MFJ-934 Antenna Tuner/Artificial Ground

IMPORTANT: PLEASE READ ENTIRE MANUAL BEFORE ATTEMPTING TO OPERATE THIS EQUIPMENT. THIS UNIT DOES NOT PROVIDE A DC OR LOW FREQUENCY EARTH GROUND FROM THE COUNTERPOISE TERMINAL. A SEPARATE WIRE MUST BE CONNECTED FROM THE STATION GROUND BUS TO AN ELECTRIC GROUND. THE LONG WIRE AND BALANCED LINE TERMINALS ON THE BACK MAY HAVE AREA. DO NOT PLACE ANY COUNTERPOISE OR NON-COAXIAL FEED WIRES NEAR METALLIC OR RF SENSITIVE DEVICES.

General Information

The MFJ-934 is a 300 watt (175 watts on 160 meters) RF output power antenna tuner and artificial ground system that will match any transmitter or transceiver to virtually any antenna. A special circuit in this tuner cancels the reactance of a ground lead or counterpoise, and reduces problems caused by RF "in the shack". Forward power, reflected power, ground current, and SWR can be read on the wattmeter's illuminated cross-needle meter.

The MFJ-934 tuner section uses a "T" network and covers all bands between 160 and 10 meters. This network will work with dipoles, inverted-vees, verticals, mobile whips, beams, random wires, and many other antennas. The MFJ-934 has rear panel connectors for coaxial, single wire or two wire feedlines. A built-in 4:1 balun allows the use of balanced open wire, twinlead, or twin-axial feedlines.

SWR/Wattmeter and Ground Current Meter

An illuminated cross-needle meter measures the FORWARD and REFLECTED power, ground current, and the SWR. The meter's full scale forward and reflected power range is controlled by the right METER RANGE switch. If your transmitter has more than 30 watts of output power, set this switch to the 300W (button in). If your transmitter has less than 30 watts of output, use the 30W switch position (button out).

Forward power is displayed on the left-hand FORWARD meter scale when the FORWARD CURRENT button is out. Read directly from the scale in the 300 watt position.

In the 30W position the forward power scale must be divided by 10.

Reflected power is read on the right-hand REFLECTED meter scale. This scale indicates 60 watts full scale when the 300W power sensitivity is selected, and 6 watts when the 30W forward power range is selected. This scale must be divided by 10 when using the 30W power range position.

The most accurate power readings occur in the upper half of the meter scales. To accurately measure power with a less than perfect match, the reflected power should be *subtracted* from the forward power reading.

SWR is measured by observing the crossing point of the forward and reflected power needles. No cumbersome or time consuming SWR sensitivity adjustments are required with this type of meter. The SWR is read directly from eight red SWR curves ranging from 1:1 to infinity. Simply observe the red SWR curve closest to where both needles cross, and read the SWR value of the curve.

Ground current is indicated on the Forward meter scale when the FORWARD CURRENT meter switch is depressed and locked.

Interconnections

Installation

1. Locate the tuner in a convenient location at the operating position. Avoid placing the tuner near microphones, speech processors, computers, TNC's or other RF sensitive devices.

WARNING: If random wire or balanced feeders are connected directly to this tuner, position the tuner so the rear panel terminals can not be accidentally contacted by persons or conductors. When transmitting with random wire or balanced lines, the rear panel burns. These high RF voltages may also damage anything contacting or within a half inch of the terminals.

2. Install the MFJ-934 between the transmitter and antenna as shown in the interconnections diagram. A 50 ohm coaxial cable is used to connect the transmitter to the SO-239 (UHF female) connector labeled TRANSMITTER on the back of the tuner.

3. Connect a short heavy wire from the post labeled GROUND to the station ground bus that connects the transmitter, receiver, and other accessories together.

4. Connect the counterpoise or RF ground to the COUNTERPOISE post. (See the Artificial Ground operating section and the Grounding Hints section on page 6 for details of suitable counterpoise grounds and other grounding suggestions.)

