Operation Manual

LIBERATOR SERIES

SWR & VNA Site Analyzer

Testing Made Simple!

Technology, Inc.

AEA Technology, Inc.

Testing Made Simple

Proprietary Information

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409 cleaner is a registered trademark of Clorox Corporation

6050-3020 January, 2019

WARNING

DC Charging Port and A/C Adapter

Charging the Site Analyzer or operating while using the A/C or D/C adapters can create external sparks during connection. Connecting or use of these power sources in an explosive atmosphere is dangerous and should never be attempted. Always charge the Site Analyzer away from any explosive atmosphere. Use ONLY internal battery power if the presence of explosive fumes is a potential hazard.

Coax Test Ports

The presence of any voltage, from an applied source or static build-up on cables or antennas, particularly vacant cables with no terminations or grounding, can cause an ignition spark when they are connected to the Site Analyzer. Caution should be taken to ensure cables are free of any voltages or static charge prior to connecting the instrument in a potentially explosive atmosphere.

The SWR Site Analyzer instrument is not to be used in critical applications where failure of the instrument or inaccuracies in data might cause personal injury or property damage. Use in such applications is not recommended.

Operating Precautions

1. The Site Analyzer should not be used on outdoor antennas if the potential for lightning exists. Wait until any lightning storm potential is well clear of your area before attempting testing on outdoor antennas, particularly those mounted on towers.
2. The Site Analyzer is designed for recharging NiMH AA cells only. Do NOT install and attempt to charge LiION cells as overheating or fire may result. The resulting damage is not covered under warranty.
3. Alkaline cells may be used safely in the Site Analyzer, but when installed go to the Battery Menu and change the Battery Type to ALKALINE or NONE to turn off the charger. Attempting to charge alkaline or carbon cells may result in the cells outgassing. The resulting damage is not covered under warranty.
4. The Site Analyzer, when in its Belt Case, is splash resistant and designed to work for relatively long periods in rain depending on intensity. It is not designed to be immersed in water. See Cleaning Instructions in the appendix.
5. The Test Port is limited to +22dBm input power. Power exceeding this level could damage sensitive input components. Vacant antenna leads can build a static charge and should be grounded to discharge them prior to connection.

The SWR Site Analyzer is designed to be safely operated in normal testing environments. If you have any questions concerning the use of the Site Analyzer or other AEA Technology, Inc. instruments please contact us at:

Tel: 1-800-258-7805 or +1-760-931-8979 or Fax: +1-760-931-8969
Email: techsupport@aeatechnology.com

Site Analyzer Literature Introduction

There are two literature items available for the SWR Site Analyzer:

Quick Start Guide is a laminated tri-fold held in the Belt Case's inside pocket. This provides a light-weight condensed guide to calibration, measurement functions and menus

Operator Manual is this printed instructional guide which has three purposes:

1. Gives a concise description of the instrument, keypad, menus and measurement screens.
2. Provides user instructions in more detail that the Quick Start Guide including a section on Measurement Information and Helpful Tips.
3. Provides specifications, troubleshooting guides, and accessories lists.

Both these items are also available on the enclosed CD in PDF format ready for printing.

NOTES:

1. In addition to digital files of this literature the enclosed CD also contains Site Analyzer PC Vision™ software and a training Power Point.
2. All these items and technical support is also available on our website:

www.aeatechnology.com

Table of Contents

1. Site Analyzer Description

AEA's Site Analyzer comes in two models, The SWR Site Analyzer Single port, and the VNA Site Analyzer Dual port. Both instruments are rechargeable battery powered, SWR and Return Loss meter with an FDR (Frequency Domain Reflectometer). The VNA Model in addition, features Vector Network Analysis (single and dual port) and Spectrum analysis. The SWR's primary use is for antenna systems testing. Secondary applications are for testing cabling networks, electronic components, etc. Any application calling for a portable SWR and Return Loss meter or an FDR from 100KHz to 1.5GHz. The VNA's measurement capabilities lends itself to in-depth magnitude and phase analysis of RF components such as antennas, resonant cavities, filters and the like. Further, it's spectrum analyzer function is used in applications where RF carrier level and frequency measurements are required.

The SWR Site Analyzer is capable of performing the following testing:

Standing Wave Ratio (aka Voltage Standing Wave Ratio-VSWR)
Return Loss
Frequency Domain Reflectometer (FDR) with measurements in either SWR or Return Loss

Additional features in the instrument are:

Cable Null – Removing the test lead or antenna cable's measurements from the attached antenna. Starts Broadband calibration.

Autotune – Find the best SWR or RL reading for an antenna in a selected frequency band.

Limit Lines – Set Pass/Fail limits for SWR, RL or FDR Screen to get a graphical indication of when your measurements are within the limits that you have selected

BroadBand Calibration – Calibrate once for full band width 100KHz to 1.5GHz and it is calibrated for all frequency ranges. This calibration provides a good level of calibration accuracy and the convenience of not having to recalibrate for every change in the frequency or span being tested.

Frequency Specific Calibration – This is the most accurate calibration, when precision readings are important. This mode will automatically trigger the recalibration cycle with any change in frequency or span. It is required for use with the FDR mode.

Memory – Saving and Recalling test results and settings (calibrations)

Rechargeable NiMH batteries (installed and preconditioned)

Full color QVGA Display. User can choose color scheme

Saves Current Operation and calibration data on power down

HELP includes: Measurement Screen navigation and setup guidance

Contact Sensitive Help – From any Menu item selected or highlighted, pressing Help will provide guidance for that specific item or function being performed.

USB-2 Communications Port

SWR Site Analyzer PC Vision™ Software

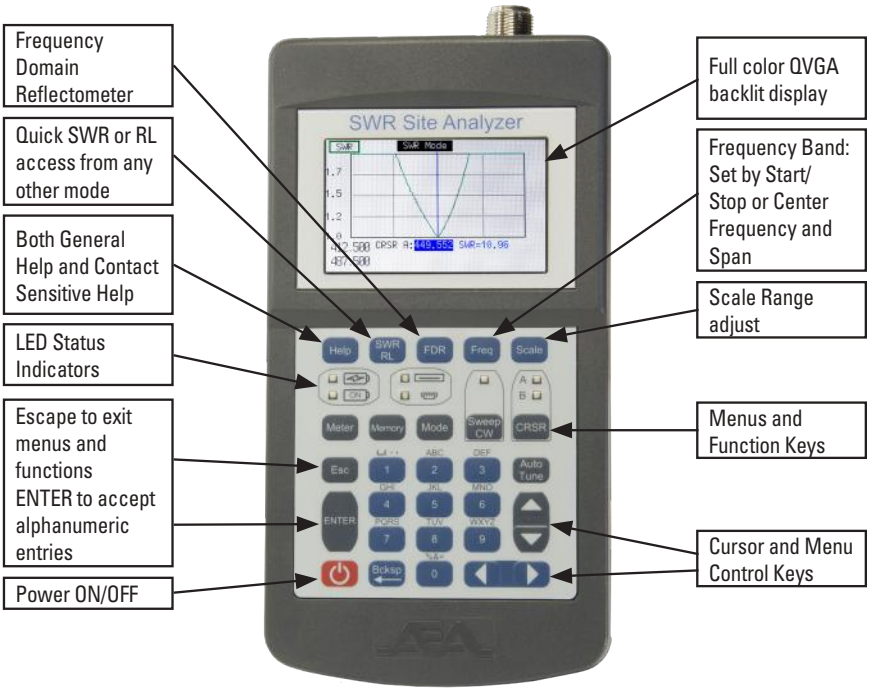
In addition to all of the above, the VNA Site Analyzer is capable of the following tests:

Vector Network Analysis - Single port (S_{11}) impedance analysis, measurements including Impedance Magnitude, impedance angle, resistance, reactance, rho, theta.

Dual-Port (S_{21}) Insertion Loss - Insertion loss ($|S_{21}|$) and phase response analysis of any passive two-port network. Scalar-only measurement also available, utilizing the S_{21} Tracking feature.

Spectrum Analyzer - Classic amplitude-vs-frequency RF spectrum display.

Instrument Layout



Not shown on the back is a desktop stand and battery compartment

SWR/RL Model Top End

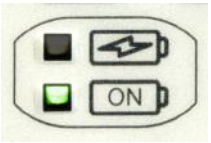
VNA Model Top End

For complete specifications refer to Appendix A.
For a complete list of accessories refer to Appendix B or visit our website at:
www.aeatechnology.com

Keypad Operations

The ON/OFF key is used to power the instrument on and off. There are different ON/OFF sequences; Normal for starting with using the last settings at power down or Soft Reset for starting with default settings. There are two different power down sequences as described below the Power ON:

POWER ON – Press the ON/OFF key for one second.
A splash screen with AEA Technology's logo and Version information will appear for several seconds. It will then open to the testing being used at the time it was normally or automatically powered down.



Keypad Power ON indication: LED lit

NORMAL POWER DOWN – From any Measurement screen, Press and hold the ON/OFF key for one second only. Power Down sequence will start within one second later. This power down sequence saves all the settings for resuming testing on the next Normal Power On press. The BATTERY SAVER Auto-Power Down is a normal power down and saves all the settings also.

HARD POWER DOWN – Press and hold the ON/OFF key for ten seconds. This forces the Site Analyzer to shut down and should be used if:

A. The unit will not power down with a Normal Power Down (1 second hold of the key).
B. If the Site Analyzer is not performing correctly, menus or cursor keys do not work, or the measurement screen does not appear correctly formatted.

NOTE: A Hard Power Down will NOT save the current settings as their data/data corruption may be causing the firmware issue. If a Hard Power Down needs to be executed the next power on should be the Soft Reset procedure to perform firmware housekeeping and restore normal operation.

Soft Reset steps:

1. With the Site Analyzer OFF, Press and hold the ENTER key
2. Press and release the ON/OFF key to power the Site Analyzer ON.
3. After power comes on... (~1 second) release the ENTER key
4. Display will allow you to confirm reset to factory default settings.
5. When Measurement Screen appears you can recall a saved setting or set desired settings

Menu Keys:

and


Refer to Section 2. Menus

Function Keys:

The Help key has two modes of operation; First, if no function keys are active (CRSR, FREQ, etc.) and no menus are open, pressing Help will open the help information for the displayed Measurement Screen. This includes help with navigation in the screen and adjusting Frequency or Scale ranges. Second, when a menu is open or a function key is active Context Sensitive Help will open and provide instructions and options that address that particular open or highlighted menu item or function.
Using the Help key is a great tool for getting started, refreshing your memory on how things work.

Press the SWR/RL key from any other mode of operation to go directly to one these measurement modes, or press as desired to alternate between SWR and Return Loss modes. See section 3 Measurement Screens for information on cycling modes, setup, and scales.

Press the FDR key to enter the Frequency Domain Reflectometer mode of operation. See section 3 Measurement Screens for information on cycling readings modes, setup, and scales.

Press the FREQ key to set frequency band of interest. There are two types of setting screens for this operation:

A. Press once to enter START and END FREQUENCIES.
B. Press twice to enter CENTER FREQUENCY and SPAN.

Use the left/right arrow key to navigate digit positions, the alpha-numeric keypad to enter values, and up/down arrow key to jump between upper and lower entries. Press ENTER key to save changes and exit. If Broadband Calibration is selected it will go directly back to the Measurement Screen. If Frequency Specific Calibration is selected it will exit to the Calibration procedure.

The Scale key is used to cycle through preset vertical scales on the measurement screens. SWR, RL and FDR have only one scale on the left side of the plot. Repeated presses will present the next scale range in the cycle. See Section 3 Measurement screens for more information on selecting and changing Scales.

The Sweep/Continuous Wave key will switch the modes between them. The LED indicator flashes when the instrument is sweeping the selected band or transmitting the center frequency.
Sweep is the normal mode performing frequency sweeps from low to high frequency selected and measurements appear in graphic plots. Continuous Wave mode stops the Sweep mode and only emits a **continuous wave** at the Center Frequency. This changes the graphic plot to a list of tests showing digital value responses. The Continuous Wave mode is useful when the antenna or other DUT is being tuned or adjusted. In CW mode, measurements refresh at a faster rate than in Sweep mode.
See section 3 Measurement Screens for information on setup and cycling through the readings list. To exit Sweep/CW, press SWR/RL or FDR to enter those modes.

The CRSR (Cursor) key is used to activate Cursor A or both A & B Cursors with a second press of the key. Cursors are controlled as follows:

A. Single cursor with data on screen. Cursor A LED lit. Use the left/right arrow key to move the cursor. Readings will automatically update to cursor's position.

A & B. Press the CRSR key a second time to add the B cursor. Both A & B Cursor LEDs will be lit. Dual cursors will display on screen with cursors' differential reading (CRSR Δ) below Cursor B. The active cursor will be the last CRSR summoned with the CRSR key and the left/right arrow key will control that cursor. To alternate between the Cursors A & B to change which cursor is active, press the CRSR key as needed. Exit cursors – Press the ESC key once to exit Cursor B only or reduce to Cursor A only and twice to exit both cursors.

The Escape key has the following uses:

A. Exits menus or backs up one menu level saving any changes.
B. Exits the cursors as described above.
C. In HELP mode, ESC closes the on-screen HELP window and returns to either the Measurement Screen or the menu or function where it was pressed to continue what you what operation you were doing when HELP was pressed.
D. In Memory Save or Cable Null, Escape cancels the process prior to completion.
E. See on-screen prompts about using ESC to complete the current operation.

The ENTER key has the following uses:

A. In any measurement screen with a highlighted testing parameter, it will either cycle through that parameter's presets or exit to data entry screen like FREQ for example.
B. Saves alpha-numeric entries and moves to the next step.
C. In Menus the ENTER key activates the highlighted Item.

The AutoTune key works slightly differently in SWR/RL and in FDR mode, but in both cases it only functions with one or both cursors enabled. In SWR and RL, pressing AutoTune will cause the selected cursor to seek to the LOWEST point on the graph. In FDR mode, (again, with one or both cursors enabled) AutoTune will cause the selected cursor to seek to the HIGHEST point on the graph (not including the leftmost 2% of the display).

The up/down arrow key has the following uses:

A. In the menus it moves the highlight cursor to a desired item on the vertical menu list. In Cable List and Memory Recall it moves highlight up or down one cable type or Saved Test at a time.
B. In the measurement screens the UP arrow moves the highlight between scales or other measurement parameters to make changes to that parameter.
C. In the date/time menu it is used to cycle through the day, month, year, or time settings.

The left/right arrow key has the following uses:

A. When in the measurement screen with cursors enabled, it moves the active cursor left or right in the plot.
B. When in any alpha-numeric settings (FREQ, date/time, Memory save, etc.) it changes digit position for character entries.
C. In the menus it changes the options (horizontal menu) for highlighted items in the vertical menu.

NOTE: See section 3 for Menu Navigation, Screens' Vertical and Horizontal menus.

The alpha-numeric keypad operates like those on smaller cell phones. Press a selected key once for entering the number and repeat the key's presses to cycle to the character desired above that key. In an alpha entry screen the first press will present the first alpha character above the number. Subsequent presses will cycle the alpha characters and finally the number or use the Up or Down arrow to cycle through the entire characters set

A. The squared U ␣ above the 1 key is a space.
B. There are more than just the 3 special characters shown above the 0 key. Continued presses will cycle through them on screen for selection.
C. Bcksp = Backspace to erase the character to the left of the entry cursor.
D. Bcksp key in the Memory menu will erase the saved test result or setting.
CAUTION – There is NO UNDELETE. Once a test result or setup is erased it is permanently deleted.

Battery Charging and Cell Replacement

General information

The Site Analyzer is powered by 8 NIMH AA cells that were installed and conditioned at the factory as part of the manufacturing and testing process. New and fully charged they will provide about 4 to 4.5 hours of continuous operation. Variables that affect battery operating time are:

A. Backlight setting: Recommend use MED backlight. See Meter Menu to to select backlight and change this setting. If HIGH backlight is used it will reduce operating time.

B. Frequencies being tested: Higher frequencies consume more power and will reduce battery operating time

C. Outside temperature: temperatures in the testing environment that are too hot or too cold can affect battery operating time. This is also true during recharging. If recharging in a very cold environment (below 32ºF or 0ºC recommend leave the instrument in the Belt Case during charging to help the cells hold their temperature. If recharging at room temperature (72ºF or 22ºC or above recommend removing the Belt Case to help the cells stay cooler during recharging. If the charger detects the cells are below 32ºF or 0ºC or they become too warm it will not attempt to charge them. If the cells become too warm during charging the charger will automatically shut off and the charging LED on the Keypad will turn off to indicate charging has been aborted. This is not a normal situation, but can happen if the cells have been in use for awhile and already warm from discharging and the charger is plugged in immediately. There is NO fire hazard with NIMH cells, but the cell's chemistry will not accept a charge above a certain temperature, so the process is aborted and must be restarted by unplugging the charger's AC or vehicle adapter, wait 30 seconds, and plug the adapter back in. This should restore the charging LED to lit or blinking status. See the chart below for the Keypad's Charging LED status.

Low Battery Warnings:

30 Minutes ERT: A warning window will open indicating the Estimated Run Time is at 30 minutes or less. This is a good time to save any test results and/or plug in the AC adapter to continue testing and start a slow recharge.

Battery Icon: This icon will appear on the Measurement Screens to remind about the limited battery operational time remaining.

Final warning: a message will appear on screen indicating 20 seconds or less remaining battery operation time.

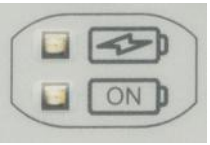
Auto-Shut-Down: The Site Analyzer will automatically power down below a set battery voltage and will not power on again normally until either the unit is recharged, the AC adapter is plugged in, or the battery cells are replaced with a fresh set of cells.

Battery Charging

The NIMH cells can be recharged using the AC adapter (included) or optional vehicle adapter. Using the AC adapter is the preferred method and charges faster. The vehicle

adapter will charge or operate the Site Analyzer, but not both. A vehicle's DC power may vary from one vehicle to the other, but generally puts out about 12.5 to 14 volts when the vehicle's engine is running. The AC adapter's input can accept 90-240VAC 50-60Hz, output is 15VDC at 1200mA. Full charge power is about 700mA @ 15VDC.

Charger LED Status



When unit if off the top LED will indicate the Charger's status as follows:

OFF – No charging power in or charging aborted due to charging error; cells to warm or cold to take a charge is one cause for abort. Others causes include: one or more cells with incorrect polarity (installed reverse). Battery Menu has Alkaline cells or None selected which turns off the charger. Dirty or corroded cell contacts and depleted cells will also cause an abort condition. In all cases, an aborted charging should be investigated by opening the battery compartment and search for any of the above listed conditions and perform corrective action before attempting to charge the cells again.

Slow, Short blink - Battery check mode. The charger is 'PINGing' the batteries to check chargeability status. Battery Menu-CHARGER STAT: Prechg.

Slow, Long blink - Charger is in slow charge. If the unit is ON, this is the highest rate it will charge. Battery Menu- CHARGER STAT: Slow Chg

Double blink: Charger is in rapid charge mode. (about 700mA at 15v). Battery Menu-CHARGER STAT: Rapid.

ON solid – Batteries are 90%plus charged in Trickle Charge to top off. Unit is ready for use. Battery Menu- CHARGER STAT: Trickle Chg.

To check the percent of battery charge turn the Site Analyzer ON, press Meter Menu and note the Battery Menu line will display the percent of charge in lieu of Estimated Run Time (ERT). If you enter the Battery Menu the Charger Status can be read in that menu. NOTE: turning on the Site analyzer will reduce charging mode to slow charging to prevent overheating the cells. The charging LED will go to Slow Long Blink mode until the Site Analyzer is turned OFF again.

Alkaline Cell Use and Cell Replacement Instructions

Alkaline cells 1.5V AA size can be used to power the Site Analyzer. Normally this would only be in the event the NIMH cells charge is too low to continue and there is no access to AC power or vehicle power to continue testing. NOTE: if you have 8 new NIMH cells available they may require charging and charge conditioning prior to being useful.

Battery Replacement Instructions

Preliminary: First ensure you have replacement cells on-hand, either 8 AA NIMH or 8 AA Alkaline cells. CAUTION: Mixing of cell types is highly inadvisable, and can lead to faulty operation. Only use cells that are all of the same type and voltage.

