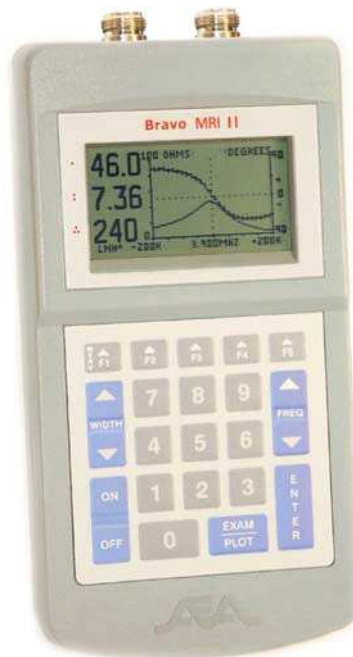


# Operating Manual

# Bravo MRI II



Dual Port Vector Impedance Analyzer –  
100KHz to 200 MHz

**AEA**  
**AEA Technology, Inc.**



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Patent No. 7,030,627 B1

# Bravo MRI II Operation Manual

## AEA Technology, Inc.

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# 1 Introduction

## 1.1 Bravo MRI II Highlights

The Bravo MRI II analyzer measures complex impedances of electrical components, Filters, antennae, and cables. The results of the measurements are displayed graphically, with some numeric detail. You can choose to display the impedance from among several formats. The Bravo MRI II 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:

1. Tune coils/antennae, filters, and feed systems
2. Measure Z, Angle, Resistance, and/or Reactance of a load
3. Measure Gain/insertion loss and phase of coupled circuits
4. Measure the length of a piece of coax
5. Portable and economic replacement for network analyzer applications that measure S11 and S21.
6. Find resonant frequency and response curve
7. CW signal generator

Two plots may be simultaneously viewed on the same graph. The Bravo MRI II connects to your PC with the VIA-RTD Software to view results on a multi color, large screen display in a Smith Chart or X-Y plot format.

The Z altering effects of coax cable can be nulled out, so that the load at the end of the coax is displayed. The Bravo MRI II operates over a wide range of characteristic impedances, so you are not limited to measuring 50 ohm systems.

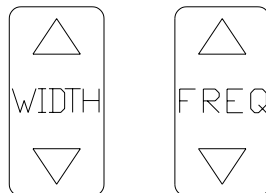
The Bravo MRI II periodically self calibrates during operation when not in “Cable Nulling” mode. The Bravo MRI II determines when recalibration is required and displays the marquee screen with a “CALIBRATING” message during the calibration. The unit begins measurements after a few seconds.

Operator conveniences include: non volatile storage, auditory cues, back lit display, battery saver options, display contrast adjustment, versatile output displays, and serial port communications. Internal Batteries (8 AA batteries, not included) power the Bravo MRI II in situations where wall power is not available.

Included accessories are the VIA-RTD MRI Software, a power pack, a serial port cable, and a soft case with shoulder strap.

## 1.2 Using This Manual

Throughout this manual, references are made to **FREQ** and **WIDTH** keys. Each of these keys has an UP or DOWN option. The operator selects the up or down keys depending on desired results.

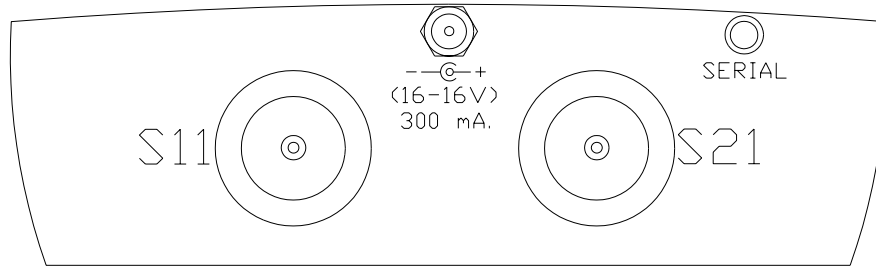


Certain words that appear as all capitals (**FREQ**, **WIDTH**, **ON**, **OFF** **EXAM/PLOT**, **ENTER**) refer to keys on the Bravo MRI II keypad. Other capitalized “words” are acronyms (**VIA**, **SWR**, **CW**, etc). Capitalized and italicized words (*ENTER* etc.) refer to keys on your PC when using the VIA-RTD Software.

**VIA** is an acronym for Vector Impedance Analyzer, **SWR** stands for Standing Wave Ratio, and **CW** is short for Continuous Wave.

## 2 Quick Start

Connect the power pack to a wall outlet, the other end of the power pack plugs into the jack located on the top panel of the Bravo MRI II, between the coaxial connectors. You may optionally use batteries to power the Bravo MRI II.



Momentarily press the ON key. You should see the AEA marquee screen for a few seconds, a calibration screen, and then a graph will appear. The factory default sets the measurement type to S11 Vector mode, the left plot (thin line) to total Z (total impedance), and the right plot (hashed line) to impedance phase angle.

An open circuit doesn't make an interesting graph, so let's connect a load to the S11 coaxial connector on the Bravo MRI II unit. A length of coax or a coaxial terminator would be a good place to start. If you use coax, it will show a resonance at the half wavelength frequency.

Enter a center frequency by pressing a number on the keypad (press the first digit of your desired frequency). The screen changes to show the digit that you pressed. Press more digits to until your center frequency shows on the display. Press the ENTER key when done. **Note:** if you press a wrong digit, just add digits until you have an out of range frequency. When you press enter, the frequency is erased and you can re-enter your frequency.

Now enter a sweep width by entering digits to get the desired width. Press one of the WIDTH keys when ready. Due to synthesizer limitations, the sweep widths must be certain values and the Bravo MRI II adjusts your entry to an available sweep width. The Bravo MRI II flashes a brief warning if it changes the sweep width from the number you entered. The x axis legend displays the lower and upper sweep frequencies.

Press the OFF key. The settings you have entered are automatically saved prior to the unit shutting off. The next time you power up, these settings will reload, putting the Bravo MRI II in the same state that you last used it in. If you ever want to start the Bravo MRI II with factory preset values, hold the ENTER key while you power up the unit, otherwise, the unit will load up the settings that were in effect the last time the OFF key was pressed..

Press the ON key again. Connect a load to the coaxial connector to measure its impedance. Now press the EXAM/PLOT key. The plotting will freeze and a vertical cursor appears. You may move the cursor with the FREQ keys. The two plot values at the cursor frequency and the calculated L-C value are displayed by the three big numbers on the left of the display. The top number shows the first (left) plot value, the middle number shows the second (right), while the bottom number shows the inductance/capacitance of the load. Using the FREQ keys, move the cursor to a frequency of interest. Pressing EXAM/PLOT a second time returns to normal sweeping operation, with a new center frequency equal to the last exam/plot frequency. See paragraph 3.4 for more details on EXAM/PLOT operation.

Refer to the remainder of the manual to find more operational details on these and other functions.

## 3 Operating the Bravo MRI II Unit

You will navigate through various menus to control the operation of the Bravo MRI II. Most menus operate in a similar manner. The top level menu is entered by pressing an F key. The cursor on the left is scrolled to the desired choice by using the WIDTH or FREQ keys. With the cursor aligned to the desired choice, press ENTER, and the first sub menu appears. Again, use WIDTH or FREQ to scroll to the choice and press ENTER. Some sub menus require different keys to operate, and this will be noted on the display.

A few functions require numeric entries instead of cursor movement. Enter the required number using the numeric keys. Numeric entries set center frequency, sweep width, freq step size, cable Z or cable VF.

Most menus will place the cursor at the current setting. So if you enter a menu by mistake, you can usually press ENTER enough times to push through the menus without altering the settings

Whenever you are in a menu, the Bravo MRI II lists your choices for keypad entries to help you make your choice and return to measuring.

A table that shows the menu selections can be found in paragraph 9.2.

### 3.1 Center Frequency

Exit any menus that you may be in and then press the first digit of your desired center frequency. The frequency entry screen pops up. Finish entering the center frequency. Note that you may need to add zeroes to get your entry to align properly with the decimal point. When the correct number is ready, press the ENTER key. The unit should start plotting with the new center frequency.

```
ENTER FREQ IN MHZ
      0.000MHZ
PRESS ENTER FOR CENTER FREQ
OR FREQ↕ UP/DOWN FOR STEP
OR WIDTH↕ FOR SWEEP WIDTH
```

You may also alter the center frequency using the FREQ keys. The center frequency will shift up or down by the frequency step size. You are able to select the desired frequency step size (see Para. 3.3).

If you make an error while entering the frequency, you can continue to enter digits until an illegal frequency (too high) is entered. When you press the ENTER key, the display resets, allowing you to start a new frequency entry.

### 3.2 Sweep Bandwidth

There are two ways to set sweep bandwidth, the first way is similar to center frequency entry, except use WIDTH instead of ENTER; the second method is to just press WIDTH. Notice that when you change the sweep width, the Bravo MRI II MRI will recalibrate itself.

