HF/VHF SWR Analyzer

Model MFJ-209

INSTRUCTION MANUAL

CAUTION: Read All Instructions Before Operating Equipment

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VERSION 1A

DISCLAIMER

Information in this manual is designed for **user purposes only** and is ***not*** intended to supersede information contained in customer regulations, technical manuals/documents, positional handbooks, or other official publications. The copy of this manual provided to the customer will ***not*** be updated to reflect current data.

Customers using this manual should report errors or omissions, recommendations for improvements, or other comments to MFJ Enterprises, 300 Industrial Park Road, Starkville, MS 39759. Phone: (662) 323-5869; FAX: (662) 323-6551. Business hours: M-F 8-4:30 CST.

MFJ-209 HF/VHF SWR Analyzer

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INTRODUCTION

The MFJ-209 SWR Analyzer is an easy to operate, versatile test instrument for analyzing nearly any 50 ohm RF system on frequencies between 1.8 and 170 MHz. In addition the MFJ-209 can be used as signal source.

The MFJ-209 combines three basic circuits; a wide range oscillator, a 50 ohm RF bridge, and a calibrated bridge unbalance indicator. This combination of circuits allows measurement of the SWR (referenced to 50 ohms) of any load connected to the ANTENNA connector.

The MFJ-209 covers all ham bands from 2 meters to 160 meters. The dial calibration is approximate and for reference only. The actual frequency may vary from what is marked on the front panel. The MFJ-209 FREQUENCY switch selects the following frequency ranges:

1.8 - 4 MHz   4 - 10 MHz   10 - 27 MHz   27 - 70 MHz   70 - 114 MHz   114- 170 MHz

A frequency counter, such as the MFJ-346, can be connected to the "FREQ. OUT" jack (RCA phono) to get a more accurate reading of the frequency. As an alternative to a frequency counter, you can zero beat the output with an HF receiver. See the section on zero beating the MFJ-209 with a receiver.

The MFJ-209 can be used to adjust or measure the following:

Antennas:	SWR, resonant frequency, bandwidth, efficiency
Antenna tuners:	SWR, frequency
Amplifiers:	Input and output networks
Coaxial transmission lines:	SWR, velocity factor, losses, resonance
Balanced transmission lines:	Impedance, velocity factor, resonance
Matching or tuning stubs:	SWR, resonant frequency, bandwidth
Traps:	Resonant frequency
Tuned Circuits:	Resonant frequency
Small capacitors:	Value
RF chokes and inductors:	Self resonance, series resonance, value
Transmitters and oscillators:	Frequency

Warning: Please read this manual thoroughly before using this instrument. Failure to follow the operating instructions may cause false readings or even damage this unit.

A Quick Word about Accuracy

Inexpensive SWR meters have limitations. The following text details several common problems and reasons they occur.

Measurement errors. Unreliable readings are rooted in three primary areas:

1.) Signal ingress from external RF sources, usually strong AM broadcast stations.

2.) Diode detector and A/D converter errors.

3.) The impedance of connectors, connections, and lead lengths.

Virtually all low cost impedance meters use broad-band voltage detectors. The reason virtually all analyzers use broadband detectors is cost. Narrow band detectors are very expensive, since the detector system would have to use at least one selective gain-stable receiver. Narrow band detectors would price antenna and impedance analyzers far outside the price range of most casual users.

Broadband detectors are sensitive to out-of-band external voltages, and solutions to most out-of-band interference are not simple. Common low-pass or band-pass filters behave like small transmission lines of varying impedances on different frequencies. Low-pass or high-pass filters change impedance and SWR readings, just as an additional section of transmission line would. This modification of impedance caused by filters severely limits their usefulness.

One solution to this problem (often mentioned by users) is to increase internal generator power. Unfortunately the power required to operate a clean, harmonic-free broadband VFO system greatly reduces battery life. In this unit, more than 70% of the total battery drain (-150 mA) is used to produce the low harmonic distortion test signal.

Most RF interference problems occur on lower frequencies, since high power AM broadcast signals couple well into large antennas (especially 160 meter verticals). MFJ offers an adjustable filter that attenuates all off-frequency signals while having virtually no small effect on measurements between 1.8 and 30 MHz. Properly used, this adjustable filter reduces external interference while having nearly no measurable effect on desired measurements.