Steps:

1. Remove the Belt Case, turn the Site Analyzer OFF and remove any external power and/or antenna or other DUT and place the Site Analyzer face down on a clean padded surface.
2. Lift the tilt stand to reveal the two battery cover screws and use a number 1 Philips screwdriver to remove them.
3. Lift the battery cover and stand to expose the cells. DO NOT REMOVE the RETAINING BAND across the upper four cells.
4. Remove the lower cells and slide the upper cells under the retaining band down to a vacant location to remove them. If installing AA alkaline cells as a temporary powering measure, be sure to place the NIMH cells in a plastic bag and save them for re-installation and re-charging. If the NIMH cells are being replaced due to end-of-life cycle, please consult your local regulations concerning hazardous waste disposal. DO NOT PLACE NIMH cells IN THE TRASH.
5. Inspect the battery case for any signs of outgassing (white or blue/green corrosion) on the contacts or in the battery case. If any is found use a cotton tipped swab and alcohol to clean the battery compartment and contacts thoroughly and dry before installing any new cells. Instrument damage due to outgassing cells is NOT a manufacturer defect and repair is NOT covered under our warranty.
6. Install the 8 replacement AA cells being sure to follow the battery polarity markings stamped in the battery case. Remember they MUST all be the same type either alkaline, or NIMH, DO NOT MIX CELL TYPES, Li-Ion batteries ARE NOT SUPPORTED.
7. Replace the battery cover and stand bale and ensure it seats back on the back case correctly. NO force should be required for correct seating.
8. Re-install the two retaining screws. Tighten snuggly, but do not over tighten.
9. If alkaline cells were installed, Turn on the instrument ON and press the Meter Menu key, select Battery Menu, then select Battery Type: and use the arrow keys to change to Alkaline. This is important to turn OFF the Battery Charger and prevent accidentally applying charging voltage to alkaline cells which could cause outgassing of the cells and become hazardous.
10. If removing alkaline cells and re-installing NIMH cells, Turn ON the instrument and press the Meter Menu key, select Battery Menu and, then select Battery Type: use the left/right arrow key to change to NIMH to turn the Battery Charger back on. This will re-activate the Battery Charging circuit. Lithium cells of any type use a different charging process and are NOT to be used in the Site Analyzer at any time.
11. Conditioning New NIMH cells: When a new set of NIMH cells are installed they will need to be conditioned before the Battery Menu can present valid Estimated Run Time (ERT). Conditioning requires performing up to two deep discharging and full recharging cycles (recommend charge overnight for full charge). The cells supplied by our production facility where pre-conditioned at the factory, However, new cells purchased as replacements have an unknown shelf time and condition and will require conditioning so they charge and discharge in a consistent manner.

2. Menus

Menu Navigation

Menus contain two types of lists; vertical list is the one you can see all items available and horizontal lists that only show the selected item's options; mode or value. The other horizontal selections are hidden. Navigation is accomplished as follows:

A. Use the UP/DOWN arrow keys to select (highlight) the desired item in the vertical menu list
B. Then use the left/right arrow keys to change the highlighted item's current setting and scroll through the options. Some setting lists (horizontal menus) are as simple as ON or OFF options, others are longer lists like the Color Schemes with 16 colors to choose from for each item on the list.
C. Use the ENTER key as indicated to call a sub-menu of selections. Navigation in sub-menus works the same.
D. When selections are completed, use the ESC key to save and exit the menu. Sub-menus, if any, exit back to main menu and main menu exits back to measurement screen.

The Meter Menu provides for control of the instrument itself. It has direct action items that when highlighted and the left/right arrow key is pressed changes the current setting to the next item in the horizontal menu. Below is a list of items and their options:

BACKLIGHT:	LO, MED, HI (recommend MED for best light with less battery power consumption)
COLOR SCHEME:	Press ENTER to open sub-menu
KEYPAD BEEP:	ON or OFF
UNITS:	FEET or METERS
BATTERY MENU:	Press ENTER to open sub-menu (also shows batteries' % charging or ERT- Estimated Remaining Time on battery power)
DATE/TIME:	Press ENTER to open sub-menu
	Press ENTER to exit and save changes in Meter Menu

Meter Menu's Sub-Menus

COLOR SCHEME

TRACE A – 16 color list (use left/right arrow key to select)
TRACE B – 16 color list (use left/right arrow key to select)
CURSOR A – 16 color list (use left/right arrow key to select)
CURSOR B – 16 color list (use left/right arrow key to select)
MENU TEXT – 16 color list (use left/right arrow key to select)
BACKGROUND– 16 color list (use left/right arrow key to select)

Note: Menu Text and Background are linked so the same color can NOT be used for both. This ensures that the instruments menus will always be visible.

BATTERY MENU

BATTERY SAVER:	ON or OFF
BATTERY TYPE:	NONE, NI-MH, or ALKALINE
BATTERY MA-HR:	2300
EST. REMAINING TIME:	4.5HRS or
EST. Chg:	60.7% (only if charging) ERT: (if operating on battery power)
BATTERY STATUS:	11.5V, -479MA (voltage & pwr draw)
CHARGER STATUS:	OFF, PRE Chg, Slow Chg, TRICKLE Chg

Notes: 1. First three items are only items user changeable as follows:

BATTERY SAVER – ON (will automatically power down in 5 minutes after last key press). This is a normal power down and all modes and set-ups are saved and recalled on powering back up. Not recommended when working with Site Analyzer PC Vision software. Auto power downs will interrupt communications between the PC and Site Analyzer.

BATTERY TYPE – NONE & ALKALINE (turns the battery charger system OFF). NIMH & turns charger on.

BATTERY MA-HR – Can be changed if new rechargeable cells are installed with a different MA-HR rating. This adjusts the charger and estimated run time (ERT).

BATTERY STATUS – Cells total voltage and either negative mA when discharging to power the unit or positive mA to indicates the amount of charge being applied to the cells. Fast charging (~700mA) can't be seen as unit must be ON to view this screen. Only Slow charging is used when unit is ON to avoid overheating the cells.

CHARGER STAT: Chgr Off – No input power or Battery Type: Alkaline or None is selected, or charging has been aborted.

2. Abort Causes: Battery Check found errors: Alkaline cells detected, reversed polarity on one or more cells (installation error), Depleted cells can't be charged, cells too cold or too hot to take a charge. The later can occur during the charging process as the batteries become warm during charging. Recommend charging without the Belt Case on to improve cooling and possibly moving to a cooler location or use a fan to assist in cooling, before restarting the charging process. NOTE: If charging overnight/unattended and the Charge LED is out when you return the charging process is incomplete due to an abort condition. This requires finding the source/ cause and taking corrective action before restarting the charging cycle. First turn the Site Analyzer on, press Meter Menu, then select and enter Battery Menu. If BATT STATUS: is 10 or more volts, Site Analyzer will likely operate for 3 plus hours before needing charging. If battery status is less, search for the condition causing the abort, take corrective action, and continue the charging. If the Site Analyzer is needed for immediate use, recommend replacing the NIMH cells with a fresh set of 8 AA alkaline cells to get 6-7 hours continuous performance.(See Section 1, Battery Cell Replacement for instructions) Save the NIMH cells to re-install and attempt recharging again. Try observing/checking of the charging process to see when the charger aborts and troubleshoot the cause.

DATE/TIME MENU

Date: 17 MAY 2017
Time: 09 35
AM PM or MIL

Notes: Use LEFT/RIGHT arrow keys to highlight data to be changed. Use UP/DOWN arrow keys to modify a data field.
Press ENTER to exit and save changes in Date/Time Menu. Exit will go up a level to Meter Menu, press ESC to exit to Measurement Screen.

The Mode Menu contains a list of the following modes. Use UP/DOWN arrow keys to select (highlight) desired mode and LEFT/RIGHT arrow keys to select options in horizontal menu list or use ENTER to go to a submenu when indicated.

MODE MENU (SWR Single port unit)

CALIBRATIONS:	BROADBAND, FREQ SPECIFIC
CABLE NULL:	<ENTER> (opens a submenu process)
SWEEP TIME:	1SEC, 500ms, 250ms, 125ms, 62ms, 31ms, 15ms, 8ms
SWEEP ON/OFF:	ON, OFF
LIMIT LINES:	ON, OFF
LIMIT SETTINGS:	<ENTER> (opens a settings dialog box)

MODE MENU (VNA Dual port unit) see section 5

CALIBRATIONS: If BROADBAND is selected, that calibration, along with any test lead and/or adapters desired is performed for the Site Analyzer's entire frequency range of 100KHz to 1.5GHz (See Section 4 for procedures). After that, any frequency range can be selected without having to re-calibrate. This form of calibration will provide moderate accuracy and the convenience of not having to recalibrate for each frequency or bandwidth change. For the most accurate measurements select "Frequency Specific".

FREQUENCY SPECIFIC This calibration mode will require recalibration with any change in frequency or bandwidth (Span). In this mode, the Site Analyzer will automatically go to the calibration screen prompts when any frequency changes are entered. The measurements, however, will be more accurate than using Broadband Calibration.

CABLE NULL: This is used to perform the Broadband calibration, and can be used with or without a test lead and/or adapters attached. It will display a series of calibration screens prompting the user to attach the Open, Short, and Load Terminators in turn. Press ENTER for each one to complete the process. The Open prompt can use the open end of the test lead, adapter or instrument's N connector. Attaching an Open Terminator is optional, although recommended for testing above 700MHz. Once this process is complete, the calibration data is stored, and the instrument will be placed in BROADBAND calibration mode. See Section 4 for more information on calibration steps. For best results allow unit to warm- up 5-10 minutes and use precision 3 way Open Load and Short.

SWEEP TIME: Sweep Time can be adjusted as desired for the best measurement results. Fastest is 8mS to slowest 1 second. Select desired time using the Left/Right Arrow keys.

SWEEP ON/OFF: Use the Left/Right Arrow keys to turn the Sweep ON or OFF. When Sweep is on the frequency band selected is constantly being swept. The Sweep/CW LED will blink indicating that Sweep is ON. Sweep ON can consume battery power more rapidly. Turning Sweep off stops the sweep, turns off the Sweep/CW LED and conserves battery power. This is a recommended mode when working at the PC with Site Analyzer PC Vision software and not performing live bench testing. Not only does it stop transmitting a frequency sweep, but saves battery power. It may also be useful in some environments to stop transmitting a potentially interfering frequency band when not connected for testing. Be sure to turn Sweep back ON before starting calibration or testing.

LIMIT LINES: Pressing <ENTER> with this menu item selected, turns the limit lines ON and OFF.

LIMIT SETTINGS: Pressing <ENTER> here will bring up the Limit Line Parameters dialog box, where you can enter or edit the parameters for the limit lines. See page 26 for details

The Memory menu is for saving and recalling test results and settings to/from the Site Analyzer's internal memory.

MEMORY OPERATIONS

DATA SAVE – (Press ENTER to open a screen to enter the test result file name, then save it in memory)

DATA RECALL – (Press ENTER to open a list of saved test results to select and recall)

SAVE SETTINGS – (Press ENTER to save the instruments current operating state. You will be prompted to enter a name for the .SET file)

RECALL SETTINGS -- (Press ENTER to open a list of saved instrument setting files)

NOTE: When SAVE SETTINGS is invoked, the entire instrument state is saved- This INCLUDES the current calibration, if FREQUENCY-SPECIFIC calibrations are in use! These appear as files with the .SET extension.

When test results are recalled via DATA RECALL, the stored trace is displayed on screen. Press ESC to return to the MEMORY menu.

When you are done with MEMORY operations, press ESC to exit Memory Menu.

3. Measurement and Support Screens

General Information

The SWR Site Analyzer has the following screens:

Measurements:
SWR – switchable via repeat presses of the SWR/RL Key
Return Loss – switchable via repeat presses of the SWR/RL Key
CW Mode – Continuous Wave mode
FDR – Adjustable range, frequency, VF, SWR or RL readings.

Support:
Frequency Setting – Both Start-End and Center Frequency &
Bandwidth (Span) Screens
Frequency Specific Calibration Screens – Calls a series of Prompt screens to attach the Open, Short, and Load Terminators, followed by using ENTER to process calibration data for each terminator. After processing the Load Terminator the calibration process is completed and the Site Analyzer returns to the selected measurement screen.
FDR's support screens:
VF= Velocity Factor Screen (Cable List or new entry)
ΔF= For cable's display distance entry and Return Loss Center Frequency
NOTE: Always set the VF first then ΔF= settings last.

CABLE NULL – Calls a series of Prompt screens to attach the Open, Short, and Load Terminators, followed by using ENTER to process calibration data for each terminator. After processing the Load Terminator the calibration process is completed and the Site Analyzer returns to the selected measurement screen.
NOTE: Cable Null can be used to perform the calibration process with or without a test lead, antenna feed line, or adapter attached. If a Test Lead and/or adapter is attached those items are calibrated with the instrument and MUST be attached to all measurements using that calibration. If no test lead, antenna feed line, or adapters are attached at calibration, only the Site Analyzer will be calibrated through to the N connector and any items attached after that will be part of the measurements.

Measurement Screens
In general all the measurement screens provide either a graphic representation of the measurement parameter(s) selected (Sweep mode) or a fast changing digital readout (CW mode). The support screens are designed for entering various settings (ie. Frequency, VF, etc.) or saving and recalling test results from the memory.

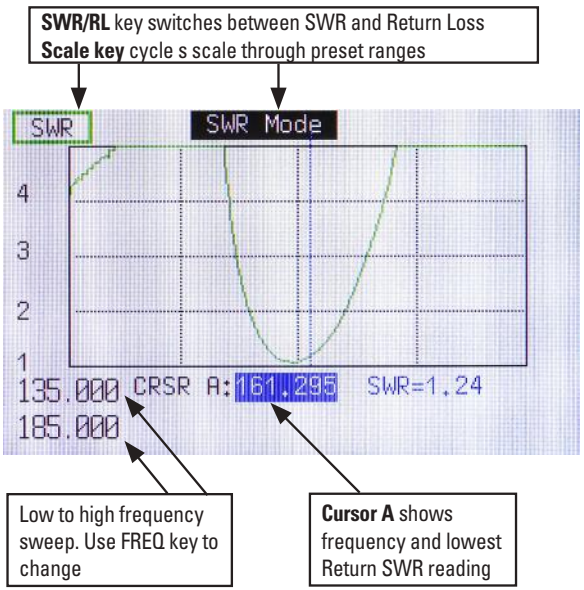
Scales can be changed by pressing the UP arrow key to highlight the desired measurement parameter, then press the Scale key repeatedly to selected the desire preset scale. In the case of SWR or RL there is only one scale on the left, so the Scale key can be used at anytime to adjust the measurement screen's SWR or Return Loss scale.

Cursors can be used to get exact frequency points, measurements, or FDR distances by pressing the CRSR key. Control of the cursors is via the LEFT/RIGHT arrow key. When both A & B cursors are selected a CRSR Δ (differential) reading will appear below the B cursor. To switch the active cursor between A or B press the CRSR key again. The LEFT/RIGHT arrow keys will move the active cursor only. Holding the LEFT/RIGHT arrow keys will increase the cursor movement speed.

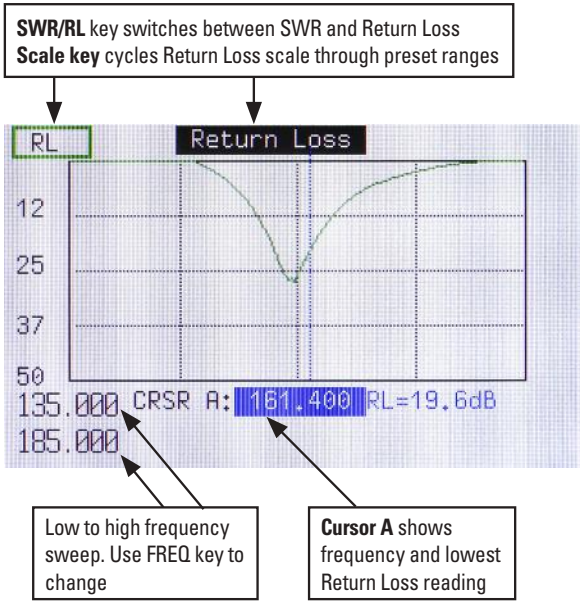
NOTE: When Cursors are active the high frequency display on the right of the plot will shift to under the Low frequency display on the left of the plot to make room for Cursor data.

Other parameters can be changed by pressing the UP arrow key repeatedly to cycle the highlight to the desired parameter. Then press the ENTER key to cycle to the desired preset or ENTER may cause an exit to a setting screen as with FREQ.

SWR Screen

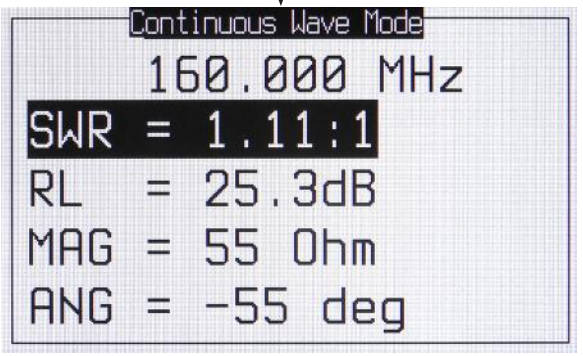


Return Loss Screen



CW – Continuous Wave Screen

Sweep/CW key opens this mode
Center Frequency is at the top
Use FREQ screen to change frequency
UP/DOWN arrow keys scroll through 2 pages of results
Press Sweep/CW key again to exit to last testing mode
(Sweep mode will be restored upon exiting).

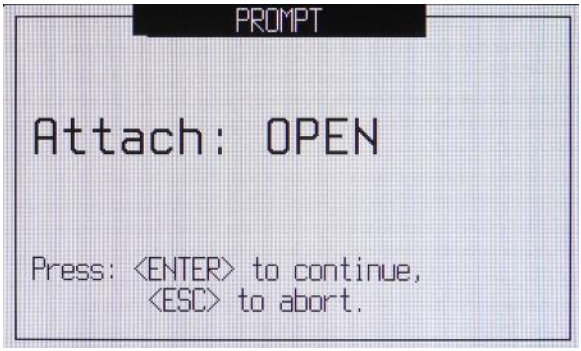


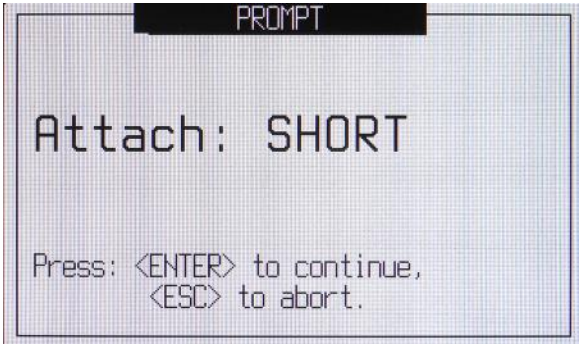
When the Site Analyzer is in Continuous Wave mode, only the Center Frequency will be transmitted. Eliminating the Swept Frequency eliminates the need to graph the results and only the values at Center Frequency are posted as a digital result. This permits faster viewing of any changes during antenna or DUT tuning being performed. To exit press the **Sweep/CW** key again to return to the previous testing mode and the swept measurements will resume.

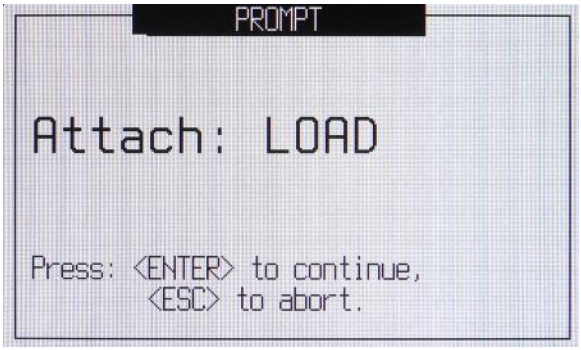
Cable Null Screens

The Cable Null function opens a series of screens to "Calibrate" the attached test lead, antenna feed line and/or any adapters along with the instrument to remove them from the measurements. It can also be used to perform an instrument only calibration by attaching the required terminators directly to the instrument's N connector. If this type calibration is used, any adapters, test leads or antenna feed line will be part of the measurement test results which may or may not be desired.

