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MFJ-259 HF/VHF SWR ANALYZER

INTRODUCTION

The MFJ-259 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-259 can be used as signal source and as an accurate frequency counter.

The MFJ-259 combines four basic circuits; a wide range oscillator, a frequency counter, 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-259 FREQUENCY switch selects the following frequency ranges:

1.8	-	4	MHz
4	-	10	MHz
10	-	26.2	MHz
26.2	-	62.5	MHz
62.5	-	113	MHz
113	-	170	MHz

The MFJ-259 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

The MFJ-259 is also portable. It can be used with either an external low voltage supply, such the MFJ-1312B AC adapter or with internal AA battery packs.

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.

POWERING THE MFJ-259

The MFJ-259 requires between 8 and 18 volts for proper operation. Any power supply used with the MFJ-259 must be capable of supplying 200mA of current. An optional power supply, the MFJ-1312B, is available from MFJ.

The MFJ-259 has a standard 2.1 mm coaxial type jack 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, the battery should be checked after storage to ensure the supply voltage does not drop below acceptable levels.

WARNING: Never apply unfiltered AC or incorrectly polarized DC to this jack. Peak voltage must never exceed 18 volts.

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.

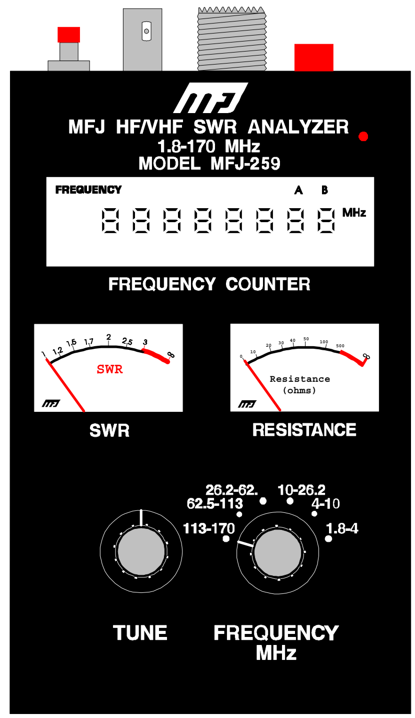
The battery case has two external terminals that connect to a "pigtail" that has two terminals on it. This connector looks like the type used for 9 volt transistor radio batteries and connects in the same way. ***Do not attempt to use 9 volt batteries with this unit***. After the batteries are installed 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 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-259.
- 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-259



After the MFJ-259 is connected to a proper power source the red on-off button can be depressed to apply power. When pressed, the power button should lock into position.

Upon initial power up all segments of the display will be lit for a few seconds and then will read MFJ before starting to count.

SWR and the MFJ-259

Some understanding of transmission line and antenna behavior is necessary in order to use the MFJ-259 properly. For a thorough explanation the ARRL Handbooks or other detailed textbooks can be used for reference.

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-259 measures the 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-259 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-259 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.

The "ANTENNA" connector (SO-239 type) on the top of the MFJ-259 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.

To measure the SWR of a 50 ohm coaxial line simply connect the line to the "ANTENNA" connector. The counter input should be set to "A". Press the "Input" button until the "A" appears on counter display.

To measure the SWR on a predetermined frequency adjust the "TUNE" and "FREQUENCY" knobs until the counter displays the desired frequency. 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 frequency of the lowest SWR directly from the counter display.

Note: The internal oscillator of the MFJ-259 will not produce an entirely stable reading on the frequency display due to short term drift in the oscillator. This drift is normal and does not affect the accuracy, results or usefulness of this instrument since a null will even be maintained on the highest Q (narrow bandwidth) antennas or loads.

It is perfectly acceptable to ignore decimal place readings more than two places to the right of the decimal point in the counter (ten's of kilohertz) above 15 MHz and three places to the right of the decimal point (kilohertz) below 15 MHz.