Component limitations are another source of inaccuracy. Diodes detecting very small voltages are non-linear. The accuracy of the MFJ-259B is enhanced by the use of special microwave zero-bias Schottky detectors with matching compensating diodes. Each unit is individually compensated to provide the best possible linearity with both high and low impedance loads, making the A/D converter's 1/2 percent resolution the primary limitation.

POWERING THE MFJ-209

The MFJ-209 requires between 8 and 18 volts for proper operation. Any power supply used with the MFJ-209 must be capable of supplying 200mA of current ***MFJ has an optional power supply, the MFJ-1312D, that satisfies all external supply requirements. We recommend only using this supply***.

The MFJ-209 has a standard 2.1 mm female receptacle on the top right edge of the case. This jack is labeled "12VDC" and has the word "POWER" near it. A pictorial polarity marking appears on the case near the power jack. The outside conductor of the plug must connect to the negative supply voltage and the center conductor of the plug must connect to the positive voltage. The internal battery pack is automatically disconnected when an external power plug is inserted in this jack.

SWR measurement will be inaccurate when the supply voltage falls below 7 volts. To avoid false readings maintain fresh batteries and always use the correct power supply.

WARNING: REVERSE POLARITY OR EXCESSIVE VOLTAGE CAN DAMAGE OR DESTROY THE MFJ-259B. NEVER APPLY MORE THAN 18 VOLTS, NEVER USE AC OR POSITIVE GROUND SUPPLIES!

BATTERY INSTALLATION

If batteries are used, they must be installed by removing the 8 phillips head screws on each side of the case. The eight batteries fit in two separate battery holders with the positive terminal of the batteries positioned toward the round fixed connection, and the negative terminals toward the springs of the battery holder.

The battery case has two external terminals that connect to a "pigtail" that has two terminals on it. This connector looks like the type used for 9 volt transistor radio batteries and connects in the same way. ***Do not attempt to use 9 volt batteries with this unit***. After the batteries are installed in the plastic holders and the connections are made to the battery packs, the battery holders can be slid directly into the chrome retaining clips on the cover.

MFJ recommends the use of ALKALINE AA (or rechargeable nicad) cells to reduce the risk of equipment damage from battery leakage. Avoid leaving any batteries in this unit during periods of extended storage. Remove weak batteries immediately!

Carefully check the following:

* The battery packs are positioned so that they do not interfere with any internal parts of the MFJ-209.
* The leads are positioned to reach with the cover in the original position.
* The wires are not pinched between the cover and the chassis.

OPERATION OF THE MFJ-209

After the MFJ-209 is connected to a proper power source the red on-off button can be depressed to apply power. When pressed, the red button should lock into position.

The "ANTENNA" connector (SO-239 type) on the top of the MFJ-209 provides the SWR bridge output connection. To measure SWR, this connector must be connected to the load or device under test.

Warning: Never apply power to the "ANTENNA" connector.

SWR and the MFJ-209

Some understanding of transmission line and antenna behavior is necessary to use the MFJ-209 properly. For a thorough explanation the ARRL Handbooks or other detailed textbooks can be used for reference.

The "**ANTENNA**" connector (SO-239 type) on top of the MFJ-209 provides the RF measurement output connection. This port is used to measure SWR or perform other RF impedance measurements, with the exception of the Frequency Counter mode.

WARNING: NEVER APPLY EXTERNAL VOLTAGES OR RF SIGNALS TO THE ANTENNA CONNECTOR.

Remember to use proper RF connections. Keep leads as short as possible when measuring components or any system or device that is not a 50 ohm coaxial system. When measuring 50 ohm coaxial systems or antennas, interconnecting transmission lines may modify impedance and SWR. Use properly constructed 50 ohm coaxial cables of known quality to avoid errors.

SWR is the ratio of a load impedance to source impedance. Since nearly all feedlines and radio equipment used in amateur service are 50 ohms, this instrument is designed to measure the system SWR normalized to 50 ohms. For example a 150 ohm load placed across the "ANTENNA" connector will give an SWR reading of 3:1 .