Calibration Sequence Screens

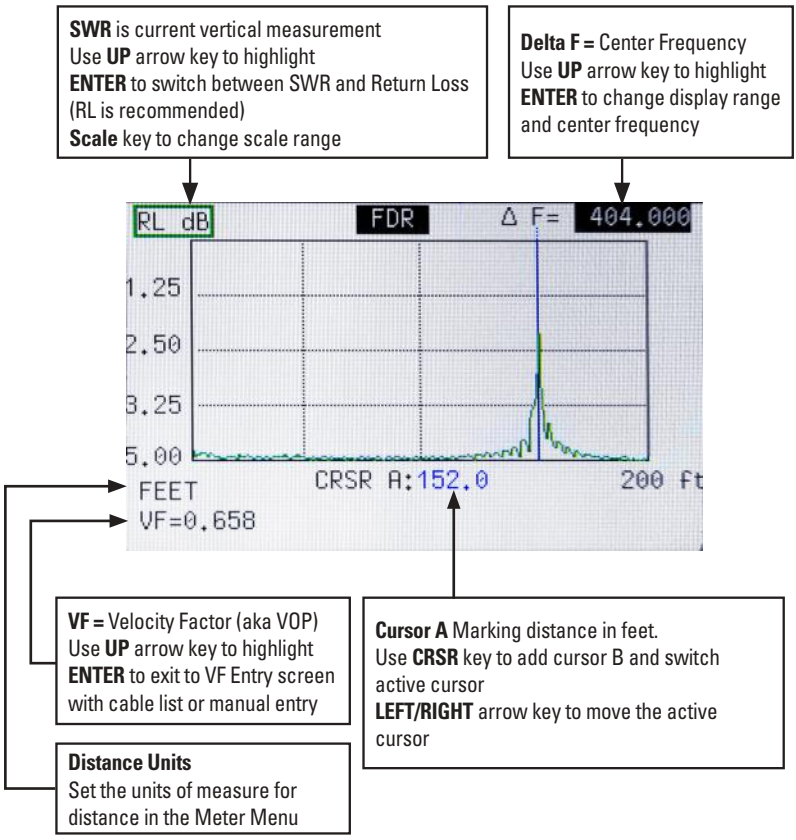






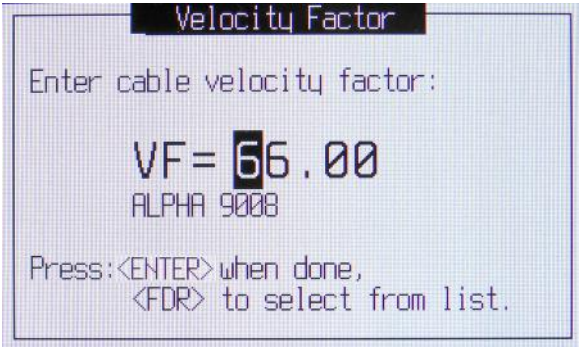
Pressing ENTER after the Load is attached completes the calibration process and will return the Site Analyzer to the previously selected measurement screen. Pressing <ESC> Goes to un-calibrated measurement screen.

FDR – Frequency Domain Reflectometer Screen

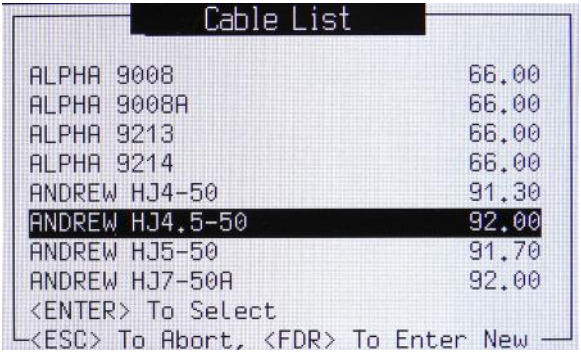


NOTES: 1. Always set Cable's VF FIRST
2. Always set the Cable Length's display range to a value longer than the known or estimated cable length (at least 10 to 15% longer). This avoids false end of cable distance readings.

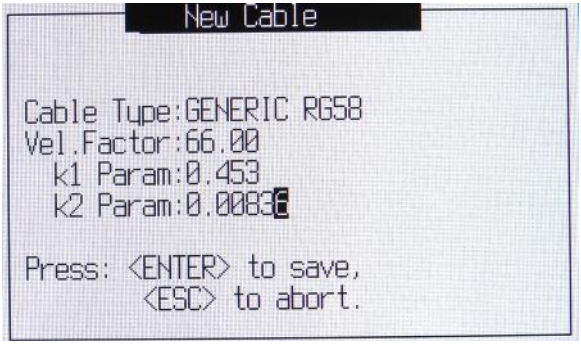
FDR's VF Screen



Velocity can be entered here starting at the cursor (highlighted) or press the FDR key to bring up the Cable List and select the cable type and it's VF from the list. See next screen.

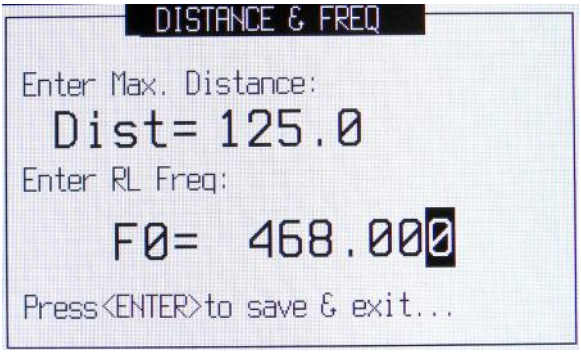


Use UP/DOWN Arrow keys to move the highlight to the desired cable type, then press ENTER to select and exit. If you wish to add a new cable to the list and know its VF, press FDR key to call the next screen.



Use the Alpha/Numeric keypad to enter the cable's name (15 characters max), then use the down arrow to enter the VF.
Down arrow again, enter the k1, then k2 cable parameters (see the tips section for more information about these). Press ENTER to save and exit back to the cable list. The new cable will be at the top of the Cable List and should be highlighted, press ENTER to select that cable and it's VF. Screen will exit to Velocity Factor Screen and show the new cable's name under the VF and entered VF. Press ENTER to exit back to FDR Measurement screen.

FDR's Distance and Frequency Screen



Enter the cable's display distance (10-15% longer than the cable) and press the DOWN arrow key to enter the return loss center frequency F0.

The SWR Analyzer's FDR function is, in reality, two distinct tests. The first is simply the standard FDR distance-to-fault test, used to accurately determine the length of the feed line under test, as well as displaying its return loss or SWR along that length.

The length information measured by the FDR process is then used to measure the return loss of the antenna at the end of that line (if present). This test is done at the operating frequency of the antenna under test, and is entered in the screen above

as F0. The SWR Site analyzer will calculate the feed line's losses per unit length at that frequency, and subtract these losses from the return loss measurement to get the antennas actual return loss at its feed point. If this return loss measurement is not needed (or if the feed line under test is un-terminated), F0 can be left at 0. No frequency-specific return loss measurement will be made in that case.

Center Frequency, Cable Length and ΔF.

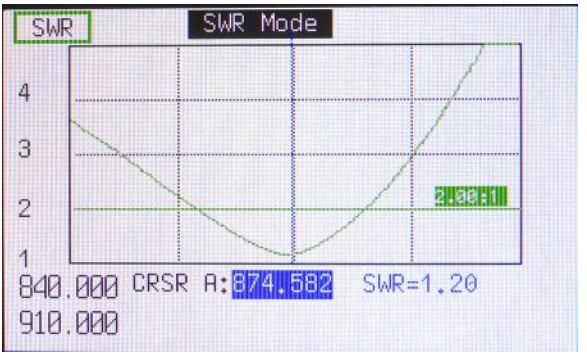
The FDR test method requires that the shorter the length of the cable under test, the wider the frequency span (ΔF) required to test it. With a maximum frequency range of 1.4GHz, that breaks down to a minimum test distance of approximately 55-60ft. This does not mean that shorter lengths cannot be tested; it simply determines the minimum length of the trace that can be displayed. Using the AutoTune key, it should be possible to resolve cable lengths as short as six feet.

Limit Lines

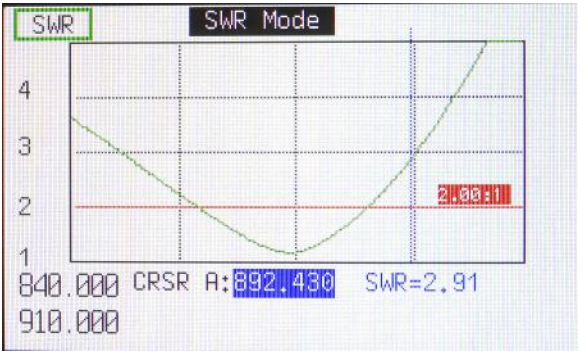
Limit Lines can be used on any of the SWR, RL or FDR screens to allow quick, easy determination of in-tolerance conditions, especially when tuning antennas. They give you a graphical indication of when your measurements are within limits that you specify

Limit Lines SWR & Return Loss

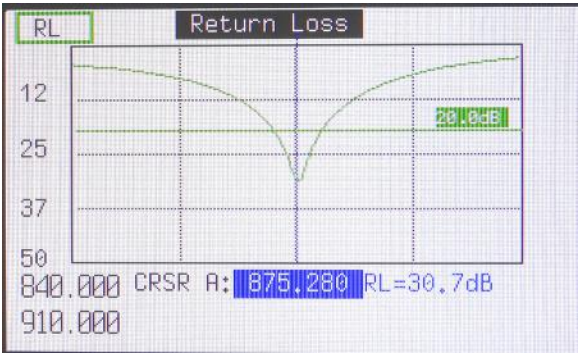
The photo below shows a limit line in use:



Here, the limit is set for an SWR of 2:1 or better. When the cursor is on a part of the curve that is below this limit, the limit line and its marker tag both turn green. Should that part of the trace go above this limit, (as shown on next page), the limit line and its tag will turn red.



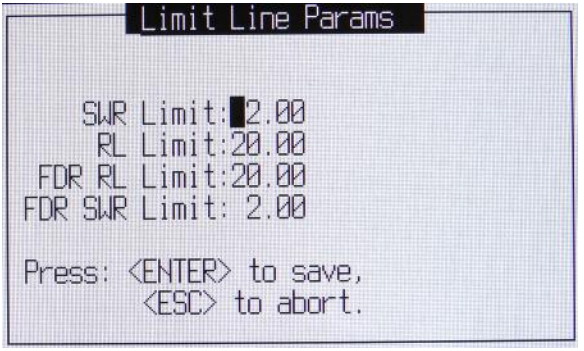
Note that SWR reading at the cursor is above the 2:1 limit line. For illustrative purposes, we moved the cursor rather than the center frequency to show how limit lines work. The limit lines also work in return loss, as shown here:



The return loss at the cursor is 30.7dB, well below the 20dB limit set here; hence the limit line is green, indicating a good return loss.

Limit lines setup

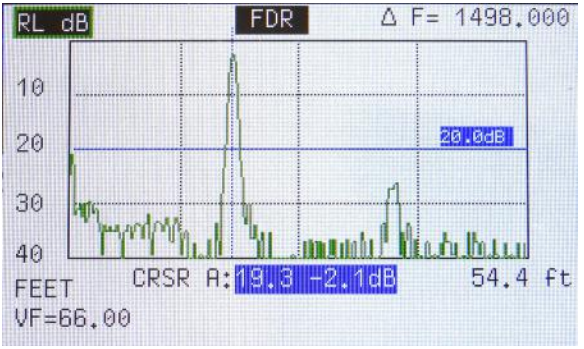
All of the limit line settings are accessed via the MODE button, which brings up the OPTIONS menu. Selecting the LIMIT LINES option here allows you to turn the limit lines on and off. Pressing <ENTER> with the LIMIT SETTINGS menu item selected, will bring you to the limit lines setting screen shown here:



Here you can set the limits for SWR, Return Loss, and FDR scales. When you're done editing the limits, press <ENTER> to save.

Limit Line and FDR

A word about FDR limit lines. The FDR trace will nearly always involve a peak marking the end of the cable. This peak is always there, and is indistinguishable from any of a number of spikes or other anomalies that can appear on an FDR trace. For that reason, the limit line of the FDR trace will not change color. A limit line on an actual FDR trace is shown here:



The limit line is drawn in blue, in this case; and simply serves as a visual indicator for return loss along the line. Because the end spike will nearly always be above the limit line, and because the cursors are your best indicators for line length, having the limit line change color in this case would be erroneous. Hence, the FDR limit line will always remain a neutral color.

4. Calibration, Measurement Information and Helpful Tips

Calibration Processes

The SWR Site Analyzer has two types of calibrations; Broadband and Frequency Specific.

Broadband is a calibration that is done one time using the Site Analyzer's entire frequency range 100KHz to 1.5GHz and saved for use with any shorter frequency ranges selected for use. The advantage of using Broadband Calibration is not having to recalibrate the instrument for every change of frequency. It can also include any test lead or adapter or both and null them from the measurements. However, that same test lead and/or adapter MUST be used with all SWR or RL tests performed when Broadband Calibration is being used. The disadvantage of using Broadband Calibration is that it will not be quite as accurate as Frequency Specific Calibration.

NOTE: Broadband Calibration can NOT be used with FDR measurements. FDR requires Frequency Specific Calibration.

Frequency Specific Calibration is performed with any frequency selection or adjustment of the Start, Stop, Center Frequency or Span. The advantage of Frequency Specific Calibration is it provides the maximum accuracy possible by the Site Analyzer. The disadvantage is that it requires a recalibration process with any frequency change. Frequency Specific Calibration can be done using an adapter or test lead or both to null them from any measurements and applying the terminators (Open, Short and 50Ω Load) at the far-end of the test lead or applying the terminators (Open, Short and 50Ω Load) directly to the instrument's N connector or awn adapter. If a test lead is used, the same test lead is required during any measurements at the calibrated frequency range.

NOTE: When operating the Site Analyzer at 700MHz or less the open end of the test lead or open N connector is sufficient. Using an Open Terminator is optional depending on your preference. Calibrating instrument with a testing frequency above 700MHz requires a precision open, short and 50Ω load, included in the Site Analyzer Kit purchase model **6050-5050**, for the best accuracy.

Broadband Calibration Process

Preliminary: To perform this process, first decide if you will be using an adapter, test lead or both. Remember if you do, that same test lead and/or adapter MUST be used with all measurements employing the Broadband Calibration.

Second, make sure you have the correct terminators OPEN (for 700MHz plus), SHORT and LOAD with correct gender to fit either the far-end of the test lead or the instrument's N connector.

Steps:

1. Press the SWR/RL key to select either measurement type.
2. Press Mode key and select CABLE NULL (even if no cable or adapters are attached).
3. First prompt will be to attach: OPEN. As said previously the open N connector, adapter, or test lead will suffice. Using an OPEN Terminator is optional at user's discretion.
4. Press ENTER to continue.
5. Second prompt will be to attach the SHORT Terminator.
6. When attached press ENTER to continue
7. Last prompt will be to attach the LOAD. Normally this will be a 50 Ω load supplied with the instrument or purchased locally.
8. When attached press ENTER to continue and end the Broadband calibration process. The Site Analyzer will save the Broadband calibration, set the calibration mode to BROADBAND, and return to the SWR/RL Measurement screen. You now select the frequency (via the FREQ key), and attach an antenna or other device to be tested. The SWR/RL key switches between SWR and Return Loss.

Frequency Specific Calibration Process

Preliminary: To perform this process, first decide if you will be using an adapter or test lead or both. Remember if you do, that same test lead and/or adapter MUST be used with all measurements employing the Frequency Specific Calibration.

Second, make sure you have the correct terminators OPEN (for 700MHz plus, SHORT and LOAD with correct gender to fit either the far-end of the test lead, adapter or the instrument's N connector.

Steps:

1. If not already in Frequency Specific Calibration mode, press Mode Menu key. Otherwise jump to Step 4.
2. If required, use the UP Arrow to select (highlight) CALIBRATIONS: then press the LEFT/RIGHT arrows as need to select FREQUENCY SPECIFIC
3. Press ESC to save and exit Mode Menu
4. Press the "Freq" key once to select by Start and End frequencies and twice to select by Center Frequency and Span.
5. Press ESC to exit to the Frequency Specific Calibration Screens
6. First prompt will be to attach: OPEN. As said previously the open N connector, adapter, or test lead will suffice. Using an OPEN Terminator is optional at user's discretion., but required for testing at or above 700MHz.
7. Press ENTER to continue
8. Second prompt will be to attach the SHORT Terminator.
9. When attached press ENTER to continue
10. Last prompt will be to attach the LOAD. Normally this will be a 50 Ω load supplied with the instrument or purchased locally.
11. When attached press ENTER to continue and end the Frequency Specific calibration process. The Site Analyzer will return to the SWR/RL Measurement screen and start measuring. You can now attach an antenna or other device to be measured and you can switch between SWR and Return Loss. If you desire to change the frequency, the Site Analyzer will cycle back through the Frequency Specific Calibration process again.

SWR (Standing Wave Ratio aka Voltage Standing Wave Ratio-VSWR)

SWR is a measurement of impedance matching of loads to the characteristic impedance of a transmission line or waveguide. Impedance mismatches result in standing waves along the transmission line. Examples are defective antenna, wet line coupler, kinked transmission line, poor quality transmission or lossy cable, etc. SWR is defined as the partial standing waves' amplitude at an antinode (maximum) to the amplitude at a node (minimum) along the transmission path.

It is often thought of as the maximum and minimum AC voltages along the transmission line lending to the term VSWR (Voltage Standing Wave Ratio). For example: with a VSWR = 1.3:1 an AC voltage due to standing waves along the transmission line is reaching a peak value 1.3 times that of the minimum AC voltage along that line. Hence, SWR can be defined as the ratio of the maximum amplitude to minimum amplitude of the transmission lines currents, electric field strength, or the magnetic field strength. Neglecting transmission line loss these ratios are identical.

In general, the lower the SWR the better quality of the transmission line, component, antenna, or antenna system under test. Each component of a system will have SWR defined for that item at its designed frequency range. When an antenna system is designed the engineer will compute what the maximum SWR should be at center frequency for that particular system. When a new system is installed the SWR reading should meet or be lower than maximum and be documented for "As Built" or "Base Line" measurements. Later measurements can then be compared to the As Built measurement to see if anything has changed.

Tips:

1. When taking SWR measurements on a new system, measure the components separately first and document each item's SWR. Then measure the antenna system as a whole and document that measurement. This will help later when measuring a faulty system to identify the component that changed.
2. When measuring a transmission line or line component in the line, be sure to attach an impedance matched terminator at the far-end. An un-terminated line or component will show a high SWR. Antenna's are a termination in themselves
3. Be sure about the line or component's center frequency for which it was designed is correctly entered in the SWR Site Analyzer. This will center the SWR's dip at or close to the center of the measurement screen.
4. If the lowest SWR reading is not on center frequency be sure to move the cursor to the planned use center frequency and read the SWR at that frequency. The lowest point in the waveform may meet system requirements, but the reading at the planned usage frequency is what counts and that should also be under the maximum design specifications.

Return Loss

Return Loss is the loss of power in a transmitted signal due to impedance mismatches or discontinuities in the transmission line, line components or antenna causing reflected power back to the transmission's source. It's expressed in dB as defined by the equation shown below:

$$RL(dB)=10\log_{10}\frac{P_i}{P_r}$$

RL(dB)=Return Loss, Pi = incident power, and Pr = Reflected power

The above equation will return a positive dB value. Historically, most instruments are designed to show Return Loss as a negative dB value. This requires taking the ratio of reflected to incident power as in the modified equation shown below:

$$RL'(dB)=10\log_{10}\frac{P_r}{P_i}$$

RL'(dB) will be a negative value. Technically this value is known as "Reflection Coefficient" but is commonly termed Return Loss in Return Loss meters and Network Analyzers.

