Operation Manual

Liberator Series

Bravo MRI 3000 Analyzer

Testing Made Simple!

Technology, Inc.

Proprietary Information

Acknowledgements:
Windows 7, Windows 10, and Power Point are registered trademarks of Microsoft Corp. WD-40 is a registered trademark of WD-40 Company
409 cleaner is a registered trademark of Clorox Corporation

6055-3020 October, 2021

WARNING

DC Port and A/C Adapter

Power requirement 12-18 VDC, 1.2ADC Max

Connecting and Operating the Analyzer 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 connect the MRI-3000 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 MRI 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.

Operating Precautions

Although the Bravo MRI 3000 is a rugged instrument, care should be taken to avoid exposing it to excessive external RF or a Magnetic Field. Do not connect the Bravo MRI to an active transmitter. The Bravo MRI Should Not be allowed to get closer than 3 feet (1 meter) with a 1.5T Coil, and 5 feet (1.5 meter) with a 3T Coil

The MRI 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.

The Test Port is limited to +15dBm input power. Power exceeding this level could damage sensitive input components.

Batteries

Due to the strong magnetic fields involved with MRI servicing, the use of batteries is not recommended. Both the Bravo MRI unit and the MRI unit under test could be more susceptible to damage if batteries were installed. for convenience we provide a 20 ft long DC extension cord to use with the Ac adapter plug, if you must use batteries follow operating precautions instruction and keep the analyzer a min of 3 feet (1 meter) away from the magnet

When batteries are required you can use Alkaline, NI-MH, LiION "AA" Batteries in the MRI Analyzer, but when installed go to the Battery Menu and change the Battery Type to ALKALINE, Rechargeable or NON.

Please note rechargeable batteries can't be charged inside the unit.

Cleaning

Under ordinary operating conditions, it should only be necessary to occasionally wipe the VIA Bravo MRI with a soft, water moistened cloth. Avoid using solvents which may attack the plastic.

Battery Precautions

Failure to carefully observe the following procedures and precautions can result in leakage of battery fluid (electrolyte), heat generation, bursting, fire and serious personal injury.

- Never dispose of batteries in a fire or heat them. Doing so may cause them to burst.
- Do not connect the + (positive) and - (negative) terminals of batteries together with electrically conductive materials, including lead wires.
- Never disassemble batteries.
- The + (positive) and - (negative) terminals of batteries are predetermined, observe polarity.

WARNING

1. Keep batteries or the equipment out of the reach of infants and small children.
2. Do not use batteries if the outer tube/label is scratched or damaged.

CAUTION

1. Do not use old and new batteries mixed together, or batteries at different charge levels. Do not use Ni-MH batteries mixed together with a dry cell or other battery of a different capacity, type, or brand name.

2. After they have been removed from equipment, store batteries in a dry place and within the recommended storage temperature range.

Electrostatic Discharge (ESD) Precautions

The MRI-3000 Analyzer was constructed in an ESD protected environment. This is because most of the semiconductor devices used in this instrument are susceptible to damage by static discharge.

Static charges are generated in numerous ways, such as simple contact, separation of materials, and normal motions of persons working with the Analyzer. To prevent instrument damage, practice industry accepted techniques for handling static sensitive devices when using the MRI-3000. Very often, coaxial cables and antennas also build up a static charge, which, if allowed to discharge by connecting to the Analyzer, may damage the instrument input circuitry. To avoid such damage, it is recommended to dissipate any static charges by temporarily attaching a short to the cable or antenna prior to attaching to the instrument.

If this instrument does become subject to ESD, be advised that the instrument may reset itself in this event, and re-entry of the sweep parameters may be necessary.

The MRI Analyzer is designed to be safely operated in normal testing environments. 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

If you have any questions concerning the use of the MRI Analyzer or other AEA Technology, Inc. instruments please contact us at:

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

MRI-3000 Literature Introduction

There are two literature items available for the MRI 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 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 than 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 available on line or the enclosed CD in PDF format ready for printing.

NOTES:

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

Table of Contents

MRI Analyzer Description

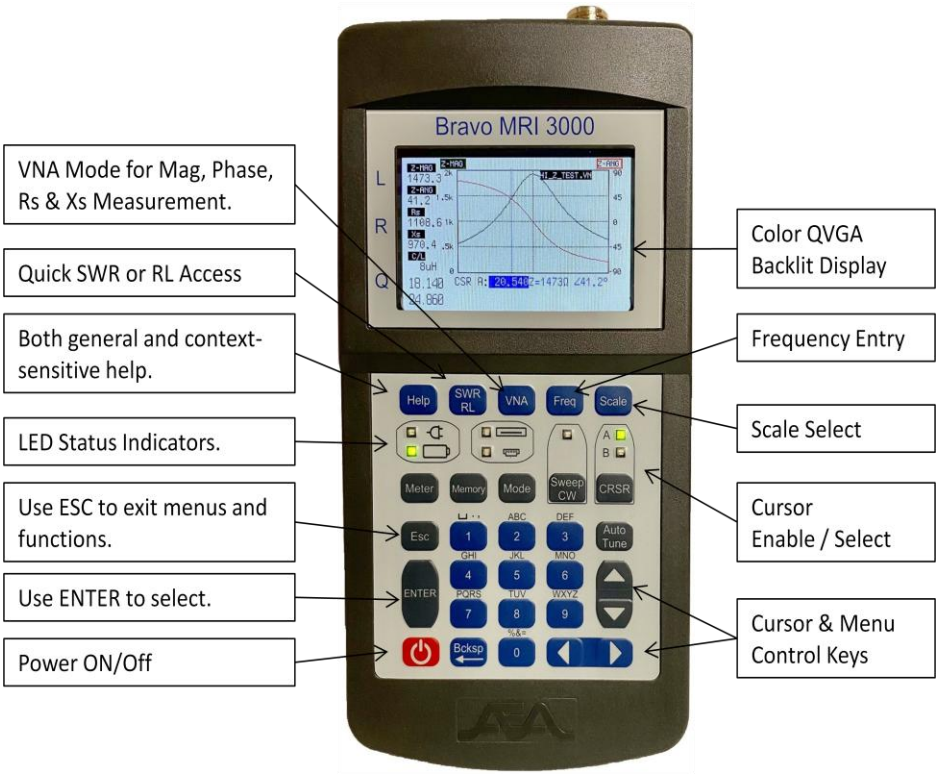
General

The MRI-3000 analyzer measures complex impedances of electrical components. In particular, its design has been focused on making these measurements on the circuitry used in MRI machines. The results of the measurements are displayed graphically, with some numeric detail. You may choose to display the impedance from among several formats. The MRI-3000 sweeps across a range of frequencies, or operates at CW, either way the display is continuously updated with new measurement results. This unit has many applications, including, but not limited to:

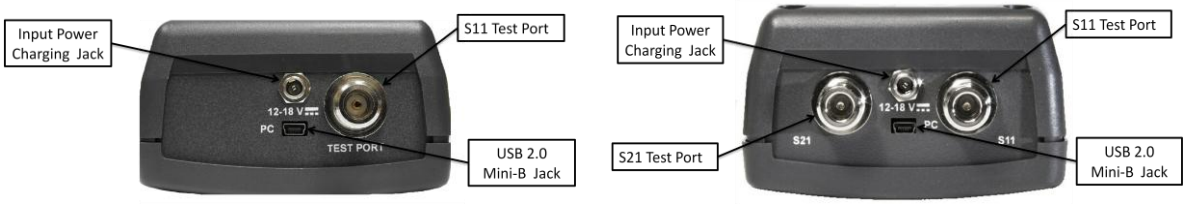
1. Tune/align MRI coils (transmit and receive)
2. Measure Z, Phase Angle, Resistance, and/or Reactance of a load
3. Portable and economic replacement for network analyzer applications that measure S_{11}.
4. Find resonant frequency and response curve
5. CW signal generator
6. Two plots may be simultaneously viewed on the same graph.

The MRI-3000 communicates with your PC via the MRI PC Vision™ application software allowing the user to remotely control the instrument or view results on the PC's much larger display, in either X-Y or Smith Chart plot format. The impedance altering effects of coax cable can be nulled out, so that the load at the end of the coax is displayed. The MRI-3000 operates over a wide range of characteristic impedances, so you are not limited to measuring 50 ohm systems.

Operator conveniences include: Non volatile storage, back lit display, display brightness adjustment, versatile output displays, and USB port communications. Internal Batteries (8 AA batteries, not included) power the MRI-3000 in situations where wall power is not available.



Instrument Front Panel Layout



Single Port Model

Dual Port Model

Instrument Top Panel Layout

Screen Layouts

General

The MRI-3000 has two operating modes, VNA and SWR/RL. Each single-port mode has two possible screen layouts, Wide and Narrow. Dual port mode (S21) is displayed in Wide only. This gives a total of five possible screen layouts, which will be described here.

The MRI-3000's measurement screens are divided into two sections: The chart or graph section, and the sidebar section. The Graph section is where the instruments measurements are graphically represented by plots on a chart. This graph will display a different number of points depending on the width selected. The sidebar section to the left of the chart, numerically indicates measurements *at center frequency*. The size and content displayed also varies depending on the graph size selected. The sidebar indications ALWAYS represent their respective measurements at center frequency (f0).

VNA Mode Screen Layout (Wide Format)

VNA Wide Format

Shown above is the VNA mode screen, in wide chart format. Features of interest are as follows:

Left & Right Scale indicators: These labels, in the upper corners of the chart area, indicate which measurement that scale is for, and, more importantly, which trace is using that scale. The color of the frame drawn around the label is always the same color as the trace using that scale.

Displayed Frequency Range: Displayed in the lower left of the screen, they indicate the frequency endpoints *actually displayed on the chart*. The trace actually has points not visible on the chart, and these can be viewed by enabling a cursor, and rolling the cursor past the left or right edge of the chart, which will cause the graph to scroll left or right. This will also cause the frequencies displayed to be updated as appropriate. When there are no cursors enabled, the upper frequency is displayed near the lower right corner of the chart.

Cursor Frequency: For each cursor enabled, the cursor's frequency is displayed as shown. In the above illustration, the cursor frequency is displayed highlighted-- indicating that it is selected, and can be moved using the LEFT & RIGHT arrow buttons. As the cursor is moved, this frequency value is updated.