5. A coaxial feedline may be connected to the SO-239 (UHF female) connector labeled ANTENNA.

   -OR-

   A random wire (longwire) antenna may be connected to the five-way binding post marked WIRE. (See the ANTENNA HINTS section for detailed suggestions on bringing a single wire feeder into the operating position.)

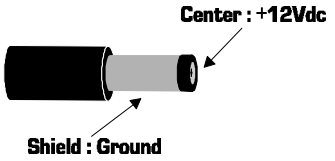
   -OR-

   A balanced feedline (twin lead, open wire, or twin-axial line) may be connected to the two five-way binding posts marked BALANCED LINE. Connect an insulated jumper wire from the WIRE binding post, as indicated by a dotted line on the MFJ-934, to one of the BALANCED LINE posts. This connection activates the internal 4:1 balun.

Note: Do not connect more than one antenna to the MFJ-934 at the same time, unless you want to apply power to the antennas at the same time. If a random length wire is used, be sure to remove the WIRE to BALANCED LINE jumper connection.

Meter Lamp

The MFJ-934 has an illuminated meter. To provide power for the meter lamp, a 12 Vdc supply such as the MFJ-1312C should be used. Use a standard 2.5 mm coaxial plug with the center positive and the shield ground.



Using The MFJ-934

***CAUTION*:** Never Change The Antenna or Inductor Selector Switch Position While Transmitting! Never Apply More Than 300 Watts To The MFJ-934.

In any conventional "T" network tuner, maximum power handling and smoothest tuning occur when the capacitance in the network is as large as possible. In this tuner the TRANSMITTER and ANTENNA controls have maximum capacitance at position 0 (fully meshed), and minimum capacitance at position 10 (fully open). Use the highest capacitance possible (lowest number on the front panel scale) for each band for the smoothest tuning, highest efficiency, and greatest power handling capability. The chart in the tuning instructions shows typical capacitor settings that can be used for each amateur band.

The INDUCTANCE switch in the MFJ-934 has maximum inductance in position "A", and minimum inductance in position "L". The chart in the tuning instructions shows typical INDUCTANCE switch settings for each amateur band. Less inductance is needed as the frequency is increased. If too little inductance is used, the tuner may not match the load properly. If too much inductance is used, the tuner will be "touchy" and power handling will be compromised.

Most modern solid state transceivers do not require tuning and loading adjustments. If the transceiver has a built in antenna tuner, be sure it is turned off or disabled. If your transmitter has an adjustable output circuit, it must be properly tuned to a 50 ohm load at the operating frequency before adjusting the tuner. This should be done with a dummy load. If you do not have a dummy load, use the recommended maximum transmitter load setting and "dip" the plate.

Note: Do **NOT** change the **transmitter's** tuning (plate) or loading (antenna) controls until after the **tuner** has been fully adjusted. The transmitter can be "touched up" *after* the MFJ-934 is fully tuned.

Set the GROUND MATCHING controls at zero (maximum capacitance) and "L" (minimum inductance) unless you already know the correct position for the band you are using. Ground matching is done after the tuner is adjusted for lowest SWR.

Adjustment Procedure

When using the MFJ-934 for receiving only, simply adjust the MFJ-934 for the highest "S" meter or signal level. The Tuning Chart can be used as a reference.

1. Select the 30W (out) METER switch scale. Turn the transmitter's power control fully down.

2. Position the TRANSMITTER and ANTENNA MATCHING controls and the INDUCTOR SELECTOR switch in the bottom Tuning Chart position for the operating frequency.

Tuning Chart

Freq MHz	Transmitter	Inductor	Antenna
1.8	4-1/2	A	4-1/2
1.8	1	B	1
2.0	5-1/2	A	5-1/2
2.0	3	B	3
3.5	9	B	9
3.5	6	C	6
3.5	4	D	4
3.75	7	C	7
3.75	5	D	5
3.75	3	E	3
4.0	7	C	7
4.0	6	D	6
4.0	4	E	4
7.15	8	F	8
7.15	6	G	6
10.1	9	G	9
10.1	8	H	8
14.2	9-1/2	H	9-1/2
18.1	9-1/2	I	9-1/2
18.1	8-1/2	J	8-1/2
21.2	9-1/2	J	9-1/2
21.2	7	K	7
24.9	9	K	9
28.5	9-1/2	K	9-1/2

