

Quick guide for 4-electrode vertical electrical soundings (VES)

For more detailed and in-depth instructions regarding proper usage of the instrument, please consult the *ABEM Terrameter VES User Manual*. Note that instrument menus can be changed to alternative languages using the *Language* tab on the *Instrument* page of the Terrameter *Main Menu*.



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.** If using cables with dust caps, always interconnect / cover them to keep them clean and dry during measurements (right).

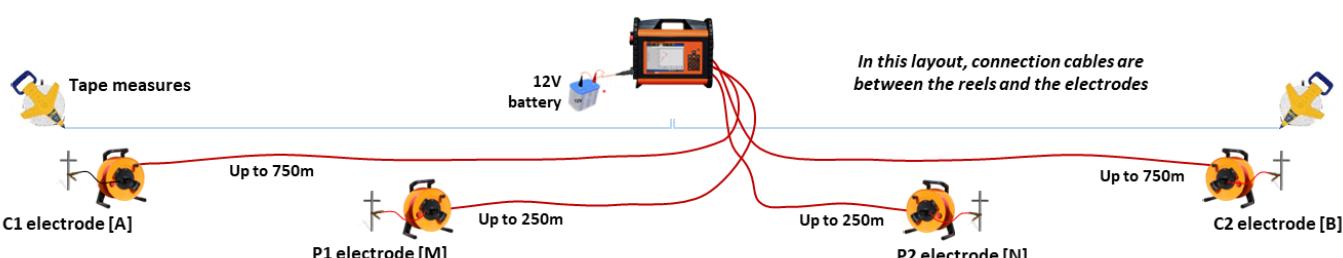
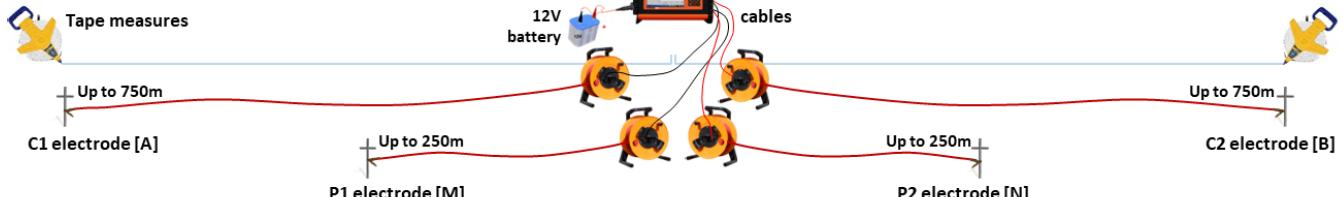
LAYOUT PROCEDURE

A. Setting-up for survey

- Bring all equipment to the sounding location and lay out tape measures in two directions (GNSS, measuring wheel, etc. are more convenient for larger distances).
- Hammer the four electrodes in at the correct positions for the first measurement.
- Electrodes should be hammered vertically into the ground to a depth of no more than 1/10th of the minimum electrode spacing.
- The longer reels (750m) are for C1 and C2, the shorter reels (250m) are for P1 and P2.
- There are two methods to lay out the reels and the choice is personal preference but, before connecting everything, **ensure that the red stop button is pressed in**, this should be the case whenever handling cables or electrodes.
- **Method 1 (below, top):** leave the four cable reels by the instrument and pull the free ends of the wire out to the correct electrode. Attach a crocodile clip to the electrode

and push the banana plug on the free end of the wire through the hole in the crocodile clip handle. Now use the short connection cables to go between the centre of the cable reels and the C1/C2/P1/P2 ports on the instrument end-panel.

- **Method 2 (below, bottom):** Plug the free end of the cable reels into C1/C2/P1/P2 on the instrument and carry the reels to the correct electrode. Attach a crocodile clip to the electrode and use the short connection cables to link between the crocodile clip and the centre of the cable reels. It is a good idea to form some kind of strain relief at the instrument end, so the cables do not pull out of C1/C2/P1/P2 or put unnecessary stress on the connectors whilst moving to new electrodes; for example, place external battery or the instrument onto the 4 wires just next to the instrument.
- **Note:** If using "Method 1", remember to disconnect the connection cables before extending the long wires from the reel to the next electrode position.