Left & Right Scale Cursor Values: Immediately to the right of the cursor frequency, are the Scale Cursor Values. These are the measurements for the frequency at which the cursor is positioned. They are updated for every sweep.

It should be noted, that all of the above elements are common to both the VNA and SWR mode wide-format screens. As previously mentioned, the MRI-3000's screen is composed of the chart area, and the sidebar area (on the left side of the screen). In VNA mode, the sidebar in wide chart format is made up of the following indicators (all of which represent their respective measurements *at center frequency*):

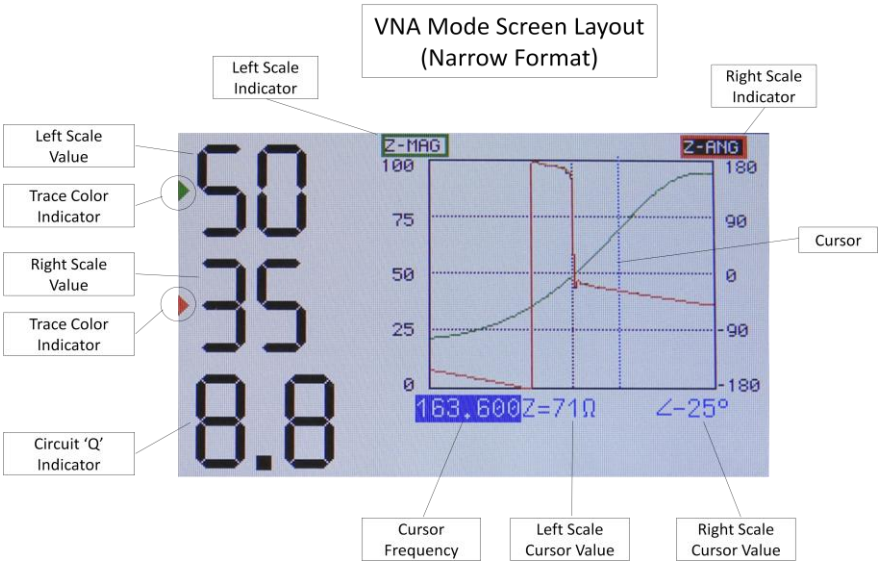
Impedance Magnitude: Labeled "Z-Mag", this is the vector sum of the impedance's resistance and reactance components. This value is in Ω.

Impedance Angle: Labeled "Z-Ang", this is the relative phase shift of the impedance, in degrees.

Resistance: Labeled "Rs" is the resistive component of the impedance, in Ω.

Reactance: Labeled "Xs" is the reactive (i.e. complex) component of the measured impedance, in Ω. Reactance values can be positive or negative.

Capacitance / Inductance: Labeled "C/L", this indicator calculates the value of the equivalent series or parallel reactive component to give the measured complex impedance. If the reactive part of the impedance is negative, this value will be represented as a capacitance value. If it is positive, an inductance value will be displayed. The RLC model used in the calculation can be selected from the 'OTHER OPTIONS' menu, on Page 15.



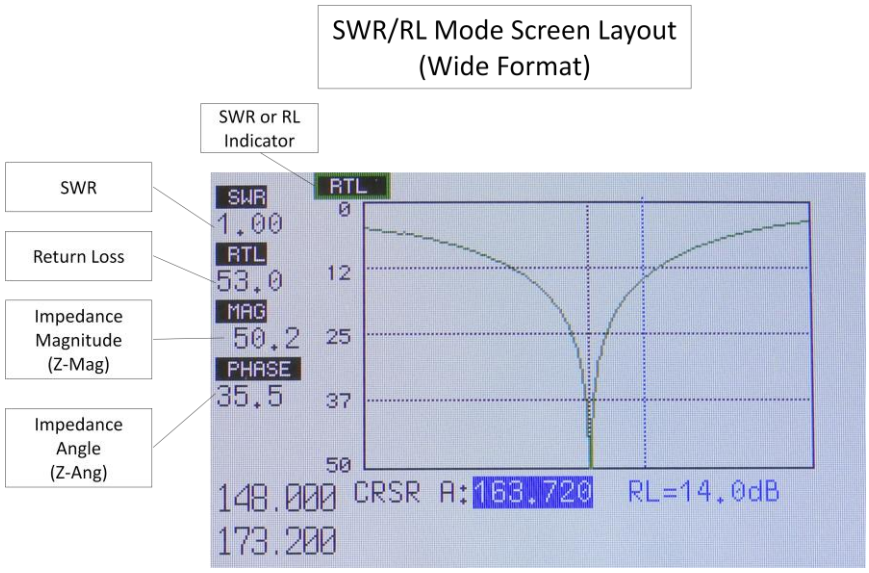
VNA Narrow Format

Shown above is the VNA mode presented in narrow chart format. In this mode, the chart is windowed to 152 points visible. Note that the left and right scale indicators are still present, as well as the cursor frequency, left and right scale cursor values displayed below the chart. As was the case in wide chart format shown previously, moving the cursor past either edge of the chart will cause the chart to scroll, revealing the data points that were previously not visible.

The sidebar now has fewer indicators, and the numerals for them are much larger-- enabling the user to see them from a distance. The top indicator will always be the measurement for the left scale, at center frequency. The trace color indicator (the triangle to the left of the indicator) gives the user a visual cue as it will always be the same color as the trace that it belongs to.

The second indicator will always be the associated with the chart's right side scale, and the trace color indicator will be the same color of that trace as well.

The third indicator will not always be present. This is the indicator for the value of 'Q' for the circuit under test. In VNA mode, the 'Q' factor is displayed only when narrow chart format is selected (shown here), and only if the impedance magnitude ('Z-MAG') is selected for either scale. The 'Q' factor measurement will be explained in detail later in this document.



SWR/RL Wide Format

Shown above is screen of the MRI-3000 in SWR/RL mode, with wide chart format selected. This appears similar to the screen in VNA mode, with some differences. In SWR/RL mode, only the left scale is displayed, and only one trace is drawn on the chart. Only two measurements can be selected to be plotted on the chart, SWR and RL (return loss). Pressing the SWR/RL key will cause the displayed trace to switch between SWR and Return Loss.

The Sidebar to the left of the chart contains the following indicators, which will always be present for this mode and chart format, and will *always* be the measurement at center frequency:

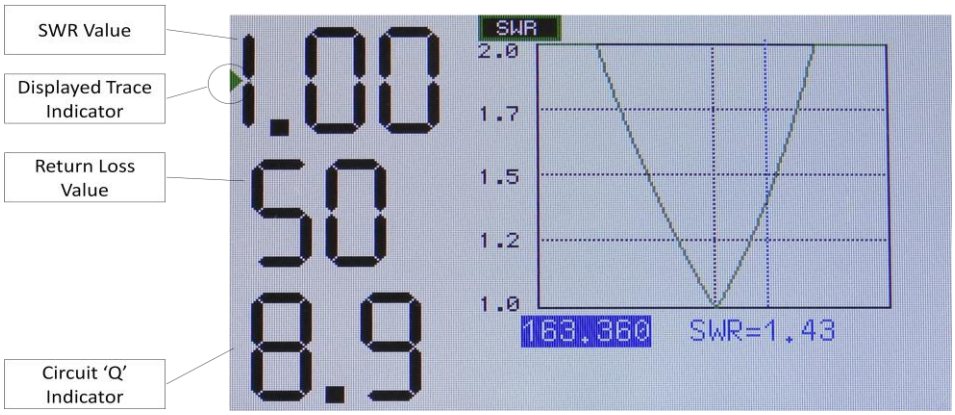
SWR: This indicator displays the Standing Wave Ratio measurement of the current trace *at center frequency*.

Return Loss: Labeled 'RTL' this indicator is the measured return loss of the unit under test.

Impedance Magnitude: Labeled "MAG", this is the vector sum of the impedance's resistance and reactance components. This value is in Ω, and is the same measurement as the one in VNA mode.

Impedance Angle: Labeled "PHASE", this is the relative phase shift of the impedance, in degrees. It's the same as the equivalent in VNA mode.

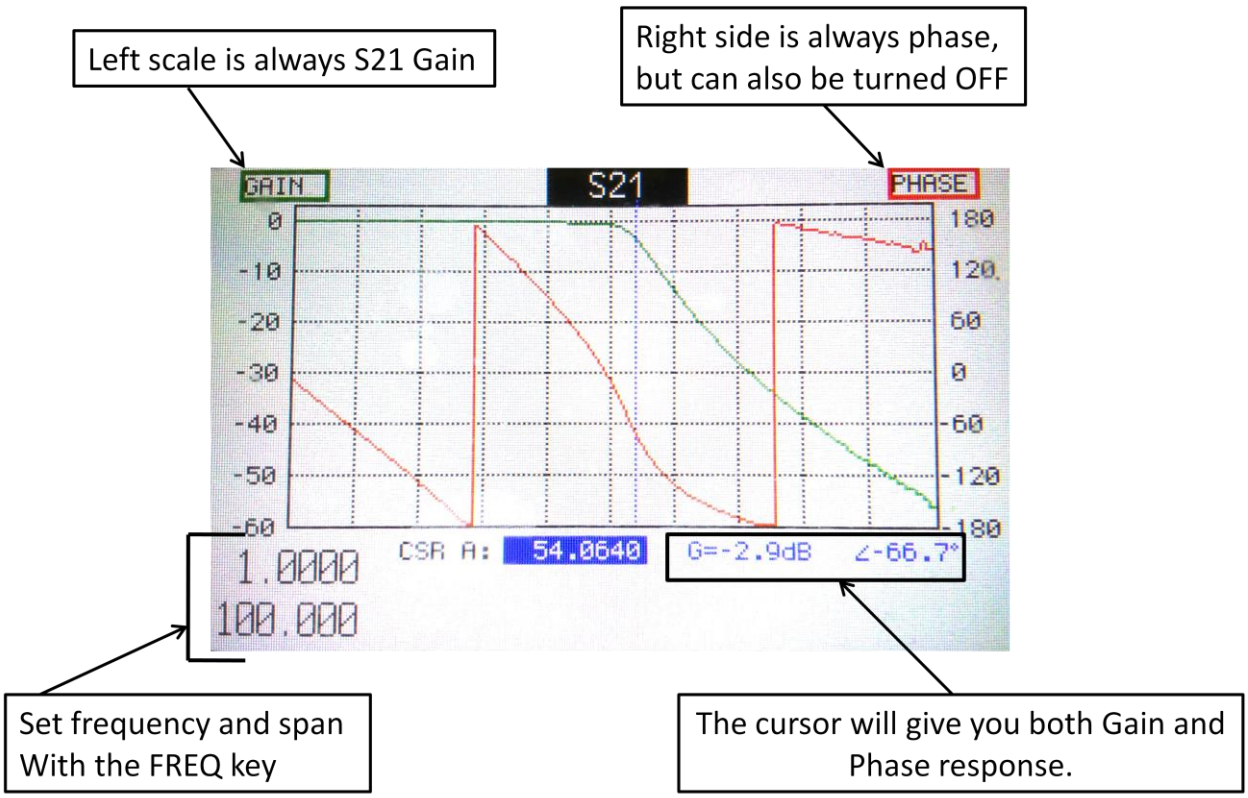
SWR/RL Mode Screen Layout
(Narrow Format)



SWR/RL Narrow Format

Shown above is the SWR mode presented in narrow chart format. In this mode, the chart is windowed just as it is in VNA mode. Cursor operation is the same, with only the left scale displayed, and selected by pressing the SWR/RL key.