Exit any menus that you may be in, then press the first digit of your desired sweep bandwidth. The frequency entry screen pops up. Finish entering the sweep bandwidth. Note that you may need to add zeroes to get your entry to align properly with the decimal point. When the correct number shows in the display, press the WIDTH key. The unit should start plotting with the new sweep bandwidth.

```
-6.40M  FC= 75.320MHZ+6.40M
```

If you enter a width of zero, the unit will change to CW mode. Entering a non zero width will convert the unit into sweep mode. The display formats are different for these two modes. Another way to toggle these modes is explained in paragraph 3.8.4.

Due to synthesizer limitations, the sweep widths must be certain values and the Bravo MRI II adjusts your entry to an available sweep width. For example if you enter a 1.000 MHz wide sweep, the Bravo MRI II sets the sweep width to 1.000 MHz if the unit is plotting 100 points, but will set the sweep width to a 1.600 MHz if the graph is set to 80 points. The Bravo MRI II flashes a brief warning if it changes the sweep width from the number you entered. The x axis legend displays the lower and upper sweep frequencies of the chosen sweep bandwidth.

Sweep width may also be set using the WIDTH keys. Pressing one of these keys will increase or decrease the sweep width by a factor of 2. The WIDTH key may be pressed The WIDTH key may be pressed **and held** for larger changes. Release the width key after the desired number of beeps (each beep represents a factor of 2). If the width key is not held, but is repeatedly pushed, you will have to wait for a calibration cycle to finish for each sweep width.

Some combinations of center frequency and sweep width will cause the graph to be truncated. The sweep truncates at the Bravo MRI II's frequency limits. Truncation can also occur using the EXAM/PLOT mode, see paragraph 3.4 for details on this.

If you make an error while entering the sweep width, you can continue to enter digits until an illegal width (too wide) is entered. When you press the ENTER key, the display resets, allowing you to start a new sweep entry.

### 3.3 Frequency Step Size

The frequency step size determines the change in center frequency when the FREQ key is pressed. The center frequency will be adjusted up or down by using the appropriate FREQ key. Setting the frequency step size is similar to center frequency entry, except use FREQ instead of ENTER.

Exit any menus that you may be in then press the first digit of your desired step frequency. The frequency entry screen pops up. Finish entering the step frequency. Note that you may need to add zeroes to get your entry to align properly with the decimal point. When the correct number is ready, press either FREQ key. The unit should start plotting with the new center frequency. Any future presses of the FREQ keys will increment the center frequency by this new step size.

If you make an error while entering the step size, you can continue to enter digits until an illegal step (too big) is entered. When you press the FREQ or ENTER keys, the display resets, allowing you to start a new step size entry.

The frequency step sizes are limited by the sweep parameters. If you enter an unavailable step size, the Bravo MRI II flashes a brief warning and sets the step to a valid value as close as possible to the step size you selected.

EXAMPLE: My unit was set at 75.3 MHz with a step size of 15 MHz. I wanted to step up at 1 MHz increments, so I hit 1, 0, 0, 0, and then the Freq up-arrow. The synth required a step size other than exactly 1 MHz, so it set it at 1.12 MHz. If I needed an exact frequency, I can set it directly. In other words, if I needed to set the center to 76.3 MHz I would hit 7, 6, 3, 0, 0, and then ENTER.



### 3.4 Exam/Plot

The EXAM/PLOT key toggles between two modes of operation. In the plot mode, the screen is periodically updated with the results of a new measurement. The exam mode freezes the display, and adds a frequency cursor. The cursor shifts by pressing the FREQ keys. The plot data values under the cursor are displayed numerically on the left edge of the graph.

When the Bravo MRI II calibrates itself, it sweeps a bandwidth that is twice as large as the display. This will allow you to do panning operations in the exam mode without triggering a new calibration cycle. This expanded calibration width improves operator convenience when panning, especially when using the cable null feature. To suppress the calibration cycle, only press the FREQ key while in exam mode, pressing the FREQ key in the plot mode forces a new calibration.

You may also press the ENTER key during exam mode. The cursor position determines the new center frequency, and you will be back in plot mode.

If you pan far enough, you will notice that the graph truncates. The truncation occurs at the edge of the calibrated frequencies. If you wish to remove the truncation, you must force a new calibration cycle. One way to do this is to just enter a new center frequency (para 3.1). Other ways to force a calibration cycle are to press the FREQ or WIDTH keys while in the plot mode (para 3.1 or 3.2).

**EXAMPLE:** Once you press the EXAM/PLOT key, the cursor comes up. Press the FREQ down key until the cursor reaches the far left of the screen. Hitting EXAM/PLOT again brings the unit back to PLOT mode with the new center frequency **without recalibrating**. You can now hit EXAM/PLOT again and continue moving the cursor to the left.

### 3.5 Power On

The unit is powered up by pressing the ON key. Be sure the power pack is connected or that you have good batteries installed. The unit is configured with the settings that were in effect when the OFF key was last pressed. If you ever want to start the Bravo MRI II with factory preset values, hold the ENTER key while you power up the unit.

### 3.6 Power Off

To turn off the unit, press the OFF key. The settings (center freq, sweep width etc.) are automatically saved to memory prior to turning off. These values will be recalled the next time you power on. If you power down by merely unplugging the power pack, the present settings will not be saved.

### 3.7 F1 Help Screen

The help screen displays an abbreviated overview of the function keys. This can be used to figure out which menu something is located in without having to explore through the menus.

F2 AUDIO/BACKLIGHT/CONTRAST  
CABLE NULL

F3 PLOT SELECT AND WIDTH  
RLC MODEL, NOISE FILTER

F4 GRID, X LABEL, SCALES

F5 SAVE, RECALL, PLOT NAME  
CABLE Z0, BAUD

## 3.8 F2 Instrument Properties (Adjustments and Settings)

This menu contains items that alter the physical properties of the Bravo MRI II unit.

```
WIDTH⇄ MOVES CURSOR  
PRESS ENTER TO SELECT  
  
->BACKLIGHT CONTROL  
DISPLAY CONTRAST  
AUDIO OPTIONS  
CABLE NULLING
```

### 3.8.1 Backlight Control - Time/Intensity

The backlight provides a convenient way to view the display when operating in dimly lit locations. The life of the backlight (and the batteries, if used) can be extended by using the backlight only when needed. You have control of the backlight operation. You may turn the backlight on (continuous) or off. There are also 3 choices to turn the backlight on for a limited time before it automatically shuts off. You can also adjust the backlight brightness from this menu. Use WIDTH to move the cursor to the desired choice for the timer. Use FREQ to adjust the intensity. When you have finished choosing your settings, press ENTER and you will be back to measuring.

Note that the backlight turns on when you enter this sub menu. If you want to keep the light on while measuring, the timer must be set to something other than "off". When using the timer (10, 20, or 50) any key presses will reset the timer function. If you have the backlight set to 10 sweeps, the light goes out after 10 sweeps. If you press a key, the light will come on again for another 10 sweeps after returning to measuring.

Also note the maximum intensity is limited and the backlight will only be noticed in dim light conditions. When the Bravo MRI II is in a bright environment, the backlight will be washed out.

The lowest brightness level is equivalent to the off setting. Either way of shutting off the backlight will save the same amount of battery power. The brighter the backlight intensity, the more battery power is used (if running off of the batteries).

### 3.8.2 Display Contrast

The display contrast can be affected by ambient temperature, so an adjustment is included. Once in the contrast sub menu, press and hold the WIDTH or FREQ key until the desired contrast appears. Press ENTER when done.

### 3.8.3 Audio Options

Pressing a key on the keypad optionally produces an audible beep. You may adjust the volume level of these beeps. You may also activate an audio readout for when you want to hear the effects of your adjustments rather than watching the display. In the audio readout mode, the pitch of the audio varies as the left plot value at the center frequency changes. Thus if you are measuring total Z on the left plot, the audio pitch gives an indication of the total Z measured at the center frequency,

Once in the audio sub menu, press WIDTH to set the volume, or press FREQ to toggle the audio readout mode. Press ENTER to leave the audio sub menu.

### 3.8.4 Cable Nulling

The Bravo MRI II Unit can operate with or without cable nulling. Enter this sub menu to select which mode of operation you want. When you select the nulling option, the unit will step you through the appropriate cable nulling routine depending on whether you are in S11 or S21 mode. You will be prompted to utilize the supplied Short and 50 Ohm terminators at the proper times.