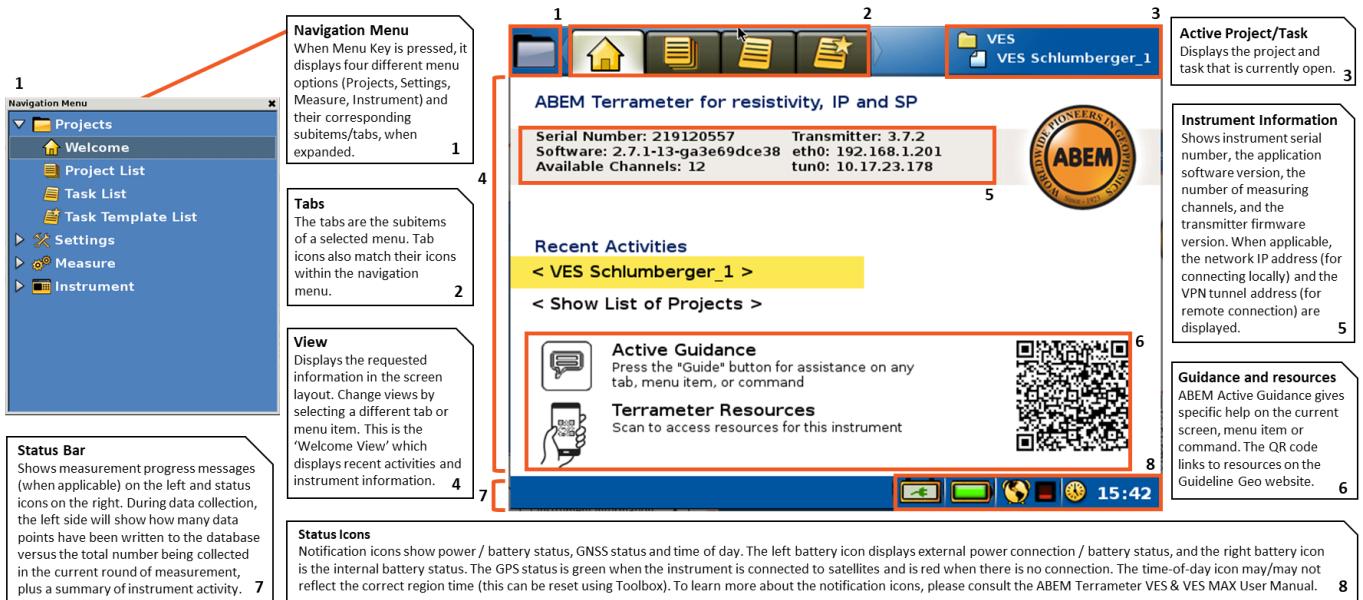
B. Powering the system

- Using the external power cable, connect the instrument to an 12V battery. An internal battery (if present) should be sufficient for several VES soundings in normal conditions but we always recommend using an external battery and keeping the internal as a back-up power source.
- Press the **Power** button on the instrument to start. On a Terrameter VES MAX, clicking noises during start-up are from the instrument 'exercising' the onboard relay matrix.



