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# 1.0 INTRODUCTION

**Attention:** Read section 2.0 before attempting to use this product. Incorrect power supply voltages or excessive external voltages applied to the ANTENNA connector will damage this unit.

### Description

The MFJ-259B RF analyzer is a compact battery powered RF impedance analyzer. This unit combines four basic circuits; a 1.8-170 MHz variable frequency oscillator, a frequency counter, a 50 ohm RF bridge, and an eight-bit micro-controller. This unit makes a wide variety of useful antenna or impedance measurements, including coaxial cable loss and distance to an open or short.

Primarily designed for analyzing 50 ohm antenna and transmission line systems, the MFJ-259B also measures RF impedances between a few ohms and several hundred ohms. It also functions as a signal source and frequency counter. The frequency range of impedance measurement is 1.8 to 170 MHz, in six overlapping bands.

## 1.1 A Quick Word about Accuracy

Inexpensive impedance 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.

**Connection lengths are another problem.** Connection lengths between components in the bridge and the bridge and output connector upset readings, especially when the impedance is very high or very low. The MFJ-259B minimizes this problem by using surface mount low capacitance microwave components with nearly zero lead length.

Unlike instruments that present readings outside the reliable range as exact numbers, the MFJ-259B gives a display warning. If (Z>650) appears on the display, the impedance is greater than 650 ohms and outside the reliable instrument range.

## 1.2 Typical Uses

**The MFJ-259B can be used to adjust, test, or measure the following*:***

Antennas: .................................. SWR, impedance, reactance, resistance, resonant frequency, and bandwidth
Antenna tuners: .......................... SWR, bandwidth, frequency
Amplifiers: ................................ Input and output matching networks, chokes, suppressors, traps, and components
Coaxial transmission lines: ........ SWR, length, velocity factor, approximate Q and loss, resonant frequency, and impedance
Filters: ....................................... SWR, attenuation, and frequency range
Matching or tuning stubs: .......... SWR, approximate Q, resonant frequency, bandwidth, impedance
Traps: ......................................... Resonant frequency and approximate Q
Tuned Circuits: .......................... Resonant frequency and approximate Q
Small capacitors: ........................ Value and self-resonant frequency
RF chokes and inductors: .......... Self resonant frequency, series resonance, and value
Transmitters and oscillators: ...... Frequency

**The MFJ-259B measures and displays the following:**

| | | |
|---|---|---|
| Cable length (feet) | Impedance phase (degrees) | Resonance (MHz) |
| Cable Loss (dB) | Inductance (uH) | Return loss (dB) |
| Capacitance (pF) | Reactance or X (ohms) | Signal Frequency (MHz) |
| Impedance or Z magnitude (ohms) | Resistance or R (ohms) | SWR (referenced to 50 ohms) |

**The MFJ-259B is useful as a non-precision signal source.** It provides a relatively pure (harmonics better than -25 dBf) signal of approximately 3 Vpp (approximately 20 milliwatts) into 50 ohm loads. The MFJ-259B internal source impedance is 50 ohms.

**Note**: A more complete description of the MFJ-259B's features and proper measurement methods can be found by reading the sections on the particular measurement you wish to make. Consult the table of contents for the various applications.

### 1.3 Frequency Range

The **FREQUENCY** switch selects the following internal oscillator frequency ranges. (A small overlap outside each range is provided):

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

## 2.0 POWER SOURCES

+ *Read this section before connecting this device to any power source. Improper connections or incorrect voltages may cause damage to this product!*

### 2.1 External Power Supply

*MFJ has an optional power supply, the MFJ-1315, that satisfies all external supply requirements. We recommend only using this supply.*

Voltage must be more than 11 volts, and preferably less than 16 volts, when the unit is on and operating. Maximum “sleep mode” and “OFF” voltage (when the power supply is lightly loaded by this unit) is 18 volts. The supply must be reasonably well filtered. The supply must *not* have a grounded positive lead!

The MFJ-259B can be used with an external low voltage dc supply’s (MFJ-1315 AC adapter recommended). The ideal supply voltage is 14.5 volts dc, but the unit will function with voltages between 11 and 18 volts. The current demand is 150 mA maximum. (Be sure you read the battery instructions if you use also install batteries!)

The MFJ-259B has a recessed 2.1 mm power-type receptacle near the RF connectors. This receptacle is labeled **“POWER 12VDC”**.

The outside conductor of the **POWER** receptacle is negative, the center conductor positive.

Inserting a power plug in the “**POWER 12VDC”** receptacle disables internal batteries as a power source. Internal batteries, although disabled for operating power by inserting a power supply plug, can still be trickle charged.

**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!**

### 2.2 Using Internal Batteries

When batteries are initially installed, a small black-plastic internal jumper must be re-positioned or checked for proper position. The battery setting jumper is located inside the unit at the top of the printed circuit board near the area of the OFF-ON switch and power connector. This jumper is accessed by removing eight screws along the both sides of the MFJ-259B. After the cover mounting screws are removed, remove the entire back cover. The black plastic jumper fits over two of three adjacent pins. It must be properly positioned for the type of battery used (either rechargeable or non-rechargeable).

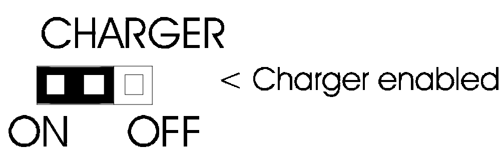
For battery replacement, batteries are accessed by removing the MFJ-259B's small rear panel. The battery cover is secured by 2 Phillips head screws.

## 2.3 Using Rechargeable "AA" Type Batteries

**CAUTION: Avoid using external power sources having less than 13 volts if rechargeable batteries are installed. If external supply voltage is too low, the charger will not work properly and batteries will eventually discharge. We recommend charging batteries with the MFJ-259B power switch off, with enough charging time to establish full battery charge (at least ten hours).**

When using rechargeable batteries, an external supply that remains between 14 and 18 volts should be used. Typical battery charging current is 10-20 mA through an internal charging system. The internal charger trickle charges internal batteries any time a proper external voltage is applied, even when the MFJ-259B is turned off. The MFJ-1315 supply fulfills all power supply requirements.