Due to there being only two graph possibilities (SWR & RL), on this screen the top indicator will always display the SWR at center frequency, the second indicator will always display the Return Loss (again, at center frequency), and the third will always display the calculated 'Q' factor. The displayed trace indicator (the triangle on the left) will always be the same color as the trace, but it will move to point to the appropriate indicator whenever the SWR/RL key is pressed.



S21 Screen format

Shown above is the instrument's screen as it appears for Dual-port (S21) measurements. The left scale will always be GAIN in dB, and the right scale will always be PHASE in degrees.

Keypad Operations

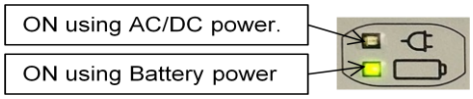
Power ON/OFF

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 test screen in use 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. 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 which also saves all the settings.

HARD POWER DOWN – Press and hold the ON/OFF key for ten seconds. This forces the MRI-3000 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 MRI-3000 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

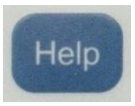
- With the MRI-3000 OFF, Press and hold the ENTER key
- Press and release the ON/OFF key to power the MRI-3000 ON.

- After power comes on... (~1 second) release the ENTER key
- Display will allow you to confirm reset to factory default settings.

- When Measurement Screen appears you can recall a saved setting or set desired settings

Menu Keys

These keys bring up the Meter Settings, Options settings, and Memory Operations menus, respectively. For details, please refer to the **Menus** section, on page 11.



Function Keys

Help Key

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.

SWR/RL

Press the SWR/RL key to directly access SWR & RL. Once there, pressing SWR/RL will alternate between SWR and Return Loss modes. See section 3**:** **Measurement Screens** for information on cycling modes, setup, and scales.

VNA Key

Press the VNA Key to access complex impedance measurements such as Z-Mag, Z-Angle. See section 3 **Measurement Screens** for information on cycling modes, setup, and scales.

FREQ Key

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

- Press FREQ once to enter START and END FREQUENCIES.
- 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. See

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SCALE Key

The Scale key is used to cycle through preset vertical scales on the measurement screens. SWR and RL 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.

SWEEP/CW Key

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 the **Measurement Screens** section on page 17 for information on setup and cycling through the readings list. To exit Sweep/CW, press SWR/RL or VNA 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:

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.

A. Saves alpha-numeric entries and moves to the next step.

B. In the Mode Menu the ENTER key activates the highlighted sub-menu.

The Auto Tune key works slightly differently in SWR/RL and in VNA mode, but in both cases it only functions with one or both cursors enabled. In SWR and RL, pressing Auto Tune will cause the selected cursor to seek to the LOWEST point on the graph. In VNA Mode, the cursor will seek to the highest impedance point on the graph.

The up/down arrow key has the following uses:

In the menus it moves the menu selector to a desired item on the vertical menu list.

In the Memory Operations screen, it moves the file select highlight up or down one file entry at a time.

In the measurement screens the UP arrow moves the highlight between scales or other measurement parameters to make changes to that parameter.

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 Page 11 for Menu Navigation.

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 an underscore. Use as 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.

Menus

Menu Navigation

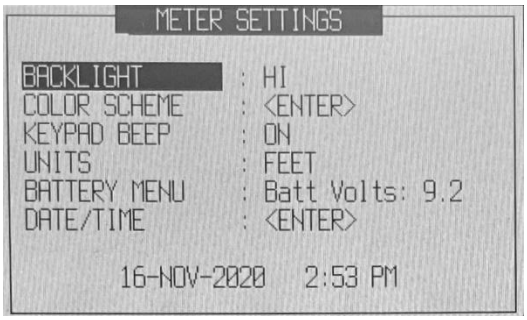
Menus contain two types of lists; vertical list is the one you can see all items available and horizontal lists that only show the selected item's options; mode or value. The other horizontal selections are hidden. Navigation is accomplished as follows:

1. Use the UP/DOWN arrow keys to select (highlight) the desired item in the vertical menu list
2. 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.
3. Use the ENTER key as indicated to call a sub-menu of selections. Navigation in sub- menus works the same.
4. 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.

Meter Menu

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.

The menu appears:



Below is a list of items and their options:

BACKLIGHT

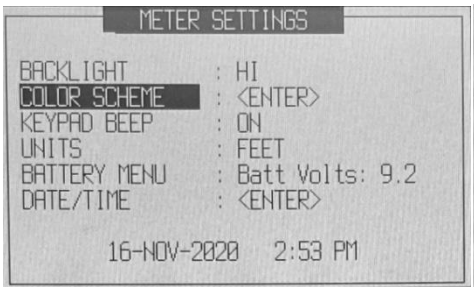
LO, MED, HI Press  to make a selection

(recommend MED for best light with less battery power consumption)

COLOR SCHEME

Selecting the 'COLOR SCHEME' menu item from the 'Meter' menu brings up this screen:

COLOR SCHEME: Press ENTER to open sub-menu:



This allows you to adjust the color of the various items on the MRI-3000's screen. When any item on this menu is selected, you can use the (left and right arrow) buttons to select the color for that item from a palette of 16 colors.

Color-settable items are:

TRACE A – This will be the color of the trace for the left scale.

TRACE B – Selects the color of the trace for the right scale.

CURSOR A – Set the color for the 1st cursor

CURSOR B – Sets color of the 2nd cursor

MENU TEXT -- This sets the color of all of the menus, all of the text items that appear on measurement screens, as well as the color of the chart graticule.

BACKGROUND– Just what it says: The backdrop against which EVERYTHING is painted. Take care that your background color has enough contrast against the menu text (set above).

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.

KEYPAD BEEP

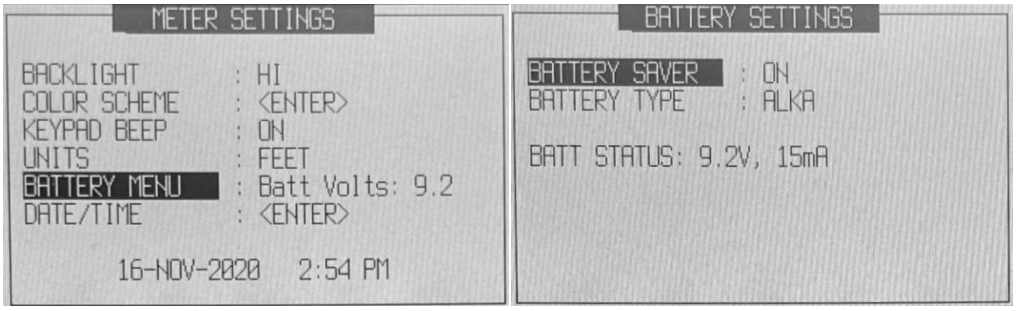
ON or OFF. Press to make a selection.

UNITS

FEET or METERS Press to make a selection

BATTERY MENU

Press ENTER to open sub-menu. Selecting the BATTERY MENU item from the 'Meter' menu will bring up the battery settings screen:



There are only two settable items here:

BATTERY SAVER: Setting this option ON will cause the unit to automatically power down in 5 minutes after last key press. This is a normal power down and all modes, set-ups and calibrations are saved and recalled on powering back up. This feature is not recommended when working with the MRI PC Vision software. Auto power downs will interrupt communications between the PC and MRI-3000.

BATTERY TYPE: When batteries are required you can use "AA" batteries of any type. This option sets the type of battery used in the unit. The possibilities are NO BATTS, ALKALINE, or RECHARGABLE. This selection is necessary as Rechargeable and non-rechargeable batteries are of different voltages.

BATTERY STATUS: Cells total voltage and Current draw are displayed in mA.

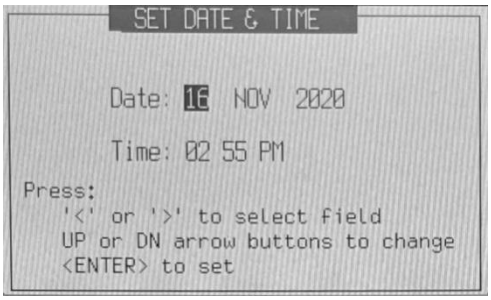
DATE/TIME

Press ENTER to open sub-menu to set date/time (see below).

Press ESC to exit the Meter Menu.

SET DATE & TIME screen

Selecting **DATE/TIME** from the Meter menu will bring up the date/time set screen:



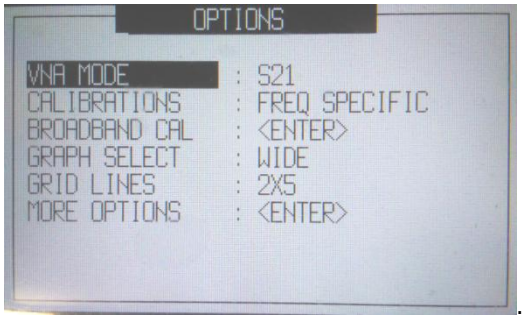
Use  keys to select the field to be changed. Use UP/DOWN arrow keys to modify.

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.