## 3.9 F3 Plot Data Properties

The Bravo MRI II can graph up to two plots on the display. More plots may be displayed if you connect the Bravo MRI II to a PC running the VIA-RTD software. In addition to the two plots, some information is also displayed numerically. When the plotting width is 100 points, all of the center frequency data is displayed with small digits. When the plot width is 80 points, the left plot and right plot values at the center frequency are displayed with large digits (viewable from 8 to 10 feet). Additionally the 80 point sweep displays using large digits, the calculated L-C (in VIA operation) or the Q of the SWR curve (in SWR operation).

```
WIDTH⇄ MOVES CURSOR  
PRESS ENTER TO SELECT
```

```
->CHOOSE 1ST PLOT: TOTAL Z  
CHOOSE 2ND PLOT: PHASE ANGLE  
CHOOSE RLC MODEL: SERIES  
PLOT WIDTH: 80 POINTS  
BIG FREQ DISPLAY : OFF  
NOISE FILTER : OFF
```

### 3.9.1 Left Plot Type (1<sup>st</sup> Plot)

This sub menu allows you to choose which data to plot on the left axis with the non-hashed curve. The data types depend on the instrument mode. The center frequency value is also displayed numerically.

#### 3.9.1.1 S11 Operation

##### 3.9.1.1.1 Total Z

This is the total Z of the load. It is equal to the square root of the sum of resistance squared and reactance squared. If resistance and reactance are made to be the two legs of a right triangle, the total Z is the hypotenuse.

##### 3.9.1.1.2 Z Angle

The impedance angle is the ratio of resistance to reactance, expressed in degrees. It is equal to the arctan of reactance divided by resistance. Note that this angle is a bipolar quantity, so zero is near the middle of the plotting range, the x axis is down at the maximum negative, and the maximum positive is still near the top of the plot.

##### 3.9.1.1.3 Resistance

Standard resistance, measured in ohms. This is the portion of the Z that is non reactive.

##### 3.9.1.1.4 Reactance

The reactance is the non resistive portion of the total impedance caused by capacitance or inductance. Reactance is also a bipolar quantity, thus zero reactance is at the middle of the plot range.

#### **3.9.1.1.5 R.C. Mag (Reflection Coefficient Magnitude)**

This is the magnitude of the S11 vector. Minimum value is zero and implies perfect match. Maximum value is 1.0, complete reflection of energy.

#### **3.9.1.1.6 R.C. Angle (Reflection Coefficient Angle)**

This is the same thing as the phase angle of the S11 vector. This angle contains the information to determine cable length. Combined with the magnitude, all the impedance information can be determined.

#### **3.9.1.1.7 SWR**

SWR is the same as voltage standing wave ratio. This can be used to roughly determine an antenna's match to its coax.

#### **3.9.1.1.8 RTN Loss**

The amount of transmitted energy that is reflected back, expressed in dBs.

#### **3.9.1.1.9 No Plot (self explanatory)**

### **3.9.1.2 S21 Operation**

#### **3.9.1.2.1 Linear Gain**

The returning signal into the S21 Port is measured in relation to the signal going out on the S11 port, expressed in linear units. i.e. a measure of 1.00 means the incoming signal is the same as the outgoing signal amplitude. (1 mW in for every mW out).

#### **3.9.1.2.2 S21 Angle**

The phase of the returning signal is measured in relation to the phase of the outgoing signal, expressed in degrees (+ / - 180 degrees)

#### **3.9.1.2.3 Log Gain**

The same measurement as Linear Gain, but expressed in dB's. a logarithmic scale.

#### **3.9.1.2.4 No Plot**

### **3.9.2 Right Plot Data**

Any data available for the left plot can be plotted on the second plot. Even the same data can be plotted on both plots (use different scales to see both). See paragraph **3.9.1** for detailed information on plots. The curve of the right plot is always a hashed line.

### 3.9.3 RLC Model Series/Parallel

The equivalent L or C (calculated from the reactance at the center frequency) can be displayed numerically. The equivalent load appears as a resistor and a capacitor (or resistor and inductor). The values of the resistance and reactive component can be calculated as two components in series or two components in parallel. Selecting series or parallel determines which calculation is used when displaying resistance or reactance. This calculation (series or parallel) affects both the numeric output and the plots for resistance or reactance. This option has no effect on SWR plots, total Z, or impedance angle.

### 3.9.4 Plot Width

The graphs can be either 80 or 100 points wide. 80 points gives a smaller sweep range with only 8 horizontal divisions, but it allows the large numeric display of center frequency values. When 100 points are used, there are 10 horizontal divisions, and the KHZ/division is easier to keep track of mentally because it is easy to divide by 10. However, the 100 point display leaves no room for large numeric displays, so all center frequency values are displayed with small digits. Pick the plot width you are most comfortable with.

### 3.9.5 Big Frequency Display

An option to display the center frequency with large digits is available. This option is only available on the 80 point plot. This display does cover a portion of the plots so you usually use it when covering a portion of the plot doesn't bother you.

### 3.9.6 Noise Filter

A smoothing filter is available to reduce the unwanted effects of high frequency interference such as gradient noise. Be aware that this filter works on ALL sharp curves in a plot and may effect your readings in sharp curve plot areas. See example #1 at the back of the manual.

## 3.10 F4 Scales and Legends

This menu allows you to select the plot scales, the x axis format, and the number of horizontal grid lines to show

```
F4
SCALES AND LEGENDS
WIDTH< MOVES CURSOR
PRESS ENTER TO SELECT

->GRID LINES : 1
X AXIS LABEL : -DF FC +DF
PLOT 1 Z SCALE : 500
PLOT 2 PHASE : 90
```

### 3.10.1 Grid Lines

You can choose 1, 3 or 5 horizontal grids

### 3.10.2 X Axis Label

You can choose between 3 frequencies (FL FC FH) or the center frequency plus/minus the delta frequencies (-dF FC +dF).

### 3.10.3 Left Plot Scale

Select the scale of the left plot. Choices vary depending on what is being plotted.

### 3.10.4 Right Plot Scale

Select the scale of the right plot. Choices vary depending on what is being plotted.

## 3.11 F5 Memory and Miscellaneous

This menu lets you save and recall data, set the plot name, set the cable properties, set the baud rate, and perform a self test.

F5

```
MEMORY/MISC FUNCTIONS
WIDTH< MOVES CURSOR
PRESS ENTER TO SELECT

SAVE
->RECALL
PLOT NAME
CABLE IMPEDANCE
COMM PORT BAUD 57600
SELF TEST
```

### 3.11.1 Save Operation

Instrument states and /or data may be saved in EEprom for recalling at a later time. There are two types of save memories. The first type only saves instrument presets; the other saves both the presets and the plot data. One can use the preset only memory to save instrument states for a number of different antennae. The full data save could record the impedance of an antenna then transfer it to a PC for further analysis or to save history information.

#### 3.11.1.1 Instrument Presets

Memory locations 1 through 16 save the instrument presets only.

#### 3.11.1.2 Plot Data

Memory locations 17 to 24 save both plot data and instrument presets.

### 3.11.2 Recall Operation

Memory recall is the compliment to memory save. When memory locations 17 to 24 are recalled, the saved data is displayed, and the unit is in the exam mode, allowing you to view the data and move the cursor across it. Once you leave the exam mode the display is updated with new data, but the saved data is still intact in the save memory slot, ready to be recalled again if necessary.

### 3.11.3 Plot Name

Allows you to assign up to a 12 character name to the save data. A descriptive name will help you remember what the plots are when downloading the data to a PC. You can enter the name via this submenu, or you can enter it during the save operation.

### 3.11.4 Cable Impedance

You set the cable  $Z_0$  and velocity factor in this sub menu. Operation is similar to frequency, you may need to enter zeroes to align the velocity factor to the decimal point. The  $Z_0$  is used for SWR calculations. The velocity factor is used in cable length calculations.

### **3.11.5 Com Port Baud**

You can set the bit rate you wish to use in this sub menu. The data format is always N-8-1 with XON/XOFF handshaking.

### **3.11.6 Self Test**

You can perform a self test by selecting this choice. Press ENTER to quit the self test. Pressing any other key creates a response that indicates the key is operating.

## 3.12 Cable Nulling using the included terminators

Any load connected to a coax that is not perfectly matched to the coaxial cable's characteristic impedance will have its impedance modified by the coax. Cable nulling allows you to remove the effect of the coaxial cable so that the impedance you read shows the impedance of the load at the end of the cable, without the cable modifying effects.

Cable nulling is selected by using one of the **(with cable)** options when selecting the instrument mode. The Bravo MRI II will prompt you for the required action during the cable nulling procedure. Basically, the Bravo MRI II takes three readings: open circuit, short circuit, and nominal  $Z_0$ .

The data that results from a procedure that nulls a cable will be specific for that cable. If the cable is changed, a new nulling must be performed. If the power is turned off, the cable nulling information will be lost, so a new cable nulling procedure will be required after power is restored. Note, if you power-up again and do not wish to use cable nulling, you can just fake it by going through the nulling procedure without any cable or load, then change the instrument state to "no cable".

### 3.12.1 Cable Definition

The coaxial cable characteristic impedance must be defined for cable nulling to operate properly. This can be done in the Cable Characteristics sub menu (see 3.11.4 ).

