. The QR code links to resources on the Guideline Geo website. **6**

Status Icons
Notification icons show power / battery status, GNSS status and time of day. The left battery icon displays external power connection / battery status, and the right battery icon is the internal battery status. The GPS status is green when the instrument is connected to satellites and is red when there is no connection. The time-of-day icon may/may not reflect the correct region time (this can be reset using LS Toolbox). To learn more about the notification icons, please consult the ABEM Terrameter LS 2 User Manual. **8**

B. Keypad Functions

- An external keyboard can be attached to the USB port on the end panel of the Terrameter, however full operation can be achieved very easily using just the front panel keypad.
- VNC control is another option and will be covered in a separate *Quick Guide*.
- When using an external keyboard, the following relationship between external keys and keypad functions can be used:
  F9   =   ABEM Active Guidance
  F10   =   Play/Pause
  F11   =   OPT
  F12   =   Power button
  ALT   =   Menu
  TAB   =   Browse
  ESC   =   Clear
  ENT   =   OK

ABEM Active Guidance: Detects the currently active command, screen, or menu item and provides relevant guidance on it.

Menu: Displays navigation menu → Projects, Settings, Measure, Instrument.

Browse: Moves between views within a menu.

Arrow Keys: Moves cursor, scrolls through options, highlight fields.

Shift: Alters function of other keys. Shift + Browse allows for backward movement of tabs.

Play/Pause: Starts and stops measurements, and can also be used as a shortcut to jump to the 'Progress' view (data collection menus).

Power: Turns instrument on or off. Short press will bring up a confirmation dialogue.

Clear: Closes dialog, clears highlighted numerical fields.

OPT: Displays a context menu for various fields within the menus.

OK: Enter, selects options, closes virtual keyboard.

PROJECT AND SETTINGS

A. Create Project & Task

- From the "Welcome" page, use the **Browse** key to navigate to the "Project List" page (one tab to the right).
- Select < Create New Project >. The "Task List" automatically displays.
- Select < Create New Task >. A pop-out window will prompt selections for task settings.
- Use the **Up/Down arrow** keys to navigate to each option within the screen and **Left/Right arrow** keys to select the spread and protocol.
- Spread: Select 4x12 (48 electrode system) or 4x16 (64 electrode system).
- Protocol: Choose electrode array.
- Next, input Minimum Electrode Spacing X [m] by highlighting the option and pressing the **OK** key. The virtual keyboard will open. Enter the correct electrode spacing and press the **OK** key to exit. (It does not matter what values are in the Y and Z electrode spacing for 2D measurements).
- Select < OK > to exit pop-out window and automatically move to settings.

Project List

Project Name ▲	Last Updated
< Create New Project >	
Project1	Today at 13:38

Project1

Task List

Project14
TaskName_1

Task Name ▲	Created	Size
< Create New Task >		
TaskName_1	12/18/22	3.0m / 9 Measures

Create New Task

Spread:	4x16
Protocol:	Dipole-Dipole
Minimum Electrode Spacing X [m]:	4
Minimum Electrode Spacing Y [m]:	-
Minimum Electrode Spacing Z [m]:	-

< OK >
< Cancel >

23:15

B. Receiver & Transmitter Settings

- Settings are most often dictated by geologic/field conditions, instrument capabilities, and personal preference.
- To use pre-loaded instrument settings, navigate one tab to the left ("Load/Save Settings" page). This tab will allow you to load and view recommended 'starting' settings for various types of surveys.

Receiver Settings

o **Measure Mode**: Select desired measurement mode:
   - "Res" = resistivity measurements
   - "Res, IP" = resistivity and traditional 50% duty cycle IP measurements
   - "Res, IP 100%" = resistivity and novel 100% duty cycle IP measurements (Advanced models only).
o **# of Stacks & Error Limit**: Active for "Res" or "Res, IP" mode, this is number of repetitions to improve data quality; maximum will be either the chosen value or when the resistivity error drops below the percentage limit.
o **# of Current Pulses:** Active for "Res, IP100%" mode, defines how many current pulses will be used per measurement, this number is not constrained by data quality.
o **Delay & Acq. Time**: defines total 'current on' time, a longer delay will avoid IP effects, longer acquisition times average out noise better.
o **Number of IP Windows**: Defines how the IP effect will be measured. Use the pre-loaded settings for IP parameters.
o **Full Waveform**: In addition to the single averaged data values measured at each location, choose this option to map the full output and input current and voltage patterns during the measurement cycle. Does not increase measurement time but creates bigger project files.
o **Sample Rate**: Define how often the output current/voltage and input voltages are recorded for creating the full wave form.
o **Powerline Frequency**: Select the power line frequency, based on region/location of survey (either 50Hz or 60Hz).
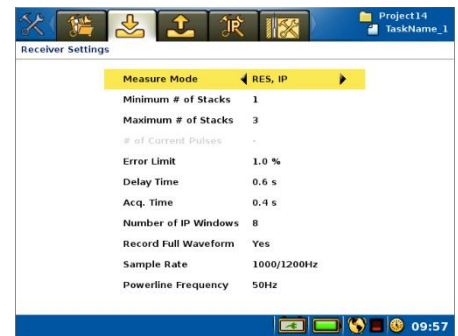
Transmitter Settings