The MFJ-209 measures actual SWR. The load must be 50 ohms of pure resistance for a meter reading of 1:1 . The common misconception that 25 ohms of reactance and 25 ohms of resistance in a load will give a 1:1 SWR is absolutely untrue. The actual SWR in this condition will be measured as 2.6:1 . The MFJ-209 is not "fooled" by mixtures of reactive and resistive loads.

Another common misconception is that changing a feedlines length will change SWR. If the impedance of a feedline is 50 ohms and the load impedance is 25 ohms the SWR will remain 2:1 as the feedline length changes. ***If line loss is low*** it is perfectly acceptable to make SWR measurements at the transmitter end of the feedline. The feedline does not have to be any particular length. However, as line loss increases, and as SWR increases, more error is introduced into the SWR reading. The error causes the measured SWR reading to appear ***better*** than the actual SWR at the antenna. Refer to the section on estimating the line loss on page 10.

If changing feedline length changes the SWR reading, one or more of the following must be true:

the feedline is not 50 ohms,
the bridge is not set to measure 50 ohms,
the line losses are significant,
the feedline is acting like part of the antenna system and radiating RF.

Feedlines with very low losses, such as air insulated transmission lines, will not have much loss even when operating at extremely high SWRs. High loss cables, such as small polyethylene dielectric cables like RG-58, will rapidly lose efficiency as the SWR is increased. With high loss or long feedlines it is very important to maintain a low SWR over the entire length of the feedline.

Any SWR adjustments have to be made at the antenna, since any adjustments at the transmitter end of the feedline can not affect the losses, nor the efficiency of the antenna system.

Measuring SWR

The MFJ-209 will measure the impedance ratio (SWR) of any load referenced to 50 ohms. The SWR can be measured on any frequency from 1.8 to 170 MHz. No other devices are required.

If the antenna does not use a dc grounded feed system, momentarily short the antenna lead from shield to center. This prevents static charges from damaging the MFJ-259B's zero bias detector diodes.

Immediately connect (in the case of a non-dc grounded feed system) the antenna lead to the MFJ-259B **"ANTENNA"** connector.

To measure the SWR on a predetermined frequency adjust the "TUNE" and "FREQUENCY" knobs to the desired frequency. To accurately measure the MFJ-209's frequency connect a counter to the "FREQ. OUT" jack or zero beat the MFJ-209 with a receiver. Read the SWR from the "SWR" meter.

To find the lowest SWR adjust the frequency until the SWR meter reaches the lowest reading. Read the approximate frequency of the lowest SWR from the "TUNE" scale or measure the exact frequency with a counter.

ADJUSTING SIMPLE ANTENNAS

Most antennas are adjusted by varying the length of the elements. Most home made antennas are simple verticals or dipoles that are easily adjusted.

Dipoles

Since a dipole is a balanced antenna, it is a good idea to put a balun at the feedpoint. The balun can be as simple as several turns of coax several inches in diameter, or a complicated affair with many windings on a ferromagnetic core.

The height of the dipole, as well as it's surroundings, influences the feedpoint impedance and the line SWR. Typically, dipoles have a SWRs below 1.5:1 .

Generally the only adjustment on a dipole is the length of the antenna. If the antenna is too long it will resonate too low in frequency, and if it is too short it will resonate too high.

Verticals

Verticals are usually unbalanced antennas. Most antenna manufacturers downplay the importance of good radial systems with grounded verticals. If you have a good ground system the SWR of a quarter wave vertical can be nearly 2 to one. The SWR generally gets BETTER as the ground system, and performance, get worse.

Verticals are tuned like dipoles, lengthening the element moves the frequency lower, and shortening the element moves the frequency higher.

Tuning an Antenna

Tuning basic antennas fed with 50 ohm coaxial cable can be accomplished with the following steps:

1 Connect the feedline to the MFJ-209.
2 Adjust the MFJ-209 until the SWR reaches the lowest reading.
3 Read or measure (with a counter) the MFJ-209's frequency.
4 Divide the measured frequency by the desired frequency.
5 Multiply the present antenna length by the result of step 4. This is the new length needed.

Note: This method will not work on loaded or electrically shortened antennas. They must be tuned by adjusting and re-testing until the proper frequency is obtained.