### 3.12.2 Nulling Procedure

The nulling procedure begins by selecting a <with cable> option when setting up the instrument mode (see Error! Reference source not found.or Error! Reference source not found.). Install the cable to be nulled to the RF connector of the Bravo MRI II unit. Once the instrument mode is selected and the cable is connected, the procedure can begin using the included terminators.

#### 3.12.2.1 Open Circuit Reading

With the far end of the coax un-terminated (open circuit) press the ENTER key once. A few seconds later the Bravo MRI II will prompt you for the next reading...(a short).

#### 3.12.2.2 Short Circuit Reading

With the far end of the coax shorted using the coaxial short, press the ENTER key once. When this step is complete the display shows that it wants the nominal impedance termination, usually 50 (or 75) ohms.

#### 3.12.2.3 Nominal Z Reading

With the far end of the coax terminated with a matched load (50 Ohms is included in the kit), press ENTER once. The firmware will compute and apply the corrections. This completes the cable nulling procedure. To verify that you completed the procedure correctly, notice that the display shows flat line(s) at  $Z_0$  (and near zero degrees). If that procedure went well, remove the matched load. Now you are ready to take measurements at the end of the coax. If you do not see flat lines at the expected values, redo the procedure starting at 3.12.2.



### **3.12.3 Calibration Cycles**

The Bravo MRI II MRI will periodically enter a calibration cycle. This ensures the best accuracy over long periods of time. Changing certain sweep parameters can also induce a calibration cycle. Sometimes you may want to enter something into the keypad while a calibration cycle is in progress. This is allowed, so you may repeatedly bump the width or alter the center frequency without waiting for the calibration cycles to finish. However after you have completed your sweep alterations, the Bravo MRI II MRI performs one last calibration cycle before displaying the new data.

### **3.12.4 Numeric Quantities**

The Bravo MRI II compliments the plot displays with a number of numerical quantities. These quantities depend on the sweep settings and the instrument mode.

### **3.12.5 80 Point Sweeps**

The 80 point sweeps use large font numbers that can be read from about 10 feet away with proper lighting/backlight conditions. The numbers are, from top to Bottom:

1. Left Plot center frequency value
2. Right Plot center frequency value
3. Q of Impedance plot if Z is plotted

### **3.12.6 100 Point Sweeps**

There are 11 numbers listed on the left side in a small font. The numbers are, from top to Bottom:

1. Z = Total Z
2. A = Z Angle
3. R = Resistance, or real portion of Impedance
4. X = Reactance, or Imaginary portion of Impedance
5. S = SWR
6. L = Return Loss
7. C = Reflection Coefficient Magnitude
8. A = Reflection Coefficient Angle
9. G = Linear Gain
10. P = Gain Phase
11. L = Log Gain

## 4 Applications and Measurement Examples

### 4.1 Make a 1/2 wavelength coaxial line

To make a coaxial line that is tuned to one half wavelength:

1. Start with a piece of coax that is slightly longer (about 5 to 10%) than calculated. The formula for a 1/2 wave cable is:  
$$L = 491(vf) / fr$$
 where  
L = length in feet  
vf = velocity factor (usually between .6 and .9)  
fr = frequency.
2. Connect one end of coax to Bravo MRI II (preferably using a coaxial connector), the other end is left **open**. Set the Bravo MRI II center frequency to the desired 1/2 wave frequency. There should be an impedance peak (and a zero phase crossing) slightly to the left of the center frequency. The zero phase crossing should go from upper left to lower right. Use wire cutters to snip off small pieces of the coax from the unconnected end. Every time a piece is removed, the zero phase crossing should move to the right. When the zero phase crossing reaches the center frequency, the coax is at 1/2 wave length.
3. **Alternate method:** Far end of coax is shorted. Look for zero phase crossing from lower left to upper right. Impedance will be very low. This method is less preferred, as the coax must be re-shortened after every snip.

### 4.2 Make a 1/4 wavelength coaxial line

To make a coaxial line that is tuned to one half wavelength:

1. Start with a piece of coax that is slightly longer (about 5 to 10%) than calculated. The formula for a 1/2 wave cable is:  
$$L = 245.5(vf) / fr$$
 where  
L = length in feet  
vf = velocity factor (usually between .6 and .9)  
fr = frequency.
2. Connect one end of coax to Bravo MRI II (preferably using a coaxial connector), the other end is left **open**. Set the Bravo MRI II center frequency to the desired 1/4 wave frequency. There should be a low impedance and a zero phase crossing slightly to the left of the center frequency. The zero phase crossing should go from lower left to upper right. Use wire cutters to snip off small pieces of the coax from the unconnected end. Every time a piece is removed, the zero phase crossing should move to the right. When the zero phase crossing reaches the center frequency, the coax is at 1/4 wave length.
3. **Alternate method:** Tune the Bravo MRI II to twice the 1/4 wave frequency, and look for the zero phase crossing (upper left to lower right).

### 4.3 Load Couples into Power Line

Occasionally, an antenna will strongly couple into nearby power lines (e.g. a long wire antenna in the attic). When this occurs, the plot lines may be “thicker” and the readings will shift around a lot. There are two methods to eliminate this effect

1. Power the Bravo MRI II from batteries. The wall power pack must be unplugged from the Bravo MRI II power jack to do this.
2. Connect the ground sleeve of the coaxial connector to an earth ground.

If the above methods do not clear up the plots, there is most likely an interfering signal causing the problem.

### 4.4 Tune an antenna to resonance

To tune an antenna to resonance, set the Bravo MRI II center frequency to the desired resonant frequency. Connect the Bravo MRI II to the antenna. Using the adjustment provided by the antenna manufacturer, tune the antenna for a zero phase crossing at the Bravo MRI II center frequency. The tuning adjustment could be one of several methods, and should be mentioned in the instructions for the antenna.

### 4.5 Measure the length of a coax

To find the length in degrees (at some frequency) set one of the plot types to Reflection coefficient angle (see paragraph 3.9.1.1.6). Set the Bravo MRI II center frequency to the frequency of interest. Note the RCA reading. By adjusting the sweep width to the widest, and stepping through a number of center frequency values, determine how many positive to negative zero crossings there are below the frequency of interest. The length in degrees is:

$$L = (180)(\text{number of zero crossings}) + \text{modified RCA}$$

Calculate the modified RCA using this algorithm: if the RCA is positive then subtract off 360 from RCA (if RCA is negative, don't subtract anything). Now multiply the new RCA by negative  $\frac{1}{2}$ . The result will be a number between 0 and +180.

To convert the length to wavelengths, divide L by 360.

#### EXAMPLE:

I have chosen 14.200 MHz as this is where I want to tune one of my antennas. We want to measure a coax that disappears into a wall panel and comes out at the roof egress box, so we do not know it's actual length. We have reason to believe that the velocity factor of this coax is the standard .66, but this is not really important since this calculation is based, already, on measurements with velocity incorporated. To give the measurement in feet would require Vf .

By stepping through several sweep widths and center frequencies I have determined that there are only 2 positive-to-negative zero crossings and the RCA value is – 46 degrees. Using the formula from above we start with multiplying 180 times 2 (crossings)= 360. Since the RCA is already negative, we do not need to subtract out 360 from our number of –43. The Mod-RCA number is = -46 times  $-1/2$ , or +23. To finish out the calculation we add the first half of 360 to the Mod-RCA of 23 to get 383 degrees.

To get wavelengths we divide by 360 to get 1.0639.

To convert to feet we do the following:

Divide 982.08 by 14.3 (MHz) = 68.677Ft. (wavelength in air), times Vf (.66) = 45.327 ft (in coax). Multiply our L of 1.0639 times 45.327 = 48.223 Ft or just over 48 Feet 2 1/2 inches. The plans called for 1 1/2 wavelengths, so I think we have a problem to look for.

## 5 Operation with the VIA-RTD Software

The VIA-RTD software has its own manual on the CD. This manual is loaded to the hard drive when you install the program on your computer. Connect the Bravo MRI II to the PC with an AEA serial cable (PN 0070-1201) or extra long cable(PN0070-1215). Be sure that the bit rate of the serial port matches the setting selected on the Bravo MRI II unit.

The RTD software will NOT AUTO-LOAD from the CD. To install, RUN the SETUP.exe file in the Software directory.

If you are updating your software from a previous version, you must UN-INSTALL the older version before installing the newer. To UN-INSTALL, follow this sequence: Click on START, CONTROL PANEL, ADD / REMOVE PROGRAMS. Find the listing for VIA-RTD down near the bottom of the list and left-click on it. Follow the directions as posted by the operating system. Once this is done you can install the new version.

**NOTE!** When the Smith Chart was added, all previous version PLOT files are unusable to the new version due to a totally different data structure. Therefore, if you have important files that you must access in the future, you should keep the old version. This means that you must save the new version into a different directory than what is suggested by the software setup program. Your registration information will work on both versions. You can rename the shortcut to the second version "RTD-Smith".

Remember to save your REGISTRATION INFORMATION in a safe place.