o **Minimum & Maximum settings**: Maximum values will limit the instrument output; the minimum value does not force that amount of current to be used (actual value is based on ground conditions) but instead it will provide a warning if the current falls below this threshold.
o **Electrode Test**: Choose "On", this allows the instrument to test the contact resistance and connection of each electrode on the survey line.
o **Bad & Fail Electrode**: Select threshold for classifying each electrode during the electrode test. Values below "bad", count as a pass (low contact resistance).
o **Electrode Test Current**: Do not change.
o **Load Variation Margin**: Defines how much the instrument can vary the settings during measurement to maintain constant current – set to 10%.
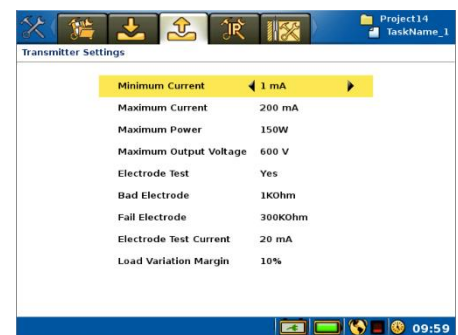
MEASUREMENTS

A. Measurement Configuration

- Navigate to the "Progress" page; < SAFETY SWITCH STOP > indicates that the red stop button is in use.
- Select < Create New Station (Roll Along) > and a pop-out window will open.
- "Station Position" is the first electrode in the full spread, *including* any cables that may not be in use, and the value represents 'relative electrode position' rather than distance (i.e. take-out 1 is electrode position 0, take-out 48 is electrode position 47, take-out 64 is electrode position 63). This means that the sequence of "Station Positions" is the same for every survey using a given cable set. True distance is the product of electrode position and electrode spacing; check that the "Spread extent" values (shown above the table) reflect the correct length of survey line.
- Select "4 cables no move" and exit pop-out window by selecting < OK >.
- Caution: before beginning measurements, check the survey line and ensure the area is clear.
- Turn the red stop button until it pops out. Then, select the < Start Measuring > message and press the **Active Guidance** button to access more help and tips for successful survey, or **OK** key to begin.
- A warning message will appear when you begin, select <OK> to accept and start the measurements.
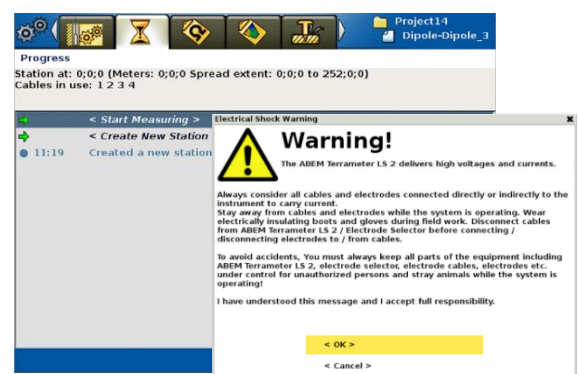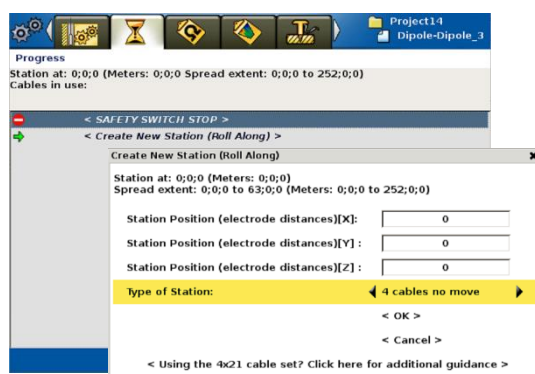
B. Electrode Contact Test