Return Loss is related to both SWR and reflection coefficient. Decreasing return loss is measurement of how well antenna system components are impedance matched. A low return loss indicates a better match in components and also indicates a lower "Insertion Loss."
Return Loss is often a preferred measurement over SWR as it has a better resolution for small values of reflected waves.

Tips:

1. See the Tips for SWR as they apply equally to Return Loss measurements.
2. Generally, If you draw a horizontal line at the -20dB mark on the measurement screen, the Return Loss values below that line indicate a good usable frequency range for that antenna system. On the SWR Site Analyzer you can position Cursor A at the low frequency mark with a -20dB reading and Cursor B at the high frequency -20dB mark to see the usable frequency range clearly between the Cursors from low to high frequency.

SWR and Return Loss Measurement Steps

SWR or Return Loss Measuring

1. Connect the test lead and any adapter, if they are to be removed from the measurements.
2. Press the SWR/RL key to select desired measurement.
3. Either select Broadband Calibration or perform the “Frequency Specific Calibration” (instructions described earlier in this Section).
4. When calibration is complete connect the antenna or other device to be tested, aka DUT (Device Under Test).
5. Use the Scale key to adjust the SWR or Return Loss scale for the best plot presentation.
6. Press the Cursor key to select Cursor A or A & B with Δ reading. Use Left/Right Arrow keys to adjust Cursor positions as desired. Press Cursor key to select active Cursor for arrows control.
7. If Broadband Calibration was used, the frequency band can be adjusted without recalibration.
8. If Frequency Specific Calibration was used you will need to disconnect the DUT from the test lead or N connector press Freq key, select new frequency range and perform the Frequency Specific Calibration with the new frequency range.
9. SWR/RL key will switch between those two measurements with no recalibration. Use the Scale key to cycle the scale to the best plot presentation.
10. (Optional) To save the plot press the Memory key and use alpha numeric keys to enter a name, then press ENTER to save.

FDR (Frequency Domain Reflectometer)

The FDR is an excellent tool for checking a transmission line for distance to faults. SWR and Return Loss measurements will tell you if a transmission line is good. However, if either of those measurements are out of specification, an FDR will show you distance to the fault or faults on the line.

The FDR in the SWR Site Analyzer can be set for showing reflections in either SWR or Return Loss mode. For the reasons previously stated in Return Loss this is the preferred mode to use in FDR.

The FDR's presentation will always show the best reading at the bottom of the plot and any reflections (faults or end of cable) will be positive going spikes. Generally, small spikes well below or at the -40dB level are common and not a problem. A spike peaking above -40dB can indicate an issue, particularly in higher frequency systems. A spike above -20dB is an absolute fault that must be corrected.

Tips:

1. When selecting the plot's range always select a range longer than the length of the transmission line. It is important to see the end reflection in the Site Analyzer's display. Select the correct VF for the cable being tested to get correct distance to faults or far-end measurement of the cable.
2. To start, recommend leaving the far-end open or use a short terminator. If there is an antenna on the far-end the reflection spike at that end maybe very small. If the far-end distance is not correct ensure the VF being used is correct for that cable and see tip 1 about plot range setting. If the VF and Plot range are correct then the cable may be completely shorted or open at the distance to the highest reading spike.
3. To test the far-end of the cable, particularly the far-end connector, attach a matching terminator. The large spike at the end of the cable should disappear. If it does, then the cable is good through the far-end connector. If the large spike remains or changes, but remains in some form, there is a fault at the far end connector. The terminator and the cable may have a slight impedance mismatch. This may leave a very small up spike at the far-end. Again, below -40dB this is not an issue.
4. If the end of cable reflection is about the center of the plot then the plot range is too long. Reduce the range to get a better resolution, but keep tip 1 in mind.
5. When measuring faults place the cursor at the left edge of a spike as is starts upward to get the best distance to the fault. To read the actual amplitude of the fault in dB, place the cursor at the peak of the reflection.
6. FDR will show a positive going reflection for faults and far-end of the cable. Unlike a TDR, they do not indicate the type of fault by the reflection they show. It only indicates a spot where the wave is reflecting some or all the frequency sweep being injected.

FDR Measurement Steps.

NOTE: FDR has its own Calibration process as part of the measurement procedure. It can NOT use the Broadband Calibration.

1. Press the FDR key to select FDR Measurement Screen.
2. Attach any test lead only if one is to be used. Do NOT attach the cable to be tested at this time.
3. First, if the VF= is not highlighted use the UP Arrow key to highlight and press ENTER.
4. Go to the Cable List and highlight the Cable Type to be tested using the UP/DOWN Arrow keys.
5. NOTE: This step MUST be done before steps 6 & 7. Press the ENTER key on the desired cable type to set the VF setting.
6. Use the UP Arrow key to highlight the ΔF= and enter the cable's maximum length plus 10-15% more to ensure the end of the cable appears in the plot. Use the Down arrow to select and enter the antenna's center frequency (F0). F0 can be left at 0 if the antennas RL is not needed. Press ENTER to start Frequency Specific Calibration for FDR and follow the on-screen prompts for attaching terminators. When completed, the instrument will return to FDR Measurement Screen.

NOTE: Screen's ΔF= will show an assigned test frequency span based on the cable's VF, length, and Center Frequency.

7. At the Measurement Screen use the UP Arrow key to highlight the SWR or RL parameter. Use ENTER to switch to desired parameter: SWR or RL and Scale key to adjust the scale so the cable's trace and any reflections are visible.

NOTE: Return Loss is the recommended measurement for FDR as it will display smaller changes in reflected signals.

8. Use the Cursors to mark any high readings as potential faults. The AUTOTUNE key can be used to find the highest peak. NOTE: end of cable reading should be the last high reading at the cable's far-end distance.

(Optional) Press Memory key to name and save the trace.

NOTES:

1. If the cable has a good trace to the far-end, recommend attaching matched terminator to the far-end of the cable. The high Return Loss reading should diminish or go away and a good Return Loss reading will continue on to end of display. This will confirm there are no defects in the cable-to-end connector's connection. If the connector is not properly installed the far-end reflection will remain the same or similar. This will require attention to that connection point to locate the open center conductor, shield or a short between them in the connection.
2. If you see a large reflection at the cable's far-end distance and smaller reflections after the far-end, those are ghosts or artifacts and can be ignored.
3. If no end of cable reflection appears at the expected end distance, the entered distance maybe to short or the velocity setting maybe incorrect. Recommend starting FDR setup over again using a longer range setting and double-check the VF to ensure the entered value is correct for the cable type being measured.
4. Velocity uncertainty is always a factor when making electrical measurements of cable whether using and FDR or TDR. Manufacturers are also allowed a specified percentage of error in their published Velocity for a specific cable type.
5. If an antenna is attached to the end of the cable this will likely be a matched termination and only a small or no reflection will show at the cable's connection point to the antenna. If there are no other faults on the cable, this is actually a good measurement over the cable's length into the antenna.

FDR Return Loss & k1/k2 Parameters.

There are two aspects of the FDR measurement process as implemented in the SWR Site Analyzer. The first (and most obvious) is the traditional distance-to-fault measurements made on an un-terminated feed line. The SWR and Return Losses 'along the line' are displayed on the graphs, making faults in the feed line apparent.

The second aspect, has arisen from the need to measure antenna performance without having to climb a tower and measure it there. By taking into account the feed line length (as determined by the FDR distance-to-fault), the antenna's operating frequency (supplied by the user), and the type of cable, it is possible to make this traditional return loss measurement at the tower's base. Critical to this measurement is the cable loss per unit length at the operating frequency. In the past, cable manufacturers of commercial-grade feed lines have specified these cable losses (in dB/100ft) at specific frequencies. This has generally been adequate for most purposes, but it's less accurate if you need to determine line losses at other frequencies. In response to this, a formula was developed to allow calculation of line losses (per 100ft) for any cable at any frequency. The formula is:

$$\text{loss per } 100' \text{ (dB)} = k_1 \mathbf{e} f_0 + k_2 f_0$$

Where: f0 = operating frequency (in MHz)

k_1 = Skin losses parameter

k_2 = Dielectric losses parameter

Whenever you select a cable type from the cable list, the appropriate parameters are read from the database, and the line loss for the selected frequency is then calculated. This loss data is then used when making the return loss measurements at the frequency you specify.

Moreover, when entering a new cable type to the database, you are given the option of entering these k_1k_2 parameters, along with the velocity factor. Some manufacturer's spec sheets list the k_1k_2 parameters, but most do not. If all you have is a table of cable losses at discrete frequencies (either supplied by the manufacturer, or measured directly), AEA has supplied a utility that will determine these parameters for you. It is a part of the PC-Vision application that was supplied with your SWR Site Analyzer, and it merely requires that you enter the data from the cables' specification sheet (frequency and line loss/100ft.). The k_1k_2 parameters will be calculated, so you can enter them into the Site Analyzer's database (see the section at the end of this manual for more information about PC-Vision).

5. VNA Site Analyzer Measurements

General Information

These screens are peculiar to the VNA Site Analyzer:

VNA Site Analyzer Specific Measurements

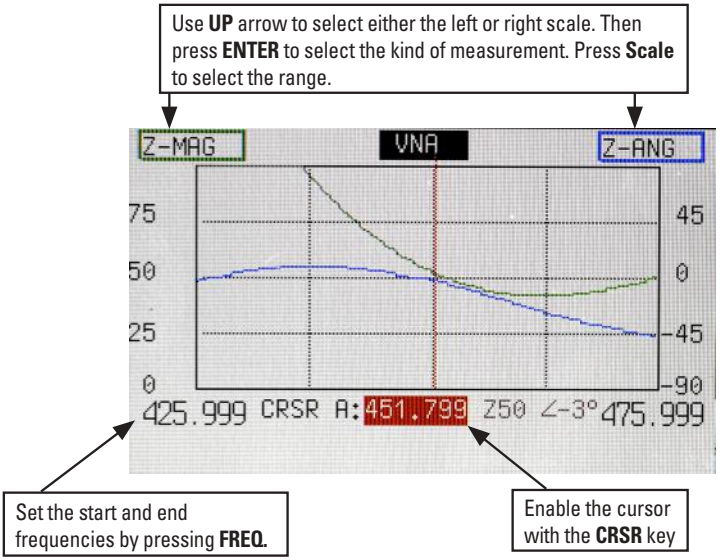
In addition to all of the functionality shown previously in the SWR Site Analyzer, the VNA Site Analyzer has the following capabilities:

MODE MENU (VNA Dual port unit)

VNA PLOT:	Vector Impedance Functions
S21 PLOT:	Two-port measurements, including Tracking.
SPECTRUM ANALYZER:	Spectrum analyzer screen.
FDR:	Frequency-Domain Reflectometer
CABLE NULL:	Starts the Broadband calibration process.
OPT. SETTINGS:	Options Setting' menu

Use UP/DOWN arrow keys to select (highlight) desired mode and LEFT/RIGHT arrow keys to select options in horizontal menu list or use ENTER to go to a submenu when indicated.

VNA PLOT: Access the instrument's Vector Network Analyzer (VNA) functions with this menu selection. The single-port (S11) complex impedance measurements include Z-Mag (Impedance magnitude vs. frequency), Z-Ang (phase angle vs. frequency), Resistance, Reactance, Rho & Theta.

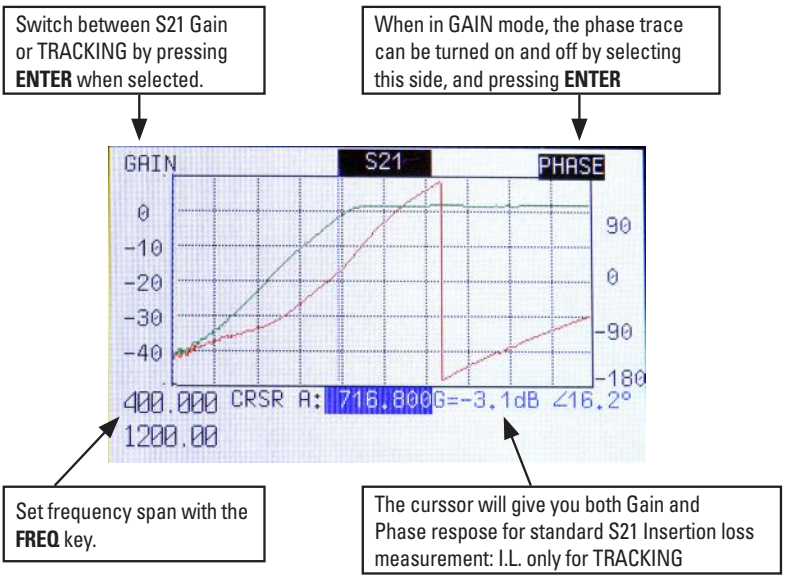


VNA Screen

The VNA screen (shown here) will allow you to directly view impedance magnitude and phase characteristics of virtually any single-ended device. Keep in mind that the instrument must be calibrated (either broadband, or frequency-specific) as when

doing RL and SWR measurements. The calibration process is identical, and occurs whenever center frequency or span is changed (when in frequency specific mode). Once calibrated, use the UP arrow to select the left or right scales. With a scale selected, <ENTER> will switch the kind of measurement for that scale. The possible selections are Z-Mag (|S_{11}| in Ω), Z-Ang (S_{11} phase angle in degrees), R_S, X_S, Rho, Theta. With the desired parameter selected, press <SCALE> to select the scale to best view the traces.
With the cursor enabled via the <CRSR> key, the measurements at the cursor location are displayed along with the cursor frequency.

S21 PLOT: The instruments dual-port (S_{21}) measurement capabilities are accessed with this menu selection. Here it is possible to measure the attenuation vs. frequency characteristic of virtually any passive two-port RF device, resolving both the GAIN (loss) in dB, and the phase response in degrees. In addition, a scalar-only measurement can be made with the Tracking Generator feature, accessed on this screen. This is useful for tuning RF filters such as duplexers.



S21 SCREEN

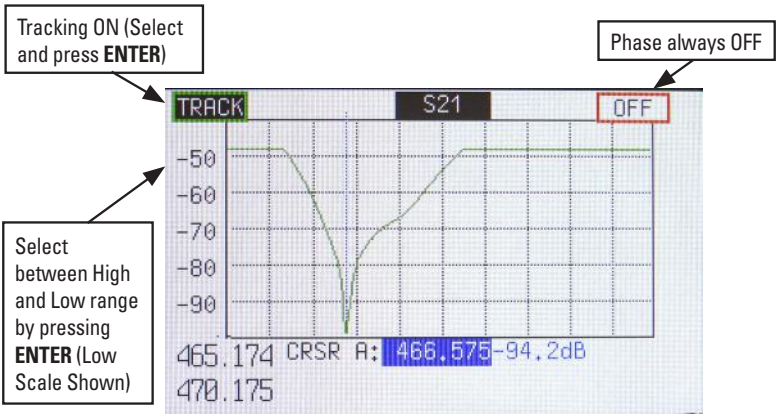
Shown above is the 'standard' S_{21} measurement screen, used to measure the gain (insertion loss) and phase response of a two-port device vs. frequency. Please note, only measurements on passive devices are currently supported. As is the case with the VNA screen, the UP arrow will select the scale on either side. With the left side selected, pressing <ENTER> will switch from the standard GAIN measurement, to TRACKING (referenced below), and back. Selecting the right scale while in the GAIN measurement, turns the PHASE trace on and off, which can be useful if only magnitude information is needed. Cursor operation is the same as in S_{11}.

Standard S_{21} Measurement Procedure:
Press <FREQ>, enter the desired frequency range. If you're running frequency-specific calibrations, you will be prompted to do the usual OPEN-SHORT-LOAD calibration process, same as SWR, RL, FDR, etc.

Once the O-S-L part of the calibration is completed (assuming you're using frequency-specific calibrations), you will then be prompted to attach what's referred to as the THROUGH cable. This cable should be a loop of all of the cabling that will be used to attach the UUT to the instrument. This loop is attached to the S_{11} port of the instrument on one end, and the instruments' S_{21} port on the other end. Press <ENTER> to calibrate the THROUGH. This will compensate for any losses in the test leads. The magnitude should now show a FLAT trace at 0dB, and a FLAT phase trace at close to 0°.

When the calibration process is complete, attach the test leads to your device, and adjust the scales to best view the traces. Depending on what type of device you're measuring, you should get a result similar to the above photograph.

S_{21} TRACKING is a special adaptation of the traditional S_{21} test, that is aimed at aiding in the adjustment of tunable filters-- most notably duplexers. Our standard S_{21} measurement has a magnitude resolution of ±0.5dB, but a 'floor' of about -60dB. In TRACKING, the bottom end of the magnitude scale has been extended to -100dB (in two ranges), but limiting the magnitude accuracy to approximately ±3dB. In addition, the instrument's TRACKING feature has been calibrated to give the best results in the 140 - 170MHz, 440 - 470MHz, and 720 - 870MHz bands. Tracking results outside of these ranges may not be entirely reliable. The primary goal of this test is to allow the technician to test/adjust tunable notch filters.



S21 SCREEN (Tracking)

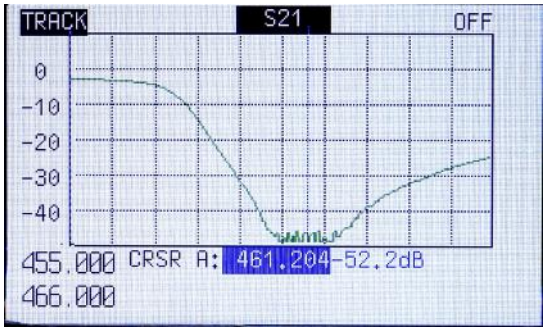
Procedure:

While TRACKING is enabled, attach your test cable to the instruments S_{11} and S_{21} ports. Ideally, the cables themselves should have fairly low losses (< 3dB, preferably).

Press <FREQ>, and enter the frequency range desired. No calibration will be required. Press the <SCALE> key to bring up the high range (0 to -40dB). The resulting base line

should be reasonably close to zero, but it may not be right on the zero line (remember we're at ±3dB here).

Attach the UUT. If you've chosen the correct frequency range for the device, you will see a pattern similar to this one (assuming you're tuning a notch filter:



S21 SCREEN (Tracking, High Range)

Tune your device to put the notch on the desired frequency (the CRSR is very useful for this). If the notch is deep enough, you won't be able to see the bottom of it (it will be below the bottom of the scale, as is the case here.).

Set the instrument to LOW range, by pressing SCALE. The bottom of the notch should now be visible, and it is now possible to fine-tune the notch depth and frequency, as shown in the S21 SCREEN (Tracking) photo above. Note that this will indicate the notches frequency, and its approximate depth. Use the 'standard' S_{21} measurement to determine the pass band I.L. of the device.

SPECTRUM ANALYZER: This selection brings up the spectrum display. Reference level settings are from +20dBm to -70dBm in ten ranges. RBW selections are 10kHz, 30kHz, 100kHz, 300Khz, 1MHz & 3MHz.

SPECTRUM ANALYZER SCREEN

Selecting the SPEC ANALYZER item from the MODE menu, will bring up the VNA Site Analyzer's spectrum analyzer function. Use the UP arrow to select each field on the screen in turn: frequency, Resolution Band Width (RBW), reference level setting, and SPAN.

With the center frequency field selected, pressing <ENTER > will allow you to enter a new center frequency or span. Press <ENTER> again to save. Pressing the <FREQ> key will allow frequency entry also.

With the RBW field selected, pressing the <ENTER> key will switch the RBW settings between 10Khz, 30khz, 100KHz, 300KHZ, 1MHZ, and 3MHZ bandwidths. With the REF Level field selected, pressing <ENTER > will change the reference level, in 10dB increments, from +20dBm to -70dBm top of scale. Also, the REF Lev can be switched any time by pressing <SCALE>. Lastly, the SPAN can be adjusted by pressing the UP arrow to select the SPAN field, and pressing <ENTER>.

FDR: This menu selection is identical to pressing the FDR key on the front panel (See section 4-7 for details).

CABLE NULL: Used to start the Broadband calibration. See Section 4-2 for details.

OPTIONS MENU - This menu is accessed via the VNA's MODE menu. It allows the setting of various options, similar to those in the MODE menu of the SWR. See Section 2-3 for details.