3. Apply just enough power on CW (or AM / FM / RTTY) to obtain noticeable deflection on the reflected power meter.

4. Carefully adjust the "TRANSMITTER" and "ANTENNA" MATCHING controls for the lowest reflected power.

Note: These controls interact. Adjust the TRANSMITTER control for minimum, then adjust theANTENNA control for minimum SWR. Go back and forth between these adjustments as many times as required until the lowest reflected power (best SWR) is obtained.

5. If a perfect or very low SWR can not be obtained, ***stop*** transmitting. Increase the INDUCTOR SELECTOR control (higher letter) and decrease the capacitance (lower number). Try the row of chart settings just above the last one tried. Repeat from Step 3.

Note: If an SWR of 1:1 can not be obtained, repeat Steps 3 and 4 for each new INDUCTOR switch position. Move the switch towards the end of the alphabet one position at a time until a match is obtained but always use the highest alphabetical setting possible.

WARNING: Never transmit while changing the INDUCTOR SELECTOR.

6. Increase the transmitter power until the Forward power level is full scale (30 watts) and observe the reflected power or SWR. If the reflected power and SWR are not satisfactory, adjust the MATCHING controls again.

Note: If your transmitter will not put out 30 watts, set it to the maximum power available.

7. After a low SWR is obtained, the transmitter power may be increased to any value up to 300 watts carrier, or 300 watts PEP (175 watts on 160 meters).

The MFJ-934 will reduce the SWR of most antenna systems to 1:1. In some cases, a perfect 1:1 SWR may not be obtainable. If this is the case, the length of the antenna or the feedline can be changed slightly until a low SWR can be obtained. See the antenna hints section.

In Case Of Difficulty

If this tuner **fails to tune,** please double check all connections and follow the tuning procedures again. Be sure you are using enough inductance (highest letter usable for band) and have the capacitors open far enough (highest front panel number).

The power rating of this tuner is 300 watts on 80 meters and above, and 175 watts on 160 meters. If this tuner **arcs** at the rated power levels, please double check all connections and follow the tuning procedures again. Be sure you are using the least amount of inductance (toward A) and the greatest capacitance (toward 0) possible to match the load on the operating frequency.

If you are still unsuccessful, but the tuner does adjust and operate when connected to a dummy load or another antenna, please read the following ANTENNA HINTS text.

Grounding Hints

To minimize RFI, single wire feedlines (such as used with Windom or longwire antennas) should be kept away from other wiring. Radiation will be minimized if the single wire feeder runs parallel and reasonably close to the wire that connects the tuner to the outdoor ground. The antenna feed wire should be adequately insulated to prevent arcing or accidental contact.

For safety, please use both dc and RF grounds. It is particularly important to have a good RF ground while using a single wire feeder. When using a single wire feeder, the tuner needs something to "push" against in order to force current into the line. If a good RF ground is not available, RF will usually find it's way back into the power line (RFI), transmitter audio circuits (RF feedback), or the operator (RF burns).

Water pipes provide good dc and ac safety grounds, but they are often inadequate for RF grounding because they are long single conductors. RF grounds require large "spread out" surfaces with direct multiple connections to the equipment ground point. Water pipes, heating ducts, or multiple ground rods may work (especially if they are all connected together with jumper wires), but the best RF grounds are radial systems or multi-wire counterpoises.

RF and lightning travels on the surface of conductors. Braided or woven conductors have high surface resistance to lightning and RF. Ground leads for RF should have wide *smooth* surfaces. Avoid the use of woven or braided conductors in RF and lightning grounds unless the lead needs to be flexible.

Antenna Hints

WARNING: For operator safety, a good outside earth ground or water pipe ground should **always** be installed and connected to the case of the MFJ-934. Make certain the safety ground connects to the same terminal that connects to the transmitter and other station accessories.