Registration is accomplished by left clicking on the open program HELP menu tab and clicking on REGISTRATION. Enter the Registration Name and Number as provided on your CD package and hit ENTER. This is CASE SENSITIVE, so be sure to type it in exactly as listed on your documentation. The upper left corner of the title box should now say "Registered to (your registration name). You need to do this within 15 minutes of starting the software, or you will get a note stating that the DEMO PERIOD IS OVER. If this happens to you - Do NOT hit the OK button! Click on the HELP menu tab and register. The Box will go away.

Once you have the software up and running you will notice that there is a new menu item labeled SMITH CHART. For those of you unfamiliar with the Smith Chart, it is a means by which to graphically represent a lot of data simultaneously. To describe, in depth, the workings of the Smith Chart would require a whole book. Many have written such texts and they are available where ever you buy your technical texts. There is a partial list of links at the bottom of this page. However, a quick overview is in order here.

You will notice that the Smith Chart is divided horizontally by a straight line. The ONLY straight line in the whole chart. This is the RESISTANCE (R) line. Any plot points that are on this line have only pure resistance, Zero Ohms to the far left and Infinity Ohms to the far right. The very center is marked as "1", representing the characteristic IMPEDANCE of the circuit being tested, usually 50 Ohms. This is the NORMALIZED IMPEDANCE point.

Any plot points above the R line have INDUCTANCE as well as RESISTANCE and have positive Phase Angle and REACTANCE (X) values. Any points below the R line have CAPACITANCE and RESISTANCE and have negative Phase and X values. If you need further information, please consult one of the many texts available on this subject.

REFERENCE : [http://www.web-ee.com/primers/files/SmithCharts/smith\\_charts.htm](http://www.web-ee.com/primers/files/SmithCharts/smith_charts.htm)

## **6 Care and Maintenance**

### **6.1 Operating Precautions**

Although the Bravo MRI II is a rugged instrument, care should be taken to avoid exposing it to excessive external RF (either from a nearby transmitting site or from your own installation).

Before attaching the Bravo MRI II to an antenna, it's a good practice to briefly ground the feed line in order to allow any accumulated static charge(s) to dissipate.

When adjustments to an antenna are complete, disconnect the Bravo MRI II from the feed line in order to avoid damage from lightning strikes.

### **6.2 External DC Power**

If you wish to power the Bravo MRI II from an external DC source (other than the AEA AC-1), ensure that it meets the requirements of **9.1.4.3.1**.

### **6.3 Batteries**

For optimal performance in the field, the Bravo MRI II should be powered by eight "AA" Alkaline or NiMH batteries.

While NiCad batteries may be used, there will be some degradation in backlight performance.

Whenever you recharge NiCad or NiMH batteries, it will be necessary to remove the batteries from the unit and use an external charger. Be sure that the charger is compatible with the battery type you are using.

If the Bravo MRI II is to be stored for more than 30 days, the batteries should be removed in order to avoid leakage.

### **6.4 Cleaning**

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

## **7 Limited Warranty**

AEATechnology, Inc., warrants to the original purchaser that the Bravo MRI II Analyzer shall be free from defects in material or workmanship for a period of one year 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 this company's option. No other warranties are implied, nor will responsibility for operation of this instrument be assumed by AEA Technology, Inc

## 8 In Case of Trouble

Some problems may be identified and solved by the operator. More involved problems will require factory service. To try to solve a problem yourself, refer to the chart below:

Symptom	Possible cause	Refer to paragraph
On power up, I hear relays click but there is no visible display	Display contrast setting	<b>3.8.2, 8.1, 8.1.2</b>
On power up, I hear no relays click nor do I get a display	Power source or batteries	<b>6.2, 6.3, 3.5, 8.2</b> , if available, try a second power pack.
On power up, I see a display, but there appears to be no activity	Illegal instrument state	<b>3.5</b> (hold ENTER key)
The display fills with a faint blue rectangle and nothing else happens	Bad power on condition	<b>8.1.3</b>
Unit gives bad readings	Cable nulling function is in wrong state	<b>3.12</b>

### 8.1 Contrast

#### 8.1.1 Environment and Contrast

Occasionally, changes in temperature or ambient light conditions may necessitate adjustment of the display contrast. Instructions may be found in section **3.8.2**.

#### 8.1.2 Power on Preset Value if Contrast Was Lost

If the contrast has dropped so you cannot see the display then you can try the following procedure. If you should accidentally push the wrong key, you will have to restart the procedure.

Turn off unit, if there is a faint blue rectangle filling up most of the display then check paragraph **8.1.3**

Hold the ENTER key while you press the ON key. Wait a few seconds while the relays finish their activity.

Press the F2 key.

Press the ENTER key.

Press and hold either the FREQ up key or the WIDTH up key. A usable display should soon appear.

### 8.1.3 Power Induced Failure

Application of power with poor start up characteristics can cause the internal controller to malfunction. This is not actually a contrast problem, but the faint blue display is a symptom of the power start up malfunction. You need to remove power for about 5 seconds, then restart the unit. If there are no batteries installed, just unplug the power pack. If batteries are installed, the battery power must be interrupted using one of two methods:

1. Remove battery cover, then remove at least one battery. Replace battery after 5 seconds, then replace cover.
2. Plug power pack into unit, but do not plug the power pack into the wall. If you are using wall power, plug the power pack into the wall after 5 seconds. If you are using battery power, unplug the power pack from the Bravo MRI II unit.

The faint blue rectangle should be gone. After the power has been removed for 5 seconds, you may press the ON key to restart the unit.

If this is a recurring problem, you should investigate your power source, i.e. weak batteries, poor wall power, damaged power pack, etc.

## 8.2 Batteries

Install a fresh set of "AA" batteries; or (if possible) observe the operation of the Bravo MRI II while switching back and forth between battery power and and external DC supply (refer to Section 0).

## 8.3 Serial Port

Ensure that your cabling and communication software is configured in accordance with the specification in Section 9.1.4.2.

VIA-RTD Users: Verify that your Software and Computer settings conform with the specifications in Section 9.1.4.2.

Terminal Users: Verify that you are observing the protocols specified in Sections 9.1.4.2 and 9.3



## 8.4 Other Problems

If you have any questions concerning instrument maintenance, cleaning, care, or before making any return, warranty or out-of-warranty for an operational issue, material defect, or routine calibration, please contact AEA Technology first. Our trained staff can and do resolve most issues and get our customers operating again over the phone or by email.

Please contact AEA Technology at 1-800-258-7805 US & Canada or +1-760-931-8979, M-F 7:00am – 4:00pm Pacific Time or by email at [techsupport@aeatechnology.com](mailto:techsupport@aeatechnology.com)

### **Return Material Authorization (RMA) Number**

If after contacting AEA Technology's Technical Support it is determined your instrument needs to return to calibration or repair, we need to issue an RMA number to include on the package addressing. The RMA number will tell everyone at AEA Technology handling your instrument exactly what to do, who to contact about repair costs, and who to return the instrument to when repairs are completed. It makes the entire process go smoothly and efficiently.

**Be sure to include your RMA number with the return address (shown on the back of this manual).**

## **9 Appendices**

### **9.1 Bravo MRI II Specifications**

#### **9.1.1 Output Characteristics**

##### **9.1.1.1 Frequency Range**

From 100 KHz to 200MHz

##### **9.1.1.2 Sweep Width**

Min: Less than +/- 1.0% of center frequency

Max: 25.6MHz or 32 MHz (for 80 or 100 point graphs)

For center frequencies >51.6MHz (80 points) or 64.4MHz (100 points) the maximum sweep widths are 51.2 MHz and 64MHz respectively.

##### **9.1.1.3 Tuning Resolution**

Less than 0.02% of center frequency

##### **9.1.1.4 Output level**

+5 dBm typical

##### **9.1.1.5 RF Connector**

Dual 'N' type receptacles. BNC type receptacles optional.

##### **9.1.1.6 Output Impedance**

50 ohms nominal. VSWR typically better than 1.2:1. Operates with non 50 ohm systems.

##### **9.1.1.7 Output Distortion**

Harmonic distortion <30dB for 25MHz or less, <15 db for 100MHz or less, <10 dB for 200MHZ or less.

##### **9.1.1.8 Phase Noise**

Better than -75dBC @ 10KHz offset for 25 MHz or less. Better than -65dBC @ 10KHz offset for higher frequencies.

#### **9.1.2 Measurement Specifications**

##### **9.1.2.1 Impedance Range**

10 to 2000 ohms

## **9.1.2.2 Impedance Formats**

### **9.1.2.2.1 S11 Measurements**

Total Z, Z angle, Resistance, Reactance, SWR, Return loss, Reflection Coefficient (RC) magnitude, RC angle

### **9.1.2.2.2 S21 Measurements**

Linear Gain, Gain angle, Logarithmic Gain

## **9.1.2.3 Accuracy**

### **9.1.2.3.1 Impedance**

The accuracy varies as a function of the load.