Measuring the Feedpoint Resistance of Antennas

The feedpoint resistance of a low impedance (10-100 ohm) resonant HF antenna or load can be measured with the MFJ-209. A low value non-inductive potentiometer (250 ohms) and a conventional ohm meter can be used to make these measurements.

1 Connect the MFJ-209 directly across the terminals of the unknown impedance. If the load is unbalanced be sure that the ground is connected to the SO-239 "ANTENNA" connector's ground.
2 Adjust the MFJ-209 until the SWR reads the lowest value.
3 If the SWR is not unity (1:1), place the potentiometer in parallel with the load. Adjust the potentiometer until the SWR is as good as possible.
4 If the SWR only becomes worse go to step 7.
5 If the SWR reached unity, remove the potentiometer and measure its resistance.

6 The resistance of the load is found by using the formula below.

$$R_A = \frac{50R_P}{R_P - 50}$$

R_A = Antenna resistance

R_P = Potentiometer resistance

7 If the earlier steps did not work put the potentiometer in series with the center pin (ungrounded terminal) of the SO-239 "ANTENNA" connector.
8 Adjust the value of the potentiometer until the SWR is unity (1:1).
9 Remove the potentiometer and measure the resistance of the setting used in step 8. Subtract this value from 50 to determine the load resistance.

TESTING AND TUNING STUBS AND TRANSMISSION LINES

The proper length of quarter and half wave stubs or transmission lines can be found with this unit and a 50Ω carbon resistor. Accurate measurements can be made with any type of coaxial or two wire line. The line does ***not*** have to be 50 ohms.

The stub to be tested should be attached with a 50Ω noninductive resistor in series to the center conductor of the "ANTENNA" connector with a coaxial line. The shield should be grounded to the connector shell. For two wire lines the 50Ω resistor connects in series between the ground shell of the PL-259 and one conductor. The other conductor of the balanced line connects directly to the center pin of the connector.

Coaxial lines can lie in a pile or coil on the floor, two wire lines ***must*** be suspended in a straight line a few feet away from metallic objects or ground. The lines must be ***open circuited*** at the far end ***for odd multiples*** of 1/4 wave stubs (i.e., 1/4, 3/4, 1-1/4, etc.) and ***short circuited for half wave stub multiples*** (like 1, 1-1/2, etc.)
Connect the PL-259 to the "ANTENNA" connector of the MFJ-209 and adjust the line or stub by the following method. For critical stubs you may want to **gradually** trim the stub to frequency.

1 Determine the desired frequency and theoretical length of the line or stub.
2 Cut the stub slightly longer than necessary.
3 Measure the frequency of the lowest SWR. It should be just below the desired frequency.
4 Divide the measured frequency by the desired frequency.
5 Multiply the result by the length of the stub. This is the necessary stub length.
6 Cut the stub to the calculated length and confirm that it has the lowest SWR near the desired frequency.

Velocity Factor of Transmission Lines

The MFJ-209 can accurately determine the velocity factor of any impedance transmission line. Measure the velocity factor with the following procedure:

1. Disconnect both ends of the transmission line and measure the physical length of the line in feet.
2. Set up the line to measure 1/4 stubs as in the section on Testing and Tuning Stubs, page 7.
3. Find the ***lowest*** frequency across all the bands at which the lowest SWR occurs. The dip should occur slightly below the 1/4 wavelength frequency.
4. Measure the frequency from the MFJ-209. This is the 1/4 resonant wavelength frequency of your transmission line. Note that you will get low SWR reading at all odd multiples of 1/4 wavelength.
Example: On a 27 foot line the measured frequency was 7.3MHz.
5. Divide 246 by the measured frequency. This gives you the free space 1/4 wavelength in feet.
Example: 246 divided by a dip frequency of 7.3 MHz is 33.7 feet, the free space 1/4 wavelength
6. Divide the physical measured length of the feedline in feet by the free space 1/4 wavelength calculated in number 5.
Example: 27 feet (physical length) divided by 33.7 feet (calculated length) equals .80 . The velocity factor is .80 or 80%.

$$\text{Free space } 1/4 \text{ wavelength} = \frac{246}{\text{Low SWR frequency}}$$

$$\text{Velocity Factor} = \frac{\text{Free space } 1/4 \text{ wavelength}}{\text{Actual feedline length}}$$

<u>Impedance of Transmission Lines</u>

The impedance of transmission lines between 15 and 150 ohms can be measured with the MFJ-209, a 250 ohm potentiometer, and an ohm meter. Lines of higher impedance can be measured with a higher resistance potentiometer if a broad band transformer is used (see the section on testing transformers) to transform the line impedance to approximately 50 ohms.

