

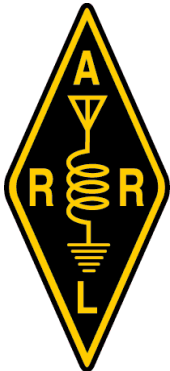
# The Amazing MFJ 269

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# What Can be Measured?

- Frequency
- VSWR (SWR)
- Impedance
- Impedance Phase Angle
- Electrical line length
- Feed line loss in dB
- Inductance in  $\mu\text{H}$
- Capacitance in pF
- Resistance in ohms
- Resonance
- Return loss
- SWR at  $Z_0$
- An RF signal source
- Measurements at other than  $Z_0 = 50 \Omega$

# Typical Uses

- **Antennas** – SWR, Impedance, Reactance, Resistance, Resonant Frequency & Bandwidth
- **Amplifiers** – Input & Output Matching Networks & Traps
- **Coaxial Transmission Lines** – SWR, Length, Velocity Factor, Loss & Impedance
- **Filters** – SWR, Attenuation & Frequency
- **Matching or Tuning Stubs** – SWR, approx. Q, Resonant Frequency, Bandwidth & Impedance

# Typical Uses (continued)

- **Traps** – Resonant frequency & approximate Q
- **Tuned Circuits** – Resonant frequency
- **Small Capacitors** – Value & self resonant frequency
- **RF Chokes & Inductors** – Value, self resonance & series resonance
- **Transmitters and Oscillators** – Frequency
- **Adjusting an Antenna Tuner** for best match before connecting it to the transmitter

# Typical Uses (continued)

- **The MFJ 269 is also useful as a non precision RF Signal Source with the following characteristics:**
  - Relatively pure sine wave (Harmonics -25dB)
  - Output signal is approx. 3 volts pp
  - Output impedance is 50Ω
  - The source is not synthesized and has no modulation capability
  - Frequency accuracy is better than 0.05%

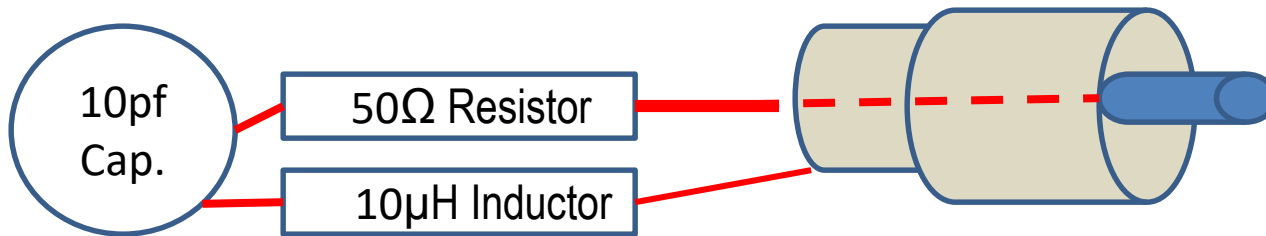
# Frequency Range

## Seven Measurement Frequency Ranges:

1. *1.8 to 4 MHz*
2. *4 to 10 MHz*
3. *10 to 27 MHz*
4. *27 to 70 MHz*
5. *70 to 114 MHz*
6. *114 to 170 MHz*
7. *415 to 470 MHz*

# Making a Dummy Antenna

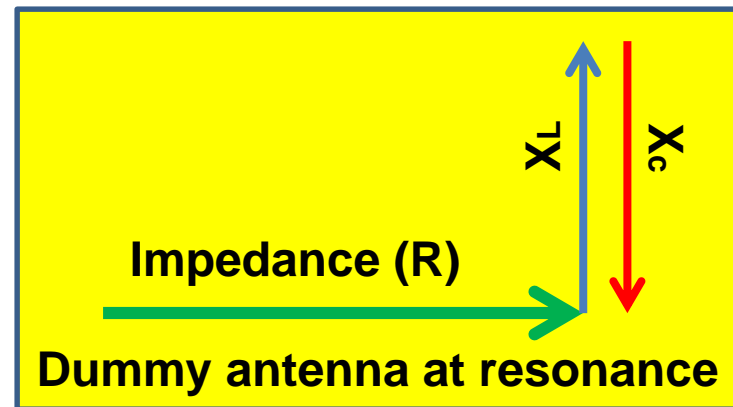
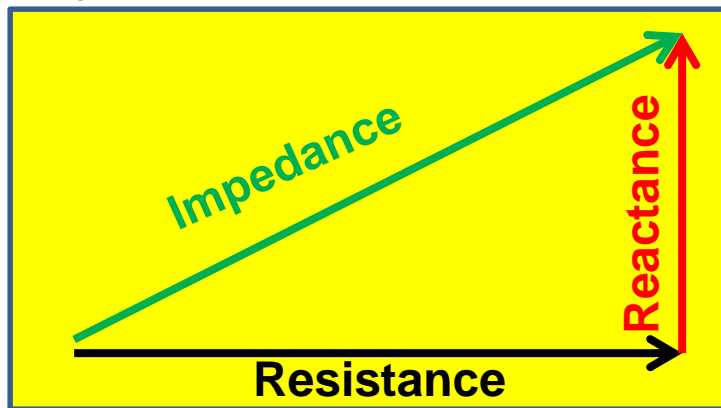
- A simple dummy antenna is useful in learning how to use the MFJ 269