Resistance Meter

The resistance meter section of the MFJ-259 will provide resistance readings for the load connected to the ANTENNA jack. The resistance meter will not give an accurate reading of a reactive load. For example, if an antenna is resonant at 7.1 MHz and you attempt to measure the resistance at 7.3 MHz, the resistance reading will not be accurate. To get an accurate reading the TUNE knob should be adjusted until the lowest SWR reading is obtained. The point of lowest SWR is generally the point of lowest reactance therefore the most accurate point to read the antenna's pure resistance.

If the resistance meter indicates 50 ohms but the SWR meter indicates a high SWR the load is probably reactive. Any time the resistance meter indicates a resistive ratio that disagrees with the SWR reading the load is reactive. For example: If the resistance meter indicates 25 ohms (a 2:1 SWR) but the SWR meter indicates greater than 2:1, the load is reactive. ***For the SWR to be 1:1, the load must be 50 ohms of pure resistance.***

The SWR can not be 1:1 if reactance is present or the resistive component is not 50 ohms. If the SWR meter indicates 1:1 but the resistance meter reads other than 50 ohms you are experiencing an instrument error.

Frequency Counter

The frequency counter in the MFJ-259 will typically measure frequencies between a few hertz and 200 MHz. At frequencies above 1 MHz, the frequency counter is sensitive to 600 mV. Below 1 MHz, the counter is sensitive to TTL input voltage levels (5V peak to peak) with a square wave input. The counter function is accurate to 1 part per million at room temperature.

WARNING: The frequency counter has a CMOS input device that can be easily damaged. To avoid damage to the counter while using the "FREQUENCY COUNTER INPUT" jack the user must observe the following precautions: ***NEVER*** **exceed 5 volts peak input.** ***NEVER*** **apply an input signal with the power switch off.**

To use the frequency counter turn the power "ON" and press the "INPUT" button on the top panel until a "B" appears in the upper right corner of the counter display. The BNC jack is now selected for input to the counter.

A basic operational check of the Channel B input on the counter can be made with a short jumper wire. If a short jumper is placed from the center of the SO-239 connector to the center of the BNC connector, the output of the MFJ-259 oscillator will be displayed on the counter readout. The frequency displayed will be the same on both Channel A and Channel B, while the jumper is in place. This check is useful when a reliable external RF source is not available.

Input to Channel B may be provided in many different ways. The most common usage is measuring the transmitter frequency. ***Never transmit directly into the MFJ-259, or it may be***

severely damaged. A coupling loop is useful for directing RF at a reduced level into the counter. A coil of wire, or even a straight piece of wire attached to the BNC connector may be sufficient for operation. The length and number of turns will vary with the power supplied by the transmitter. A weak signal will require a larger area of wire to supply a good level to the counter, compared to a powerful transmitter.

A standard HT antenna, which has a BNC connector, may act as a conductor of RF into the counter. An antenna with no loading coils is preferred to one which does. A 2 meter antenna may not conduct enough energy to the counter if it is used on the HF bands. Antenna attenuation can greatly reduce the RF level into the counter. The coupling antenna may have to be much closer to the transmitting antenna if the transmit level is low. On a high power transmitter, the coupling level may be useful for quite a distance from the transmitter.

Coupling of the RF signal into the counter may also be done by placing several turns of wire around a coax feedline, and attaching it to the counter input. More turns will be needed for a well-shielded cable than for a lossy cable. Hard-line is not usable since there is no leakage. The leakage from the cable is usable under normal conditions for a low level counter input. Experimentation will be needed to determine how many turns are needed for a particular installation.

A loop of wire placed inside the case of a wattmeter, dummy load, low-pass filter, etc., is another way to couple RF into the counter. The inductance of the loop will act as an antenna, to direct low level RF into the counter. Almost any type of wire may act as a receiving antenna for coupling RF into the counter.