+/- 1 ohm at 10 ohm load

+/- 1.5 ohms at 50 ohm load

+/- 4 ohm at 100 ohm load

+/- 35 ohms at 500 ohm load (freq < 75MHz)

+/- 35 ohms at 300 ohm load (freq >= 75MHz)

Indication only above 500 ohms load (freq < 75MHz)

Indication only above 300 ohms load (freq >=75MHz)

### **9.1.2.3.2 Phase**

< +/- 5 degrees (below 50MHz).

< +/- frequency(MHz)/10 (above 50MHz).

## **9.1.2.4 Spectrum Analyzer**

This spectrum analyzer has no RF filtering, and can display image signals as well as actual signals. The IF BW filter has sidelobes that show on the displayed spectrum.

### **9.1.2.4.1 Range**

50 dB

### **9.1.2.4.2 Reference level**

+10dBm

### **9.1.2.4.3 Accuracy**

+/- 5 dB <50MHz, not specified above 50 MHz.

## **9.1.3 Display Characteristics**

64 by 128 pixel Super twist LCD.

Graph area: 81 by 57 pixels or 101 by 57 pixels

Character height: 2.5 mm standard, 7.5mm for large format

### **9.1.3.1 Plotting Ranges**

Resistance: 0 to 100, 200, 500, 1K, 2K ohms  
Reactance: Same as resistance but +/- (+/-100 etc)  
Total Z: Same as resistance  
Z angle: +/-15, +/-45, +/-90 degrees  
SWR: 1 to 3, 6, 11 (no units)  
Return Loss: 0 to 20, 50, 90 dB  
RC Magnitude: 0 to 0.2, 0.5, 1.0 (no units)  
RC angle: +/-15, +/-45, +/-90, +/-180 degrees  
Linear Gain: 0 to 0.2, 0.5, 1.0, 2.0 (no units)  
Gain Angle: +/- 15, +/- 45, +/- 90, +/- 180 degrees  
Log Gain: 0 to 20, 50, 90 dB

### **9.1.3.2 Graphing Formats**

All graphs are X-Y format  
Select one or two plot curves  
Left axis plots with thin line  
Right axis plots with hashed line  
X axis is 81 or 101 points wide

### **9.1.3.3 Plotting Rate**

Approximately 2 sweeps per second.  
In CW mode, several updates per second.

## **9.1.4 Miscellaneous Specifications**

### **9.1.4.1 Non Volatile Memory**

24 total user definable memory slots.  
Slots 1 to 16 store instrument preset values only.  
Slots 17 to 24 store presets and plot data.

### **9.1.4.2 Serial Port**

The serial port allows a PC or other terminal to control and read the Bravo MRI II unit. Use of VIA-RTD Software is highly recommended. Connect Bravo MRI II to PC with DB9F to 1/8 inch stereo plug serial port cable AEA PN 0070-1201.

#### **9.1.4.2.1 Baud Rates**

Baud Rate selectable: 4800, 9600, 19200, 28800, 57600

#### **9.1.4.2.2 Data Format**

Data type 8 bit, no parity, and 1 stop bit, with XON/XOFF handshake

#### **9.1.4.2.3 Connector type**

Serial input is a 1/8 inch stereo jack. Tip = RD (from Bravo MRI II to PC), Ring = TD (from PC to Bravo MRI II), Common=ground

### **9.1.4.3 Power Requirements**

The Bravo MRI II may be battery or wall powered. Use of the AEA wall power pack (PN 5001-0201) is recommended when using wall power.

#### **9.1.4.3.1 DC input (Power jack)**

Min 10 VDC (450 ma)

Typical 14VDC (250ma)

Max 20VDC (250 ma)

2.1 mm center pin DC power connector.

Note: Back light performance is impaired when input is below 12VDC

Positive polarity is applied to the center pin of the power jack for proper operation.

### **9.1.5 Battery Power** (choice of:)

8 AA Alkaline

8 AA NiMH

8 AA NiCad usable with impaired backlight performance.

### **9.1.6 Absolute Maximum Ratings**

#### **9.1.6.1 RF Input (RF jack)**

+10dBm Max

+/- 16VDC Max

#### **9.1.6.2 DC Input (power jack)**

+/- 20VDC Maximum

#### **9.1.6.3 Serial Port Input**

Max applied voltage on Ring (TD) +/- 20 VDC

Max applied voltage on Tip (RD) +/- 10 VDC

### **9.1.7 Size**

8.5 x 4.3 x 2.25 inches

## 9.2 Menu Chart

### 9.2.1 Function Key Operations

Function Key	1st level menu	2nd level menu	3rd level menu
F1	Help Page		

F2 Unit Properties	Backlight Control	Off, 10, 20, 50 sweeps, or continuous, plus 16 brightness levels	
	Display Contrast	16 levels	
	Audio Options	4 Volume levels plus 3 modes: on, off, readout	
	Cable Nulling	On or Off	

F3 Axis Selection	First Plot	S11 or S21	Z, A, R, X, SWR, RL, S11, S11A or G, P, L or none
	Second Plot	S11 or S21	Z, A, R, X, SWR, RL, S11, S11A or G, P, L or none
	RLC Model	Series or parallel	
	Plot Width	80 or 100 points	
	Big Freq Display	On or Off	
	Noise Filter	On or Off	

F4 Scales and Legends	Grid lines	1, 3, or 5 +/- delta F or	
	X axis Label	absolute frequency	
	Plot 1 Scale	Scale choices vary with plot selection	
	Plot 2 scale	Scale choices vary with plot selection	

Z scales: 100, 200, 500, 1K, and 2K    Z angle scales: +/-15, +/-45, +/-90    Resistance scales: same choices as Z, Reactance scales: +/- same choices as Z

SWR scales: 3, 6, 11 Return Loss scales: 20, 50, 90 dB S11 mag scales: same choices as Z, S11 angle scales: same choices as Z angle plus +/- 180

F5 Memory and Miscellaneous	Save	Enter 1 to 24	Enter memory name
	Recall	Enter 1 to 24	
	Plot Name	Alpha-numeric entry up to 12 chars	
	Cable Impedance	Numeric Entry Routine with limit checks	
	Com port baud	4800, 9600, 19200, 28800, 52600	
	Self Test	Self rest results and keypad tester	

### 9.2.2 Non Function Key Operations

First Action	Final Action	Result
Numeric entry	Enter	New center frequency
	Freq up	New step size and center frequency incremented
	Freq down	New step size and center frequency decremented
	Width up or down	New sweep width
Freq up	-	Center frequency incremented by step size
Freq down	-	Center frequency decremented by step size
Width up	-	Sweep width doubled
Width down	-	Sweep width halved
Exam/Plot	Freq up or down	Move cursor across plot and view plot values at the cursor frequency

## 9.3 Serial Port Command and Control

The Bravo MRI II serial port sends and receives strings of ASCII characters. These strings usually contain several pieces of information. Each piece of information has a letter prefix to identify the information that immediately follows. This information is usually a number in ASCII format. Decimal points are not sent, the decimal position is inferred by the prefix letter. The end of a piece of information (such as a number) is denoted by the prefix letter of the next piece of information. At the end of the command (or response) string, an End Of String (EOS) marker is appended. This EOS marker pushes the last piece of information through the software routines. Some commands do not require the EOS marker. The Bravo MRI II unit sends an EOS marker in response to a command. If the Bravo MRI II doesn't understand the command, no EOS response occurs. The ASCII char "\*" (ASCII 0x2a) is used as the EOS marker. The Bravo MRI II unit appends the EOS character to the end of any response.

The commands to the Bravo MRI II unit fall into two major categories;

1. Data request
2. Unit setup

These commands and the unit's responses can be controlled or read via the Director software or by any terminal program running on a PC. The controller unit that communicates with the Bravo MRI II unit will be referred to as the Terminal throughout this document.

### 9.3.1 Data Requests

The data requests are short commands that receive a fairly large block of data from the unit. This data can be one of several formats, as selected in the unit setup. These formats are:

Impedance magnitude and angle.

Resistance and reactance

SWR and return loss

Reflection coefficient magnitude and angle

For fastest throughput, set the unit into R-X mode (D101) and perform calculations to other formats in the Terminal software.

The contents of save memory locations can be loaded into the terminal. All save memory locations contain the instrument settings of the Bravo MRI II unit, while only some of the locations contain saved data.

Also the entire unit setup data can be extracted in a fixed format block.

#### 9.3.1.1 Data Request Commands

##### 9.3.1.1.1 R

Send a block of measured data (data dump). The response is dependent upon the type of data being sent out of the unit. The type of data may be set by one of the setup commands (S100) or is determined by the left plot on the unit. This command requires no EOS marker, but one may be sent if desired.

##### 9.3.1.1.2 Q

Send the Q calculation result. The number send must be divided by 10 to get the correct result. This command only operates in the SWR mode. . No EOS marker is required if, but one may be sent if desired.