- With the values shown this dummy antenna will resonate at approximately 16 MHz (the only critical value is the 50 ohm resistor). The inductor and capacitor can be anything close, but the resonant frequency will change.

# How does it work

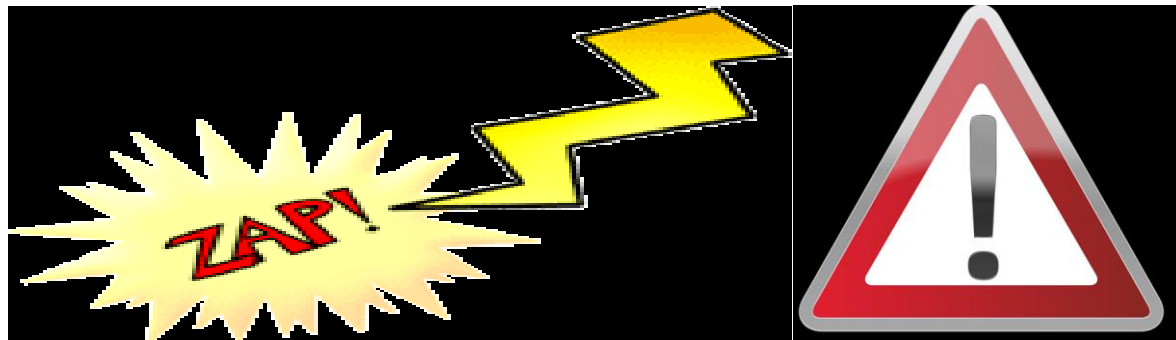
- The dummy antenna consists of a 50 Ohm Resistor and an inductor and capacitor.
- When the reactance of the Inductor and Capacitor are equal, they cancel out and you only see the 50 resistor and the lowest SWR.





# Caution to Prevent damage

When connecting any cable or device be sure to discharge any static electricity before connecting it by shorting the center pin to the shield before connecting it to the MFJ 269 to prevent damage to the antenna analyzer. Repairs at MFJ are around \$100 or more and repair turnaround time is long.



# Caution to Prevent damage

- Do not apply any RF voltage (such as a transmitter) or DC directly to the antenna connector.



- Be sure the UHF button is off (out) before turning the power on.

# Main Measurement Modes

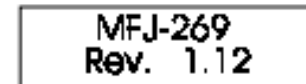
There are five measurement modes available at turn on of the MFJ 269.

- MODE 1 – SWR (VSWR)– Impedance – Resistance – reactance.
- MODE 2 – Coaxial cable loss.
- MODE 3 - Capacitance
- MODE 4 – Inductance
- MODE 5 – Frequency

# Measuring R & X (mode 1)

1. Be sure the UHF button is off (out)
2. Turn on the Analyzer
3. When you first turn the analyzer on it will cycle through three LCD Screens:

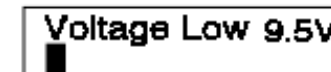
- The first screen shows the firmware revision number
- The second screen shows the MFJ copyright notice
- The third screen shows the voltage of the batteries or external power supply and will indicate if it is okay or low.



MFJ-269  
Rev. 1.12



MFJ-Enterprises  
(c) 1999



Voltage Low 9.5V  
■



Voltage OK 14.7V  
■■■■■■■■■■

# Measuring R & X (mode1)

(continued)

4. The next screen will momentarily show the mode which is “Impedance R & X”.



IMPEDANCE  
R & X

5. Connect antenna (or dummy antenna) to the Antenna connector on the top of the unit (type N connector, use the provided N male to UHF female (SO239) if needed.
6. Use the shortest possible cable length to connect to the MFJ 269 to the device you are testing. *Long cables will give less accurate measurements.*

# Measuring R & X (mode 1)

(continued)

7. Select the desired frequency range and adjust the tuning control for desired test Frequency (frequency is displayed on the LCD screen).
8. Read the VSWR and Impedance from the two analog meters or the LCD display.