USER INTERFACE AND KEYBOARD FUNCTIONS

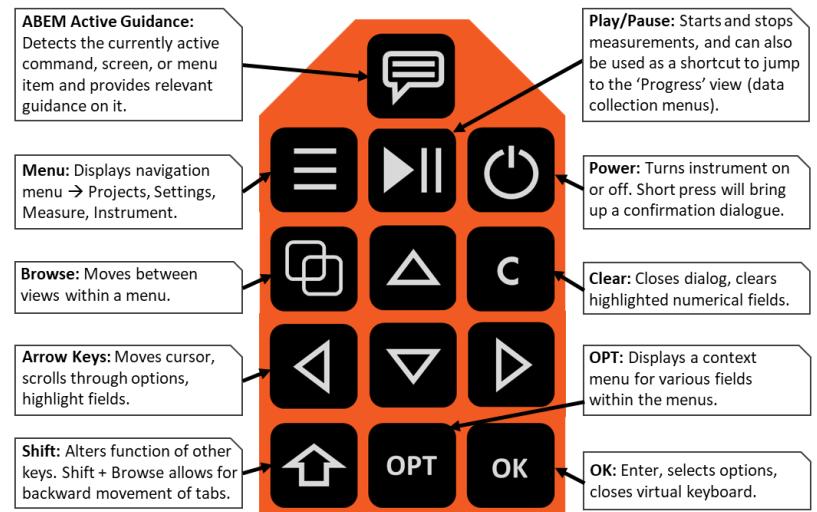
A. Welcome page & screen features



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:

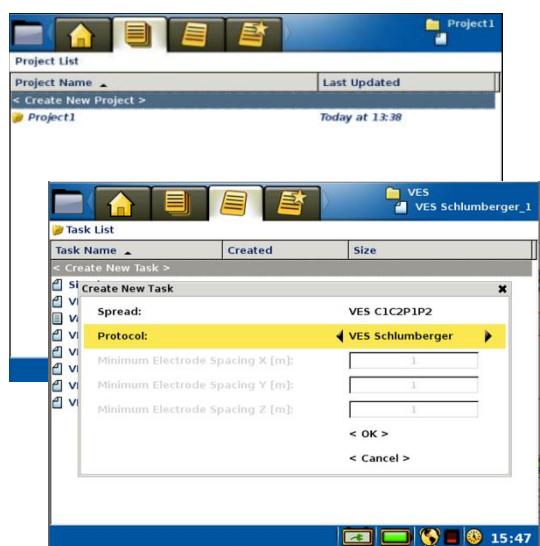
F9	= ABEM Active Guidance
F10	= Play/Pause
F11	= OPT
F12	= Power button
ALT	= Menu
TAB	= Browse
ESC	= Clear
ENT	= OK



PROJECT AND SETTINGS

A. Creating projects & tasks

- From the **Welcome** tab, use the **Browse** key to navigate to the **Project List** tab (one tab to the right).
- Select < Create New Project >. The **Task List** tab 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 **VES C1C2P1P2**.
- Protocol: Choose the required electrode array.
- The X, Y and Z boxes are greyed-out as VES protocols are written in absolute distances, and without a regular interval, so there is no need to define the electrode spacing.
- Select < OK > to exit pop-out window and automatically move to the settings tabs.

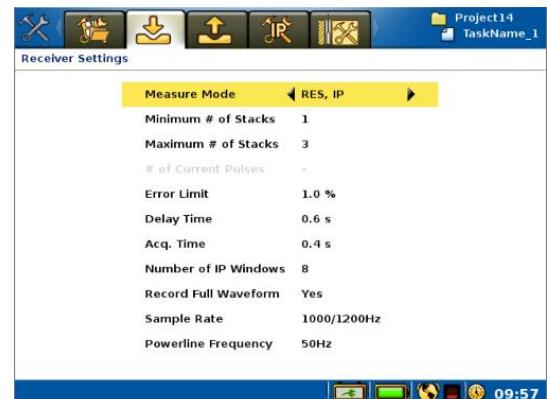


B. Receiver & transmitter settings

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

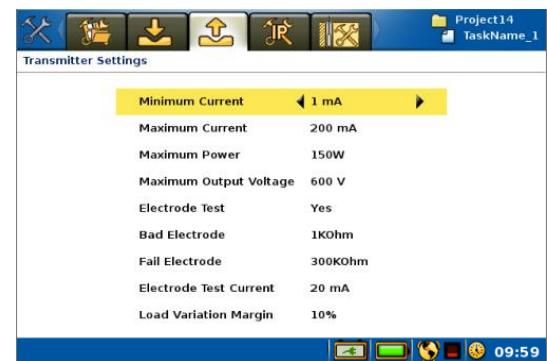
Receiver Settings

- o **Measure Mode:** Select desired measurement mode:
 - "Res" = resistivity measurements
 - "Res, IP" = resistivity and 50% duty cycle IP measurements
 - "Res, IP 100%" = resistivity and novel 100% duty cycle IP measurements. [VES MAX / 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. [VES MAX / Advanced models only]
- 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. [VES MAX / Advanced models only]
- 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