When using rechargeable batteries, the internal black plastic jumper located inside the cover (near the external power jack on the back side of the circuit board) must be set to the proper position. If it is not set to the proper position, the batteries will not charge. With rechargeable batteries, the internal charger jumper located on the printed circuit board near the power jack should be set like this:



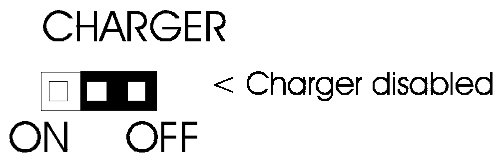

## 2.4 Using Conventional "AA" Drycell Batteries

Try to use good quality alkaline batteries. Conventional batteries will work fine, but good quality alkaline batteries offer less risk of battery leakage and equipment damage and usually provide longer service and shelf life.

If you use any type of non-rechargeable dry cell battery, *remove weak batteries immediately*. Batteries must be removed before storing this unit for extended periods of time (longer than one month).

**WARNING: WHEN USING CONVENTIONAL NON-RECHARGEABLE BATTERIES, THE CHARGING SYSTEM MUST BE DEFEATED!**

When using conventional non-rechargeable batteries, the internal jumper located on the back side of the printed circuit board near the power jack *must be* set like this:




## 2.5 "Power Saving" Mode (sleep mode)

The operating current drain of the MFJ-259B is approximately 150 mA.

Battery life is extended by using an internal "Power Saving" mode. "Sleeping" battery drain is less than 15 mA. If you do not make **MODE** switch changes, or change frequency more than 50 kHz during any two minute time period, a power saving (Sleep) mode begins. "Sleeping" is indicated by a blinking **"SLP"** message in the display's lower right corner, as shown here:

7.1598 MHz 3.7
R= 38 X= 61 SLP

To wake the unit up, momentarily press the **''MODE''** or **''GATE''** button.

Disable the "Power Saving" mode by pressing and holding the **"MODE"** button before power is applied (or before the "**POWER"** button on the unit is turned on). You must hold the **"MODE"** button and only release it after the copyright message appears.

If the "Power Saving" mode is successfully disabled on power up, when the **"MODE"** button is released the display will momentarily indicate:

Power Saving OFF

# 3.0 MAIN MENU AND DISPLAY

**WARNING: NEVER APPLY RF OR ANY OTHER EXTERNAL VOLTAGES TO THE ANTENNA PORT OF THIS UNIT. THIS UNIT USES ZERO BIAS DETECTOR DIODES THAT MAY BE DAMAGED BY EXTERNAL VOLTAGES. READ SECTION 2.0 BEFORE APPLYING POWER TO THIS UNIT! INCORRECT SUPPLY VOLTAGES CAN ALSO DAMAGE THIS UNIT.**

## 3.1 General Connection Guidelines

The **"ANTENNA"** connector (SO-239 type) on the top of the MFJ-259B provides the RF measurement output connection. This port is used for SWR or other RF measurements, with the exception of the Frequency Counter mode.

The **"POWER"** connector (2.1 mm type) is described in section 2.0. Be sure to read section 2.0 before operating this unit, since incorrect power supplies can damage this unit.

The **"FREQUENCY COUNTER INPUT"** connector (BNC type) is for use as a frequency counter only.

**Note**: The following is a description of the opening or default menu used by the MFJ-259B. This unit also has an advanced user section in section 4.0.

## 3.2 Power-up Display

After turning on the **"POWER"** switch, or after applying external power with the **"POWER"** switch on, a sequence of messages appears on the display.

The first message is a program version, this "VER" number indicates the software version.

```
MFJ-259B
Rev.   2.00
```

The second message is the software copyright date.

```
MFJ Enterprises
(c) 1998
```

**Note**: Holding the **"mode"** button in continuously before applying power or turning the **"POWER"** switch on, and continuing to hold the **"MODE"** button down until the copyright message appears, causes a "POWER SAVING OFF" message to appear just as the **"MODE"** button is released. This message appears just before the voltage check. This message confirms the battery saving "sleep mode" has been disabled.

The third message is a voltage check. It displays the operating voltage, indicating battery charge or external power supply voltage.

```
Voltage Low 9.5V
█
```

```
Voltage OK 14.7V
█████████████
```

The final power-up display is the "working" display described in 3.2 (Impedance R&X) below.

Two panel meters indicate SWR and Impedance of loads connected to the **"ANTENNA"** port.

If you press the **"MODE"** button, the mode changes. After releasing the **"MODE"** button, the display will show the proper data for the new mode. The five main (or opening) menu modes are described below.

## 3.3 Main MODE descriptions

If the "**MODE**" button is momentarily pressed during normal main (or opening) mode operation, the MFJ-259B changes display modes. When the mode first switches, the measurement mode comes up on the screen for a few seconds. The five display modes are described below:

**Impedance R&X** is the initial power-up mode. In this mode, the MFJ-259B LCD (liquid crystal display, with numbers and letters) shows frequency in MHz, SWR, the resistive part of load impedance (R=), and the reactive part of load impedance (X=). The IMPEDANCE meter displays the complex impedance (Z in ohms), and the SWR meter displays SWR.

```
IMPEDANCE
  R & X
```

**Coax Loss**, the second mode, is reached by pressing the **"MODE"** button once. The liquid crystal display (LCD) indicates the test frequency and approximate loss of any 50 ohm coaxial cable, 50 ohm attenuator pad, or 50 ohm transformer or balun (for differential mode current only). In this mode, the 50 ohm device or cable under test must not be connected or terminated by a load resistance at the far end. If the device under test is terminated, measured loss will be higher than actual loss.

**Capacitance in pF** is the third mode. The LCD shows measurement frequency, capacitive reactance (Xc=) in ohms, capacitance (C=) in picofarads or pF. The Impedance meter indicates reactance in ohms, and the SWR meter displays SWR.

**Inductance in uH** is the fourth mode. The digital display indicates measurement frequency, capacitive reactance (Xl=) in ohms, inductance (L=) in microhenries or µH. The Impedance meter indicates reactance in ohms, the SWR meter displays SWR.