7.1598 MHz 3.6  
Rs= 153 Xs= 62  $\Omega$

*Rs= Resistance*

*Xs= Reactance*

# Antenna Bandwidth (Mode 1)

1. Connect the antenna to the Antenna jack on the MFJ269.
2. Adjust the frequency until the lowest SWR reading is obtained, this is the center frequency of the Antenna.
3. Move the frequency lower until the SWR reaches 2.5 this is the lower side bandwidth of the antenna.
4. Move the frequency higher until the SWR reaches 2.5, this is the upper side bandwidth of the antenna.

# Antenna Bandwidth (mode 1)

(continued)

5. Subtract the lower frequency from the higher frequency. The result is the 2.5 SWR bandwidth of the antenna at the previously noted center frequency.
6. The 2.5 SWR limit of was chosen for this example. Use whatever limit the manufacturer specifies or that you want to set for your transmitter.



# Measuring Coax. Loss (mode 2)

1. Press the mode button once. The LCD display will momentarily display “**Coax Loss**”.

Coax Loss

1. Connect the coax you wish to test (**remember to discharge it before connecting**) Leave the far end open (un-terminated).

2. Set the frequency where you wish to test the cable. The LCD display will display the cable loss in dB.

28.721 MHz  
CoaxLoss = 24dB


144.23MHz  
CoaxLoss = 0.6 dB

50.157 MHz  
Coax Loss <0.28 dB

Less than .28 dB



# Measuring Capacitance (mode 3)


1. Press the mode button one more time or until the LCD display momentarily displays “**capacitance in pf**” 
2. Connect a capacitor to the antenna connector.
3. Select the frequency where you wish to measure the capacitance.
4. Read the capacitance in pf and reactance ( $X_c$ ) in ohms directly from the LCD display.

15.814 MHz 51  
C= 197 pF  $X_c$

4.0456MHz  
C(Z>1500)  $X_c$

4.0456MHz  
C(X<7)  $X_c$

# Measuring Inductance (mode 4)

1. Press the mode button one more time or until the LCD display momentarily displays **“Inductance in  $\mu\text{H}$ ”** 
2. Connect the inductor across the antenna input connector.
3. Select the frequency where you wish to measure the inductance.
4. Read the inductance from the LCD display.

15.814 MHz 51  
L= 0.513  $\mu\text{H}$  XI

144.04 MHz  
L(Z>1500) XI

3.5456MHz  
L(X<7) XI

# Measuring Frequency (mode 5)

1. Press the mode button one more time or until the LCD display momentarily displays **“Frequency Counter”**
2. **Ensure the signal you want to measure has no DC component and is less than 2 volts peak** (*1.4 volts RMS or 40 milli-watts/50 ohms*)
3. Connect the frequency to be measured to the “Frequency counter input” BNC connector.

# Measuring Frequency (continued)

4. Read the frequency directly from the LCD display.

Freq. Counter

14.32 MHz 0.01s  
Freq. Counter

14.325MHz 0.1s  
Freq. Counter

14.3258MHz 1s  
Freq. Counter

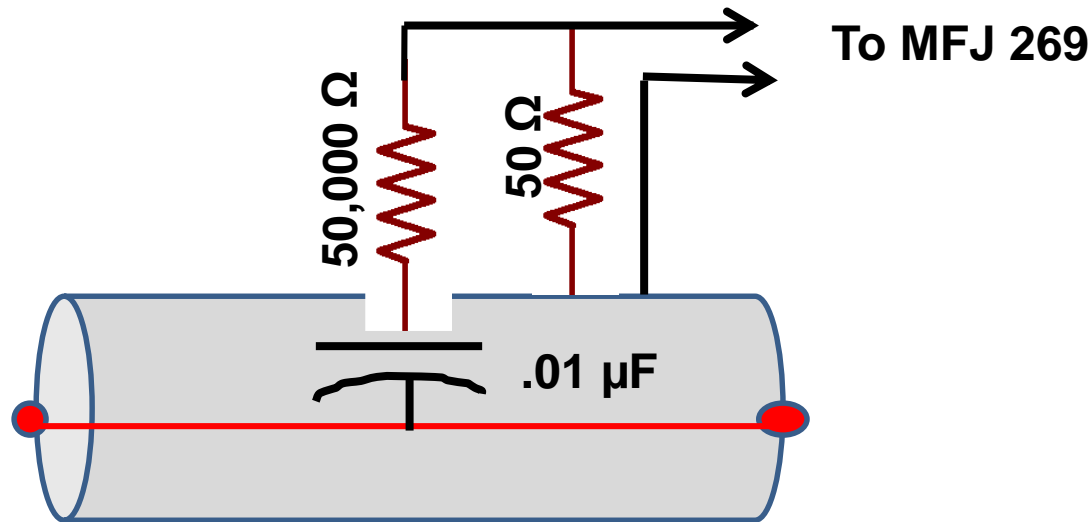
5. You can set the gate time that is used as the counter measurement period to .01, 0.1 or 1. seconds by pressing the GATE button.
6. The Specified frequency accuracy is  $\pm 0.05\%$  which would yield an error of as much as 7.5 KHz at 30 MHz and  $\pm 73$  KHz at 146 MHz.