6. PC-Vision

Abstract

The Site Analyzer PC-Vision™ is the companion windows application for your SWR Site Analyzer. Besides allowing for remote operation of your Site Analyzer, it also contains tools and utilities to help you get the most out of your instrument.
Although the Site Analyzer is connected via a USB Cable it uses Serial port protocol to communicate with the PC Vision application. Hence you will need to select a virtual COM Port on your PC.

Installation

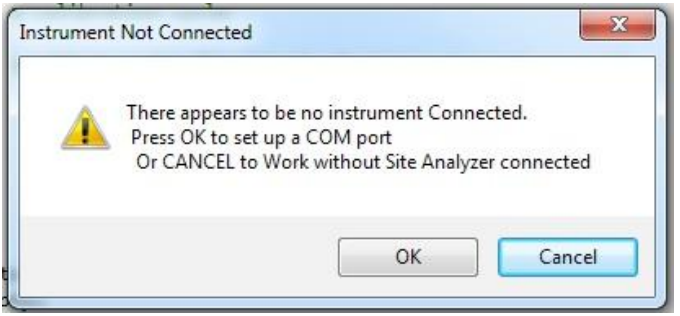
Site Analyzer PC-Vision will supports Microsoft Windows 7 and higher, and communicates to your instrument via a USB connection. A direct connection to your PC is recommended; the qualities of certain USB Extension Hubs have been known to cause communications issues with the unit.

To install, simply run the installation package (SETUP.EXE), and follow the installation prompts. The default location for your user files is:
\Users\<username>\My Documents\ AEATechnology\
All of your pertinent user data, downloads, traces, etc. will be stored there.

Initial Setup

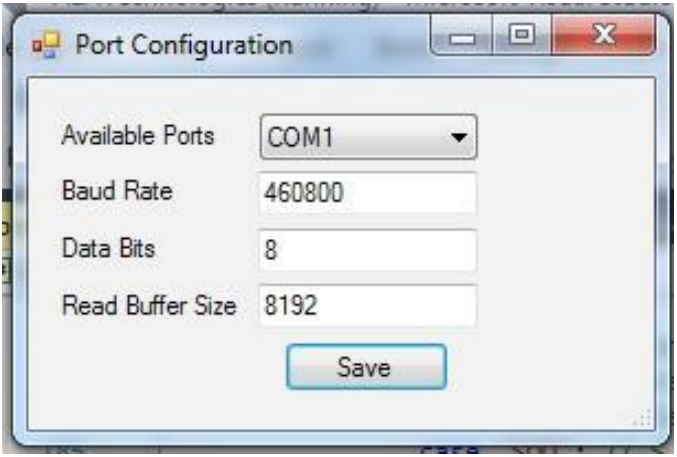
When starting the PC-Vision application, it will attempt to communicate with the instrument via the USB connection. Before starting the application, connect the instrument to your PC, turn it ON and verify that Windows can 'see' it, and that it is actually connected.

Start the application, and the program will attempt to communicate to the instrument. If you haven't previously used PC-Vision with your instrument, you may get this dialog box:

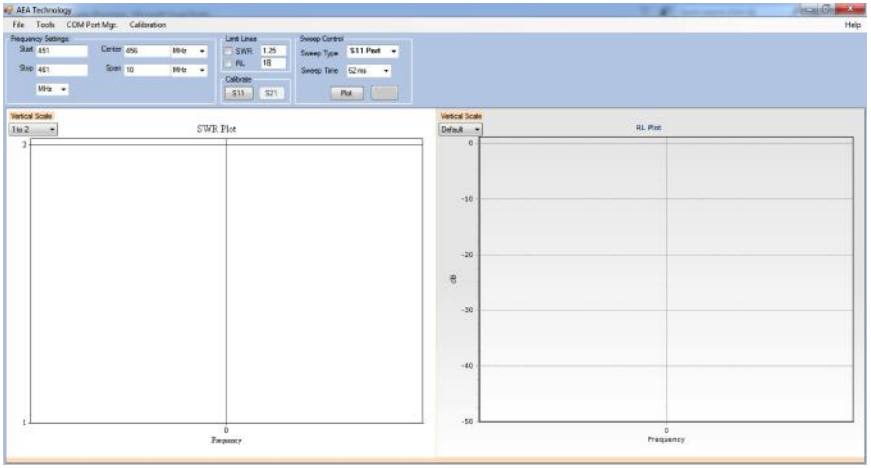


You may choose to click CANCEL, and continue to use PC-Vision without connecting to an instrument. This is useful for viewing traces that have been previously stored.

Clicking OK will take you to this screen, where you can configure the COM port used to communicate with your Site Analyzer:

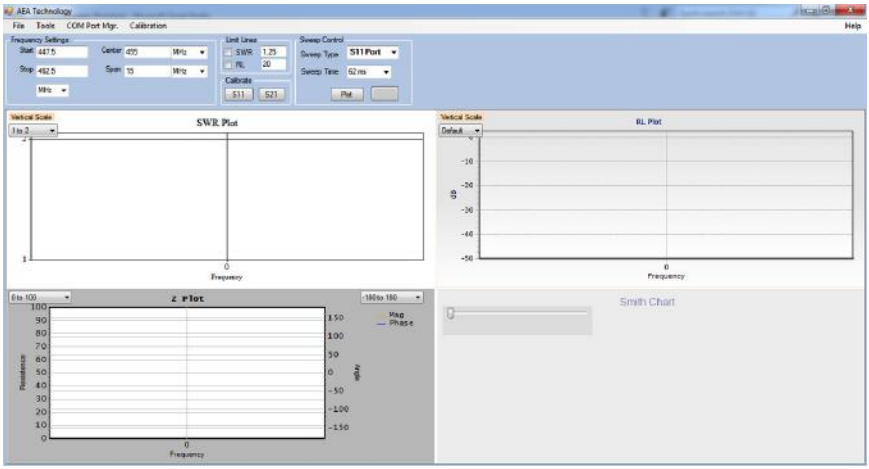


Please Note: You must ONLY change the COM port number. DO NOT adjust any of the other settings! Click on the drop-down box labeled “Available Ports” and select the COM port used by the instrument. If there is any doubt about which COM port is correct, consult the Windows Device Manager for details. Select the appropriate COM appropriate port, and press ‘Save’.
Once the PC-Vision application establishes communication with the SWR Site Analyzer, you should get a screen similar to this one:



PC-Vision Opening Screen (SWR)

If, on the other hand, you have a VNA Site analyzer, your PC-Vision opening screen will look more like this:



PC-Vision Opening Screen (VNA)

Display Screen

In either case, there are two main areas of the PC-Vision display:

The control/settings area, and the measurement/display areas.

The control/settings area fills the upper quarter of the screen. This is where you specify test conditions such as frequency and span, and test options such as sweep speed and Limit-line options. In FDR mode, this is also where you specify parameters pertinent to that: Estimated distance to cable end, cable type & velocity factor, etc.

The measurement/display area takes up the rest of the screen. It is further subdivided in to displays for SWR and Return Loss measurements, additionally Z-Plot and Smith Chart for the VNA instrument. Each of these displays (except for the Smith Chart) has a drop-down menu control to select the scale to use.

Running across the top of the screen is the Menu Bar. Here, there are four pull-down menus:

File - Utilities to upload/download files to/from the instrument, and to view save trace files.

Tools - Misc utilities and tools to get status information from the instrument, to calculate cable parameters, etc.

COM Port Mgr. - Use this to set COM port settings should you switch USB ports while using this application, or to re-establish the connection with your instrument.

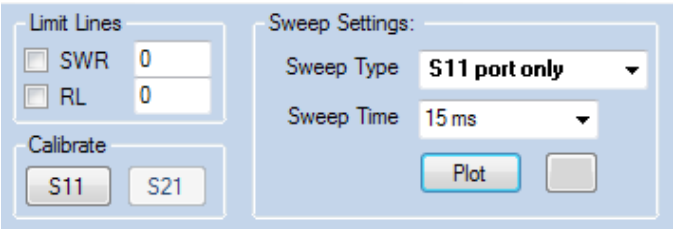
Calibration - Select this item to initiate a calibration cycle of the instrument (AFTER you've set the frequency range you want to test). Please note that this menu is for compatibility with earlier versions; the S_{11} and S_{21} Calibrate buttons will do the same thing.

Basic Operation

Once the PC-Vision application has established communications with the instrument, the application can now use the instrument to actually make measurements. First and foremost, you must select the frequency range to test. The frequency information entered in the appropriate boxes in the 'Frequency Settings' section at the top of the screen:

The Frequency Settings section (above) can accept frequency information expressed in center/span or start/stop frequency formats. Whatever format you use, ensure that the correct units are selected for each (KHz, MHz, or GHz).

Once a frequency range has been selected, you should adjust your sweep settings using the controls in the 'Sweep Settings' section, shown here:



Select the sweep type using the 'Sweep Type' dropdown box. For an SWR unit, the two that are allowed are 'S11 Port Only' which is used for SWR and Return Loss measurements, and 'FDR Analysis', which invokes the Frequency Domain Reflectometer (cable fault) functions. For a VNA instrument, the S_{21} Port and Spectrum analyzer menu entries will be enabled.

Select the Sweep Time you wish to use; lower sweep times will result in faster screen updates, but for most S_{11} and S_{21} measurements sweep rates <35ms is not recommended.

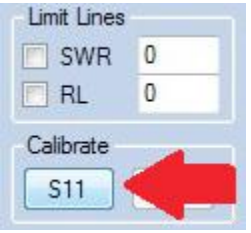
Do NOT press the 'Plot' button at this time.

With the frequency information entered, and the sweep type selected, it's time to calibrate the instrument. To do this, requires three reference standards: An OPEN, a SHORT, and a reference LOAD. For frequencies below 700MHz or so, the OPEN is not too critical, and many users do not use anything for this. The SHORT is always required, should be as close to 0Ω as possible, using a high-quality connector. The 50Ω LOAD is critical, and inaccuracies originating here become more apparent at

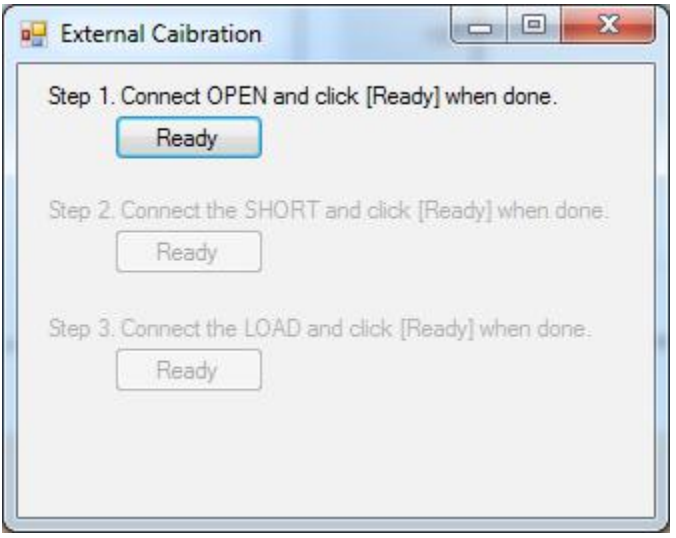
higher frequencies. It's DC resistance should be as close to 50Ω as possible, with good frequency characteristics (the Termination Standards AEA supplies are rated to 3GHz).

Calibration

At this time, press the S11 button in the 'Calibrate' section of the PC Vision screen, shown here:



The Calibration process dialog box will appear as shown here:

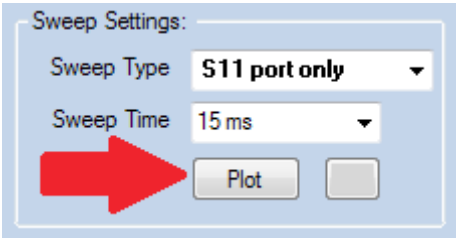


Attach the (optional) OPEN standard to the Site Analyzer, and press the 'Ready' button for step one. The PC Vision Program will assume control over the instrument, and begin the calibration process. The 'OPEN' part of the calibration is complete, the second 'Ready' button will become active; prompting you to attach the SHORT standard to the instrument. When you've done that, press the second 'Ready' button to continue the calibration process. When the 'SHORT' part of the procedure is completed, the third 'Ready' button will become active, prompting you t attach the 50Ω load to the Test Port. When attached, press the third 'Ready' button, and the calibration process will complete.

Once the calibration process is complete, the PC Vision application, along with the Site Analyzer, is ready to make measurements. Bear in mind that the calibration is only

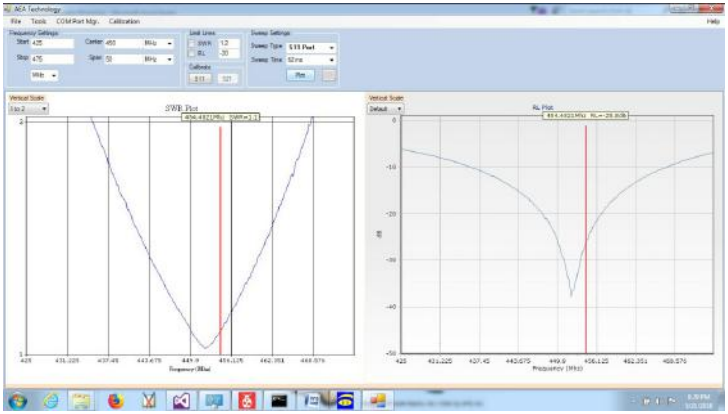
valid for as long as the frequencies are NOT changed. If any of the frequencies (start, stop, center or span) are changed, you must repeat the calibration process again before you can make measurements.

To begin the measurement process, press the PLOT button, shown here....

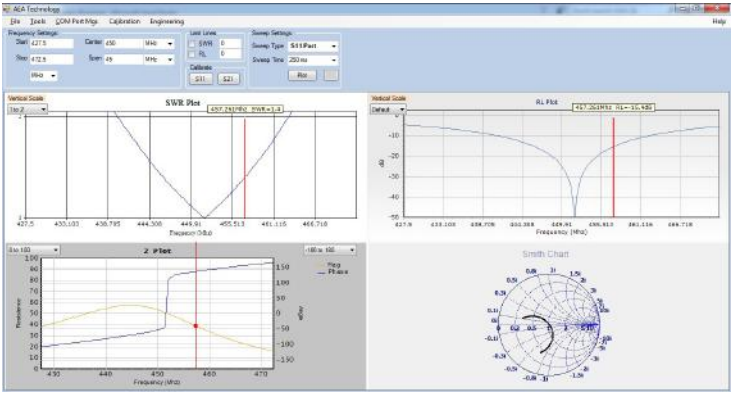


(if calibration has not been completed you will be prompted to do so)

...and the measured results of the UUT (unit under test) will be drawn on the graphs as shown here:

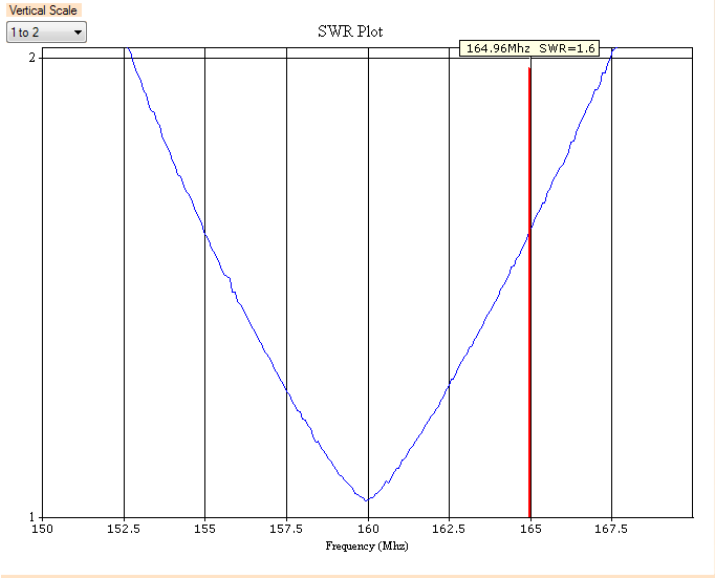


and here, for the VNA…



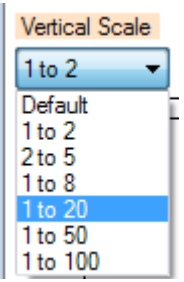
Graphs in Detail

Now that we have a 'live' measurement display running, we can examine the displayed charts in detail. When first started, the cursors (one on each chart) may or may not be present. The cursor will appear by clicking your mouse anywhere on the chart. The cursor will appear wherever you click on the chart. When the cursor is on-screen, a text box will appear above it, indicating the frequency and the SWR or Return loss at that point, as shown here:



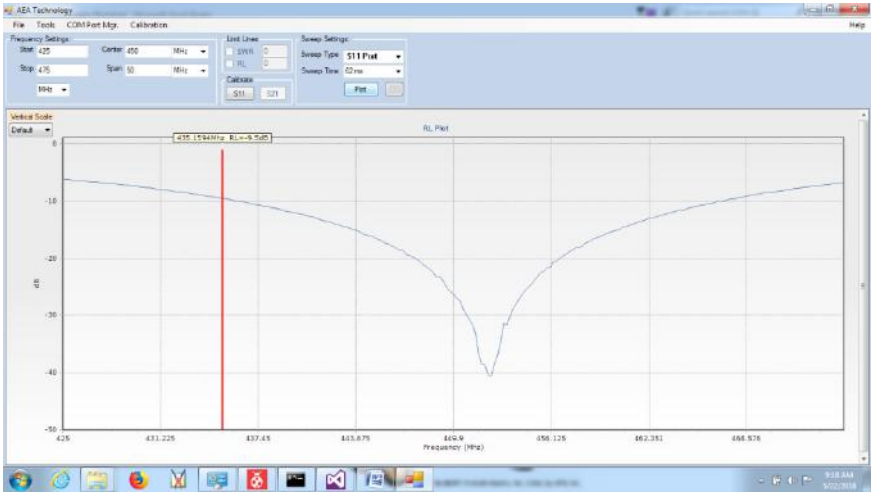
Note also the horizontal frequency scale along the bottom, in MHz, and the vertical scale control, top left. While the frequency scale is fixed (it's determined by the frequency range you chose when you calibrated the instrument), you can use the vertical scale control to change the appearance of the chart to get the best view of the trace.

You can select the vertical scale by clicking on this control, and selecting a suitable range:



Allowable SWR ranges are 2, 5, 8, 20, 50, and 100:1. Similarly, the Return Loss vertical scale can also be selected, the allowed ranges are -1,-2,-5,-10,-20, and -50dB.

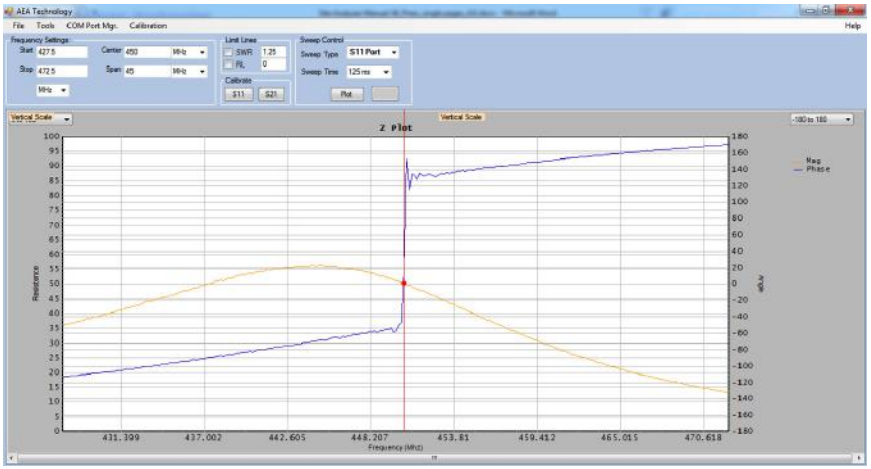
Chart Zoom: Either the SWR or Return Loss charts can be zoomed to full-screen by right-clicking on the chart you wish to zoom, allowing you to examine the trace in greater detail:



Another right-click on the chart will cause both charts to be displayed once again.