**Freq. Counter** is the fifth and final function of the main mode. The BNC connector labeled FREQUENCY COUNTER INPUT should connect to the RF sample you want to measure. The sensitivity of this port ranges from 10 millivolts at 1.7 MHz to 100 millivolts at 180 MHz. The frequency counter is not design for use below 1 MHz. The **"GATE"** button controls the gate time of the frequency counter. Longer gate times are accompanied by additional digits in the display, increasing counter resolution.

```
Freq. Counter
```

```
14.15 MHz  0.01s
Freq. Counter
```

```
21.324 MHz  0.1 s
Freq. Counter
```

```
144.2389MHz  1 s
Freq. Counter
```

**WARNING: NEVER APPLY MORE THAN TWO VOLTS OF PEAK VOLTAGE, OR ANY DC VOLTAGE, TO THE FREQUENCY COUNTER BNC PORT.**

## 3.4 Blinking "VOLTAGE LOW" display warning

If supply or battery operating voltage is less than eleven volts, a blinking "**VOLTAGE LOW**" warning is displayed. Pressing the "**MODE"** button during a low voltage warning will disable the warning, and allow operation with low supply voltage. Readings might not be reliable when operating with supply voltages of under 11 volts.

```
Voltage Low  9.5V
█
```

# 4.0 MAIN (OR OPENING) MODE

**WARNING: NEVER APPLY RF OR ANY OTHER EXTERNAL VOLTAGES TO THE ANTENNA PORT OF THIS UNIT. THIS UNIT USES ZERO BIAS DETECTOR DIODES**

**THAT ARE EASILY DAMAGED BY EXTERNAL VOLTAGES OVER A FEW VOLTS. BE SURE THE POWER SUPPLY IS CORRECT, AS DESCRIBED IN SECTION 2.0, BEFORE OPERATING THIS UNIT.**

A basic understanding of transmission line and antenna behavior and terminology is very important in understanding information provided by the MFJ-259B. Most explanations are available in the ARRL Handbooks, and they should suffice for amateur applications. Avoid relying on popular rumor, or unedited, poorly edited, or self-edited handbooks or articles.

## 4.1 General Connection Guidelines

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

## 4.2 Antenna SWR

To measure SWR of an antenna or antenna tuner input:

a.) 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.

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

c.) Set the **"FREQUENCY"** knob to the proper frequency range.

d.) Turn the MFJ-259B **"POWER"** switch on, while watching the display. Battery voltage should be "OK", and indicate more than 11 volts and less than 16 volts.

e.) The main or opening mode opening menu displays frequency, SWR, resistance, and reactance on the LCD, along with SWR and impedance on the analog meters. In this mode, the resistance (real part) and reactance (imaginary part) of the system impedance is displayed in ohms.

```
7.1598  MHz 3.6
R=153 X= 62 SWR
```

```
14.095 MHz Z>25
 R(Z>650)   SWR
```

f.) Adjust the **"TUNE"** knob until the counter displays the desired frequency, or until you find the lowest SWR.

Advanced antenna measurement modes are available and described in section 5.0, but unless you fully understand them we suggest you avoid them. Most advanced features are different ways of displaying the same basic information given in the main or opening mode menu.

## Antenna hints:

Display readings are the SWR, impedance and resonant frequency of the antenna system at the point in the system the MFJ-259B is connected. The impedance and resonant frequency (frequency where reactance crosses zero) at the point where this unit is connected might not be the resonant frequency of the antenna itself.

This unit (or any other impedance measuring device) displays the antenna's impedance, 50 ohm SWR, and resonant frequency as modified by transmission line "transformer" actions of the feedline and other components between the antenna and the MFJ-259B. If the line is 50 ohms, this unit will always display the antenna's true SWR, with the exception of a slight reduction in SWR with longer or more lossy feedlines.

1.) **RESONANT FREQUENCY** is where reactance is zero ohms, or in some cases as close to zero ohms as the MFJ-259B indicates. Since resistance has nothing to do with resonance, the resonant frequency is NOT always at the point of lowest indicated SWR (although they certainly can be the same). The most desirable load is almost always the load with lowest SWR, even though it may not necessarily be the point of no reactance (resonance).

2.) An **IMPEDANCE** of 50 ohms can be composed both resistive and reactive components. If the impedance is 50 ohms, but the SWR is not 1.0 to 1, the likely cause is reactance makes up part or all of the impedance. Contrary to popular (but very incorrect) misconceptions, it is impossible to obtain a perfect 1 : 1 SWR when the load is reactive, even if the complex impedance is 50 ohms.

A good example is a 50 ohm nearly pure reactance load. The MFJ-259B LCD will indicate R=0 X=50, while the impedance meter reads 50 ohms. The SWR would overflow (SWR>25), since the reactive 50 ohm impedance load absorbs almost no power from the source and has a nearly infinite SWR.

3.) Even if a perfect transmission line is cut to an exact electrical half-wave (or a multiple thereof ) it is a true half-wave multiple only on one frequency in that band. On a slightly different frequency the line will not represent the true feedpoint impedance of the antenna. The line is only "impedance transparent" when lossless and when an exact multiple of 1/2 wl. The longer the transmission line in wavelengths, the "more length critical" it becomes and the less accurate measurements become.

4.) If the feedline is not an exact multiple of 1/4 wl, the resonant frequency of the antenna might be shifted higher or lower by the transmission line. A mismatched non-quarter wave multiple feedline adds reactance that can cancel antenna reactance at frequencies where the antenna is not resonant.

Multiple antenna and feedline combination resonances commonly occur with dipoles, where reactance crosses zero (indicating resonance) at some frequency other than the antenna's actual resonant frequency. This is a normal effect.

5.) If the line is a 50 ohm line, has no radiation or parallel currents, and if the line has minimal loss, moving the analyzer to another point on the line will NOT change SWR reading. Impedance and resonant frequency might change from line transformation effects, but the SWR will not change.

6.) If SWR changes with coaxial line length, line placement, or line grounding (any distance away from the antenna) changes, the feedline has one or more of the following shortfalls:

a.) The feedline is carrying common mode current and radiating.
b.) The feedline is not a 50 ohm line.
c.) The feedline has high loss.

## 4.3 Coax Loss

The second main (or opening) mode is "Coax Loss". Access this mode by turning the MFJ-259B on and stepping to the Coax Loss display. In this mode, the MFJ-259B LCD indicates frequency and coax loss in dB. The impedance meter is disabled in this mode. This mode was designed to measure 50 ohm cables, but measures differential mode loss in many types of 50 ohm transmission line transformers and choke baluns, as well as loss in 50 ohm attenuator pads.

**CAUTION: Do not measure conventional transformers, or attenuators and coaxial cables, with impedances other than 50 ohms. When making measurements, the opposite end of the device under test must have an open circuit, a short circuit, or a pure reactance for termination. Any loss resistance will make attenuation appear worse than it actually is.**

### To measure loss:

1.) Connect the MFJ-259B to the 50 ohm cable, attenuator or transmission line type balun or transformer you wish to measure. Be sure the distant end of the component you are testing is not terminated in any resistance.