# Measuring Frequency (continued)

7. The longer the gate time the more frequency resolution the display will have.
  1. A one second gate time give 1 Hz resolution
  2. A 0.1 second gate time give 10 Hz resolution
  3. A 0.01 second gate time give 100 Hz resolution
8. The 0.05% overall accuracy of the counter is ***not accurate enough to verify that your HT is exactly on frequency. Accuracy is typically 05% (+/- 73 KHz @ 146 MHz)***

# A Simple Signal Sampler

- The following circuit can be used to sample a signal from your 5 watt or less handheld transmitter for measurement by the frequency counter. The sampler loss is approx. 30 dB.



# UHF Measurements

- Many of the same measurements are available at UHF frequencies.
- Simply chose the mode in the main VHF menu and then press the UHF button.
- In the UHF mode the maximum SWR that can be measured is 5:1. In the “impedance RX mode the impedance meter is disabled and SWR is shown as a number and as a bar graph.





# Advanced Measurements

1. In addition to the measurements available in the basic, turn on mode, there three additional measurement modes available in the advanced mode.
2. To access the advanced modes press and hold the gate and mode keys down until “the display shows “Advanced 1”

# Advanced 1 (mode 1)

3. The first mode in advanced 1 is “Impedance  $Z = \text{mag}, \theta = \text{phase}$ ” at a selected frequency.
- In this mode the impedance is given in polar form as a vector in ohms at an angle in degrees.
  - The display will momentarily show:

IMPEDANCE  
 $Z = \text{mag. } \theta = \text{phase}$

And then will show the impedance in  $\Omega$  and angle in  $^\circ$

28.814 MHz 3.6  
 $Z = 87\Omega \theta = 53^\circ$   $S_{R}^{W}$

4.0456MHz >3I  
[Z>1500]  $S_{R}^{W}$

# Advanced 1 (mode 1 Continued)

4. Series and Parallel Equivalent Impedances Press the gate button to see the series equivalent impedance.

**Series equivalent display examples:**

```
7.1598 MHz 3.2  
Rs= 50 Xs= 62 sRW
```

```
14.095 MHz > 31  
Rs(Z> 1500) sRW
```

5. Press the gate button again to see the parallel equivalent.

**Parallel equivalent display example:**

```
7.1598 MHz 3.5  
Rp 126 Xp 102 Xs=41 SWR
```

# Advanced 1 (mode 1 Continued)

6. By pressing the GATE button the Magnitude and Phase of Load Impedance mode toggles the analyzer between the series and parallel equivalent impedance sub-mode.
7. In the left-hand display (step 5) example, the equivalent parallel resistance is  $R=126$  ohms. That  $R_p$  appears to be in parallel with  $102$  ohms  $X_p$ . If we parallel connect an opposite-sign reactance of  $-102$  ohms, the parallel equivalent reactance is canceled and Only the  $126$ -ohm resistance remains.

# Advanced 1 (mode 1 Continued)

6. This is a powerful tool used in matching antennas. The MFJ-269 places that tool at your fingertips. By checking a load for both  $R_p$  and  $R_s$ , you can see if either is close to the desired resistance. If one resistance value is close to the desired value, adding only one component will match the load by canceling reactance.

# Advanced 1 (mode 2)

## 1. “Advanced 1” mode 2, Return Loss and Reflection coefficient (press mode to enter)

- Return Loss and Reflection coefficient are read directly from the LCD Display.

14.159 MHz 1.0  
RL=48 dB  $\rho=0$  SWR

144.23MHz 1.9  
RL=9.8 dB  $\rho=32$  SWR

14.159 MHz >31  
RL=0 dB  $\rho=1$  SWR

21.450MHz >91  
RL<0.5dB  $\rho >0.99$  SWR

# Advanced 1 (mode 3)

1. “Advanced 1” mode 3, Resonance (Press mode to enter)

Resonance mode  
tune for X=0

- Tune frequency for a zero  $X_s$  reading on the LCD display.
- Read the resonant frequency from the LCD display.