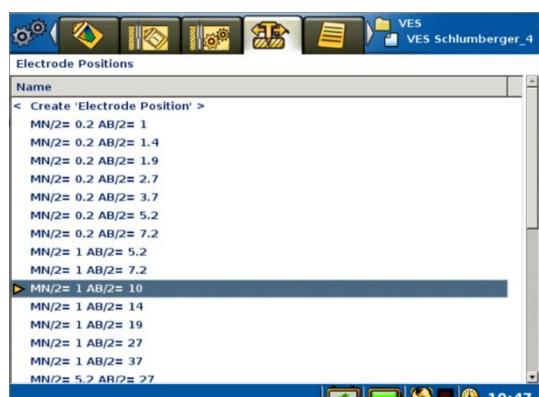
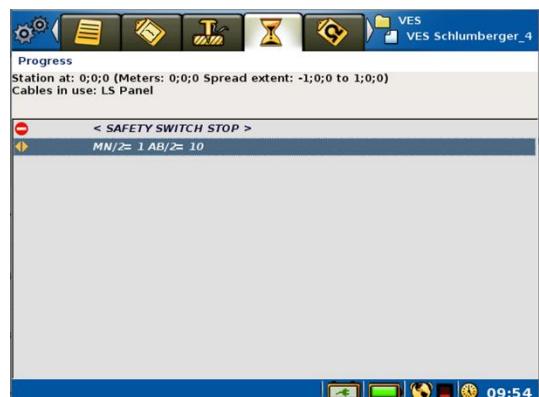
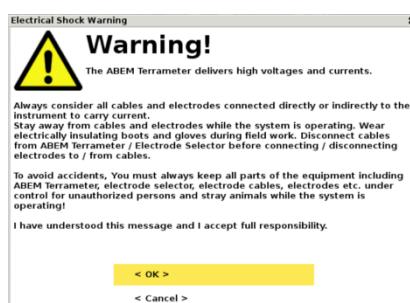
- o **Minimum & Maximum settings:** Maximum values limit the instrument output; minimum value does not force that much current to be used (actual value is ground conditions vs. voltage vs power), instead it shows a warning if current falls below this threshold.
- o **Electrode Test:** Choose "On" to test the contact resistance and connection of C1 and C2 electrodes.
- o **Bad & Fail Electrode:** Select threshold for classifying the electrode test result. Values below "bad" threshold count as a pass.
- o **Electrode Test Current:** Do not change.
- o **Load Variation Margin:** Defines how much the output voltage can vary during measurement to maintain constant current; set to 10%.



MEASUREMENTS

A. Measurement selection & start

- Navigate to the 'Progress' page; the **Play/Pause** key will shortcut to there. < SAFETY SWITCH STOP > indicates that the red stop button is in use.
- The **Left/Right arrow** keys will select a set of electrode positions from the protocol that was chosen during the Task creation.
- To view or edit the full protocol list, go to the *Electrode Positions* tab. You can select any of the listed positions, choose to create a new position, delete a position (**C** button) or save the new list (**OPT** button) for future use. **Play/Pause** returns you to the *Progress* tab.
- **Caution:** before beginning measurements, check the survey line and ensure the area is clear.
- Turn the red stop button until it pops out. Then either press the **Play/Pause** key or select < Start Measuring > and press **OK** to begin.
- A warning message will appear when you begin, select <OK> to accept and start the measurements.