1 Measure the 1/4 wavelength frequency of the transmission line to be tested as in Testing and Tuning Stubs on page 7.
2 Terminate the far end of the transmission line with a non-inductive 250 ohm potentiometer.
3 Connect the transmission line to the MFJ-209 "ANTENNA" connector and set the analyzer to the 1/4 wave frequency.
4 Observe the SWR as you vary the "TUNE" from end to end of the "FREQUENCY" range selected.
5 Adjust the potentiometer until the SWR reading varies as little as possible, over the "TUNE" range. Note that the ***value*** of the SWR is not important. Only the ***change*** in SWR as the frequency is varied is important.
6 The value of the potentiometer will correspond closely to the line impedance.

<u>Estimating transmission line loss</u>

The loss of 50 ohm feedlines (between 3 and 10 dB) can be measured with the MFJ-209. It is a simple matter to find the loss at a known frequency and then estimate the loss at a lower frequency.

To measure feedline loss:

1. Connect the feedline to the MFJ-209 "ANTENNA" connector.
2. The far end of the feedline is either left unconnected or terminated with a direct short.
3. Adjust the MFJ-209 frequency to the frequency desired and observe the "SWR" meter.
4. If the SWR is in the red area of the scale the loss is less than 3 dB. Increase the frequency until the "SWR" meter reads 3:1. This is the 3dB loss frequency.
5. If the SWR on the operating frequency is in the black area of the "SWR" meter, pick the closest SWR point and estimate the loss from the chart below.

SWR	LOSS
3.0 : 1	3.0 dB
2.5 : 1	3.6 dB
2.0 : 1	4.7 dB
1.7 : 1	5.8 dB
1.5 : 1	6.9 dB
1.2 : 1	10.3 dB

You can estimate the approximate loss at the operating frequency by remembering that the feedline loss in dB is reduced by 70 % at half the frequency, and increased by 140 % at twice the frequency you measured. This method is reasonably accurate if the loss is distributed along the feedline and not confined to one bad area.
For example, assume an operating frequency of 28 MHz. You want to know what the feedline loss is at 28 MHz. At that frequency the "SWR" meters needle is in the red uncalibrated portion of the meter. Increase the measured frequency until the needle falls on a calibration mark. At 60MHZ the meter reads 3:1 SWR. Using the chart you know that the loss is 3 dB. Since 28MHz is about half of 60MHz, you can multiply 3dB by .7 giving a loss of about 2dB at 28MHz.

ADJUSTING TUNERS

The MFJ-209 can be used to adjust tuners. Connect the MFJ-209 "ANTENNA" connector to the tuner's 50 ohm input and the desired antenna to the normal tuner output. This connection can be made with a manual RF switch to facilitate rapid changeover.

Warning: Always connect the common (rotary contact) of the switch to the tuner. The switch must connect either the MFJ-209 or the station equipment to the tuner. ***The Station Equipment Must Never Be Connected To The MFJ-209.***

1 Connect the MFJ-209 to the tuner input.

2 Turn on the MFJ-209 and adjust it to the desired frequency.
3 Adjust the tuner until the SWR becomes unity (1:1).
4 Turn off the MFJ-209 and re-connect the transmitter.

ADJUSTING AMPLIFIER MATCHING NETWORKS

The MFJ-209 can be used to test and adjust RF amplifiers or other matching networks without applying operating voltages.

The tubes and other components should be left in position and connected so that stray capacitance is unchanged. A non-inductive resistor that equals the approximate driving impedance of the tube is installed between the cathode of the tube and the chassis, or a resistor should be connected between the anode and the chassis that equals the calculated plate impedance of the tube. The appropriate network can now be adjusted.

The antenna relay (if internal) can be engaged with a small power supply so that the coax input and output connectors are tied to the networks.