15.814 MHz 2.4  
Rs= 63 [Xs= 51]

# Advanced 1 (mode 4)

1. **“Advanced 1”** mode 4, **Match Efficiency** (press mode to enter)
  - Connect load. Tune frequency to where measurement is to be made.
  - Read Frequency and match efficiency from LCD Display.

1.8963 MHz 3.1  
Power = 74 % SWR

50.097 MHz 1.3  
Power = 98% SWR

53.34 MHz > 31  
Match < 12%  $\frac{SW}{R}$



# Advanced 1 (mode 4 continued)

NOTE: Match efficiency ONLY applies to the loss in power transfer from a perfect 50 ohm fixed tuned source to the input of the feedline or system where the measurement is made. It is mostly useful in laboratory situations.

# Advanced 2

1. To get to the advanced 2 mode simultaneously press and hold the Gate key and the MODE key until advanced 2 is displayed .
2. The advanced 2 mode is related to cable lengths and you will need to input the cable velocity factor for your cable.
  - The default is .66. use the gate and mode keys to increment the velocity factor up or down.
  - simultaneously press and hold the Gate key and the MODE key to exit the velocity factor set mode.

# Advanced 2 (mode 1)

- “Advanced 2” mode 1, “Dist. to fault in feet”  
(HF and VHF only)
    - Connect unknown length cable to antenna Jack  
**(discharge it before connecting)**
    - Adjust frequency for an XS reading of zero.
    - Press the GATE button and hold until “1<sup>st</sup>” stops blinking.
- 21.324 MHz 1st  
DTF Xs= 0
- Readjust the frequency up or down to the very next point where RS again goes to Zero.

# Advanced 2 (mode 2 continued)

## 2. “Advanced 2” mode 1, “Dist. to fault in feet” (HF and VHF only)

- Press the gate button and hold until “2<sup>nd</sup>” stops blinking.

```
68.511 MHz  2nd  
DTF   Xs= 1
```

- Read the distance to fault on the LCD display

```
Dist. to fault  
6.6 ft
```

# Advanced 2 (mode 2 Continued)

1. **“Advanced 2” mode 2, “Line length in degrees”** (HF and VHF only)
  - Pressing the MODE button once (after finding a valid DTF) displays the distance to fault in feet and the electrical length of the line (in degrees) at the frequency the analyzer is set on:



68.511 Mhz  
L = 6.6 ft = 251 °

# Advanced 2 (mode 3)

## 1. “Advanced 2” mode 3, “Line length in Feet”

(HF and VHF only)

- Pressing the MODE button again causes the analyzer to calculate the length of one wavelength of line for the velocity factor and at the frequency of the display. Remember, this is the length of a full wavelength (360 degrees) at the frequency selected and with velocity factor selected in step 1.

```
146.51 MHz  
l=360° = 4.0 ft
```

# Advanced 3 (mode 1)

## 1. “ADVANCED 3” mode 1 Characteristic Impedance setup

- Upon entering this mode you are asked to choose the Characteristic Impedance, **Z** pressing the mode and gate keys to increment or decrement the value.
- **Z** is normally set to 50 ohms.
- Press and hold the gate and mode keys to exit

```
21.273 MHz 9.1  
Rs= 16 Xs= 72  $s_H^w$ 
```

```
21.273 MHz 9.1  
Rs= 16 Xs= 72
```

# Advanced 3 (mode 1 Continued)

## 1. “ADVANCED 3”, mode 1, **Characteristic Impedance setup**

- The flashing “swr” on the display means the display is indicating SWR referenced to a new  $Z_0$ . The meter
- continues to indicate 50 ohm SWR .



# Advanced 3 (mode 2)

- “**ADVANCED 3**” mode 2, **Coaxial loss** (press mode to enter)
  - This mode measures coax loss for the line  $Z_0$  selected in 5.6.1. it is important that the line is not terminated in any sort of dissipative load when making this measurement.
- 1. Connect a length of coax to the MFJ 269 (**discharge it first**)
- 2. Adjust to desired test frequency
- 3. Read cable loss directly on the LCD display

# In Conclusion

You should now be able to make many useful measurements with the MFJ 269 antenna analyzer

*Note: The MFJ 259B/C can make most of the same measurements but they do not have UHF capability.*



This presentation is available on my web site  
[www.ad7fo.com](http://www.ad7fo.com)

# Any Questions

**NOT SURE IF I CAN ANSWER ALL  
OF THEM**

**BUT I WILL TRY MY BEST**