- The instrument will begin the electrode contact test prior to taking any measurements and will only test the electrodes required to complete the next phase of measurement.
- **Electrode Test Pass**: If all electrodes pass, the instrument will begin survey measurements automatically.
- **Electrode Test Fail**: If the electrode test fails, the instrument will wait for further user instruction. The "Progress" page will display a message, "Electrode test FAIL (OK: XX, Bad: XX, Fail: XX)", indicating how many electrodes were good, bad, or failed based on the threshold settings.
- Navigate to the "Electrode" page. This tab displays a table detailing the results of the electrode contact test.
- Pay attention to columns "S" (special instructions given to a cable or electrode), "Takeout" (indicates cable # – take-out #), and "Ohm" (measured contact resistance and a corresponding notification).
- Note all electrodes that have "Bad", "Fail", or "No Contact" flags in the "Ohm" column (consider increasing the threshold if most electrodes are "Bad" but have similar contact resistance values).
- **Push the red stop button prior to handling cables/electrodes**.
- Locate the problem electrodes and, first, check jumper wires are firmly connected to the electrode *and* take-out. Next ensure that electrodes are well grounded (hammer deeper, reposition slightly, add water, double-up electrodes etc.)
- Release the red stop button and restart measurement (either from the "Progress" tab or by pressing the **Play/Pause** button). This will automatically retest all the "Bad", "Fail", or "No Contact" electrodes; it will NOT retest electrodes that have already passed.
- After retesting, the instrument will either begin the survey or produce another failed message.
- In case of another fail, repeat the process of locating poor electrodes and attempting to improve their grounding.
- Retest the electrodes after each improvement. Repeat the process, until the electrode contact test passes.

Note that this shows a spread with 0.5m electrode spacing

- **Note** In some cases, it may be necessary to exclude or 'force use' individual electrodes. This can be done manually or by choosing an automatic option from the pop-up menu (accessed by pressing the **OPT** key) i.e. exclude all "Bad" electrodes. It is also possible to exclude a whole cable through the pop-up menu. Any excluded electrodes will have an "X" next to them in the first column; those which are forced to be used despite failing the electrode test will have a "U" next to them.
- When excluding electrodes, use the "Status" column to see the impact it will have on the final dataset; the "AB" count is how many times that electrode would be used for current injection, "MN" is how many times it would measure voltage..

C. Measurement Progress

- Navigate to the "Resistivity Results" page to monitor real-time measurements.
- The table displays channel number, electrode pairings used for measurement (cable # – take-out #), measured quantity (voltage or current), normalized standard deviation (variation coefficient), resistance, apparent resistivity and, if applicable, chargeability (IP) from the first-time window (the one at risk of spiking noise from the current switch-off if the "IP Delay Time" is too short). The bottom row reports the final transmitter output voltage and current.
- Watch for high standard deviations, excessive negative IP values and/or error messages that may appear during survey.
- When error messages appear avoid using the "Accept this and all similar and continue" option as you will no longer be notified if that error occurs again. Most error message display which electrodes were in use at the time of the failure, so attempt "Try again" first, if this is unsuccessful, then investigate the listed electrodes, check the battery health and the instrument settings. If problems persist, contact support.
- The measurement progress is shown on the left side of the status bar (described by how many measurements are complete out of the total number of station measurements). Compare this with the "Cables in use" notation on the "Progress" tab, which will tell you if any of the 4 cables are no longer needed.
- When measuring is complete, a "Measuring Done" message will appear in both the "Progress" page and the status bar.
- At this stage it is possible to 'roll-along' by returning to the "Create New Station" window and accepting the "1 cable forward" option. On the ground, Cable 1 and all the electrodes should be moved to the far end of Cable 4, and the instrument repositioned in the middle of the new cable spread position.

FILE MANAGEMENT

- The most effective way to download data is through the PC companion software ABEM Terrameter LS Toolbox, via ethernet or Wi-Fi connection. Refer to the *ABEM Terrameter LS Toolbox user manual* for more information.
- To download data using a USB storage device, insert the device into the USB port on the end panel of the instrument and wait a few seconds for USB device to be recognized and read.
- **Note** You cannot download active projects or tasks to USB. The currently active project and task is shown in the upper-right corner of the screen. To change the active project/task, open an existing project/task or create a new project/task.
- **USB Project Download**: Note that copying a whole project to USB can be quite slow. Navigate to the "Project List" page.
  - ○ Highlight the project and press the **OPT** key. A smaller pop-out menu screen will appear. Select "Export Project" (if grayed out, ensure the project is inactive and the USB device is in the USB port).
  - ○ Select < Yes > when prompted to export the project to the USB. **Note** The project database file is required for opening data in ABEM Terrameter LS Toolbox and undertaking quality assurance procedures and filtering.
- **USB Task Download**: Open the project containing the task(s) from the "Project List" page. Ensure the task is inactive.
  - ○ Highlight the task and press the **OPT** key. Select the file format preference, then select < Yes > to export.
  - ○ When data are downloaded, take out the USB memory device from the USB port.