2.) Turn the MFJ-259B on. After the display reaches the opening measurement function, press the mode switch once.

3.) The display should momentarily flash "Coax Loss".

| |
|---|
| Coax Loss |

4.) Read the loss in dB at any frequency this unit covers.

| | |
|---|---|
| 28.721 MHz<br>Coax Loss = 24 dB | 144.23MHz<br>Coax Loss = 0.6 dB |

## 4.4 Capacitance

**Note**: The MFJ-259B measures reactance, and converts reactance to capacitance. The MFJ-259B can not determine if the reactance is actually inductive or capacitive. You can usually determine the type of reactance by adjusting frequency. If frequency is increased and reactance (X on the display or Impedance on the meter) decreases, the load is capacitive at the measurement frequency. If frequency is reduced and reactance decreases, the load is inductive at the measurement frequency.

"Capacitance in pF" is the third mode. It measures capacitance values (in pF) at an adjustable frequency. Normal measurement range is from a few pF to a few thousand pF. Capacitance is calculated using measured reactance (X) and operating frequency.

The MFJ-259B becomes inaccurate measuring reactances below 7 ohms or above 650 ohms. If the reactance of the component is in the inaccurate range, "C(X<7) [X]" or "C(Z>650)" will be displayed. Capacitance values will not be displayed if measurement accuracy is questionable.

| | | | |
|---|---|---|---|
| 15.814 MHz 51 | 4.0456MHz | 4.0456MHz | 4.0456MHz |
| C= 197 pF Xc | C(Z>650) Xc | C(X<7) Xc | C(X=0) Xc |

### To measure capacitance:

1.) Turn the MFJ-259B on and step through with the mode switch until the "Capacitance in pf" display appears.

```
Capacitance
  in pF
```

2.) Connect the capacitor across ANTENNA connector with the shortest leads possible, or with the lead length normally used in the working circuit.

3.) Adjust the frequency to the closest frequency possible to the working frequency that does not produce a range warning. C(Z>650) is one warning, and C(X<7) is another. C(X=0) indicates the capacitor appears as a near perfect short to the MFJ-259B.

When measuring a capacitor, the display value will likely change with test frequency. This happens because stray inductance in the capacitor, and in wires to the "ANTENNA" connector, are in series with the capacitor. Effective capacitance does change with frequency, and is often quite different from dc or low frequency ac values. At higher frequencies the effective capacitance increases, reaching infinite capacitance when the capacitor and stray inductance becomes series-resonant.

The frequency where the capacitor's impedance, and the leads connecting to the capacitor, becomes (X=0) is the series resonant frequency. Bypass capacitors are sometimes intentionally operated at or near the series or self resonant frequency, but most applications are at frequencies far below the series resonant frequency.

The **IMPEDANCE** meter will indicate reactance (X in ohms) of the capacitor.

## 4.4 Inductance

**Note:** The MFJ-259B measures reactance, and converts reactance to inductance. The MFJ-259B can not determine if the reactance is actually inductive or capacitive. You can usually determine the type of reactance by adjusting frequency. If frequency is increased and reactance (X on the display or Impedance on the meter) decreases, the load is capacitive at the measurement frequency. If frequency is reduced and reactance decreases, the load is inductive at the measurement frequency.

"Inductance in uH" is the third mode, and measures inductor values in microhenries (uH) at an adjustable frequency. Normal measurement range is from less than .1 uH to a maximum of 60 uH. Inductance is calculated using measured reactance (X) and operating frequency.

The MFJ-259B becomes inaccurate measuring reactance below 7 ohms or above 650 ohms. If component reactance is in the inaccurate range, "L(X<7) [X]" or "L(Z>650)" will be displayed. An inductance value will not be displayed if measurement range is questionable.

| | | | |
|---|---|---|---|
| 15.814 MHz 51<br>L= 0.513 uH XL | 144.04 MHz<br>L(Z>650) XL | 3.5456MHz<br>L(X<7) XL | 4.0456MHz<br>L(X=0) XL |

## To measure inductance:

1.) Turn the MFJ-259B on and step the mode switch through until the "Inductance in uH" display appears.

| |
|---|
| Inductance<br>in uH |

2.) Connect the inductor across ANTENNA connector with the shortest leads possible, or with the lead length normally used in the working circuit.

3.) Adjust to a frequency as close as possible to the working frequency, but one that does not produce a range warning. L(Z>650) is one warning, and L(X<7) is another. L(X=0) indicates the inductor appears as a near perfect short to the MFJ-259B, and indicates frequency is too low or the inductor too small to measure.

When measuring an inductor, the displayed inductance value will sometimes change with test frequency. This happens because of stray capacitance in the inductor, and in wires to the "ANTENNA" connector. At radio frequencies inductance often changes with frequency, and is often different from dc or low frequency ac values.

The **IMPEDANCE** meter will indicate reactance (X in ohms) of the inductor.

**Note:** Lead length and placement, as well as inductor design, will affect inductance readings and in-circuit performance. With increasing frequency, measured inductance usually increases. At some frequency an inductor often becomes an "open" circuit, with infinite reactance. At others it becomes a short.

## 5.0 ADVANCED OPERATION

**WARNING: NEVER APPLY RF OR ANY OTHER EXTERNAL VOLTAGES TO THE ANTENNA PORT OF THIS UNIT. THIS UNIT USES ZERO BIAS DETECTOR DIODES THAT ARE EASILY DAMAGED BY EXTERNAL VOLTAGES OVER A FEW VOLTS.**