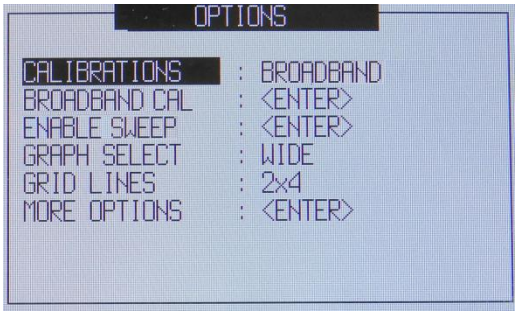
Mode Menu

The Mode Key of the MRI-3000 will open the OPTIONS screen. This allows you to change the various measurement options and settings for the instrument. Use UP/DOWN arrow keys to select (highlight) desired selection and LEFT/RIGHT arrow keys to select options in horizontal menu list or use ENTER to go to a submenu where indicated.

On a two-port MRI-3000, you will see this screen:



On the Single Port Model, the option screen looks like this:



The items on this menu are:

VNA MODE (Dual Port Models Only)

This option will allow you to select the operating mode for the VNA function of the instrument. There are two possible selections (use the button):

- **S11** - This enables single-port impedance analysis, including impedance magnitude and impedance phase. Used to analyze single-port devices such as antennas and terminated feed lines.
- **S21** - This enables two-port analysis, primarily for gain measurements on two-port networks such as filters and attenuators.

CALIBRATIONS

This option selects the type of calibration method to use for measurements. There are two possible selections (use the button):

- **BROADBAND** - When BROADBAND is selected, instrument calibration is performed over the MRI-3000's entire frequency range of 100KHz to 450MHz (See Section 4 for procedures). After that, any frequency range can be selected without having to re-calibrate. This form of calibration will provide good accuracy with the convenience of not having to recalibrate for each frequency or bandwidth change. For the most accurate measurements select "Frequency Specific" (below).
- **FREQUENCY SPECIFIC** - This calibration mode will require recalibration with any change in frequency or bandwidth (Span). In this mode, the MRI-3000 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.

BROADBAND CAL

This option will initiate the broad-banded calibration cycle. This calibration is stored in the unit, and is valid anywhere in the units operating range. The Broadband calibration may be performed 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 as it gives better accuracy overall. 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 the precision 3 way Open, Load and Short.

SWEEP ENABLE

Press ENTER to re-enable the sweep. When the sweep is running, the LED above the SWEEP/CW button will flash. This option is available as the MRI PC Vision software may, during normal operation, turn the MRI-3000's sweep OFF. If the sweep LED is not blinking, use this option to turn the Sweep back ON before starting calibration or testing.

GRAPH SELECT

Pressing <ENTER> with this menu item selected, will switch the display between wide and narrow-format graphs. The narrow format graph setting also features large-font measurement format. This selection is NOT applicable in S21 mode.

GRID LINES

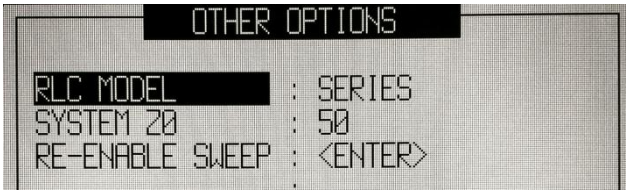
Pressing <ENTER> with this menu item selected will change the number of grid lines on the graph. You can select between 2x2, 2X4, and 2x5 divisions on the chart.

MORE OPTIONS

Selecting this menu item, will take you to sub-menu to set other, less frequently used settings. (See next section: OTHER OPTIONS, below)

OTHER OPTIONS Menu

This menu is accessed via the MRI-3000's OPTIONS menu. It allows the setting of some of the less frequently used settings. Please note, in single port models, the RE-Enable Sweep option does not appear here.



RLC MODEL

This sets the circuit configuration to use when calculating the equivalent inductance or capacitance of the circuit under test. When the complex impedance of a single-ended device is measured, this can be expressed as a combination of resistance and reactance (R + jX). The value of X in terms of equivalent capacitance or inductance will depend on whether that reactance (X) is in parallel or in series with the resistance (R). For the equivalent L or C to be calculated correctly, the user must specify which circuit model to use.

SYSTEM Z_0

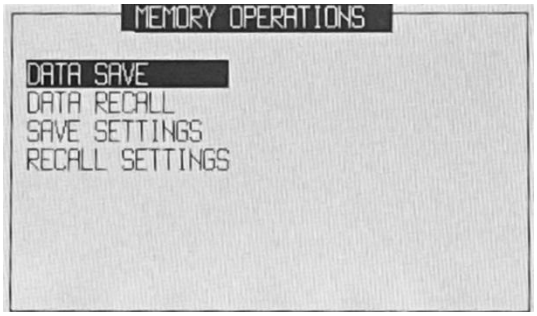
Allows the setting of the MRI-3000's reference impedance (Z_0) to something other than 50Ω (which is the default). This to be used on systems that do not use a Z_0 of 50Ω. While it is possible to set this parameter to ANY value, reasonable values will range from 15Ω to 300Ω.

RE-ENABLE SWEEP

Press ENTER to re-enable the sweep. When the sweep is running, the LED above the SWEEP/CW button will flash. This option is available as the MRI PC Vision software may, during normal operation, turn the MRI-3000's sweep OFF (This is especially true when using PC-Vision). If the sweep LED is not blinking, use this option to turn the Sweep back ON before starting calibration or testing.

MEMORY OPERATIONS

The Memory menu is for saving and recalling test results and settings to/from the MRI-3000's internal memory. Pressing the MEMORY key brings up this menu:



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.

Measurement and Support Screens

General Information

The MRI 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
- **VNA** -- Complex impedance analysis.
- **CW Mode** – Continuous Wave mode

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 MRI-3000 returns to the selected measurement screen.
- **BROADBAND CAL** – 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 for the Load Terminator is complete, the calibration process is completed and the MRI-3000 returns to the selected measurement screen.

NOTE: BROADBAND CAL 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 during the broadband calibration, those items are calibrated with the instrument. These MUST be attached to the instrument for measurements using that calibration. If there is no test lead, antenna feed line, or adapters attached during the broadband calibration, the MRI-3000 will be calibrated only 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 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 select the desired scale. In the case of SWR or RL there is only one scale on the left, so the Scale key can be used at any time to adjust the measurement screen's SWR or Return Loss scale.

Cursors can be used to get measurements anywhere on the displayed trace. Cursors are enabled by pressing the CRSR key. It is possible to have one or two cursors on the screen at once. Pressing the CRSR key the first time will enable the first cursor (CRSR A), pressing CRSR again will enable the second (CRSR B). Cursors can be moved to the desired frequency via the LEFT/RIGHT arrow key. If both cursors are enabled, pressing the CRSR key will toggle the cursor that is currently selected. The cursors' FREQUENCY field will be highlighted when selected, allowing you to select the cursor you wish to move. The LEFT/RIGHT arrow keys will move the selected cursor only.

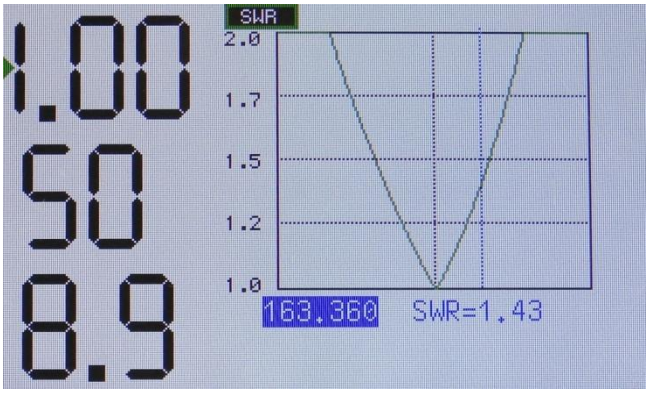
When both A & B cursors are selected a CRSR Δ (differential) reading will appear below the B cursor. Holding down the LEFT/ RIGHT arrow keys will increase the cursor movement speed.

NOTE: When the cursors are active, if you move them past either end of the displayed trace, the trace will scroll to reveal data points not previously visible. This is particularly noticeable when the graph is displayed in narrow format.

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.

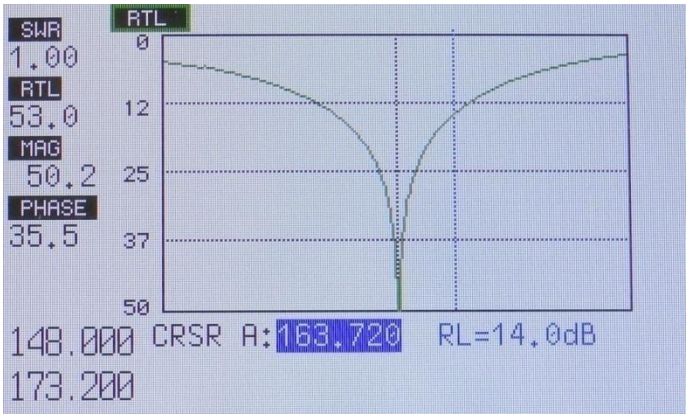
SWR Screen

SWR/RL key switches between SWR and Return Loss
Scale key cycle s scale through preset ranges



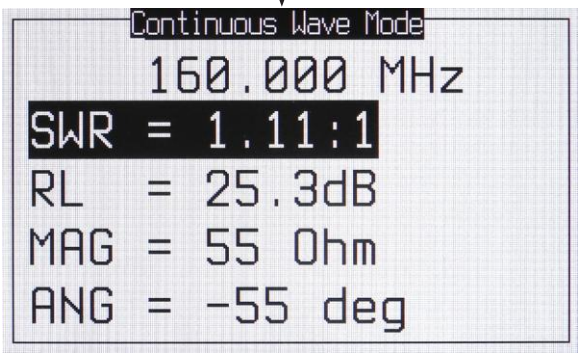
Return Loss Screen

SWR/RL key switches between SWR and Return Loss
Scale key cycles Return Loss scale through preset ranges



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).