The sample time period is selected by momentarily pressing the "GATE" button near the upper left corner of the top panel. The counter displays the average frequency over the sample time period. The red LED in the upper right corner of the front panel flashes when the count cycle is complete and the display is updated.The blinking LED will speed up and/or slow down with the changing of gate settings. At power up, the sample time period normalizes at .01 seconds. Additional count periods of 0.1, 1.0, and 10 seconds can also be selected. Connect the cable with the signal to be counted to the BNC type jack labeled "FREQUENCY COUNTER INPUT".

Gate Settings

Gate Setting	Gate Time	Measurement Time	Measurement Resolution	Example
1	10 mS	25 mS	100 Hz	162.5500
2	100 mS	130 mS	10 Hz	162.55000
3	1 S	1 S	1 Hz	162.550000
4	10 S	10 S	0.1 Hz	162.5500000

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, influence the feedpoint impedance and the line SWR. Typical heights result in SWRs below 1.5 to one on most dipoles.

In general, 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 down play 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-259.

2. Adjust the MFJ-259 until the SWR reaches the lowest reading.

3. Read the frequency display.

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 of tuning will only work on full size vertical or dipole antennas that do not employ loading coils, traps, stubs, resistors, capacitors or capacitance hats. These antennas must be tuned according to the manufacturers instructions and re-tested with the MFJ-259 until the desired frequency is obtained.

Measuring the Feedpoint Resistance of Antennas

The approximate feedpoint resistance of a low impedance (0-500 ohms) resonant HF or VHF antenna or load can be measured with the MFJ-259.

1. Connect the MFJ-259 directly across the terminals of the unknown resistance. If the load is unbalanced be sure that the ground is connected to the SO-239 "ANTENNA" connectors outer shell. If the load is balanced it may be necessary to operate the MFJ-259 using internal battery power to allow the case of the unit to float above ground.
2. Set the band switch for the desired frequency measurement range.
3. Adjust the TUNE control until the SWR reads the lowest value.
4. Read the resistance directly from the resistance meter.
5. Double check the meter readings against each other. The SWR ratio should be approximately equal to the ratio between the measured resistance and 50 ohms.

FINDING A SHORT CIRCUIT IN COAX CABLES

The MFJ-259 is very effective in locating a short circuit in coax cables. The method is as follows:

1. Connect one end of the cable to the MFJ-259 input.
2. Turn on the MFJ-259 and start sweeping the frequency, starting at the low frequency end of its range. Watch the RESISTANCE METER for a dip reading and record the frequency for zero ohms.
3. Continue the sweep for the second dip, which should be at twice the first dip frequency.
4. Calculate the position of the short: Divide 492 by the first dip frequency (in MHz) and multiply the result by the velocity factor of the coax cable being measured. The result should be the location of the short (in feet).
5. You can check this number by shorting the other end and repeating the process.

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 lay 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-259 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-259 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 8.

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. Read the frequency from the frequency counter display. 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%.

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

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

Impedance of Transmission Lines

The impedance of transmission lines between 15 and 150 ohms can be measured with the MFJ-259, 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 8.

2. Terminate the far end of the transmission line with a non-inductive 250 ohm potentiometer.

3. Connect the transmission line to the MFJ-259 "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.

Estimating Transmission Line Loss

The loss of 50 ohm feedlines (between 3 and 10 dB) can be measured with the MFJ-259. 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-259 "ANTENNA" connector.

2. The far end of the feedline is either left unconnected or terminated with a direct short.

3. Adjust the MFJ-259 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 following chart.

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 which gives a loss of about 2dB at 28MHz.

ADJUSTING TUNERS

The MFJ-259 can be used to adjust tuners. Connect the MFJ-259 "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-259 or the station equipment to the tuner. ***The Station Equipment Must Never Be Connected To The MFJ-259.***

1. Connect the MFJ-259 to the tuner input.

2. Turn on the MFJ-259 and adjust it to the desired frequency.

3. Adjust the tuner until the SWR becomes unity (1:1).

4. Turn off the MFJ-259 and re-connect the transmitter.

ADJUSTING AMPLIFIER MATCHING NETWORKS

The MFJ-259 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-259.