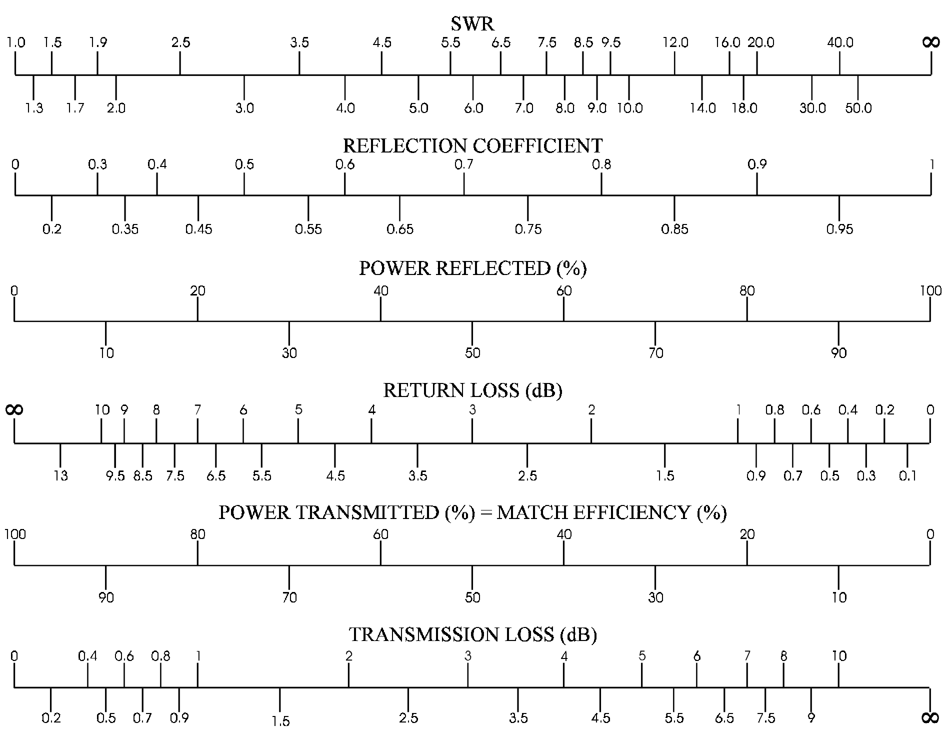
The advanced mode is reached by pressing and holding the GATE and MODE buttons together for several seconds. Upon release of the buttons, and "ADVANCED" message will appear. The following modes are available from the ADVANCED menus:

Impedance ........ SWR, impedance magnitude, phase angle of impedance
Return Loss and Reflection Coefficient ........ SWR, return loss, impedance, reflection coefficient
Distance to fault ........ SWR, impedance, and distance to fault
Resonance ........ SWR, resistance and reactance
Transmit efficiency ........ SWR, impedance and forward power as a percentage of apparent power

### 5.1 Forward

In the ADVANCED mode, the MFJ-259B measures distance to fault, impedance, reactance, resistance, and standing wave ratio (SWR).

It also measures and displays other terms used to describe SWR. These esoteric SWR descriptions include return loss, reflection coefficient, and transmitted power as a percentage of apparent power in the system. Some of these terms are misleading because their name does not necessarily describe what really happen in a system. *We strongly recommend persons unfamiliar with information supplied in special modes avoid using them.*



The MFJ-259B contains a 50 ohm bridge, with voltage detectors across each leg. An eight-bit microcontroller processes these voltages, and applies formulas to derive useful information. from the voltages. The basic calculations are resistance, reactance, SWR, and complex impedance. In accuracy challenged modes, the system cross checks itself and outputs a weighted average of the most reliable information. The system is limited by the eight bit A-D conversion and data processing, some data jumping occurs at the edges of a least-significant-bit changes in the detected voltages.

While we have attempted to make this unit as accurate as possible, some of the formulas contain square and other high order functions. The resolution of the detectors is about 1/2 percent, and we use the most direct calculation possible. Still, some errors are unavoidable for certain impedance values.

A basic understanding of transmission line and antenna behavior and terminology is very important in understanding complex information provided by the MFJ-259B. Most explanations are available in the ARRL Handbooks, and they probably suffice for most amateur applications. Avoid unedited or self-edited amateur handbooks or articles, or check them against professional sources. For complex questions or for critical information, we recommend using books written, reviewed, and edited by professional engineers.

## 5.2 General Connection Guidelines

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

The "**ANTENNA"** connector has about +7 dBm output into 50 ohms (~ .5 volts RMS), and appears like a 50 ohm source resistance (open circuit voltage ~1 volt RMS). Harmonics are at least 25 dB down over the operating range of the MFJ-259B. While the VFO is not stabilized, it is useful as a crude signal source.

The **"ANTENNA"** connector is not dc isolated from the load, external voltages will couple directly into internal detectors.

**WARNING: NEVER APPLY EXTERNAL VOLTAGES OR RF SIGNALS TO THE ANTENNA CONNECTOR. PROTECT THIS PORT FROM ESD.**

Use proper RF connections. Keep leads as short as possible when measuring components or non-50 ohm systems. When measuring 50 ohm systems, interconnecting transmission lines will modify impedance and SWR. Use properly constructed 50 ohm coaxial cables of known quality to avoid errors.

## 5.3 (Magnitude of) Impedance mode

Impedance is the first mode in the advanced menu. The opening display indicates:

```
 IMPEDANCE
Z=mag. θ=phase
```

In this mode, the MFJ-259B LCD displays frequency, impedance or Z magnitude (in ohms), and phase angle ( θ ) of impedance. The meters indicate SWR and Impedance. The maximum impedance limit is set at 650 ohms, indicated by the standard display of (Z<650).

| 28.814 MHz 3.6<br>Z=87Ω θ=53° SWR | 4.0456MHz >25<br>(Z>650) SWR |
|---|---|

**Note**: Stray connector capacitance (4.4 pF) will be lower than 650 ohms at frequencies higher than 60 MHz. This small stray capacitance will not affect high frequency measurements, and produces only minor errors in reading Impedances under a few hundred ohms at VHF.

## 5.4 Return Loss and Reflection Coefficient mode

The Return Loss and Reflection Coefficient mode is the second measurement mode in the Advanced mode menu. This mode is reached by pressing and releasing the MODE button one time, after entering the Advanced mode menu. You can also reach it, an all other modes, by stepping through Advanced modes with the MODE button until the display indicates Return Loss and Reflection Coefficient.

| Return Loss &<br>Reflection Coeff |
|---|

The Return Loss and Reflection Coefficient mode measures and displays return loss in dB and voltage reflection coefficient in percent on the LCD. The meters indicate SWR and impedance.

To use this mode, connect the load to be measured to the ANTENNA connector, adjust the frequency to the desired frequency range, and read the results on the MFJ-259 LCD and panel meter displays.

| 14.159 MHz 1.0<br>RL=48 dB ρ=.0 SWR | 144.23MHz 1.9<br>RL=9.6 dB ρ=.32 SWR |
|---|---|

## 5.5 Distance to Fault mode

The Distance to Fault mode is the third measurement mode in the Advanced mode menu. This mode is useful for determining cable length, or distance to an open or shorted connection. This mode is reached by pressing and releasing the **MODE** button two times, after entering the Advanced mode menu. It can also be reached (and all other advanced modes) by stepping through Advanced modes with the **MODE** button until the display indicates "Distance to Fault" (or other desired function).

| Distance to<br>fault in feet |
|---|

If a balanced line is used, operate the MFJ-259B *only* from internal batteries. Keep the MFJ-259B a few feet away from other conductors or earth, and do not attach any wires (other than the stub) to the unit. Use the ANTENNA connector's shield for one lead and its center pin for the other. Two wire balanced lines ***must*** be suspended in a straight line a few feet away from metallic objects or ground.