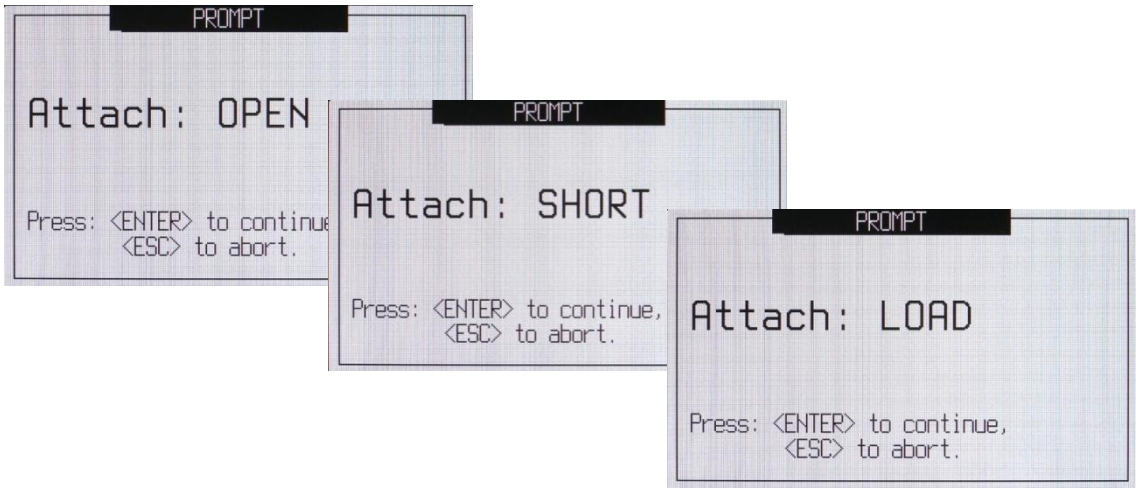


When the MRI-3000 is in Continuous Wave mode, only the Center Frequency will be transmitted. Eliminating the Swept Frequency eliminates the need to graph the results and only values at Center Frequency are posted as a digital result. This permits faster viewing of any changes during DUT tuning being 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 for single-port measurements, and will return the MRI-3000 to the previously selected measurement screen.

For two-port (S21) measurements, a fourth prompt screen will prompt you to attach a through cable from S11 to S21 before finishing.

Caution: Pressing <ESC> at any time while this process is in progress will leave the instrument in an un-calibrated state.

MRI-3000 VNA Measurements

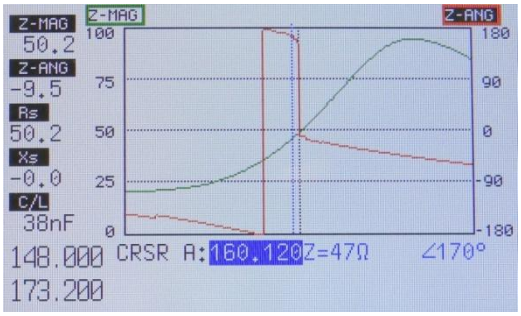
General Information

VNA PLOT - Vector Network Impedance Analysis

S11 VNA SCREEN

The VNA screen (shown here in narrow format) 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 (|S11| or Impedance Magnitude in Ω), Z-Ang (S11 phase angle in degrees), Rs (resistance) and Xs (reactance). 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.



VNA Screen shown above in wide format.

S21 VNA Screen (Two-Port Model only)

The S21 VNA Screen shown above illustrates how the MRI-3000's Two-port capabilities can be used to analyze a two-port device; in this case, a low-pass filter. Unlike for a single-port measurement, the parameters measured cannot be changed: This always displays GAIN and PHASE (although, the phase trace can be turned off). The cursors work the same as for a single-port measurement, although this display is always in 'wide' format.

Calibration, Measurement Information and Helpful Tips

Calibration Processes

The MRI-3000 has two types of calibrations; Broadband and Frequency Specific.

Broadband is a calibration that is done once, using the Site Analyzer's entire frequency range 100KHz to 450MHz and saved for use with any shorter frequency ranges selected for use. The advantage of using Broadband Calibration will be that recalibrating the instrument for every change of frequency will not be needed. It can also include any combination of test leads or adapters, effectively removing them from the measurements. However, that same test lead / adapter combination 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 as accurate as **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 MRI-3000. The disadvantage is that it requires a recalibration process with any frequency change. Frequency Specific Calibration can be done with any combination of test leads or adapters, allowing them to be effectively removed from the measurements. When prompted, apply the terminators (Open, Short and 50Ω Load) to the far-end of the test lead (if you're using those), or directly to the instrument's N connector. If a test lead and/or adaptor is used, they must remain attached during any measurements at the calibrated frequency range.

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, 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 MORE OPTIONS. Press ENTER.
3. From the OPTIONS menu, select BROADBAND CAL, press ENTER.
4. 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.
5. Press ENTER to continue.
6. Second prompt will be to attach the SHORT Terminator.
7. When attached press ENTER to continue
8. The last prompt will be to attach the LOAD. Normally this will be a 50 Ω load supplied with the instrument or purchased locally.
9. When attached press ENTER to continue and end the Broadband calibration process. The MRI-3000 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 the 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, 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 generally suffice, although using the OPEN cal standard will yield the most consistent results.
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 MRI-3000 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 MRI-3000 will cycle back through the Frequency Specific Calibration process again.

SWR (Standing Wave Ratio a.k.a. 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. 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 MRI-3000. 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.
5. If you are probing an indeterminant or unknown system, it is recommended to use the MRI-3000 with a Broadband Calibration starting with a wide frequency sweep. Gradually change the center frequency and span to locate the frequency(ies) of interest. You can then switch to a frequency specific calibration to make more precise measurements if desired.

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 MRI-3000 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.

MRI PC Vision™

Abstract

MRI PC Vision™ is the companion windows application for your Bravo MRI 3000 Analyzer. Besides allowing for remote operation of your MRI-3000, it also contains tools and utilities to help you get the most out of your instrument.

Installing MRI PC Vision

MRI PC Vision™ will support 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\MRI-Vision

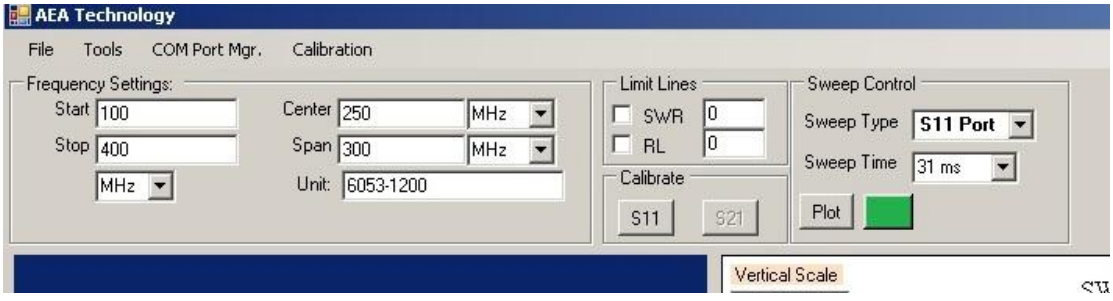
All of your pertinent user data, downloads, traces, etc. will be stored there.

Running MRI PC Vision

Start the MRI PC Vision Application by either clicking on the icon on your desktop, or by selecting it from the start menu.

When the MRI PC Vision application is started, it will detect the instrument if it is powered ON, and connected to a USB port. If the MRI-3000 is not plugged in when the MRI PC Vision application is started, the application will sense your unit when you attach it with a USB cable to any USB port on your PC. The following dialog box will be displayed when the connection is being initialized:

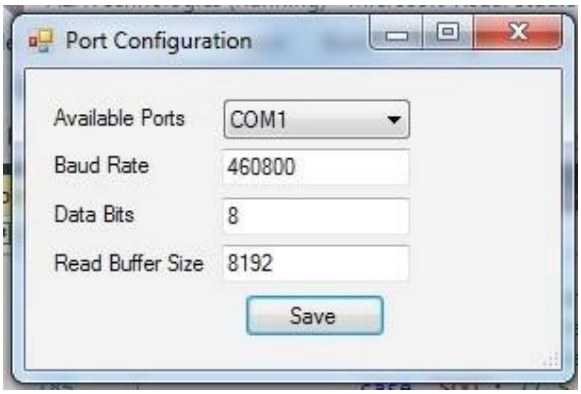
The MRI PC Vision application will signal to you that it has successfully detected and attached your instrument by indicating the instruments' model number (marked 'Unit'), and changing the status light from red to green, as shown in the screen shot below:



If the MRI-3000 remains disconnected, you will still be able to load and view previously stored data traces.

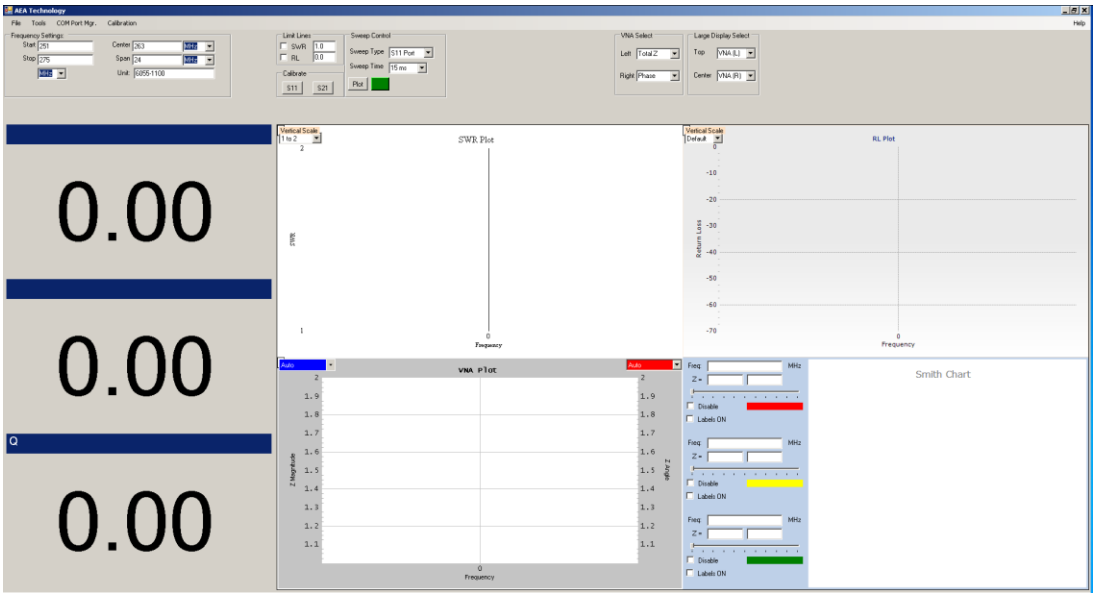
Under certain circumstances, the MRI PC Vision application may not be successful in connecting to your instrument. This is most likely to happen when there are USB to RS232 adapter cables, or similar devices already attached to your PC. In this case, the status indicator will remain red:

If this occurs, you may have to attach the instrument manually. To do this, select **COM Port Mgr->Com Port** from the dropdown menu at the top to open this dialog box:



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 port, and press ‘Save’.