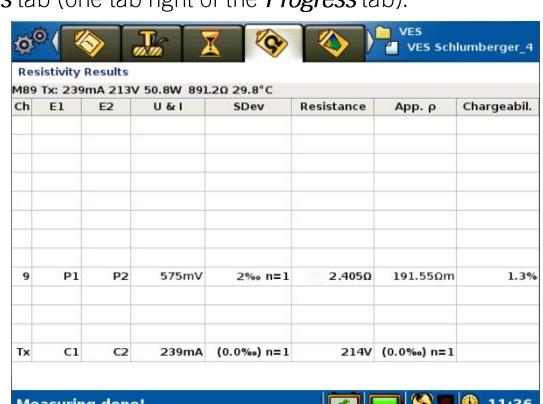
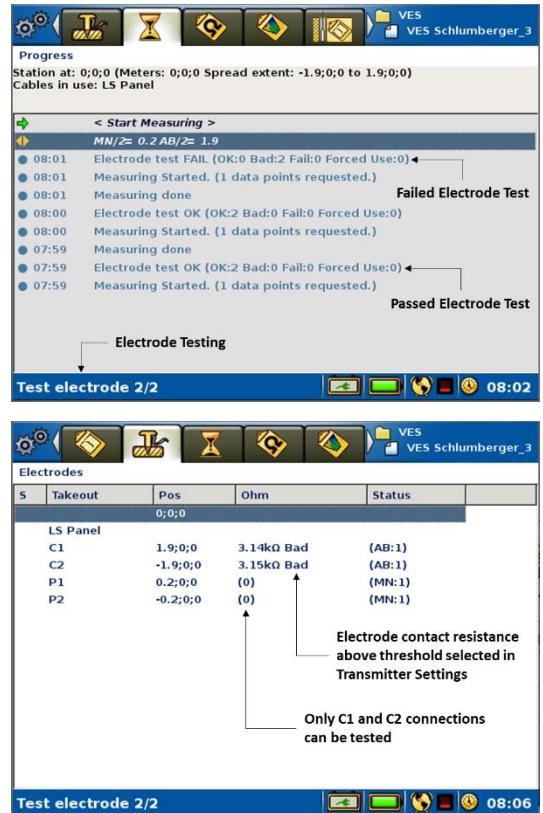
B. Electrode contact test

- The instrument will do an electrode contact test prior to taking a measurement (if the option was enabled in the Transmitter Settings) but, in VES mode, it can only test electrodes connected to C1 and C2 on the end-panel. However, ensuring low contact resistance on potential electrodes is not as critical as on current electrodes; the lower the P1/P2 contact resistance, the more accurate the measurement becomes but the high impedance of the input channels allows for good accuracy even with higher contact resistances. For current injection, as the contact resistance increases, the current flow decreases and thus the measurable signal and charging capability (when doing IP) also decreases. If it is still deemed necessary to test the contact resistance on all four electrodes, instructions are provided at the end of this section.
- Electrode Test Pass:** if both electrodes pass, the instrument will begin the measurement cycle automatically.
- Electrode Test Fail:** If the electrode test fails, the instrument will wait for further user instruction. The **Progress** tab 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 **Electrodes** tab (one tab left, press **Shift+Browse**). This tab provides a table detailing the connection point for each electrode (“Takeout”), the electrode locations (“Pos”) and the results of the electrode contact test (“Ohm”). The “Status” column describes how often each electrode will be used as a current injector (AB) or potential pair (MN) during the next round of measurements; as this is a VES survey, they are only used once during the active measurement.
- Take note of the C1/C2 contact resistance and decide whether it requires improvement or whether the values are acceptable to continue. If improvement is required, **push the red stop button prior to handling cables/electrodes**. Firstly check jumper wires are firmly connected and that the crocodile/alligator clip is firm. 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 the “Bad”, “Fail”, or “No Contact” electrodes. After a retest, the instrument will either begin survey or produce another fail message, when further improvements can be made.
- Note:** In some cases, it may be appropriate to ignore the result and ‘force use’ an electrode. This can be done from the pop-up menu (accessed by pressing the **OPT** key) by selecting “Use”. Any electrodes which are forced to be used, despite failing the electrode test, will have a “U” next to them in the left-hand “S” column.
- Follow this procedure if it is necessary to test all four electrodes:**
 - Connect the central potential electrodes to C1 & C2
 - Start a measurement and the electrode test will begin. If it fails, improve the electrode contact and start the measurement again. When the test passes, press the red Stop button on the end-panel of the instrument before it completes the measurement cycle.
 - On the **Electrodes** tab, press **OPT** and select “Clear all” to reset the test results and then put all four electrodes back to their correct positions on the end-panel.
 - Release the Stop button and start the measurement again, the outer two electrodes (which should now be plugged into C1 and C2) will be tested and the measurement completed if the electrode test is successful.