Coaxial lines can lay in a pile or coil on the floor. Internal or external power can be used, and the MFJ-259B can be placed on or near large metallic objects with no ill effects. Coaxial lines connect normally, with the shield grounded.

The Distance to Fault mode measures the *electrical* distance in feet to a transmission line fault or mistermination. To obtain physical distance, multiply electrical distance by feedline velocity factor. If the distance is displayed as 75 feet, and the transmission line is a typical RG-8 solid dielectric cable with a velocity factor of 0.66, the distance is 75 x .66 = 49.5 feet.

There is one limit to this mode, the mistermination or fault must not be periodically frequency sensitive. For example, this mode will find the distance to a remote selective circuit (like a standard link coupled antenna tuner) that appears as a short or open at all frequencies but one. It will not reliably find the distance to a low pass filter unless the test frequency is above the filter stop-band. This mode will work properly if the mistermination is a nearly pure resistance, but will not work reliably if the load is a mostly pure reactance.

To confirm reliability, make two or more groups of measurements on different starting frequencies at least one octave apart. If measured distances agree, they are almost certainly very reliable. The more base frequencies used to confirm distance, the more assurance we have that distances are correct.

### To measure fault distance:

1.) Select a frequency where the Impedance meter is at the lowest deflection possible and where minimum reactance displayed on the MFJ-259B LCD, or where the reactance crosses zero. The reactance zero-crossing frequency is the frequency where reactance rises when the MFJ-259B is adjusted either higher or lower in frequency.

```
21.324  MHz  1st
DTF   X= 0
```

2.) Press the **"GATE"** button. The blinking "1st" will change to a blinking "2nd".

```
21.324  MHz  2nd
DTF    X= 0
```

```
39.756 MHz    2nd
 DTF    X=202
```

3.) Tune the analyzer higher or lower in frequency until the Impedance meter reads the very *next* lowest impedance point on the meter, and reactance displayed on the LCD crosses zero or is at the lowest possible again. A non-zero minimum of a few ohms is acceptable.

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

4.) Press the **"GATE"** button again, and the display will indicate distance in feet.

```
  Dist.  to  fault
    10  ft x Vf
```

Multiply the distance in feet by the velocity factor of the cable. The result is the physical distance in feet.

**Example:** The MFJ-259B indicates 13 feet, and the cable is a standard foam cable with a velocity factor of 0.80. 13 multiplied by .80 is 10.5 feet. The fault is about 10.5 feet away.

## 5.6 Resonance Mode

```
Resonance mode
  tune for X=0
```

The Resonance Mode primarily draws attention to reactance, displaying reactance on the **IMPEDANCE** meter. In this mode, the MFJ-259B measures frequency, SWR, resistance (R= ), and reactance (X= ). When reactance is *zero*, the system is said to be *resonant*.

| | |
|---|---|
| 15.814 MHz 2.4<br>R= 63 [X= 51]SWR | 1.8950MHz Z>25<br>R(Z>650) [X]SWR |

**Note**: Zero reactance or resonance can occur on frequencies where the antenna is not actually resonant. Conversely, the antenna may appear to contain reactance even at its true resonant frequency when measured through a feedline.

A less than perfectly matched antenna and feedline, when used with a feedline that is not an exact multiple of 1/4 wavelength (0, 1/4, 1/2, 3/4, etc.), will have reactance added by the feedline. The added reactance may coincidentally cancel the antenna's reactance, making the system resonant. The SWR of the system, if the feedline is a 50 ohm feedline with minimal loss and free from common mode currents, will not change as the feedline length is changed. This is true even if the resonant frequency or reactance changes.

This mode functions like other SWR and impedance modes, with the exception the IMPEDANCE meter measures reactance. This allows the operator to easily observe frequencies where system reactance crosses zero.

## 5.7 Percentage Transmitted Power

Percentage Transmitted Power mode is the final measurement mode available in the Advanced mode menu. This mode is reached (after entering the Advanced mode menu) by pressing and releasing the **MODE** button four times. It can also be reached (as all other advanced modes are) by stepping through advanced modes with the **MODE** button until the display indicates **"% Transmitted Power**".

| |
|---|
| % Transmitted<br>Power |

Percentage of transmitted power is yet another way of describing SWR. It is similar to mismatch loss, but SWR data is expressed as a "percentage of transmitted power".

**CAUTION: The name ''% Transmitted Power'' may mislead those unfamiliar with SWR and energy transfer in a system. Power ''transmitted'' or transferred to a load can be nearly 100% even if the ''% Transmitted Power'' display indicates a system has *nearly zero percent transmitted power*. Conversely, ''% Transmitted Power'' can be measured as nearly 100%, and the actual transmitted power might be very low.**

| | | |
|---|---|---|
| 1.8963 MHz 3.1<br>Power = 74 % SWR | 50.097 MHz 1.3<br>Power =98% SWR | 29.538 MHz >25<br>Power< 15% SWR |

# 6.0 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.

## 6.1 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 feedline SWR. Typical heights result in SWR readings below 1.5 to 1 in most installations when using 50 ohm coaxial cable.

In general, the only adjustment available is the length of the dipole. If the antenna is too long it will resonate too low in frequency, and if it is too short it will resonate too high.

Remember feedline length, when the antenna is not exactly the same impedance as the feedline, modifies the impedance along the feedpoint. The SWR will remain constant (except for a small reduction in SWR as the feedline is made longer) if the feedline is a good quality 50 ohm cable. If feedline length changes SWR at any one fixed frequency, the feedline either has common mode currents that are detuning the antenna or the feedline is not a true 50 ohm cable. Common mode currents are caused by lack of a balun or other installation errors.

## 6.2 Verticals

Verticals are usually unbalanced antennas. Many antenna manufacturers incorrectly downplay the need for a good radial system with a grounded vertical. With a good ground system, the SWR of a directly fed quarter-wave vertical can be nearly 2 to 1. SWR often improves if the ground system (and performance) is poor.