Once the MRI PC Vision application establishes communication with the MRI-3000, you should get a screen similar to this one:



Display Screen

There are two main areas of the MRI PC Vision display:

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

The control/settings area fills the upper portion 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. The measurement/display area takes up the rest of the screen. It is further subdivided into SWR and Return Loss graphs, as well as Z-Plot and Smith Chart displays. 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.

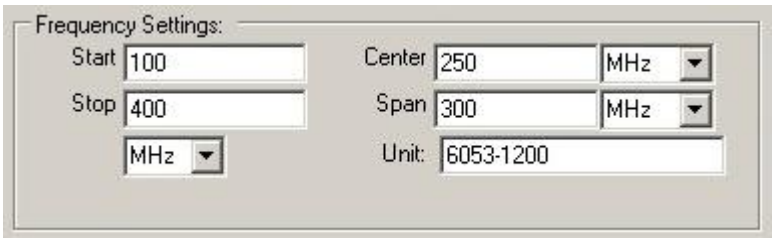
Tools - Misc utilities and tools to get status information from the instrument, change chart labels, etc.

COM Port Mgr. - Use this to manually set COM port settings should your unit not attach automatically (see the section above).

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 S11 Calibrate button will do the same thing.

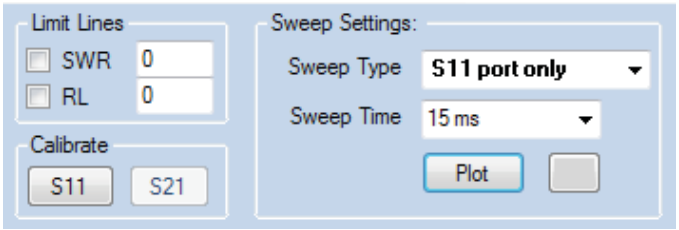
Basic Operation

Once the MRI 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).

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



The sweep type setting can be set to 'S11 Port' or 'S21 Port', although if a single port unit is being used, only the S11 selection will be allowed. Select the Sweep Time you wish to use using the 'Sweep Time' roll box. Lower sweep times will result in faster screen updates, but sweep times of <15ms are not recommended.

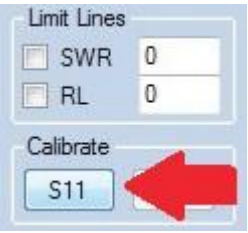
Do NOT press the 'Plot' button at this time.

With the frequency information entered, and the sweep rate selected, it's time to calibrate the instrument.

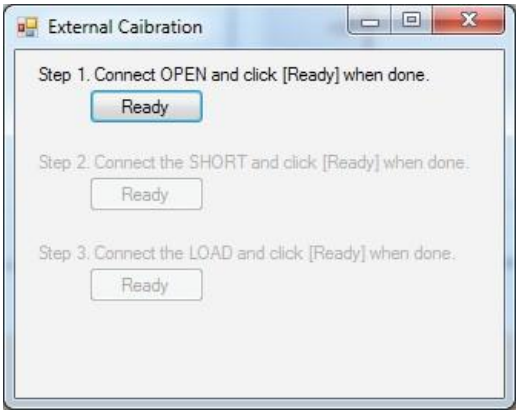
To do this, requires three reference standards: An OPEN, a SHORT, and a reference LOAD. For most applications, especially for frequencies of less than 200MHz or so, the OPEN is not too critical and many users do not use anything for this. The SHORT is always required, should be as close to 0Ω as possible, using a high-quality connector. The 50Ω LOAD is critical, and inaccuracies originating here become more apparent at higher frequencies. The DC resistance should be as close to 50Ω as possible, with good frequency characteristics (the Termination Standards AEA supplies are rated to 3GHz).

S11 Single-Port Operation

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



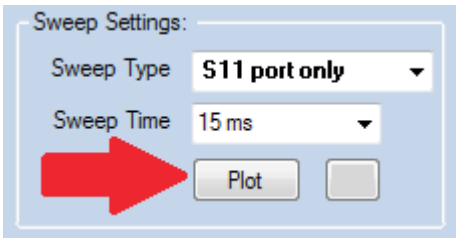
The Calibration process dialog box will appear as shown here:



Attach the (optional) OPEN standard to the MRI-3000 (or attached cable), and press the 'Ready' button for step one. The MRI PC Vision Program will assume control over the instrument, and begin the calibration process. When 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 to attach the 50Ω load. When attached, press the third 'Ready' button, and the calibration process will complete.

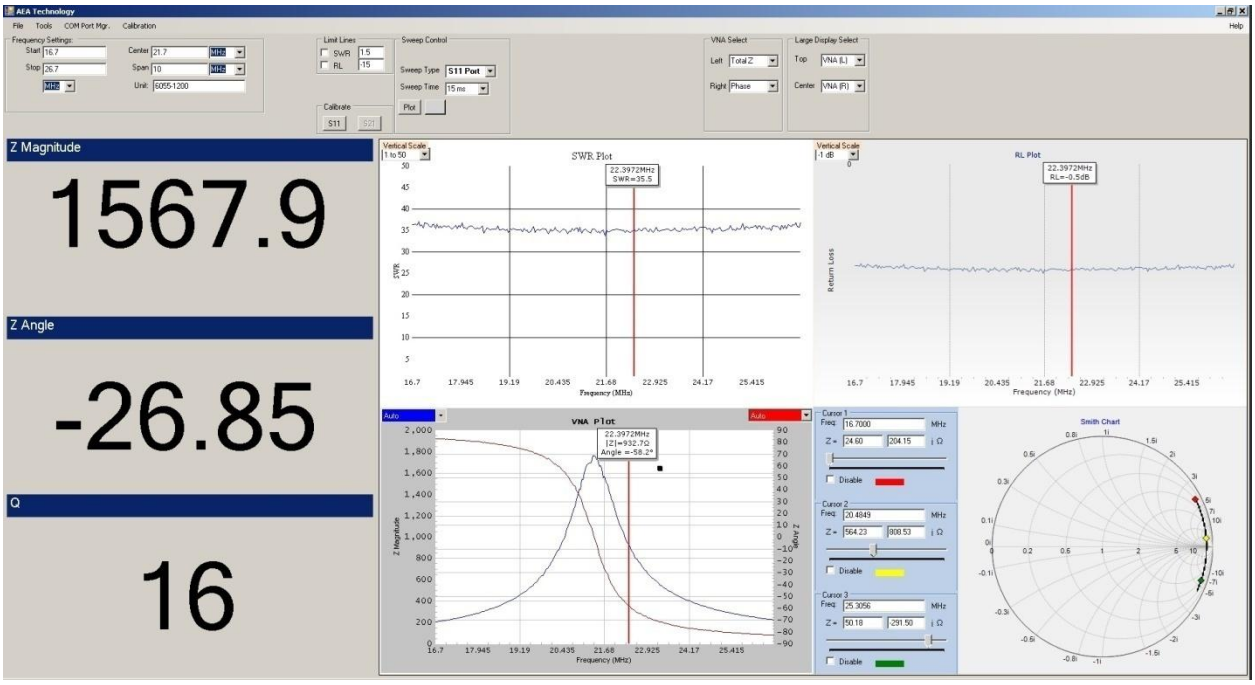
Once the calibration process is complete, the MRI PC Vision application, along with the MRI-3000, is ready to make measurements. Bear in mind that the calibration is only valid for as long as the frequencies are NOT changed. If any of the frequencies (start, stop, center or span) are changed, you must repeat the calibration process again before you can make measurements.

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



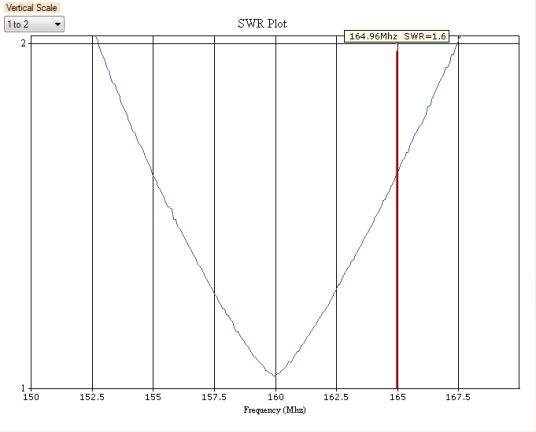
(if calibration has not already been completed you will be prompted to do so)

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



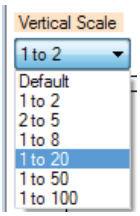
Graphs in Detail

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 pertinent measurement values associated with that chart at that point, as shown here:

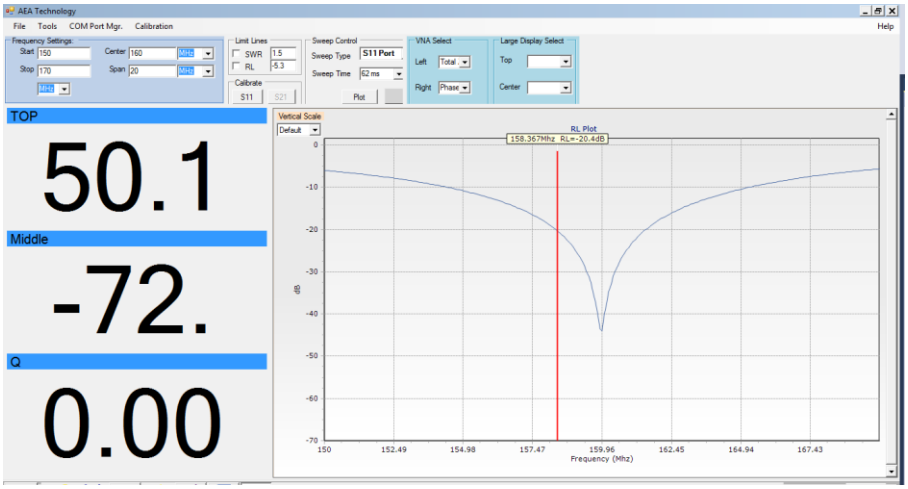


Note also the horizontal frequency scale along the bottom, in MHz, and the vertical scale control, top left. While the frequency scale is fixed (it's determined by the frequency range you chose when you calibrated the instrument), you can use the vertical scale control to change the appearance of the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