#### **9.3.1.1.3 D**

Send the distance reading in millimeters. This command only operates when the Bravo MRI II unit is in the cable analyzer mode. . No EOS marker is required, but one may be sent if desired.

#### **9.3.1.1.4 Mxx**

Read the data stored in memory location xx. The EEPROM memory location contains the unit setup info, and sometimes the plot from a single sweep saved by the user. The maximum value of xx depends on the unit version, and can be obtained using the S000 command. The number sent for xx should always be a 2 digit number, for values less than 10 a leading zero is required.

Location 00, last configuration used/power up default.

Locations 01 to 16, user defined instrument presets, no data.

Locations 17 to 24: presets and plot data.

This command requires no EOS marker, but one may be sent if desired.

#### **9.3.1.1.5 S000**

Read the unit's current setup. The entire setup is read in a fixed format block of data. This command requires no EOS marker, but one may be sent if desired.

### **9.3.1.2 Data Request Responses**

#### **9.3.1.2.1 Measured Data Response (R)**

The unit response to an 'R' command will send a common header followed by a block of data, the contents of the data are determined by the instrument state established by the keypad or previous setup commands. The information sent in the header is shown in the first column of the table. The header and data are sent in one continuous string, but they are divided up in the tables for clarity. The numbers sent will always be integers (0 to very large) and do not contain decimal points or commas.

Measured Data Header Table

Characters Sent	Range of x...x	Meaning	Notes
Fx...x	100,000 to 200,000,000	Center frequency in Hz	These numbers depend on the version
Wx...x	0 to 51.2MHz or 64MHz	Sweep width in Hz	Max width depends on plot width of 80 or 100 points
Nx...x	1 to 200	Number of data points	Data sent in pairs (Z,A or R,X etc) count as one data point
Dxxx	101 to 104	Data format	See D in unit setup command. Defines the type of data to follow

Measured Data Formats

Characters Sent	Range of x...x	Range of y...y	Meaning	Notes
Rx..xXy..y	0 to 32,767	-32,768 to 32,767	R = 10x ohms X = 10x j ohms	insert '.' Before last digit. Resist. & React. D = 101.
Zx..xAy..y	0 to 32,767	-899 to 899	Z = 10x ohms A = 10x degrees	insert '.' Before last digit. Total Z & Z angle D=102.
Vx..xLy..y	100 to 10,000	0 to 10,000	V = 100x (V)SWR L=100xRtn loss dB	insert '.' Before last 2 digits. VSR & Rtn Loss D=103
Mx..xDy..y	0 to 100	0 to 3600	M = 100x RC mag. D = 10x RC angle	Reflection coefficient or Smith Chart vector, insert '.' in appropriate place D=104

**9.3.1.2.2 Q**

Returns the letter Q with a number equal to 10 times the calculated Q value. The last character sent is the EOS marker

**9.3.1.2.3 D**

Returns the letter D with a number equal to the measured length in millimeters. The last character is the EOS marker.

#### 9.3.1.2.4 Memory Read Response (Mxx)

Sends the data stored in memory location xx. The EEPROM memory location contains the unit setup info, and sometimes has plot data from a single sweep saved by the user. The response from the unit is shown in the table below. Note that the response string is contained in the first column, and is sent as a continuous string. The string has been subdivided in the table for clarity. The format of the setup data is identical to the S000 response but with an S001 header instead of S000. The string of measured data follows the setup data. The format of the measured data is always resistance and reactance (D101- see measured data response above). This command sends the entire contents of the memory location; the software must determine the valid data points from the setup data (lower and upper valid data indices). Data that is not valid is garbage and should be tossed out.

Memory Read Response Table

Characters Received	Range of x...x	Meaning	Notes
Mxx	1 to Memmax	Header allows software to verify response	Memmax can be found with S000 command
S001 (plus Setup data)		State of the unit when the data was saved to memory.	Format is identical to S000 response (w/S001 header instead of S000)
(measured data string)	various	Data stored in memory	This data string uses the RX format. This portion of the response only occurs if xx is between 17 and Memmax.

#### 9.3.2 Unit Setup

There are several pieces of information that can configure the Bravo MRI II unit. Information such as sweep width, center frequency and data format can be altered individually. Other setup information must be sent in a block of data that contains the entire setup information for the unit. This setup information may be read from the unit (to establish current settings) or sent to the unit to change the units operation.

## 9.3.2.1 Unit Setup commands

### 9.3.2.1.1 Fx..x

Set the center frequency, x..x is the center frequency in Hz. Range of center frequencies depends on version of unit, limits can be determined from unit setup data. No EOS marker is required if immediately followed with another command, but one may be sent if desired. If this is the last command in a string, the EOS marker must be used.

### 9.3.2.1.2 Wx..x

Set the sweep width, x..x is in Hz. The unit may deviate from this value due to synthesizer and/or display limitations. The unit sends the actual sweep width to the Terminal software in the header block that precedes the block of measured data (i.e. request measured data or unit setup data to get the unit's actual sweep width). No EOS marker is required if immediately followed with another command, but one may be sent if desired. If this is the last command in a string, the EOS marker must be used.

### 9.3.2.1.3 Dxxx

When in the VIA or SWR modes this command sets the data format that the unit sends to the Terminal software. No EOS marker is required, but one may be sent if desired. See table in Para 9.3.1.2.1 for definition of xxx.

### 9.3.2.1.4 S100

Set the unit's configuration. An entire block of configuration data follows this command. The format of this data block is identical to the unit response for configuration request (without the S002). No EOS marker is required if immediately followed with another command, but one may be sent if desired. If this is the last command in a string, the EOS marker must be used. The EOS marker, when used, must be placed after the last digit of configuration data.

## 9.3.2.2 Setup Data Response

The table details the setup data block. Note that the response (command) string is contained in the first column, and is sent as a continuous string. The string has been subdivided in the table for clarity. Most data is prefixed by 'A', thus the order of the data must be followed exactly to keep in sync. The only exception is that read only data need not be sent in a command (see \* below).

\* an asterisk in column A indicates that this data is read only, attempting to alter this value will do nothing. These read only values (except for lower plot index and upper plot index) may be omitted when the terminal sends this data block as a command to the unit. Values for the low and high plot indices must be sent to stay in sync, even though these values have no effect on the unit's setup. These read only values will be sent to the terminal in response to a S000 or Mxx command.

Setup Data Table

Characters Received	Range of x...x	Meaning	Notes	A
S002		Header denotes unit setup info follows	Toss this out	
Fx...x	100,000 to 200,000,000	Center frequency in Hz		
Wx...x	0 to 51.2MHz or 64MHz	Sweep width in Hz		
Dxxx	101 to 104	Data format	Overrides plot type if in conflict. x=101; R and X x=102; Z and A x=103; V and L x=104; M and D	
Ax...x	0 to 4	Instrument mode	0=VIA, 1=SWR, 2=Cable Tester, 3=Spectrum Ana., 4=CW Generator	
Ax...x	24	Memmax	Maximum memory locations	
Ax...x	0 to 200	CW index	Factory use	*
Ax...x	0 to 50	Lower plot index	Equal to 0 except when the sweep would try to extend below the minimum freq	*
Ax...x	40 to 100	Upper plot index	Usually the same as points in a sweep except when sweep extends beyond maximum freq	*
Ax...x	0 to 1	Auto power shutoff	0-disabled, 1-enabled	
Ax...x	0 to 3	Calibration Mode	0,1 =sweep; 2,3 =CW 1,3 =Cable null mode	
Ax...x	0 to 255	Backlight Intensity& Contrast	low nibble is intensity f =off,e=bright,0=dim High nibble for contrast 0=light, f=dark	
Ax...x	0 to 4	Backlight Timer	0=off, ...,4=continuous	
Ax...x	1, 3, 5	Horizontal grids		
Ax...x	0 to 1	Big Freq Display	0=off; 1=on	
Ax...x	0 to 3	Audio Volume	0=soft;...,3=loud	
Ax...x	0 to 2	Audio Mode	0=off; 1=on; 2=audio readout	
Ax...x	0 to 15	Left plot type	0=Z;1=A;2=R;3=X; 4=RCM;5=RCA; 6=none;7=VSR;8=RL 9=Power (S.A.), 10&up	

			future use	
Ax...x	0 to 15	Right plot type	See left above	
Ax...x	0 to 1	X axis Label	0=+/- dF; 1= +/- F	
Ax...x	0 to 1	Cable test mode	0=open; 1=short	
Ax...x	0 to 2,000	Z <sub>0</sub> , characteristic Z	cable Z	
Ax...x	0 to 1000	1000x Velocity factor	Cable Vf	
Ax...x	1 to 100,000	Freq Step Size KHz	Freq up/down key	
Ax...x	100 to 50,000	Min. width KHz	in 100MHz octave	*
Ax...x	10,000 to 200,000	Max. width KHz	in 100MHz octave	*
Ax...x	1 to 1000	Min. center freq. KHz		*
Ax...x	1000 to 200,000	Max. center freq. KHz		*
Ax...x	0 to 199	Lower valid data index	Base 0, beginning of valid data	*
Ax...x	1 to 200	Upper valid data index	Base 0, end of valid data	*
Ax...x#	Alphanumeric	Memory Name, user defined name for location Mxx	up to 12 characters, #char used to denote end of name	*