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

## 6.3 Tuning a simple antenna

Select any mode that indicates SWR. Tuning basic antennas fed with 50 ohm coaxial cable can be accomplished with the following steps:

1.) Momentarily short the feedline center conductor and shield, then connect the feedline to the MFJ-259B.

2.) Adjust the MFJ-259B frequency to the desired frequency.

3.) Read SWR, and adjust the MFJ-259B frequency until the lowest SWR is found.

4.) Divide the measured frequency by the desired frequency.

5.) Multiply the present antenna length by the result of step 4. This will be close to the antenna length actually 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 should be tuned according to the manufacturer's instructions while tested with the MFJ-259B, until the desired SWR is obtained.

# 7.0 TESTING AND TUNING STUBS AND TRANSMISSION LINES

## 7.1 Testing Stubs

Resonant frequency of any impedance stub or transmission line can be measured. Select the first (or opening) measurement mode in the MAIN menu.

Connect the stub under test to the "ANTENNA" connector of the MFJ-259B.

**Note**: The line 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 all half-wave stub multiples* (like 1/2, 1, 1-1/2, etc.).:

If a **balanced line** is used, operate the MFJ-259B *only* from internal batteries. Keep the MFJ-259B a few feet away from other conductors or earth, and do not attach any wires (other than the feedline) to the unit. Use the ANTENNA connector's shield for one lead and its center pin for the other. Two wire balanced lines ***must*** be suspended in a fairly straight line a few feet away from metallic objects or ground.

**Coaxial lines** can lay in a pile or coil on the floor. Internal or external power can be used, and the MFJ-259B can be placed on or near large metallic objects with no ill effects. Coaxial lines connect normally, with the shield grounded.

When tuning critical stubs, *gradually* trim the stub to frequency. Adjust the feedline or stub using the following method:.

1.) Determine the desired frequency and theoretical length of the feedline or stub.

2.) Cut the stub 20 percent longer than calculated, and short the far end of a half-wave (or multiple of a half-wave) stub or feedline. Leave the far end open for feedlines or stubs that are 1/4 wavelength or odd multiples of 1/4 wl long.

3.) Measure frequency of lowest resistance and reactance, or lowest impedance. For fine tuning look only at the "X=?" display. Adjust for X=0, or as close as X=0 as possible. The frequency should be about 20% below the desired frequency if everything worked as planned during the length calculation.

4.) Divide the measured lowest "X" frequency by the desired frequency.

5.) Multiply the result by the length of the feedline or stub to find the required length.

6.) Cut the stub to the length calculated in step 5, and confirm lowest "X" is on he desired frequency.

## 7.2 Velocity Factor of Transmission Lines

The MFJ-259B accurately determines velocity factor of any transmission line. Select the Distance to Fault mode, the third measurement mode in the Advanced mode menu. This mode is reached by pressing and releasing the **MODE** button two times after entering the Advanced mode menu. It can also be reached (and all other advanced modes) by stepping through Advanced modes with the **MODE** button until the display indicates “Distance to Fault in feet”.

```
Distance to
fault in feet
```

If a **balanced line** is used, operate the MFJ-259B *only* from internal batteries. Keep the MFJ-259B a few feet away from other conductors or earth, and do not attach any wires (other than the stub) to the unit. Use the ANTENNA connector’s shield for one lead and its center pin for the other. Two wire balanced lines ***must*** be suspended in a straight line a few feet away from metallic objects or ground.

**Coaxial lines** can lay in a pile or coil on the floor. Internal or external power can be used, and the MFJ-259B can be placed on or near large metallic objects with no ill effects. Coaxial lines connect normally, with the shield grounded.

The Distance to Fault mode measures the *electrical length* of a transmission line. To obtain velocity factor, you must know the physical length of the line. If the distance displayed is 75 feet, and the transmission line is actually 49.5 feet long, the velocity factor is 49.5 divided by 75, for as result of 0.66 vF.

**Note**: The far end of the line can be either *open circuited* or *short circuited.* The line can not be terminated in any impedance other than an open or short.

To confirm reliability, make two or more groups of measurements on different starting frequencies at least one octave apart. If measured distances agree, they are almost certainly very reliable. The more base frequencies used to confirm results, the more assurance you will have results are correct.

### To measure velocity factor:

1.) Select a frequency where the Impedance meter is at the lowest deflection possible and where minimum reactance displayed on the MFJ-259B LCD, or where reactance crosses zero. The reactance zero-crossing (or minimum reactance reading) is the point where reactance rises when the MFJ-259B is adjusted either higher or lower in frequency.

```
21.324  MHz  1st
DTF  X= 0
```

2.) Press the **“GATE”** button. The blinking “1st” will change to a blinking “2nd”.

```
21.324  MHz  2nd
DTF    X= 0
```

```
39.756 MHz    2nd
 DTF    X=202
```



3.) Tune the analyzer higher or lower in frequency until the Impedance meter reads the *very next* impedance minimum, and where reactance displayed on the LCD again crosses zero. A non-zero minimum of a few ohms is acceptable.

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

4.) Press the **"GATE"** button again, and the display will indicate distance in feet.

```
  Dist. to fault
    10 ft x Vf
```

Use the following procedure:

1.) Measure the physical length of the line in feet.

2.) Divide the display reading by the actual feedline length.

**Example:** 27 feet (physical length) divided by 33.7 feet (measured length) equals .80 . The velocity factor is .80 or 80%.

## 7.3 Impedance of Transmission Lines or Beverage antennas

The impedance of transmission lines between a few ohms and 650 ohms can be directly measured with the MFJ-259B. Lines of higher impedance can be measured if a broadband transformer or resistance is used to extend the MFJ-259B's range. Select any measurement mode that indicates resistance (R=) and reactance (X=).

If a **balanced line** is used, operate the MFJ-259B *only* from internal batteries. Keep the MFJ-259B a few feet away from other conductors or earth, and do not attach any wires (other than the feedline) to the unit. Use the ANTENNA connector's shield for one lead and its center pin for the other. Two wire balanced lines ***must*** be suspended in a fairly straight line a few feet away from metallic objects or ground.

**Coaxial lines** can lay in a pile or coil on the floor. Internal or external power can be used, and the MFJ-259B can be placed on or near large metallic objects with no ill effects. Coaxial lines connect normally, with the shield grounded.