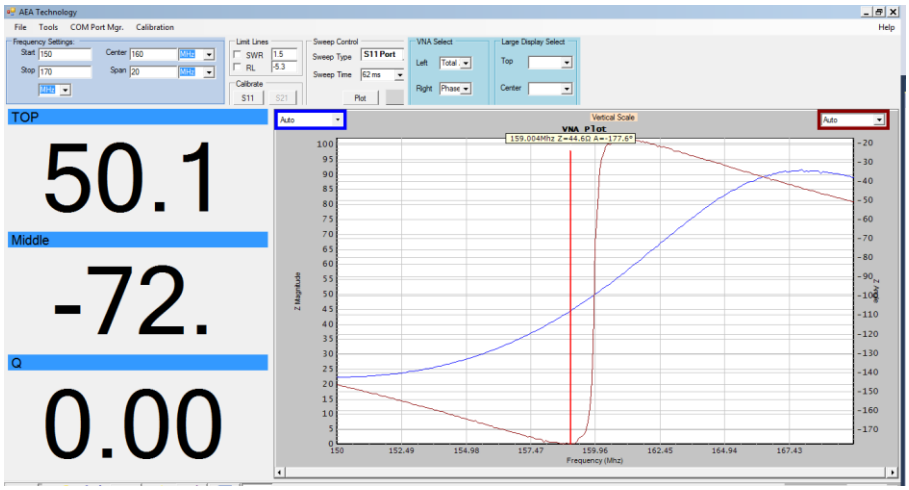
Allowable SWR ranges are 2, 5, 8, 20, 50, and 100:1. Similarly, the Return Loss vertical scale can also be selected, the allowed ranges are -1,-2,-5,-10,-20, and -50dB. Chart Zoom: Any of the charts displayed here can be zoomed to full-screen by right-clicking on the chart you wish to zoom, allowing you to examine the trace in greater detail:



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

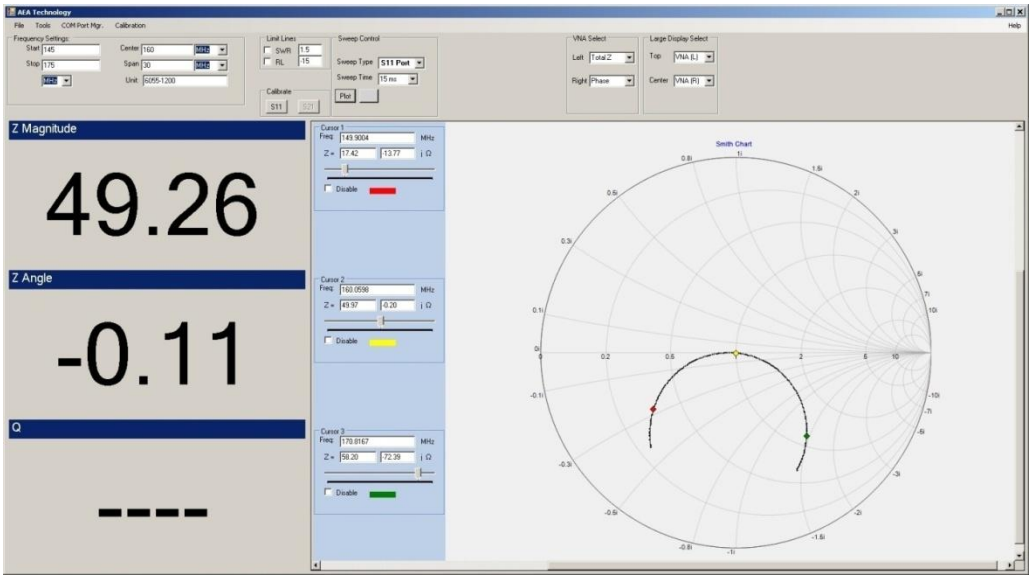
Z-Plot

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



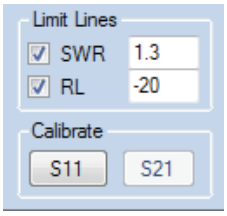
Smith Chart

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 cursors using the slide-bar controls to the left of the chart. The color label on each control matches the color of its respective cursor on the chart. Each cursor control displays the frequency, Resistance and Reactance at the position of its cursor on the chart.



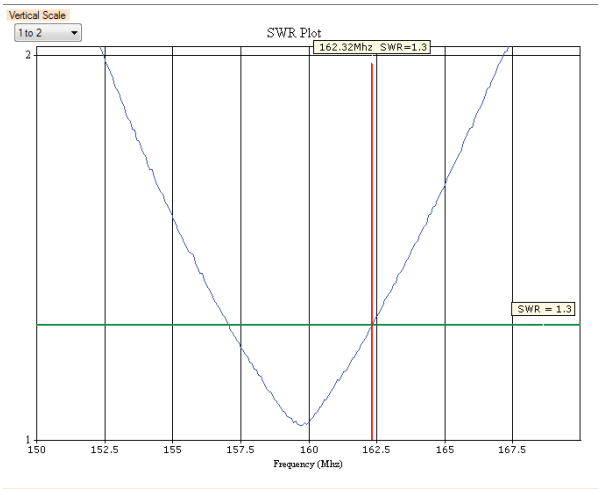
Limit Lines

The Limit Line feature allows the user to perform quick go/no-go testing on 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:



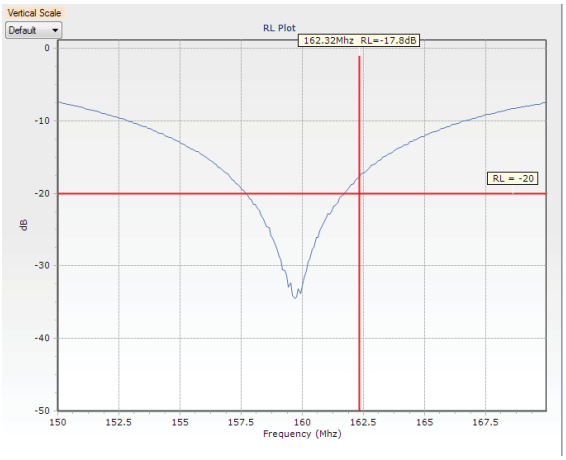
Note that limit lines only apply to the SWR and RL charts.

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.

S21 Operation (Two-port units only)

Two port or S21 operation is used if you are testing a two-port device, such as a filter or an attenuator. Calibration is also required in this case, and it is very similar to the procedure used for the single-port measurement.

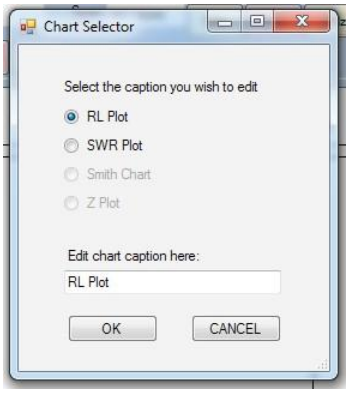
- Enter the frequency....
- Select S21 from the sweep type box...
- Do Open-short-load, same as for S11....
- Then do Thru-- punch the S21 cal button...Show dialog.
- Hit Plot....INSERT PIX

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.

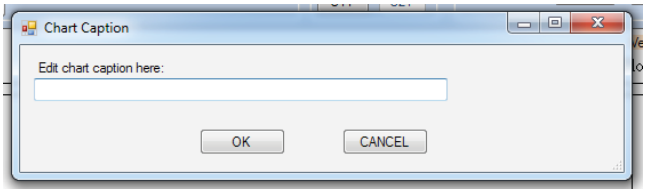
Any chart can be renamed by simply double-clicking on the title you wish to change, and this dialog will pop up, allowing you to make whatever changes you want.

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, this dialog box will be displayed:

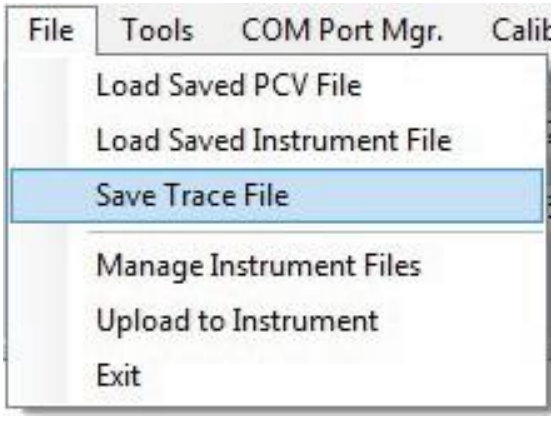


Enter the new caption, and click OK.