TESTING RF TRANSFORMERS

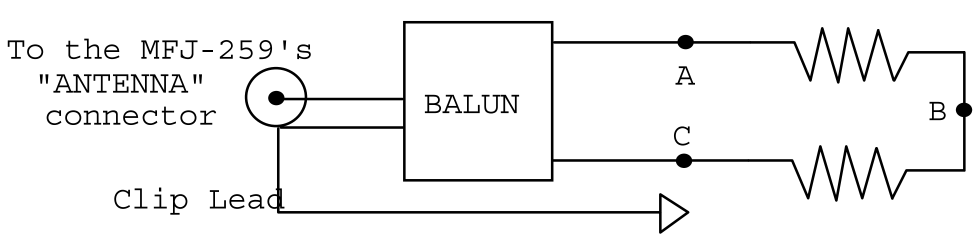
RF transformers that are designed with a 50 ohm winding can be easily and accurately tested with the MFJ-259.

The 50 ohm winding is connected through a short 50 ohm cable to the "ANTENNA" connector on the MFJ-259. The other winding(s) of the transformer is then terminated with a low inductance resistor that is equal to the windings impedance. The MFJ-259 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-259 "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).

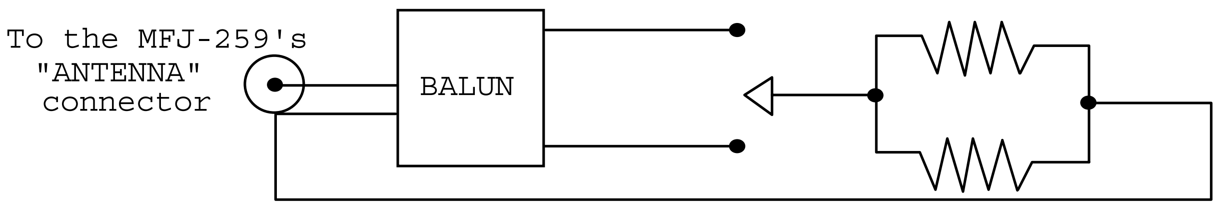
The SWR is measured by moving a jumper wire from point "A" through point "C".



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

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

$$F = MHz \quad L = \mu H$$

Measure inductance

1. Connect an unknown inductor with the highest value standard capacitor in series.

2. Connect the series 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.

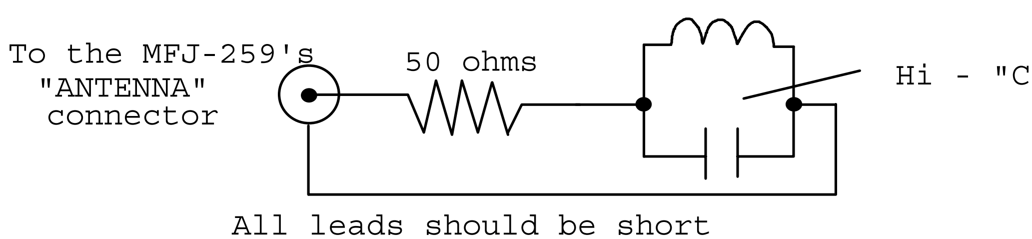
$$L(\mu H) = \frac{1}{.00003948F^2C}$$

$$F = MHz \quad C = pF$$

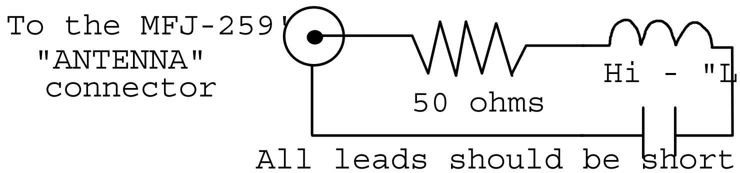
RESONANT FREQUENCY OF TUNED CIRCUITS

The MFJ-259 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-259 "ANTENNA" connector. The MFJ-259 connects through the resistor to the parallel tuned circuit. This circuit is for high capacitance values.