**Beverage antennas** must be directly connected to the MFJ-259B.

**Using fixed resistances:**

1.) Terminate the line or antenna in a non-inductive resistance somewhere around the expected value.

2.) Connect the transmission line or antenna directly to the MFJ-259B "ANTENNA" connector. Adjust the frequency (near the expected operating frequency) until the lowest resistance and lowest reactance is measured.

3.) Record the impedance value.

4.) Adjust the frequency until the highest resistance and *lowest* reactance is measured.
5.) Multiply the highest resistance by the lowest resistance, and find the square root of the result.

**Example:** The highest resistance is 600 ohms, the lowest is 400 ohms. 400 x 600 = 240,000. The square root of 240,000 is 490. The impedance is 490 ohms.

**Using a potentiometer or resistor decade box:**

1.) Connect the MFJ-259B to one end of the system (in this case you can use a broadband matching transformer).

2.) Adjust the frequency and note *only* the SWR change.

3.) Adjust the termination resistance until the SWR remains as constant as possible with very large frequency changes around the operating frequency range.

4.) The resistance of the termination resistor is the surge impedance of the system.

## 7.4 Adjusting Tuners

The MFJ-259B can be used to adjust tuners. Connect the MFJ-259B "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, provided that switch has better than 50 dB port isolation.

**WARNING: ALWAYS CONNECT THE COMMON (ROTARY CONTACT) OF THE SWITCH TO THE TUNER. THE SWITCH MUST CONNECT EITHER THE MFJ-259B OR THE STATION EQUIPMENT TO THE TUNER. *TRANSMITTING EQUIPMENT MUST NEVER BE CONNECTED TO THE MFJ-259B.***

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

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

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

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

## 7.5 Adjusting Amplifier Matching Networks

The MFJ-259B 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.

**To measure input circuits**, a non-inductive resistor equaling the approximate driving impedance of each individual tube is installed between the cathode of each tube and chassis.

**To measure tank circuits**, a resistor equaling the calculated tube operating impedance is connected from the anode to the chassis with short leads.
The antenna relay (if internal) can be engaged with a small power supply. The amplifier’s external RF input and output connectors are now connected to the amplifier’s RF matching networks.

The appropriate network can now be adjusted. When the analyzer shows 50 ohms and a 1:1 SWR at the operating frequency with the proper amounts of capacitance to set the system Q, the networks are working.

**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-259B.**

## 7.6 Testing RF Transformers

RF transformers designed to operate with 25-100 ohm termination on one of the windings can be tested with the MFJ-259B.

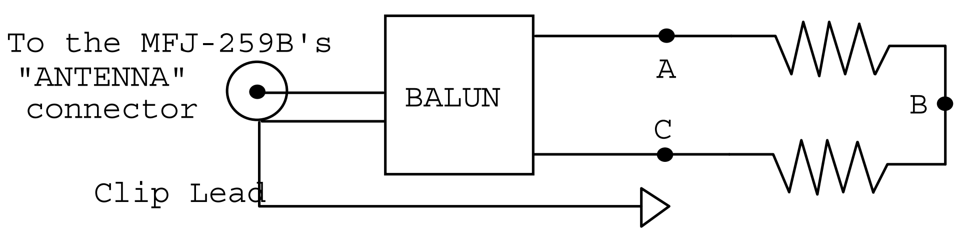
The 25 to 100 ohm winding is connected through a very short (less than one electrical degree long) 50 ohm cable to the "ANTENNA" connector on the MFJ-259B. The other winding(s) of the transformer is terminated with a low inductance resistor equal to the desired load impedance. The MFJ-259B can then be swept through the desired transformer frequency range. The impedance and bandwidth of the RF transformer can be measured.

Transformer efficiency can be measured by comparing the source voltage from the MFJ-259B to the load voltage, and using standard power level conversions.

## 7.7 Testing Baluns

Baluns can be tested by connecting the 50 ohm unbalanced side to the MFJ-259B "ANTENNA" connector. The balun must be terminated with two equal value load resistors in series. The resistor combination must have total resistance equal to balun impedance. For example, a pair of 100 ohm carbon resistors are required to properly test the 200 ohm secondary of a 4:1 balun (50 ohm input).

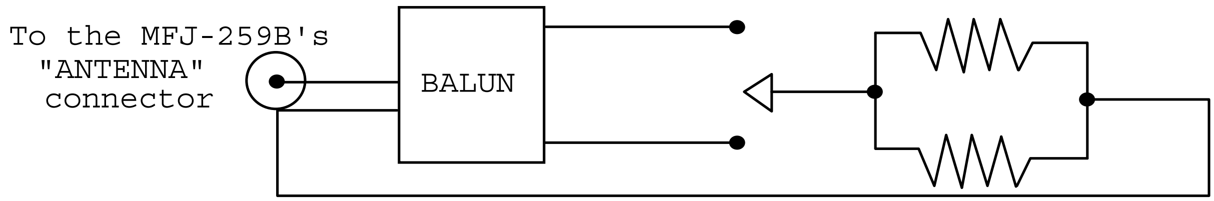
Measure SWR while moving a jumper wire from point "A" through point "C".




A properly designed current balun is the type most effective for maintaining current balance. It has the highest power capability and lowest loss for given materials. It 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". SWR should be about the same in either position “A” or “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 voltage balun is operating properly the SWR will be very low with the resistors connected from either output terminal to ground.




## 7.8 Testing RF Chokes

Large RF chokes usually have frequencies where the distributed capacitance and inductance form a low impedance "series-resonance". This series resonance occurs because the choke acts like a series of back to back L networks. This causes three problems:

First, impedance from end to end in the choke becomes very low.

Second, the voltage at the center of the resonant point becomes very high, often causing severe arcing.

Third, the current in the winding becomes very high, often resulting in severe heating.

Troublesome series resonances can be detected by installing the choke in the operating location, and connecting only the MFJ-259B from end to end through a short 50 ohms jumper cable. By slowly sweeping the operating frequency range of choke, dips in impedance identify low impedance series-resonant frequencies. By moving a small insulated screwdriver's blade along the choke, you will find a point where the series resonate impedance suddenly changes. This is the area that has the highest voltage, and the area that adding or subtracting a tiny amount of capacitance will have the largest effect. By removing turns to reduce capacitance, or adding capacitive stub at this point, the resonance can be shifted out of the desired frequency range.

A small change in capacitance has a much larger effect than a small change in inductance, because the ratio of L to C is so high.

# 8.0 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 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.