### 9.3.3 Examples

Command	Response	Notes
R*	F15000000W800000N80D101R10000X2000R10010X2100...R10100X2050*	Freq = 15MHz, Width = 800KHz, 80 points (81 actual), Data format = RX 1 <sup>st</sup> pt. 1.0K+j200; 2 <sup>nd</sup> pt. 1.001K+j210 ...
R	F15000000W800000N80D101R10000X2000R10010X2100...R10100X2050*	Note that the data dump response always has an EOS marker whether * follows R command or not.
M01	M01S001F200000W4000A0A24...A50000*	Read Save memory 1, Freq=200K, Width=4KHz, Instrument mode = VIA; Memory slots = 24, ... Max center freq=50MHz
S000	S002F500000W32000A1A5...A200000*	Bravo MRI II's current settings: Freq=500K, Width=32KHz, Instrument mode = SWR; Freq step=5KHz, ... Max center freq=200MHz
F5000000*	*	Center freq = 5MHz
W800000*	*	Sweep width = 800KHz
D102	*	Set unit to return total Z and Z angle
Q*	Q345*	Q is 34.5
D*	D8514*	Distance is 8514 mm

Command	Response	Notes
S100F1000000....A660*	*	Send unit setup data. The cable velocity factor is 0.660 and the optional read only data was not sent.
F5000000W800000*	*	Center freq = 5MHz Sweep width = 800KHz

## 9.4 ASCII Table

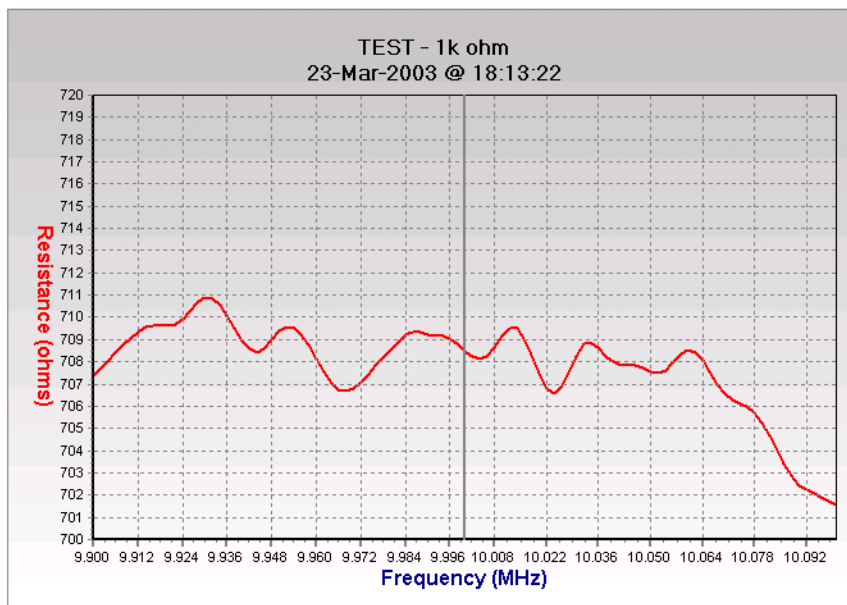
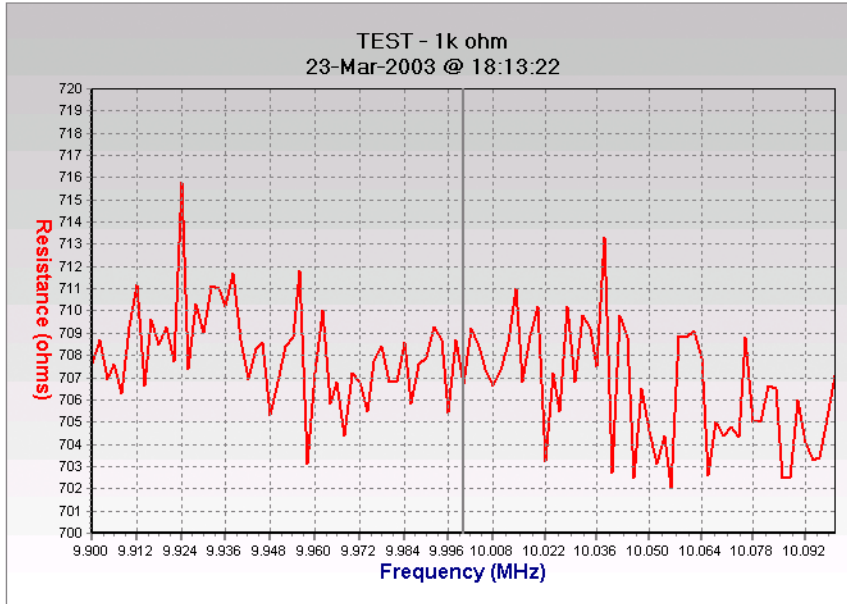
0	Null	32	Space	64	@	96	`
1		33	!	65	A	97	a
2		34	"	66	B	98	b
3		35	#	67	C	99	c
4		36	\$	68	D	100	d
5		37	%	69	E	101	e
6		38	&	70	F	102	f
7		39	'	71	G	103	g
8		40	(	72	H	104	h
9		41	)	73	I	105	i
10		42	*	74	J	106	j
11		43	+	75	K	107	k
12		44	,	76	L	108	l
13		45	-	77	M	109	m
14		46	.	78	N	110	n
15		47	/	79	O	111	o
16		48	0	80	P	112	p
17	XOFF	49	1	81	Q	113	q
18		50	2	82	R	114	r
19	XON	51	3	83	S	115	s
20		52	4	84	T	116	t
21		53	5	85	U	117	u
22		54	6	86	V	118	v
23		55	7	87	W	119	w
24		56	8	88	X	120	x
25		57	9	89	Y	121	y
26		58	:	90	Z	122	z
27		59	;	91	[	123	{
28		60	<	92	\	124	
29		61	=	93	]	125	}
30		62	>	94	^	126	~
31		63	?	95	_	127	
Characters 0 to 31 are not used by Bravo MRI II except for XON/XOFF							
Lower case letters are not used by Bravo MRI II							



## 9.5 Coaxial Cable Reference Table

Coax Part #	Characteristic Z	Velocity factor %
10base2 9907	52	80
10base5 9880	52	78
FSJ150A	52	84
FSJ1-75	73	78
FSJ4-50B	52	81
FSJ4-75A	73	81
FT4-50	52	85
HJ4-50	52	91
HT4-50	52	92
HJ4.5-50	52	92
HJ5-50	52	92
HT5-50	52	93
HJ5-75	73	90
HJ7-50	52	92
HJ8-50	52	93
HJ9-50	52	93
HJ11-50	52	92
HJ12-50	52	93
LDF2-50	52	88
LDF4-50	52	88
LDF4-75	73	88
RG-6/U 9116	73	82
RG-6A/U 8215	73	78
RG-8/U 8214	52	78
RG-8/U 8237	52	66
RG-8/U 9913	52	84
RG-8/U 9914	52	78
RG-8A/U 9251	52	66
RG-8/X 9258	52	78
RG-9/U 8242	52	66
RG-11/U 8213	73	78
RG-11/U 8238	73	66
RG-11A/U 8261	73	66
RG-11/U 9011	73	82
RG-58 9203	52	66
RG-58/U 8240	52	66
RG-58A/U 8219	52	78
RG-58A/U 8259	52	66
RG-59 9204	73	66
RG-59/U 8241	73	66
RG-59/U 8241F	73	78

RG-62 9862	93	84
RG-62A/U 9269	93	84
RG-58B/U 825	93	84
RG-63 9857	122	84
RG-71 9169	93	84
RG-122/U 9252	52	66
RG-141A/U	52	70
RG-142	52	70
RG-142B/U	52	70
RG-174/U 8216	52	66
RG-178B/U	52	70
RG-179 83264	73	70
RG-180 83266	93	70
RG-187A/U	73	70
RG-188A/U	52	70
RG-212/U 9861	52	66
RG-213/U 8267	52	66
RG-214/U 8268	52	66
RG-216 9850	73	66
RG-223/U 9273	52	66
RG-303 84303	52	70
RG-316 84316	52	70
RG-316/U 83284	52	70
RG-402/U 1673A	52	70
RG-405/U 1671A	52	70



Example #1

This shows the effectiveness of the Noise Filter. Be aware that the filter will smooth almost any curve and may alter good data. A perfectly good Return Loss plot has a very sharp point at the bottom without the filter on. Applying the filter will drastically change this sharp point.

Notes:



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