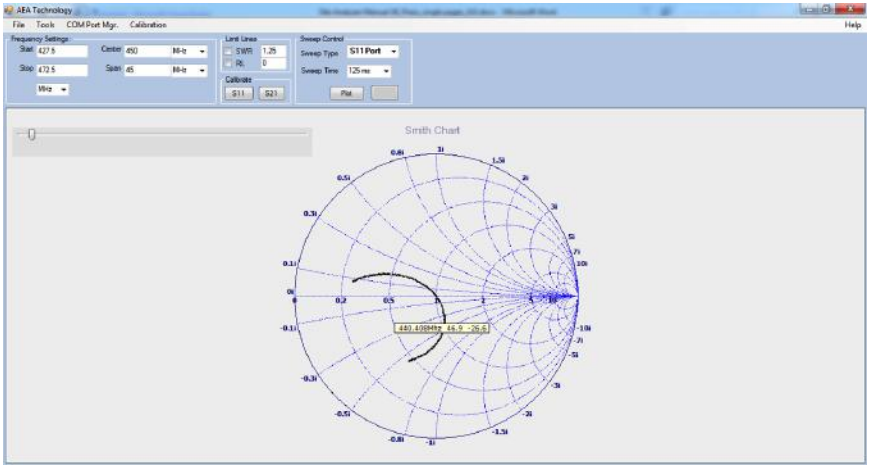
Z-Plot (VNA Only)

Shown here is the Z-Plot, it graphs the UUT's S11 impedance, and phase angle. The scales on both sides can be adjusted for best viewing.



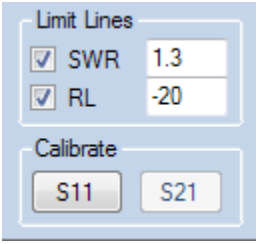
Smith Chart (VNA Only)

The Smith Chart display allows you to easily visualize the UUT's S-Parameter characteristics. Unlike the other displays in this application, you move the cursor (shown on the chart with frequency, R and X values) using the slide-bar on the upper left.



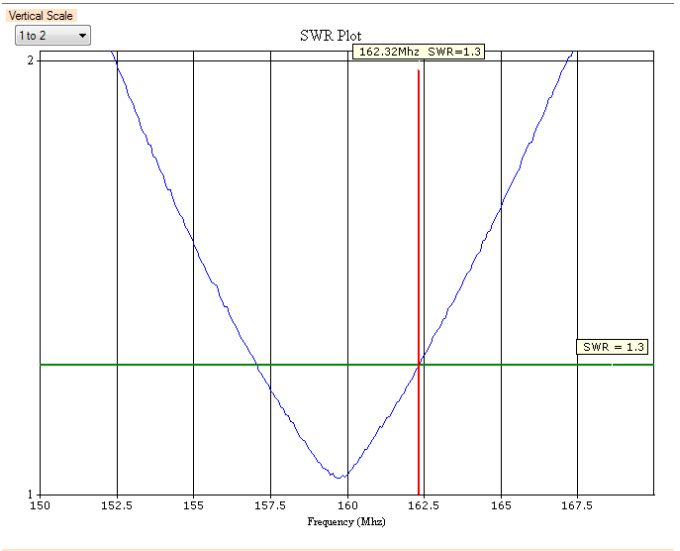
Limit Lines

The Limit Line feature allows the user to perform quick go/no-go testing on antennas or tunable resonators. The Limit lines can be enabled independently of each other by checking the appropriate box, and entering the desired test limit as shown here:



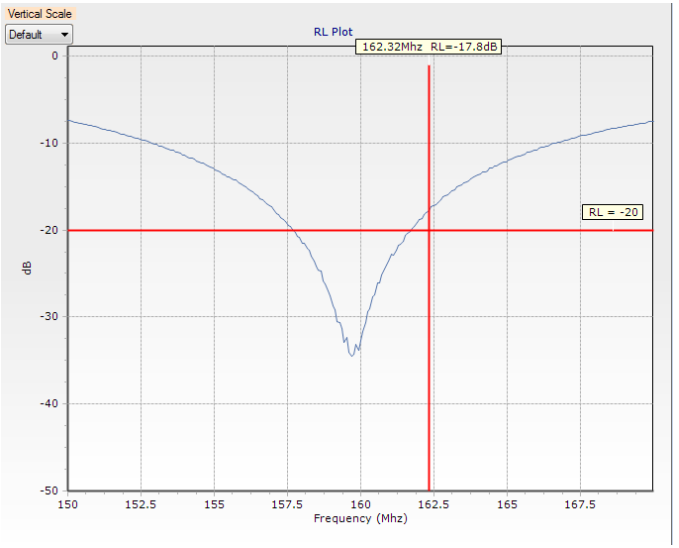
Note that limit lines only apply to the SWR and RL charts.

This shows a limit line in use on the SWR chart:



Note that the cursor is at a point on the trace where the value (in this case, the SWR) is at or below the limit line. Note also that the limit line is GREEN.

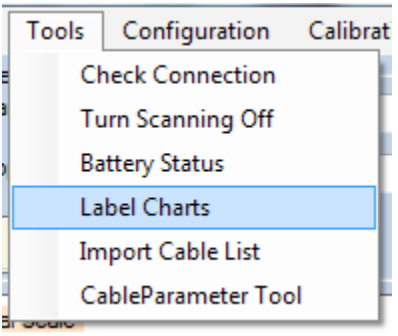
If the cursor is at a place where the trace is ABOVE the limit line, the trace turns RED, as shown here in this Return Loss example:



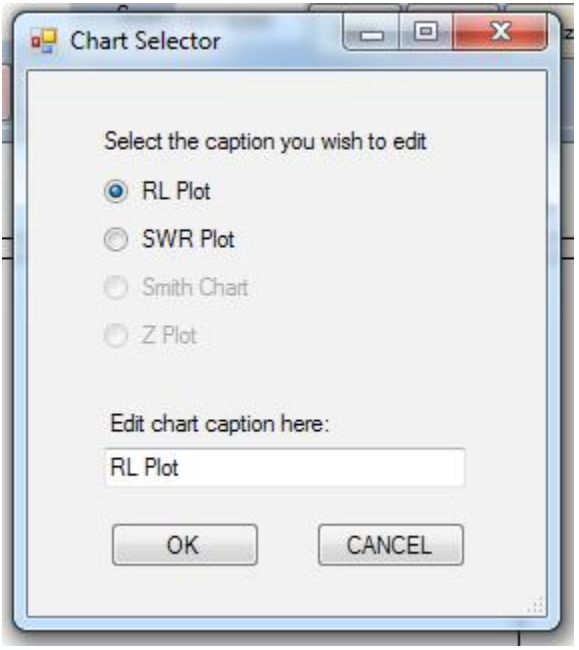
The cursor is at a point on the curve that is above the -20dB limit, and the limit line (at -20dB) is RED. Please note that the limit line values can only be changed when the sweeps are NOT running. Press the STOP button to stop sweeping, change the limits, then press Plot to resume.

Naming Your Chart

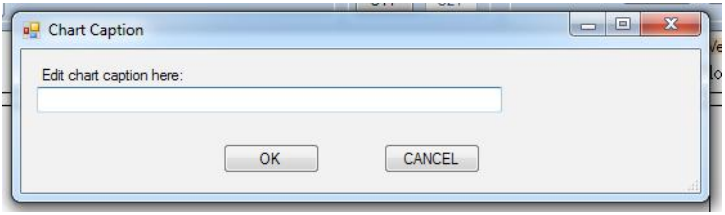
Each chart displayed on the screen has a default header, describing the measurement displayed. The default heading for the SWR chart is “SWR Plot”, for example. Sometimes it may be useful to rename these, and PC Vision will allow you to do so. To rename your chart(s), click on the ‘tools’ dropdown menu, and select ‘Label Charts’:



If you have more than one chart displayed, you will be given the opportunity to choose which chart you want to label:



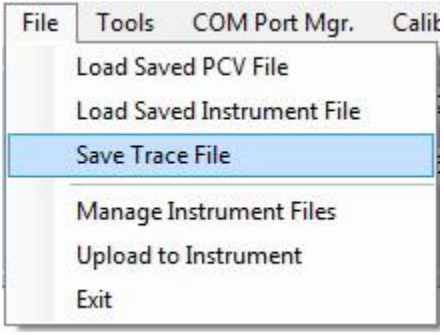
Select the chart, and type in the new header at the bottom, click OK to save.
If you only have one chart showing (you've either zoomed in, or are running FDR), this dialog box will be displayed:



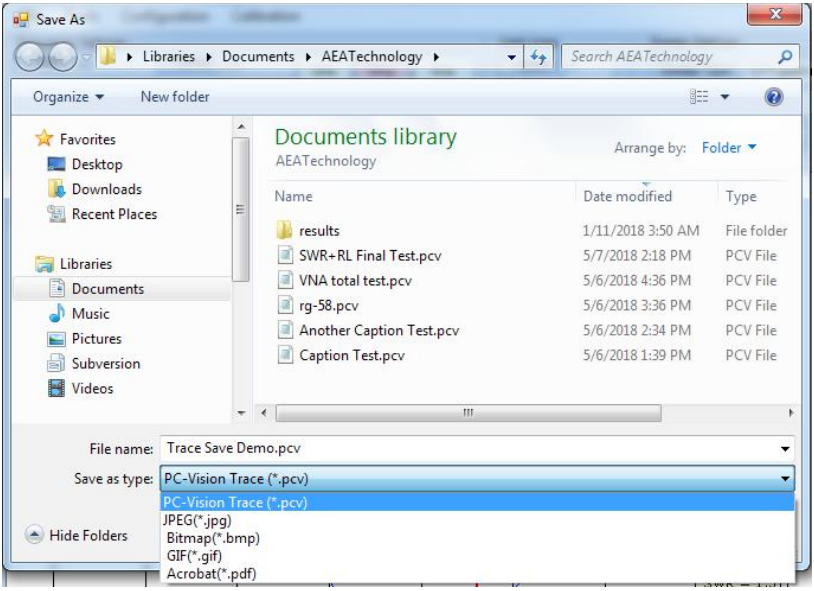
Enter the new caption, and click OK.

Saving Traces

Now that we have 'live' traces on-screen, perhaps we would like to save these for future reference or further evaluation. PC Vision will allow you to save live traces in PC Vision's own .pcv format, which includes the test data used to create the trace, or in any one of a number of graphic file formats, such as .jpg, .gif, or .pdf.
To save a trace, click on the 'File' menu at the top left of PC Vision's menu bar, and select 'Save trace File':



This will bring up a file save dialog box:



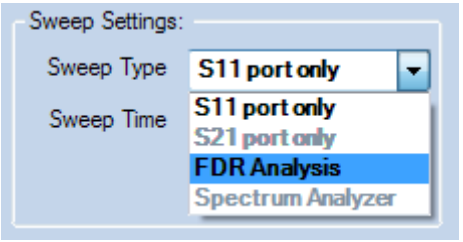
Select the format to save your trace in, give it a name, and click SAVE. It is advisable to save your traces as .PCV format first. You can later save individual charts in a standard graphic format.
Note: other formats can NOT be recalled in PC Vision only handled in their specific application file format.

Frequency Domain Reflectometer (FDR)

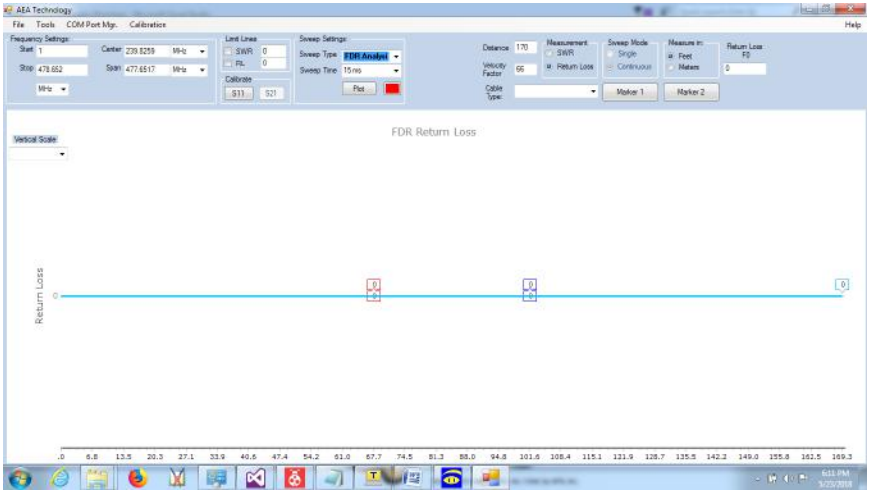
Besides the usual SWR and Return Loss measurements you might make on a feed line, there is Frequency Domain Reflectometer. This measurement presents a different way of looking at your cable's (and, possibly you antenna's) R.F. characteristics. The FDR functions primary application is to determine the length of your feed line, and whether there are any faults along that length. In addition, it is also possible to determine the approximate return loss of an antenna that may be attached at the end, for a given frequency. The minimum scan distance for the Site Analyzer is approx 55 feet for a feed line with a velocity factor of 0.66c (cables with a larger Velocity Factor require a longer minimum scan). The smallest distance that can be accurately measured by the instrument is approximately 10% of scale, although smaller distances can sometimes be seen, depending on the cable. For a cable with 0.66c velocity factor, this works out to about 5 feet. Regardless of the scan distance, the distance resolution will always be scan distance, divided by 251 (this would be 2.6" in the 55ft case).

Basic Operation (FDR)

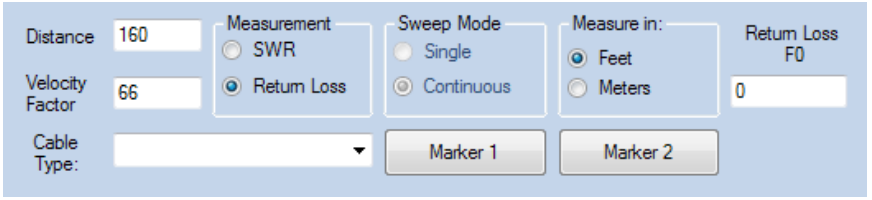
Select the FDR function by selecting it from the Sweep type drop-down box on the Sweep Settings panel as shown here:



Clicking here will take you to the FDR screen:



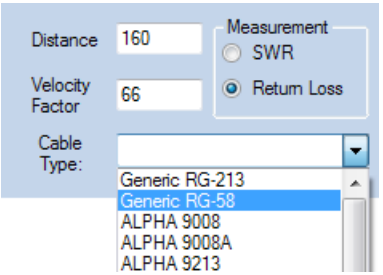
Note that a new set of controls appear on the right:



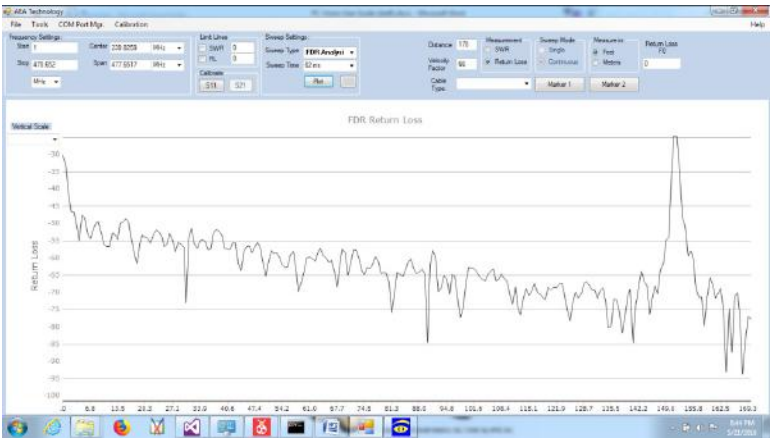
Each Field and control will be explained in detail.

It is highly recommended you select your units of measure (UOM) before doing anything else. On the right, you will see a control labeled “Measure In:”. Select Feet or Meters.

On the left side is a field marked “Distance”. Enter the estimated length of your cable, plus approximately 10-20%. The next thing is to set is the velocity factor for your cable. This can be done one of two ways: The first would be for you to manually enter the cabled VF into the field marked ‘Velocity Factor”. The other way, is to select your cable type from a list supplied by PC-Vision.
Click on the “Cable Type” drop-down control, and select your cable from the list, as shown here:



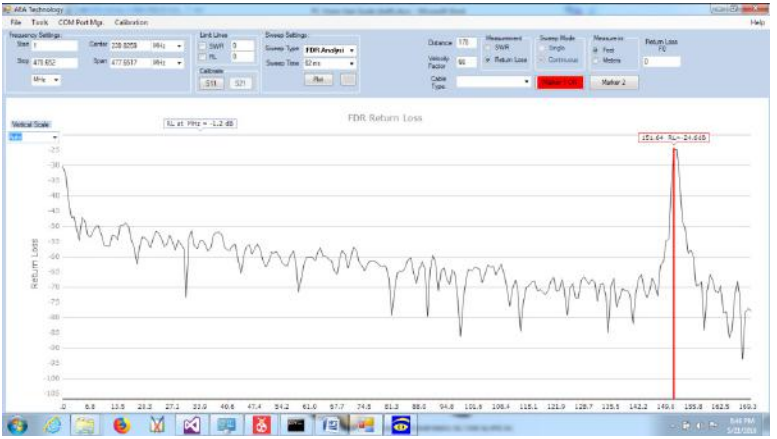
This is the preferred method, for reasons which will become clear later in this section. Once you’re selected your cable type (or entered your velocity factor), you may select whether you wish to display SWR or RL. Please note that, while most of the controls are locked out while PC Vision is sweeping ‘live’, you may select SWR or RL while the sweeps are actually running.
Once all of these steps have been completed, it’s time to run some sweeps. You will need to start the calibration process (changing either the distance or VF will change the frequencies used) by clicking on the S11 button in the calibrate box. Apply the OPEN, SHORT, and LOAD standards to the instrument in turn, and when this is complete, you’re ready to connect the feed line you wish to test. Keep in mind, that if you use a short length of cable and possibly an adapter to make this connection, the length of that cable will be added to the distance to end graph.
With the cable under test connected, click the “Plot” button, and you should have a graph similar to this one:



The tall pip on the right side of this screen shot marks the end of the cable.

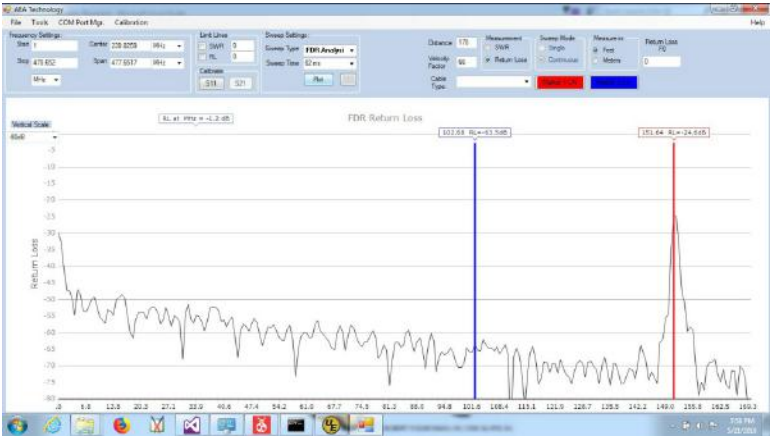
Markers

To assist with analysis and evaluation of this trace, two markers are provided, and clicking on the “Marker 1” button will bring up the first one:



Marker 1, the red one shown here, is fixed, in the sense that it will always seek to the highest point on the trace. A flag on the marker gives the distance, and the total return loss at that distance.

Cursor 2, Shown here in blue, is enabled by clicking on the “Marker 2” button:



Marker 2 is not fixed, once enabled, it will appear wherever you click on the graph. Like marker 1, it indicates distance and return loss/SWR.

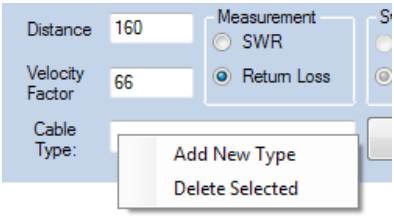
In addition to the marker buttons, there is an additional drop-down control box over the screen’s vertical scale. With this control, you can adjust the vertical scale to best view the trace.