Caution: The driving impedance of most amplifiers changes as the drive level is varied. Do not attempt to adjust the input network with the tube in an operating condition with the low level of RF from the MFJ-209.

TESTING RF TRANSFORMERS

RF transformers that are designed with a 50 ohm winding can be easily and accurately tested with the MFJ-209.

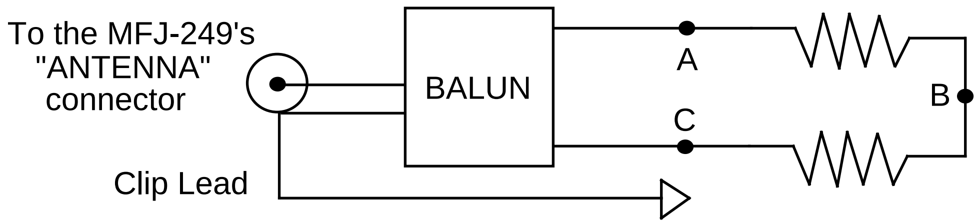
The 50 ohm winding is connected through a short 50 ohm cable to the "ANTENNA" connector on the MFJ-209. The other winding(s) of the transformer is then terminated with a low inductance resistor that is equal to the winding's impedance. The MFJ-209 can then be swept through the desired transformer frequency range. The SWR and bandwidth of the RF transformer can be measured.

Testing Baluns

Baluns can be tested by connecting the 50 ohm unbalanced side to the MFJ-209 "ANTENNA" connector. The balun must be terminated with two equal value load resistors in series. The resistor combination must have resistance total that is equal to the balun impedance. A pair of 100 ohm carbon resistors must be used to test the 200 ohm secondary of a 4:1 balun (50 ohm input).

The SWR is measured by moving a jumper wire from point "A" through point "C".

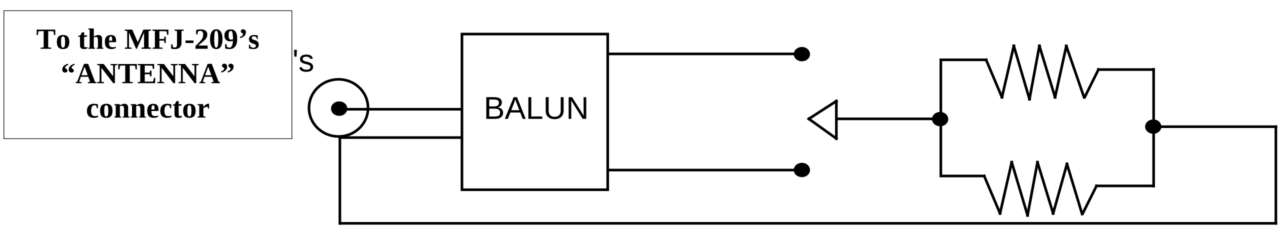
To the MFJ-209's "ANTENNA" connector



A properly designed current balun, the type that is the most effective and usually handles the most power, should show a low SWR over the entire operating range of the balun with the clip lead in any of the three positions.

A well-designed voltage balun should show a low SWR over the entire operating range when the clip lead is in position "B". It will show a poor SWR when the clip lead is in position "A" and "C".

A voltage balun should also be tested by disconnecting the outer connections of the two resistors and connecting each resistor in parallel. If the balun is operating properly the SWR will be very low with the resistors connected from either output terminal to ground.



MEASURING INDUCTANCE AND CAPACITANCE

To measure capacitance or inductance you will need some standard value capacitors and inductors. These should be collected and tested for accuracy. MFJ suggests the following sets of values:
Inductors: 330µH, 56 µH, 5.6 µH, 0.47 µH
Capacitors: 10 pF, 150 pF, 1000 pF, 3300 pF
Readings will be the most accurate if the standard test values used are between 0.5 µH to 500 µH to measure capacitance or 10 pF and 5000 pF to measure inductance.

Take a component of unknown value and connect it in series with a standard component to make a series LC circuit. Attach the series LC circuit to the "ANTENNA" connector in series with a 50 Ω resistor.

Measure capacitance.