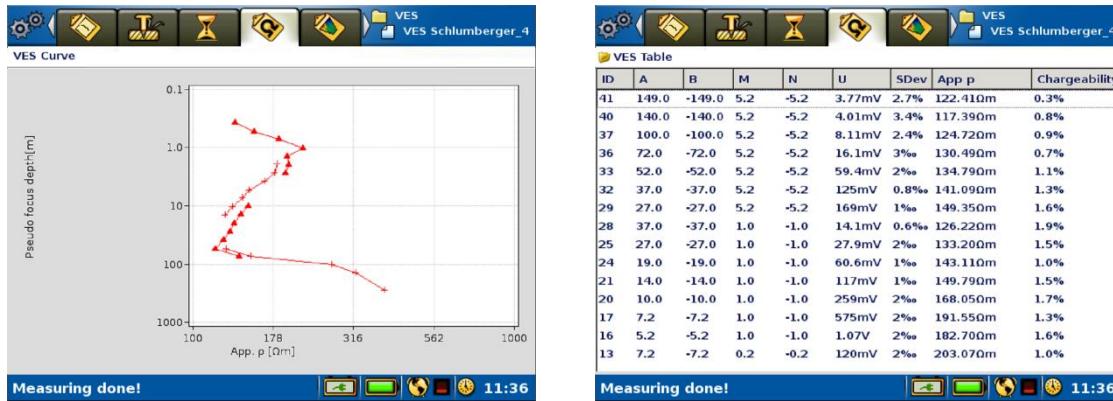
Testing the potential electrodes is only required when a new P1/P2 spacing is used, so using the Schlumberger arrangement limits the number of ‘double tests’ required.

C. Measurement progress

- To view results as they are collected, navigate to the **Resistivity Results** tab (one tab right of the **Progress** tab).
- The table displays measured voltage, normalized standard deviation (variation coefficient), resistance, apparent resistivity and, if applicable, chargeability 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 current and voltage.
- Watch for high standard deviations, excessive negative IP values and/or error messages that may appear during survey.
- If 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. Always “Try again” first, if this is unsuccessful, then investigate the electrodes, check the battery health and the instrument settings. If problems persist at multiple electrode positions, contact support.



- When measuring is complete, a “Measuring Done” message will appear on both the status bar and the **Progress** tab.
- To review all measurements made so far in the current task navigate to the **VES Curve** or **VES Table** tab.
- The **VES Curve** alternates between a cross and a triangle icon for data points every time the P1/P2 spacing changes.
- The **VES Table** lists all data with the most recent measurement first. Use the **Up/Down arrow** keys to scroll through the results; the screen will automatically refresh with the next set of data values when you scroll past the bottom of the initial list.



FILE MANAGEMENT

- The most effective way to download data is through the PC companion software ABEM Terrameter Toolbox, via ethernet or Wi-Fi connection. Refer to the *ABEM Terrameter 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* tab.
 - o Highlight the project and press the **OPT** key. A smaller pop-out menu screen will appear. Select “Export Project” (if greyed out, ensure the project is inactive and the USB device is in the USB port).
 - o Select < Yes > when prompted to export the project to the USB. **Note** The project database file is required for opening data in ABEM Terrameter 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.
 - o Highlight the task and press the **OPT** key. Select the file format preference, then select < Yes > to export.
 - o When data are downloaded, take out the USB memory device from the USB port.