Antenna Return Loss

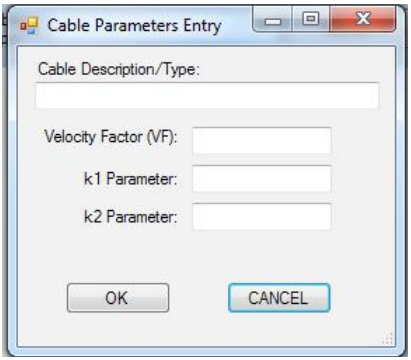
So far, we have shown you the basics of FDR operation: Setting the distance, velocity factors, using the markers, and so on. There is an additional feature we haven't covered: Antenna Return Loss. At the far right, is an *optional* setting, marked "Return Loss F0". By entering a non-zero frequency into this box, the PC Vision FDR function will calculate the return loss of your feed line & antenna *at that frequency* and subtract the feed line's attenuation to give you the RL performance of the antenna at the end (assuming an antenna is connected there). To utilize this feature properly, however, you need two things: The center frequency you want to do the test at, and an entry in the cable list with valid information for the cable you're trying to test.

After entering the distance for your FDR sweep, to use the antenna return loss feature, you must select a cable type from the list provided. The reason for this requirement is simple: Each entry in that table is more than a name and Velocity Factor. Each entry also includes parameters that are used to calculate the cable's loss vs. frequency. The PC Vision application will take the calculated distance, then use these parameters to calculate the line losses, which are then used to calculate the antennas return loss (at that frequency).

If your cable isn't listed, a new entry can be created, but you will need some information about your cable. Some cable manufacturers supply k1, k2 parameters for their feed line products. With these two parameters, the loss / 100ft can be calculated for any frequency, and PC Vision uses these parameters directly. To create a new cable entry, right-click on the cable type selector:



Select "Add New Type", and you will get the dialog box shown below:



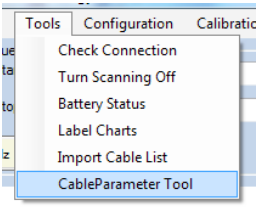
Enter a description for the cable, the velocity factor, and the k1,k2 parameters supplied by the manufacturer (consult the cables datasheet). If the k1,k2 parameters are not supplied, the next few paragraphs will explain how to get them. Click OK to save or CANCEL to abort.

If your cable's manufacturer doesn't supply the k1, k2 parameters, but does supply a table listing losses vs. frequency, such as the one shown below, you will be able to calculate the necessary values.

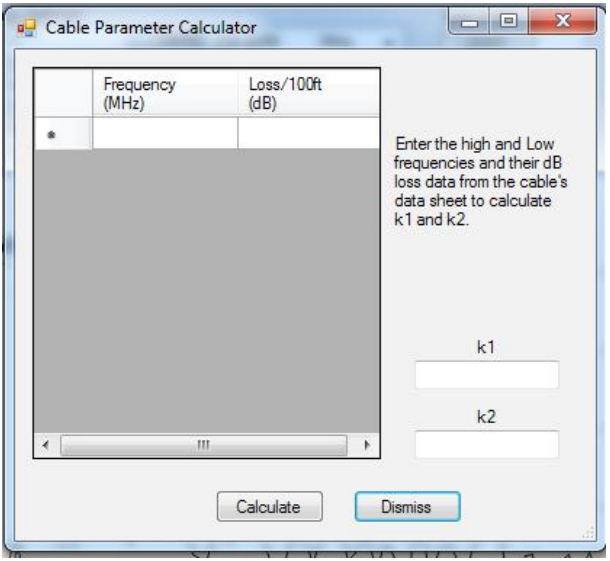
Frequency MHz	dB /100 ft
10	0.034
20	0.049
50	0.079
100	0.114
200	0.168
400	0.250
512	0.289
700	0.349
894	0.405
1000	0.435

Calculating K1 and K2

PC Vision includes a tool which you can use to calculate your k1, k2 parameters to create a new entry to the cable list. From the 'Tools' pull down menu:



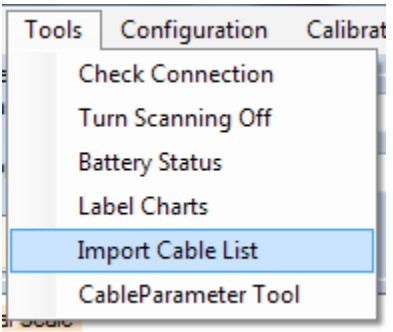
Select the 'Cable Parameter Tool', and the Cable parameter calculator will pop up:



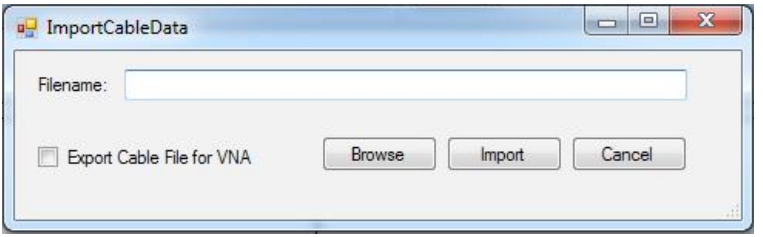
Here, key in the frequency and line loss information off of the data sheet. Some of these data sheets have excessively long tables, and it may not be necessary to key them all in. You shouldn't need more than about a dozen entries or so, but even if less than that are supplied you should still get reliable results. Once all of the data has been entered, click 'Calculate' and the k1, k2 parameters will be computed. Note the two numbers down, press dismiss.

Cable List Restore

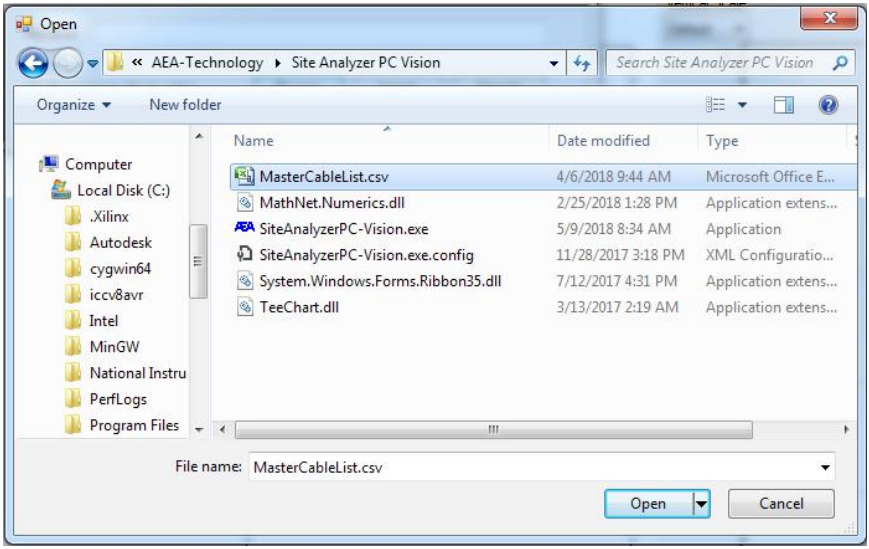
As it is possible to edit or otherwise modify the FDR cable list, you may need at some point, to restore the cable list back to its original state. This is easily done by using the "Import Cable List" tool.
To restore your cable list, first click on the 'Tools' pull down menu, and select "Import Cable List" from the menu:



This brings up the import dialog:



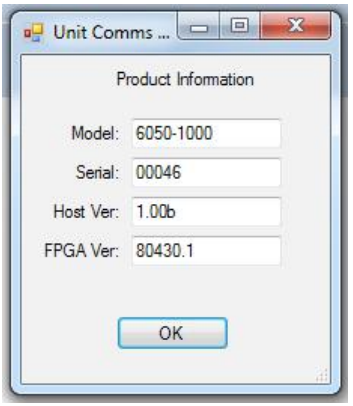
When your copy of PC Vision was installed, a plain-text copy of the Cable Table was installed as well. You will use this copy to restore your cable table.
Click on Browse, then browse to the directory to where your copy of PC Vision was installed (the default is usually: C:\Program Files(x86)\AEA-Technology\Site Analyzer PC Vision):



Select the file "MasterCableList.csv", click "Open". When the "Input Cable data" dialog box reappears, click 'Import' and the cable list will be restored. If you wish to also generate a new cable file for your instrument, check the "Export Cable File for VNA" box before clicking 'Import'.

Check Connection

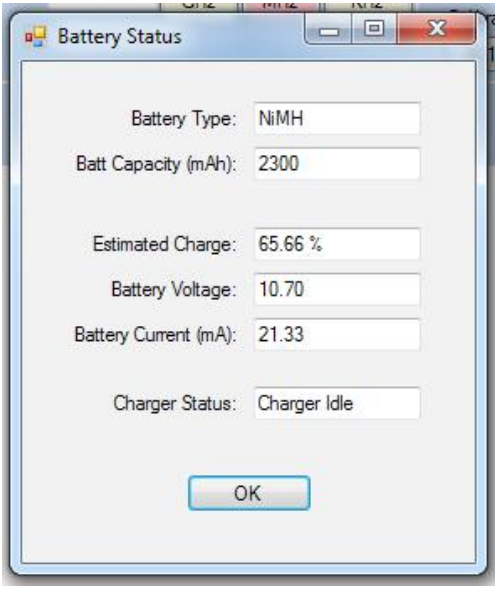
From the 'Tools' pull down menu, is a selection "Check Connection". Use this tool to verify that you are properly connected to your instrument, and that communication has been established. If the PC Vision's communication link with your Site Analyzer is active, you will get a message box like this one:



You may also be requested by service or support personnel to call up this panel should your instrument require servicing and/or updates.

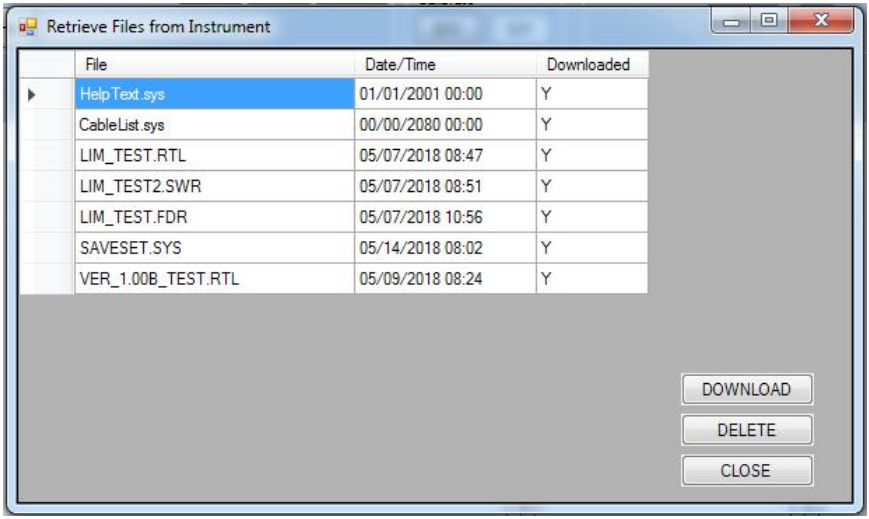
Battery Status

Another item from the 'Tools' menu is 'Battery Status'. Selecting this item will bring up the message box that you see here. It lists all of the particulars relating to the batteries in your unit, charger status, and rate or charge/discharge.

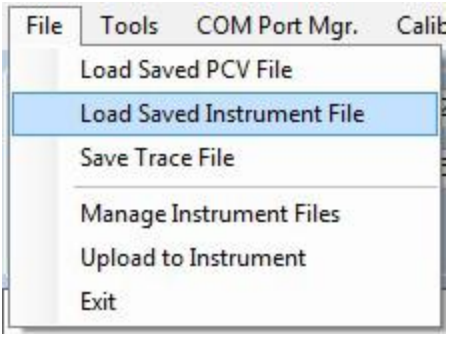


Instrument File Management

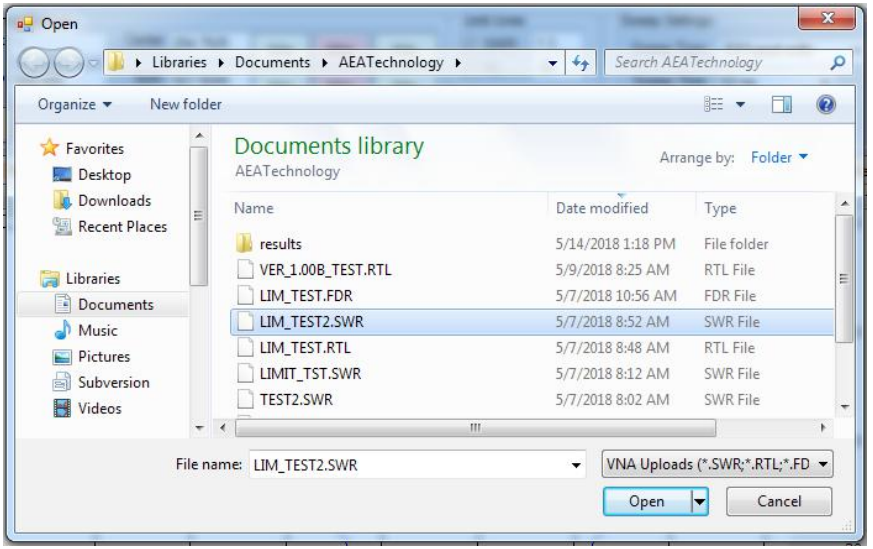
One of the key applications of the PC Vision application, is to assist with managing trace files generated by the Site Analyzer. It is possible to store traces in the instrument's file system, and PC Vision provides utilities to handle them.
To begin file management, from the 'File' pull down menu, select "Manage Instrument Files". This brings up the PC Vision File manager:



This is a listing of the files in your instrument's file system. The .sys files belong to the system, and should not be downloaded or deleted, unless instructed to do so by support personnel. The .RTL, .SWR, and .FDR, files are Return Loss, SWR, and FDR trace (data) files, respectively. There may also be .SET files, used for storing instrument setups, but those aren't relevant to this discussion.
Any of these trace files can be loaded and displayed by PC Vision. Select the files you wish to download (holding down Ctrl, Shift or both will allow you to select multiple files), and click "DOWNLOAD". PC Vision will then download your trace files to the AEA Technology folder in your Documents folder.
Once a file is downloaded from the instrument, you can view it in PC Vision by selecting "Load Saved Instrument File"



You get the familiar file open dialog box:

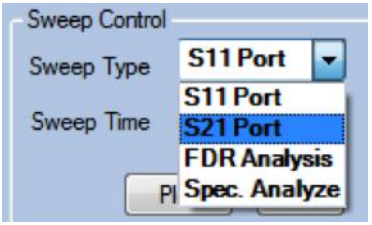


Select the file you want to display, click “Open” to view.

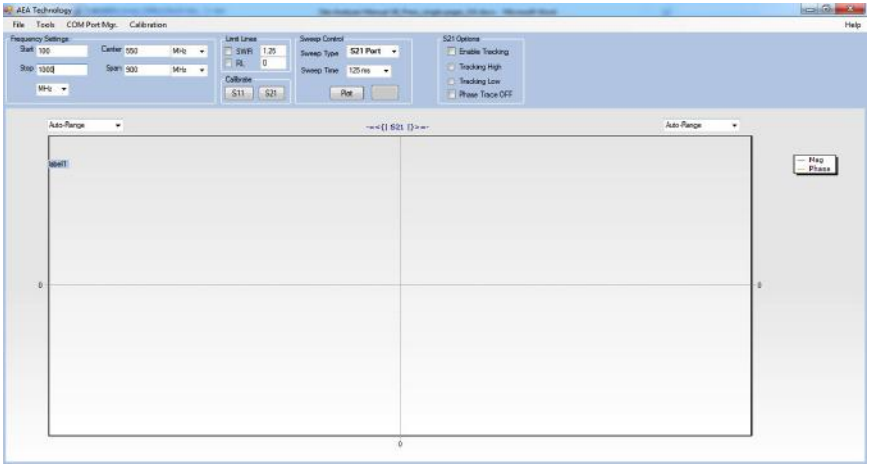
Once downloaded from the instrument, you may decide you no longer need the trace file to remain on the instrument. From the file management window (shown earlier), select the file(s) you wish to delete, and click “Delete”. “CAUTION there is no UNDELETE function, all save test results and setups deletes are permanent.”
The selected file(s) will be deleted from the instrument. Take care not to delete the .sys files. Should they be unintentionally removed, please contact customer support for instructions on restoring them.

S21 Measurement Screen

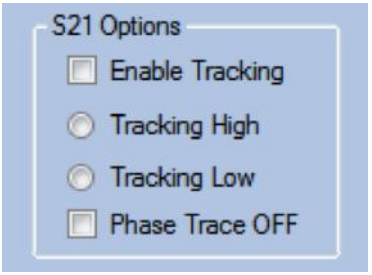
If you're using PC-Vision with the VNA Site Analyzer, you can make end-to-end dual-port insertion loss measurements of virtually any PASSIVE two port device using the S21 Measurement Screen. Access it by selecting 'S21 PORT' from the sweep control, as shown here:



And the S21 measurement screen will appear:



The controls for this screen are pretty familiar: Frequency Settings, Sweep Control, etc. But there is an additional control box with some settings that are specific to this kind of measurement:



Enable Tracking: This enables/disables the VNA's tracking Generator option, which will be covered in the next section.

Tracking High: Enables the upper scale when running the tracking gen.

Tracking Low: Enables the lower scale when running the T.G.

Phase Trace OFF: Checking this box disables the Phase trace, if not needed.

For regular S21 operation, only the last option applies. We'll address the tracking option in the next section.

Making S21 Measurements:

Start by entering the frequency range of interest, in the Frequency Settings box.

Select the sweep time you wish to use (we recommend 63ms or slower).

Start the calibration process by clicking the S11 button in the Calibrate box, as shown here:

Just as when you did SWR, RL, or FDR measurements, you will be prompted to attach the OPEN, SHORT, and LOAD references in turn, Notice that when you started this part of the calibration cycle, you were switched back to the SWR/RL screen. This is normal operation.

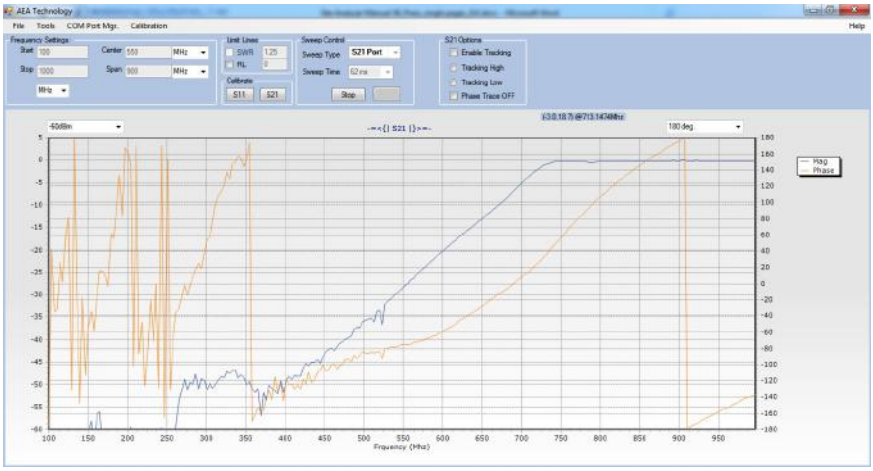
When the S11 part of the calibration is completed, use the Sweep Control to select the S21 Port once again, returning you to the S21 screen.

At this point, we have to calibrate the test cables you will be using to attach the UUT to the instrument. Attach the test cables between the S21 and S11 ports on the instrument so they form a continuous loop. You may use an N, BNC, PL-259, or even an SMA barrel or other adapter if necessary.

With the test cables attached, click the S21 button in the Calibrate box, and your instrument will compensate for losses in the test cable, effectively removing it from the measurement.