Tune the MFJ-259's frequency until the "SWR" meter reaches the highest SWR. This is the resonant frequency of the load.

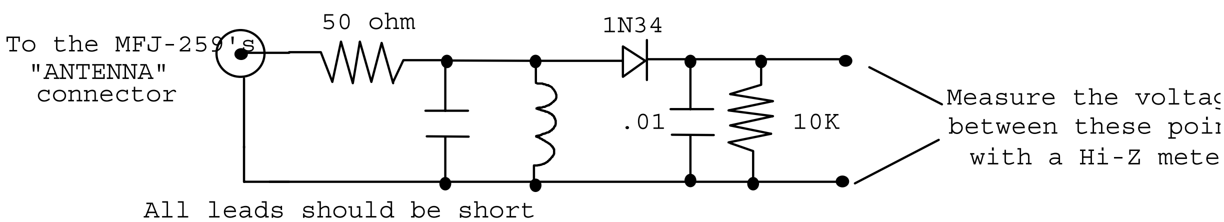


For high inductance values a series LC circuit should be used to measure resonant frequency. The inductor and capacitor should be connected in series through a 50Ω low inductance carbon resistor across the "ANTENNA" connector on the MFJ-259.



Tune the MFJ-259'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.

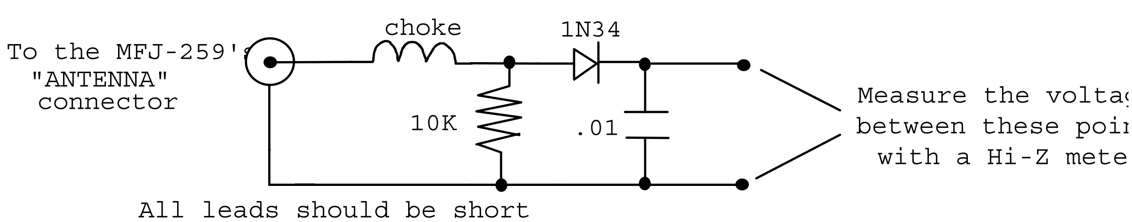


A second method of determining the resonant frequency is by using a small three or four link coil to magnetically couple to a tuned circuit for testing. The coil should be wound around the inductor in the tuned circuit. This magnetically couples the MFJ-259 to the resonant circuit.

The frequency of the MFJ-259 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-259 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 14.

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 **601-323-0549** or the *MFJ Factory* at **601-323-5869**. 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 601-323-6551; or by email 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.