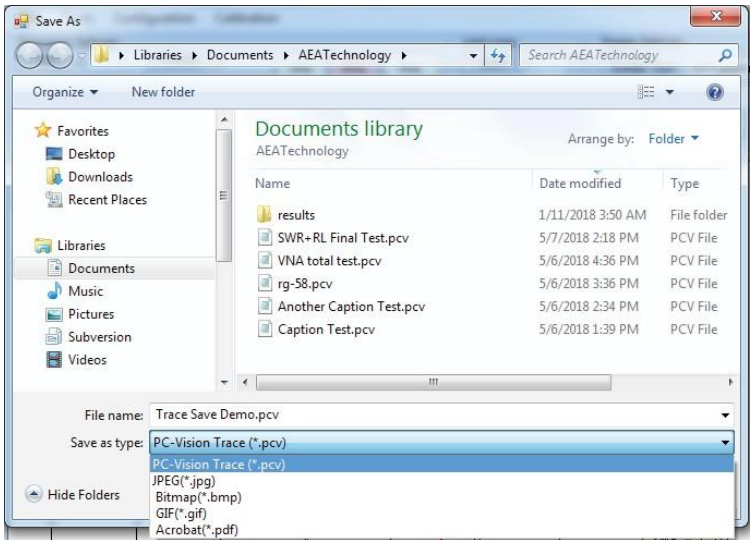
Saving Traces

Now that we have 'live' traces on-screen, perhaps we would like to save these for future reference or further evaluation. MRI PC Vision will allow you to save live traces in AEA's PC-Vision (.pcv) format, which includes the test data used to create the trace. Alternately, a graphic if the trace may be saved 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':



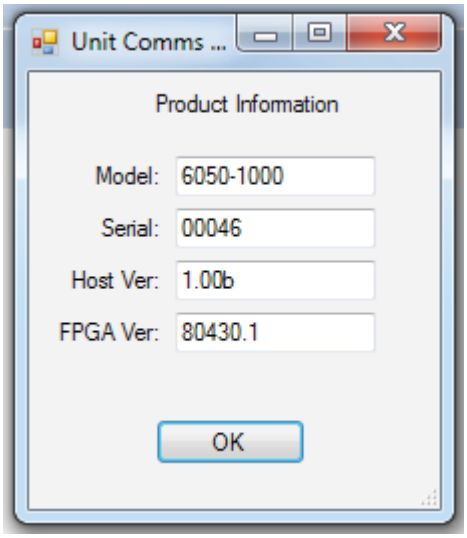
This will bring up a file save dialog box:



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: Files in these standard graphic formats (e.g., JPG) can NOT be recalled in MRI PC Vision and should be viewed using applications written for that purpose (such as Windows Photo Viewer).

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 Analyzer is active, you will get a message box like this one:

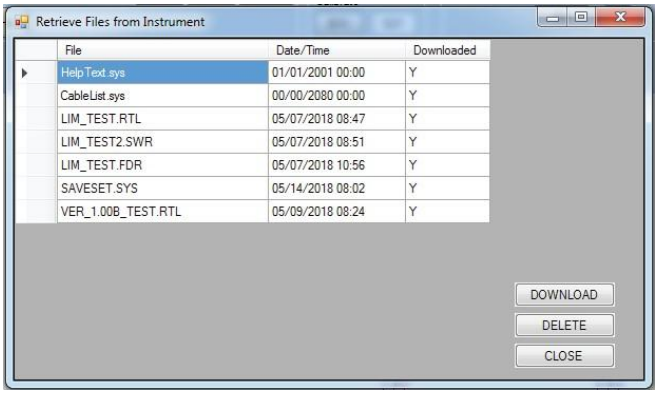


You may also be requested by service or support personnel to call up this panel should your instrument require servicing and/or updates.

Instrument File Management

One of the key applications of the MRI PC Vision application, is to assist with managing trace files generated by the MRI-3000. It is possible to store traces in the instrument's file system, and MRI PC Vision provides utilities to handle them.

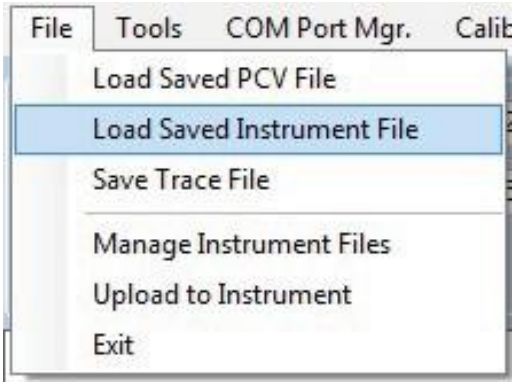
To begin file management, from the 'File' pull down menu, select "Manage Instrument Files". This brings up the PC Vision File manager:



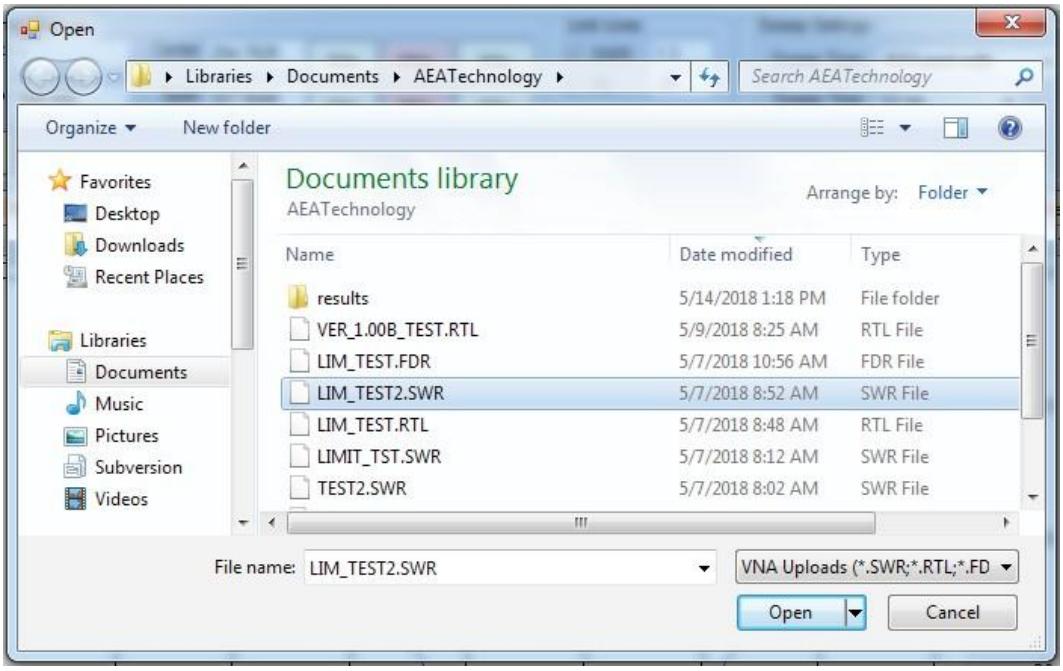
This is a listing of the files in your instrument's file system. The .sys files belong to the system, and should not be downloaded or deleted, unless instructed to do so by support personnel. The .RTL, .SWR, and .VNA, files are Return Loss, SWR, and VNA trace (data) files, respectively. There may also 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". MRI 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 saved 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.

Warranty, Maintenance, and Troubleshooting Guides

Limited Warranty

AEA Technology, Inc., warrants to the original purchaser that the Bravo MRI-3000 Analyzer shall be free from defects in material or workmanship for a period of two (2) 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 the operation of this instrument be assumed by AEA Technology, Inc. There are no warranties that extend beyond expressed 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.

Battery Replacement Instructions

Preliminary: First ensure you have replacement cells on-hand. You will need 8 AA batteries of any type, provided they are all of the same type and voltage. If you are using rechargeable batteries, ensure they have sufficient charge. 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 MRI-3000 Analyzer OFF and remove any external power and/or antenna or other DUT and place the 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 the 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 out-gassing (causing 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 out-gassing 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. DO NOT MIX CELL TYPES.
7. Replace the battery cover and stand bail 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. Turn on the instrument ON and press the Meter Menu key, select Battery Menu, then select Battery Type: and use the arrow keys and select the type of batteries used. This will ensure that the low battery warnings will operate correctly. This is due to rechargeable and alkaline batteries having different maximum voltage ratings.

Cleaning

The MRI-3000 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.

Battery Compartment: Should one or more AA cells outgas in the battery compartment use a cotton swab 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. Dry any wet areas or contacts with a dry cotton swab. NEVER reuse any AA cells indicating signs of out gassing or leakage. Disposed of spent batteries 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. Always remove the instrument first from the soft belt case 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 voltage too low	Plug in AC adapter to operate on AC power or install fresh batteries.
Display is incorrect, or menu highlight will not move, or other key actions do not respond.	Firmware has faulted	Force power down by holding down the ON/OFF key for 10 seconds. See page 6 for more help and Soft Reset instructions.
Instrument will not turn off	Firmware has faulted	Power down with 10 second hold of ON/OFF key, This will load PRIOR good settings, NOT current settings. See page 5 for more help and Soft Reset instructions .

Factory Reset

Used to recover any program faults and then restores the factory defaults
With the MRI-3000 OFF, Press and hold the ENTER key
Press and release the ON/OFF key to power the MRI-3000 ON.
After power comes on... (~1 second) release the ENTER key
Display will allow you to confirm reset to factory default settings.
When Measurement Screen appears you can recall a saved setting or set desired settings

Appendix A

Specifications

MRI Analyzer Specifications	
Frequency Range	100KHz – 450MHz (0.1 to 10 Tesla)
Tuning/Display Resolution	1Hz (100 KHz - 150MHz),200Hz > 150MHz
Refresh Rate	2.5 times/second
Frequency Display	210 points (Large Format) 150 points (Small Format)
Measurement Speed	1.6ms / data point
Output Power	<-20 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
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°
General	
Power requirement	12-18 VDC @ 650 -1200 mA. or 8 "AA" Batteries
AC Adapter (Included)	110-240 VAC 50/60Hz 0.4A Output: 15 VDC 1.2A
Memory	100 + 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
Compliance	CE compliant. EMC, Safety, and RoHS
Size	8.5” x 4.3” x 2.25” (216 x 109 x 57 mm)
Weight	1.6 lbs (0.75 Kg) with belt case
Warm-up time	10 Minutes
Software (included with product)	MRI PC Vision™

Appendix B

MRI Analyzer Model and Accessories

Included items	*Part Number*
MRI Analyzer	6055-1000
"N" to BNC Adapter	0070-1190
BNC Male Shorting Cap	0070-1140
BNC Male 50 Ω Load	0070-1150
AC Power Adapter	5001-0202CE
20' Power Extension Molded	0070-1200
USB Cable A-to-mini B	0070-1208
USB extension cord 15 ft	0070-1210
Belt Case	5001-1002
CD includes: Operating Manual, Training PPT and MRI PC-Vision™ software	6055-1220

Optional Accessories:	*Part Number*
N to SMA Adapters and Terminators Set	6025-0260
BNC Terminators, Short and 50 Ω Load kit	6015-1303
BNC Coax Test lead, 6ft (2m) P/N	0070-1500
Soft Carrying Case	6015-1002
Certificate of Calibration MRI Analyzer	6000-0402
Certificate of Calibration MRI Analyzer with before & after data	6000-0403

User's Notes

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