1. Connect an unknown capacitor in parallel with the highest value standard inductor.
2. Connect the LC circuit to ANTENNA connector with a 50 Ω resistor in series.
3. Adjust the tune knob through the bands until you get the lowest SWR. If you do not get a deep meter deflection change to the next inductor with a lower value and try again.

Continue the process until you obtain low SWR. Read the resonant frequency off the MFJ-209 scale or measure it with a counter.

4. Solve this equation using F as the resonant frequency as L as the inductance of the standard inductor,

$$C(pF) = \frac{1}{.00003948F^2L}$$

F = MHz L = μH

Measure inductance.

1. Connect an unknown inductor with the highest value standard capacitor in parallel.
2. Connect the LC circuit to "ANTENNA" connector with a 50 Ω resistor in series.
3. Adjust the tune knob through the bands until you get the lowest SWR. If you do not get a deep meter deflection change to the next smaller value standard capacitor and try again. Repeat the process until you get low SWR.
4. Solve this equation using F as the resonant frequency and C as the capacitance of the standard capacitor.

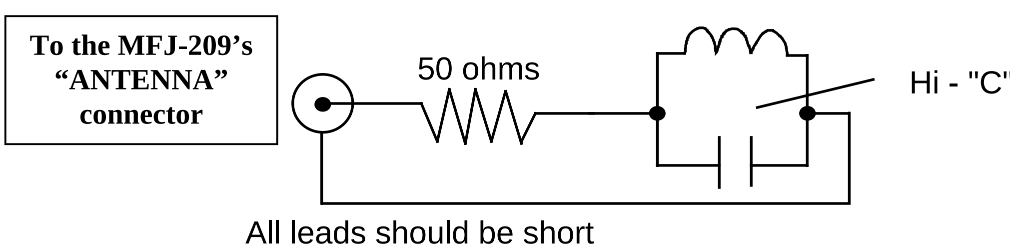
$$L(\mu H) = \frac{1}{.00003948F^2C}$$

F = MHz C = pF

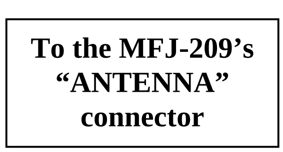
RESONANT FREQUENCY OF TUNED CIRCUITS

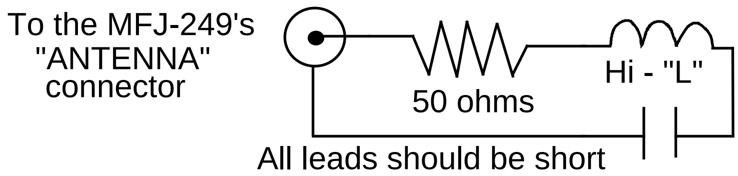
The MFJ-209 can be used to measure the resonant frequency of tuned circuits by two methods. The first method involves placing a 50 ohm resistor in series with the MFJ-209 "ANTENNA" connector. The MFJ-209 connects through the resistor to the parallel tuned circuit. This circuit is for high capacitance values.

Tune the MFJ-209's frequency until the "SWR" meter reaches the highest SWR. This is the resonant frequency of the load.



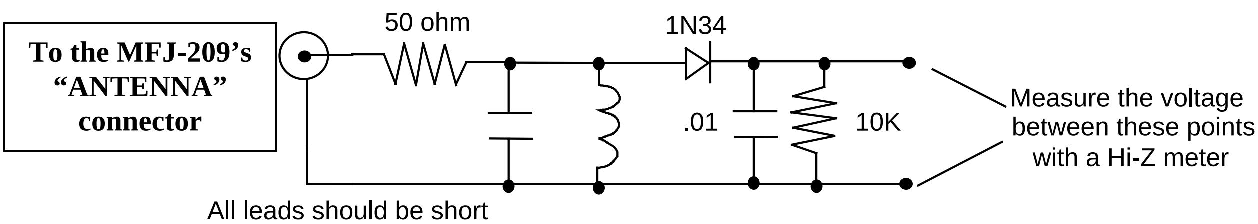
For high inductance values a series LC circuit should be used to measure resonant frequency. The inductor and capacitor should be connected in series through a 50Ω low inductance carbon resistor across the "ANTENNA" connector on the MFJ-209.





Tune the MFJ-209's frequency until the "SWR" meter reaches the lowest SWR. This is the resonant frequency of the load.