MFJ-259 PARTS LIST

Designator	Description	Part Number
BH1	Battery Holder, 4-AA	730-2342
BS1	Battery, Snap, 9v, 8"	730-3005
C1	Capacitor, Disc Ceramic, 50v, 20%, 22 pF	200-0018
C11,C13,C14,C16, C19	Capacitor, Disc Ceramic, 25/50v, 20%, .01 µF	200-0004
C17,C18,C24	Capacitor, Disc Ceramic, 50/100v, 20%, .1 µF	200-0005
C2,C3,C4,C15,C6, C7,C8	Capacitor, Disc Ceramic, 25/50v, 20%, .01 µF	200-0004
C20,C21,C25,C26, C27	Capacitor, Disc Ceramic, 25/50v, 20%, .01 µF	200-0004
C22,C23,C40,C39	Capacitor, Disc Ceramic, 25/50v, 20%, .01 µF	200-0004
C28	Capacitor, Electrolytic, Radial, 25v, 100 µF	203-0015
C29	Capacitor, Disc Ceramic, 500v, 20%, 75 pF	200-1011
C30	Capacitor, Disc Ceramic, 1 kV, 20%, 470 pF	200-2023
C31	Capacitor, Disc Ceramic, 1 KV, 20%, 33 pF	200-2016
C32	Capacitor, Electrolytic, Radial, 50v, 1 µF	203-0006
C33,C36,C10	Capacitor, Disc Ceramic, 25/50v, 20%, .01 µF	200-0004
C38	Capacitor, Electrolytic, Radial, 35v, 220 µF	203-0019
C44	Cap, Air Var, 6-200pf	204-5160
D2-D4	Diode, Germanium, 1N34A	300-8001
For C44, SW1	Knob, 1/4" Shaft	760-0033
For IC1	Socket, IC, Low Profile, 14 Pin	625-0031
For SW2	Knob, Plastic, Push-Button, Red	760-2140
IC1	IC, Op-amp, Quad Op-amp, 14 Pin, Lm324n	311-0040
IC2	Voltage Regulator, TO-220, 1 Amp, 7805T	307-1011
J2	Connector, Header, 90, 3 Pos	612-0103
J3	Connector, Socket, Dual Row, 7 Pos	612-3307
J4	Connector, UHF, 4-hole Mount, SO-239	610-2005

Designator	Description	Part Number
J5	Jack, 2.1 mm, DC Coaxial Jack	601-6021
J6	Connector, BNC, Chassis Mt. Female, UG-652/U	610-1016
JMP1-JMP3	Wire, Jumper, 1/4"-2"	870-5000
L1	Inductor, Var, 66 µH	402-3412
L2	Inductor, Xformer, 1 7.8 µH	402-3406
L3	Inductor, Xformer, 1.8 µH	402-3402
L4	Inductor, .211 µH	402-2728
L5	PCB Coil, Air Wound, 4 Turn	10-01014
L6	PCB Coil, Air Wound, .5 Turn	10-01011
L7	Pick-up Coil, #61 Pre-wound	10-01003
M1	Meter, 100 uA, SWR Meter	400-0035
M2	Meter, Resistance	400-0045
MOD1	Counter Module, LCD	50-247-3
P2	Connector, IDC, Socket, 3 Positions	612-2003
PCB	PCB, 2-side, MFJ-259	862-0249
Q1,Q2,Q4	Transistor, FET, To-92, Siliconix, J310	305-6310
Q3	Transistor, FET, Switching, VN10KM	305-6005
Q5	Transistor, HF Wide Band, To-39, NPN, 2N5109	305-0017
R1	Resistor, 1/4 Watt, 5%, Film, 18 Ohm	100-1180
R10	Resistor, 1/4 Watt, 5%, Film, 39k Ohm	100-4390
R15,R24,R29,R30	Resistor, 1/4 Watt, 5%, Film, 10.0k Ohm	100-4100
R17,R32	Resistor, Trimpot, Sub. Horz., 10 K	133-4100
R18	Resistor, Trimpot, Sub. Horz., 100 K	133-5100
R2,R21,R22	Resistor, 1/4 Watt, 5%, Film, 1M Ohm	100-6100
R26,R27,R28	Resistor, 1/8 Watt, 1%,49.9 Ohm	102-1499
R3,R8	Resistor, 1/4 Watt, 5%, Film, 100 Ohm	100-2100
R33	Resistor, 1/4 Watt, 5%, Film, 620 Ohm	100-2620
R4,R7	Resistor, 1/4 Watt, 5%, Film, 10 Ohm	100-1100
R5,R6	Resistor, 1/4 Watt, 5%, Film, 1.0k Ohm	100-3100
R9	Resistor, 1/4 Watt, 5%, Film, 100k Ohm	100-5100
SW1	Switch, Rotary, 2p6p	500-1565
SW3,SW4	Switch, Push Button, spst	504-1003
SW2	Switch, Push-Button, 2p2p	504-0022