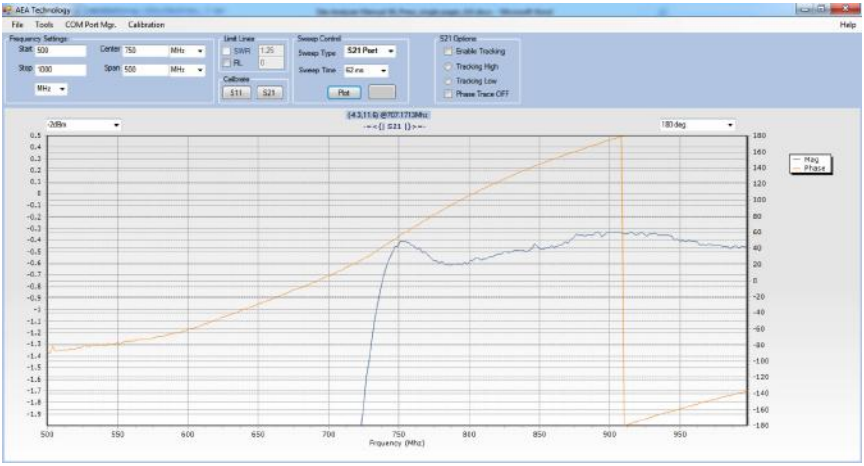
With the THROUGH part of the calibration completed, attach the UUT, and click the button marked 'Plot'.

You should see a display similar to this one:



The phase trace is in orange, and the gain trace is in blue.

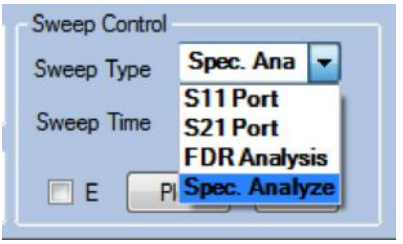
Both left and right scales are adjustable, making it possible to observe this filter's pass band ripple:



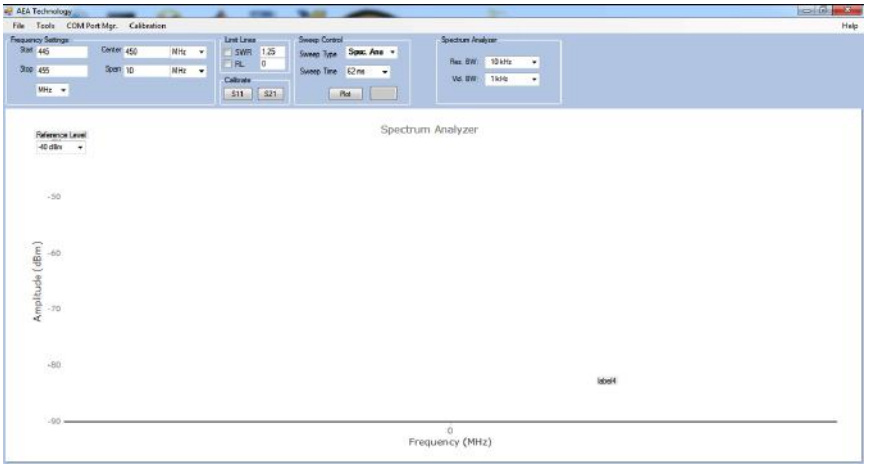
This is the same filter at high vertical resolution.

Spectrum Analyzer Screen

Selecting **Spec. Analyzer** from the sweep menu, as shown here,



will bring up the PC-Vision's Spectrum Analyzer function:



The controls are mostly familiar, but with an addition:

This is the spectrum analyzer Resolution Band Width (RBW) and Video Bandwidth (VBW) control box. Use the Resolution bandwidth to select the RF filter appropriate to the bandwidth being swept: The available values are 10kHz, 30khz, 100kHz, 300kHz, 1MHz & 3Mhz.

Recommended RBW Settings

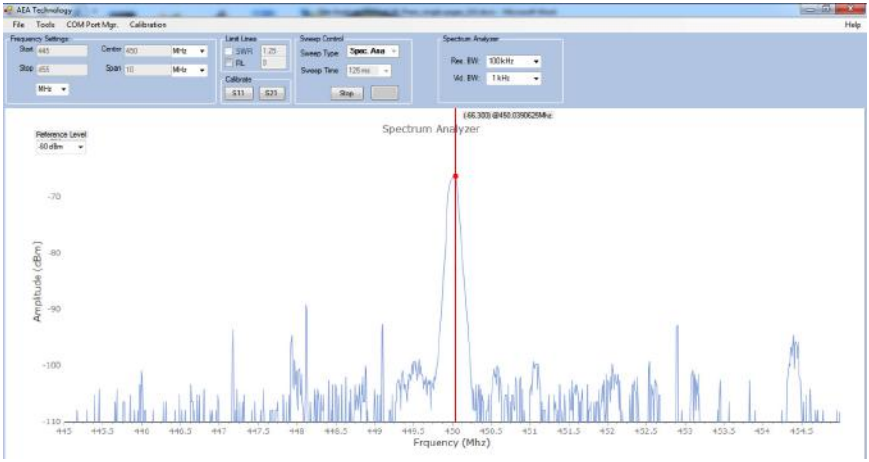
This table lists the minimum and maximum recommended span sizes for each RBW.

RBW	Min Span	Max Span	Unit
10	250	2500	KHz
30	750	7500	KHz
100	2500	25000	KHz
300	7500	75000	KHz
1	25	250	Mhz
3	75	750	Mhz

General Spectrum Analyzer Operation:

Start by entering the frequency information in the Frequency Settings control, then select the sweep rate in the Sweep Control Box, followed by the desired Resolution and Video Bandwidths. Click the 'PLOT' button to start the sweeps.

A typical Spectrum Analyzer display will look like this:



You should also select the appropriate reference level, using the reference level control to the left of the screen to best view the signal of interest.

7. Warranty, Maintenance, and Troubleshooting Guides

Limited Warranty

AEA Technology, Inc., warrants to the original purchaser that the Site Analyzer shall be free from defects in material or workmanship for a period of two years from the date of shipment. All units returned to the factory, delivery charges prepaid, and deemed defective under this warranty, will be replaced or repaired at the company's option. No other warranties are implied, nor will responsibility for operation of this instrument be assumed by AEA Technology, Inc.

There are no warranties that extend beyond express warranties stated herein. No other warranties are expressed or implied. AEA TECHNOLOGY SPECIFICALLY DISCLAIMS ALL IMPLIED WARRANTIES, INCLUDING THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. THE REMEDIES PROVIDED HEREIN ARE BUYER'S SOLE AND EXCLUSIVE REMEDIES. AEA TECHNOLOGY, INC. SHALL NOT BE LIABLE FOR ANY DIRECT, INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, WHETHER BASED ON CONTRACT, TORT, OR ANY OTHER LEGAL THEORY.

Remedies for any breach of warranty, either expressed or implied, are limited to repair, replacement, or return of the instrument, at the option of AEA Technology, Inc. Any warranty is valid for the original purchaser only.

All warranties of performance are disclaimed.

AEA Technology assumes no liability for applications assistance or customer product design.

Maintenance

There are NO field serviceable components inside the instrument. Do not attempt to open the instrument, other than the battery compartment, as this can void the warranty. If the instrument is not performing or charging correctly refer to Troubleshooting Guides at the end of this section or contact AEA Technology, Inc. to communicate with a technical representative Monday-Friday 8:00am to 4:00pm Pacific Time.
Tel: US and Canada 1-800-258-7805, International +1-760-931-8979
Fax: +1-760-931-8969
Email: techsupport@aeatechnology.com
Web: www.aeatechnology.com Be sure to include your email address and phone number and a technical support staff member will respond the same day or next working day.

Cleaning

The Site Analyzer is designed to operate in a variety of conditions and dirty environments.
Cleaning on regular basis should be accomplished with a soft, water moistened cloth. If dirt must be removed, use a mild detergent (see recommended cleaners listed

below) sprayed on the cloth first. Rinse with a clean soft damp cloth moistened in water only.
Do NOT spray detergents or water directly on the instrument. Avoid using solvents or ammonia based glass cleaners that can discolor the LCD protective cover and that may attack the plastic case or test lead insulation. Use orange based liquid or gel cleaner on a clean soft rag to remove cable gel from the instrument, test leads or carrying case.
Battery Compartment: Should one or more AA cells outgas in the battery compartment use a cotton swap dipped in Alcohol (Isopropyl or rubbing alcohol) to remove both dry powdery and liquid leakage completely. Pay particular attention to the battery contacts to ensure all leakage is removed completely. Dry any wet areas or contacts with a dry cotton swab. NEVER replace any AA cells indicating signs of outgassing or leakage. Disposed of in accordance with local hazardous material regulations.
Belt Case: The soft case should be cleaned in the same manner as the instrument, but a soft brush will help remove dirt, grime or cable gel. Always remove the carrying case from the instrument first. Washing in a machine or total immersion in soap and water is NOT recommended. Drying in a clothes drier or oven is also NOT recommended. Dry the instrument and Belt Case separately overnight on a clean cloth in fresh warm air.

The following are recommended cleaning agents for specific contamination:
Soil or light oily soil marks Household glass cleaner (non-ammonia based) or 409® cleaner
Cable gel Orange based gel or liquid cleaner, non-abrasive
Tar, creosote or sticky adhesives WD40® followed with household cleaner
NOTE: Always spray cleaners or rinse water on the cloth NOT the instrument.

Instrument Troubleshooting Guide

Symptom	Possible Issue	Corrective Action
No display, but "ON" LED is lit	Battery power is fading	Install AC adapter to operate on AC power or install Alkaline cells to temporarily operate on battery power.
Display is incorrect, or menu highlight will not move, or other key actions do not respond.	Firmware has faulted	Power down with 10 second hold of ON/OFF key, This will save PRIOR good settings, NOT current settings. See Section 1-ON/OFF for more help and Soft Reset instructions.
Instrument will not turnoff	Firmware has faulted	Power down with 10 second hold of ON/OFF key, This will save PRIOR good settings, NOT current settings. See Section 1-ON/OFF for more help and Soft Reset instructions .

Power/Battery Charging Troubleshooting Guide

Symptom	Possible Issue	Corrective Action
Operational time is getting shorter with each use	1-One or more of the NIMH cells has gone defective. 2-NIMH cells are near end of useful life	1-remove the cells and check for cell with low voltage 2-Replace cells with new set of NIMH cells
Not very old cells are not recharging	1-Battery Type: NONE or ALKALINE selected 2-Charging power is not sufficient or not on 3-Battery temperature is too HOT or too COLD 4-Batteries are damage, have one or more defective cells, or dirty contacts	1-Select Battery Menu and change Type: to NIMH. 2-Vehicle power adapter output voltage maybe too low. 3-Allow batteries to cool or warm to charging range. If case feels hot remove belt case to cool cells. 4-Check for defective cell or clean battery compartment contacts
Instrument powers down unexpectedly	1-Battery Saver is ON 2-Batteries are too low to support operation	1-Select Battery Menu to turn Battery Saver OFF. 2-Recharge or replace batteries or operate on AC power
AC power is applied, but charging status is stuck in BATT CK or IDLE	1-Battery Type: NONE or ALKALINE 2-Defective or damaged cells or expired shelf life 3-One or more cells installed incorrectly 4-Mixed cells or incorrect cells 5-Deeply depleted cells	1-Select Battery Menu and change to NIMH 2-Inpect cells for damage or age (outgassing). 3-Check cell orientation against battery compartment polarity markings. 4-All cells should be same NIMH. No mixing or alkalines 5-Take longer to charge
Battery status jumps from BATT CK to IDLE	1-One or more cells is installed with reversed polarity 2-Damaged, defective, or alkaline cells installed	1-Check cells for correct polarity per battery compartment markings 2-Check for damaged, defective or alkaline cells installed
Replaced NIMH cells with 8 new NIMH cells, but battery life is short and charge cycle cuts short.	New cells must be conditioned to take a full charge and deplete normally	Cycle the cells through 3-4 full charge and full discharge cycles to obtain normal range usage.

Appendix A Specifications

SWR Site Analyzer Specifications	
Frequency Range	100KHz – 1.5GHz
Tuning/Display Resolution	1KHz
Refresh Rate	2.5 times/second
Frequency Display	250 points
Measurement Speed	10ms to 1s
Output Power	~ 0 dBm @ 50 Ohms
SWR	
Ranges	2:1, 5:1, 10:1, 20:1, 40:1 & 100:1
Resolution	0.01
Return Loss	
Ranges (dB)	1, 2, 5, 10, 20 & 50
Resolution	0.1dB
Frequency Domain Reflectometer (FDR)	
FDR Measurements	DTF, end of cable and Antenna RL
FDR Range @ 0.66c VF	0 to>5000ft (0 to>1524m)
FDR Accuracy	0.5% of Scale
Return Loss	
Ranges (dB)	2, 5, 10, 20, 40 & 80
Resolution	1dB
SWR	
Ranges	2:1, 5:1, 10:1, 20:1, 50:1 & 100:1
Resolution	0.1
Accuracy	+/-10% of scale
Battery	8 AA NiMH included, could use NiCad or Alkaline
Continuous Run Time (full charge)	Up to 4hrs
Recharge Time	~ 6hrs
AC Adapter (Included)	110-240 VAC 50/60Hz 0.4A Output: 15 VDC 1.2A
Memory	50 + Plots or Setups
PC Communications	Mini B USB, USB 2.0
Test Port Connector	N-type female 50 Ohm
Display	LCD Color, 190 x 320
Environmental	
Operational Temperature Range[2]	-4° to 131° F (-20° to +55° C)
Storage Temperature Range	-22° to 176° F (-30° to +80° C)
Relative Humidity	0-95% non-condensating Weather rain & dust resistant
Size	8.5" x 4.3" x 2.25" (216 x 109 x 57 mm)
Weight	2.3 lbs (1.04 Kg) with belt case and batteries
Warm-up time	10 Minutes
Software (included with product)	Site Analyzer PC Vision™

NOTES: For extreme cold weather operations see page C-1

VNA Site Analyzer Specifications	
Frequency Range	100KHz – 1.5GHz
Tuning/Display Resolution	1KHz
Refresh Rate	2.5 times/second
Frequency Display	250 points
Measurement Speed	10ms to 1s
Output Power	~ 0 dBm @ 50 Ohms
SWR	
Ranges	2:1, 5:1, 10:1, 20:1, 40:1 & 100:1
Resolution	0.01
Accuracy	±10% of scale
Return Loss	
Ranges (dB)	1, 2, 5, 10, 20 & 50
Resolution	0.1dB
Frequency Domain Reflectometer (FDR)	
FDR Measurements	DTF, end of cable and Antenna RL
FDR Range @ 0.66c VF	0 to>5000ft (0 to>1524m)
FDR Accuracy	0.5% of Scale
Ranges (dB)	2, 5, 10, 20, 40 & 80
Resolution	1dB
VNA Measurements (S11)	
Resistance	Range: 0 to 2KΩ, Resolution 1Ω
Reactance	Range: ±2kΩ, Resolution 1Ω
Total Z	Range: 0 to 2KΩ, Resolution 1Ω
Z Angle	Range: ±180°, Resolution 1°
Gamma Magnitude (rho)	Range: 0 to 1.0, Resolution 0.01
Gamma Angle (theta)	Range: ±180°, Resolution 1°
Two-Port Gain Measurements (S21)	
Log Loss	0 to -60dB
Phase Delay	Range: ±180°, Resolution 0.1°
Spectrum Analyzer	
Resolution Bandwidths:	10kHz, 30kHz, 100kHz, 300kHz, 1MHz & 3Mhz
Tuning Resolution:	1kHz minimum
Input Range:	+20dBm to -110dBm
Input Sensitivity:	-110dBm @ 10kHz RBW
Battery	8 AA NiMH included, could use NiCad or Alkaline
Continuous Run Time (full charge)	Up to 3hrs
Recharge Time	~ 6hrs
AC Adapter (Included)	110-240 VAC 50/60Hz 0.4A
Memory	50 + Plots or Setups
PC Communications	Mini B USB, USB 2.0
Test Port Connector	N-type female 50 Ohm
Display	LCD Color, 190 x 320
Environmental	
Operational Temperature Range	-4° to 131° F (-20° to +55° C)
Storage Temperature Range	-22° to 176° F (-30° to +80° C)
Relative Humidity	0-95% non-condensating Weather rain & dust resistant
Size	8.5" x 4.3" x 2.25" (216 x 109 x 57 mm)
Weight	2.3 lbs (1.04 Kg) with belt case and batteries
Warm-up time	10 Minutes
Software (included with product)	Site Analyzer PC Vision™

Appendix B

Site Analyzer Models and Accessories	Part Number	SWR Site Analyzer **6050-5000**	SWR Site Analyzer Kit **6050-5050**	VNA Site Analyzer **6050-5100**	VNA Site Analyzer Kit **6050-5150**
SWR Site Analyzer	6050-1000	√	√		
VNA Site Analyzer	6050-1100			√	√
Terminator Set: N Male Short and 50Ω Load	6015-1301	√		√	
AC Power Adapter/Charger	5001-0202	√	√	√	√
USB Cable A-to-mini B connectors	0070-1208	√	√	√	√
Belt Case	5001-1002	√	√	√	√
Quick Start Guide	6050-3010	√	√	√	√
Operator Manual	6050-3020	√	√	√	√
CD includes: Site Analyzer PC Vision™ Software,back up copies of literature and Site Analyzer Training PPT	6050-1220	√	√	√	√
Padded Kit Case	6015-1002		√		√
Vehicle Recharger 6 Feet	6025-0250		√		√
"N" to BNC Adapter	0070-1190		√		√
N type Male 3 Way Termination Set Open, Short and 50 Ω load	6025-0270		√		√

Optional Accessories:	Part Number
N to BNC Adapter	0070-1190
N to TNC Adapter	0070-1134
N to SO239 (UHF) Adapter	0070-1139
N type male 3 Way Termination Set Open, Short and 50 Ω load	6025-0270
N to SMA Adapters and Terminators Set	6025-0260
N Female Terminators; SHORT & 50Ω LOAD kit	6015-1302
BNC Terminators, Short and 50 Ω Load kit	6015-1303
BNC Coax Test lead, 6ft (2m) P/N	0070-1500
Vehicle adapter/charger	6025-0251
Soft Carrying Case	6015-1002
Hard Carrying Case	6015-1003
Certificate of Calibration Site Analyzer	6050-0700
Certificate of Calibration Site Analyzer with before & after data	6050-0710

Appendix C - Cold Weather Operation

As the temperature drops the Site Analyzer's display may slow down or fade and the NIMH AA cells may not produce the milliamps required to power the instrument. Refer to Appendix A for Operating Temperature Specifications. The Site analyzer generates its own heat from three sources: Batteries' chemistry while discharging to power the instrument, its circuit boards using that power, and its LCD display. The following are tips to help with cold weather operations as temperatures approach or go below the minimum operating temperature:

1. If you are headed to a cold outdoor location turn the Site Analyzer ON while still in a warm location i.e. truck's cab while enroute to the location or a heated building. Do this with the Belt Case on and closed. This will pre-warm the instrument against the impending cold air.
2. Keep the Site Analyzer in its Belt Case and the Belt Case cover closed as much as possible. If there is wind, keeping the site analyzer inside a warm jacket you are wearing when not in actual use can give it extra operating time outside in the cold.
3. If AC power is available, try adding the AC power adapter. Charging while operating the Site Analyzer generates more heat from the batteries, plus having the extra power input adds to the available amperage if the batteries' output is being diminished by the cold.
4. Select the Meter Menu, then ENTER Battery Menu and highlight Battery Saver and use the left/right arrow keys to turn Battery Saver OFF. This will prevent automatic shutdown and keep the Site Analyzer running warm between actual testing uses.
5. If the Site Analyzer shuts down in the cold or has been outside in a vehicle or cold building all night, move it back to a warm location and remove it from the Belt Case to revive it, then replace the Belt Case and use steps 1-4 above to try to operate again in the cold.
6. If you are wearing gloves and it is hard to detect the key's activation click through your fingers, go to the Meter Menu and select Key Pad Beep and use the left/right arrow keys to select ON. This adds a beep tone with the key press activation.

AEA Technology, Inc.

Testing Made Simple

5933 Sea Lion Place, Suite 112
Carlsbad, California 92010
Tel: 1-800-258-7805 or +1-760-931-8979
Fax: +1-760-931-8969
www.aeatechnology.com