An external diode detector and volt meter can also be used to measure the resonant frequency of circuits. The maximum meter reading occurs at the resonant frequency.

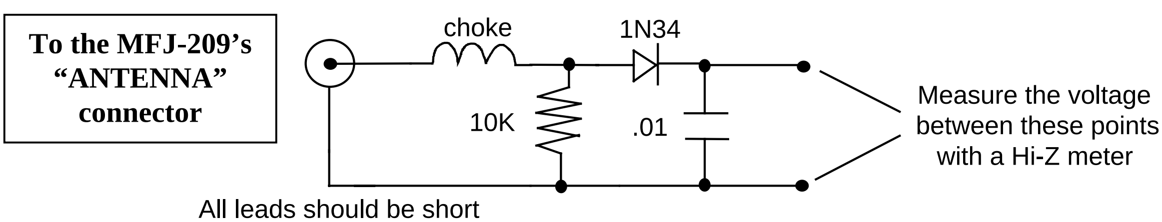


A second method of determining the resonant frequency is by using a small three or four link coil to magnetically couple to a tuned circuit for testing. The coil should be wound around the inductor in the tuned circuit. This magnetically couples the MFJ-209 to the resonant circuit.

The frequency of the MFJ-209 is adjusted for a dip on the "SWR" meter. The dip occurs at the approximate resonant frequency of the tuned circuit.

Testing RF Chokes

Large RF chokes usually have frequencies where the distributed capacitance and inductance form a low impedance series resonance. The troublesome series resonance can be detected by slowly sweeping the frequency of the MFJ-209 over the operating range of the choke. Peaks in the voltage measured by the RF voltmeter will identify the low impedance series-resonant frequencies.



Refer to the section on measuring the inductance of RF chokes on page 12.

"ZERO BEATING" THE MFJ-209

The FREQ. OUT jack of the MFJ-209 supplies enough signal to drive a frequency counter or a receiver. The signal from this jack is strong enough to drive all but the poorest receivers without direct coupling.

To measure the frequency with a receiver you should first connect a short wire to the input of the receiver or to the center conductor of coax feeding the receiver. This wire can normally just be placed near the MFJ-209 to provide ample signal strength for the receiver. In rare cases a second wire can be inserted into the FREQ OUT jack and placed near the receiver lead.

To determine the operating frequency of the MFJ-209 the receiver should be set to the widest bandwidth SSB position and tuned to the frequency setting of the MFJ-209 dial. The receiver dial can then be tuned up and down until a signal is heard swooping past.

Zero in on the signal until the pitch becomes very low. The receiver will be approximately on the same frequency as the receiver.

If you use the MFJ-209 primarily on one frequency range you can calibrate the knob. Find a frequency and loosen the set screw on the knob. Carefully pull the knob off and reinsert it at the correct setting. Be sure that the receiver and the MFJ-209 are on the same frequency throughout the procedure.

A second method would be to set the frequency of interest on the dial with a grease pen or other temporary marking device.

USING THE MFJ-209 AS A SIGNAL SOURCE

The MFJ-209 can provide a moderately stable signal source for testing and alignment. Signal is produced by the internal oscillator and can be taken from both the "FREQ.OUT" or the "ANTENNA" jacks. Signal should be taken from the "ANTENNA" jack allowing a frequency counter, such as the MFJ-346, to be attatched to the "FREQ. OUT" jack to measure the frequency of the output signal.

An attenuator pad or variable resistor can be used to reduce the output level of the MFJ-203.

TECHNICAL ASSISTANCE

If you have any problem with this unit first check the appropriate section of this manual. If the manual does not reference your problem or your problem is not solved by reading the manual, you may call *MFJ Technical Service* at **662-323-0549** or the *MFJ Factory* at **622-323-5869**. You will be best helped if you have your unit, manual and all information on your station handy so you can answer any questions the technicians may ask.

You can also send questions by mail to MFJ Enterprises, Inc., 300 Industrial Park Road, Starkville, MS 39759; by FAX to 662-323-6551; or by e-mail to techinfo@mfjenterprises.com. Send a complete description of your problem, an explanation of exactly how you are using your unit, and a complete description of your station.