A binding post labeled "COUNTERPOISE" is provided for counterpoise or other RF ground connection(s). This post will not provide a **safety** ground.

Location

For the best performance, an end-fed longwire wire antenna should be at least one quarter-wavelength long at the operating frequency. Horizontal antennas should be at least a half wave long and high and clear of surrounding objects. Good RF grounds help the signal in almost any transmitting installation, but it is extremely important to have good RF grounds with long wire antennas.

Matching Problems

Most matching problems occur when the antenna system presents an extremely high impedance to the tuner. When the antenna impedance is much lower than the feedline impedance, an *odd quarter-wavelength* feedline converts the low antenna impedance to a very high impedance at the tuner. A similar problem occurs if the antenna has an extremely high impedance and the transmission line is a multiple of a half-wavelength. The half-wavelength line *repeats* the very high antenna impedance at the tuner. Incorrect feedline and antenna lengths can make an antenna system very difficult or impossible to tune.

This problem often occurs on 80 meters if an odd quarter-wave (60 to 70 foot) open wire line is used to feed a half-wave (100 to 140 foot) dipole. The odd quarter-wave line transforms the dipole's low impedance to over three thousand ohms at the tuner. This is because the mismatched feedline is an *odd multiple* of 1/4 wavelength long. The line *inverts* (or teeter-totters) the antenna impedance.

A problem also occurs on 40 meters where the feedline is now a multiple of a half-wave (60 to 70 foot) and connects to a full-wave high impedance antenna (100 to 140 foot). The half-wave line repeats the high antenna impedance at the tuner. The antenna system looks like several thousand ohms at the tuner on 40 meters.

The following suggestions will reduce the difficulty in matching an antenna with a tuner:

1. Never center feed a half-wave multi-band antenna with a high impedance feedline that is close to an odd multiple of a quarter-wave long.

2. Never center feed a full-wave antenna with a feedline close to any multiple of a half-wave long.

3. If a tuner will not tune a multi-band antenna, add or subtract 1/8 wave of feedline (for the band that won't tune) and try again.

4. Never try to load a G5RV or center fed dipole on a band below the half-wave design frequency. If you want to operate a 80 meter antenna on 160 meters, feed either or both conductors as a longwire against the station ground.

To avoid problems matching or feeding any dipole antenna with high impedance lines, keep the lines around these lengths. The worst possible line lengths are in brackets. These line lengths assume a velocity factor of .95 :

160 meter dipole; 35-60, 170-195 or 210-235 feet. (Avoid 130, 260 ft)
80 meter dipole; 34-40, 90-102 or 160-172 feet. (Avoid 66, 135, 190 ft)
40 meter dipole; 42-52, 73-83, 112-123 or 145-155 feet. (Avoid 32, 64, 96, 128 ft)

Some trimming or adding of line may be necessary to accommodate higher bands.

WARNING: To avoid problems, the antenna should be a full half-wave on the lowest band. On 160 meters an 80 or 40 meter antenna fed the normal way will be extremely reactive with only a few ohms of feedpoint resistance. Trying to load an 80 meter (or to operate 160 with a 80 or 40 meter antenna is to load either or both feedline wires (in parallel) as a longwire. The antenna will act like a "T" antenna worked against the station ground.

MFJ-934 Artificial Ground

The MFJ-934 contains a series L-C circuit that is used to cancel any reactance in the RF ground system (either a counterpoise or a ground wire). Maximum ground current will flow through the MFJ-934 RF current meter when the GROUND MATCHING INDUCTANCE switch and CAPACITANCE adjustment are resonated with the reactance in the ground system. This resonance (maximum ground current) is indicated by the FORWARD wattmeter needle when the FORWARD CURRENT meter function switch is depressed and locked in the GROUND position. The L and C of the MFJ-934 is adjusted for maximum deflection of the meter needle.

Installation Of A Suitable Counterpoise / Artificial Ground

The RF counterpoise system can be as simple as a single wire a quarter wave long (or any odd multiple of 1/4 wave) or as complicated as several wires cut for different bands. If multiple wires are used, it is important to keep the last few feet of any wire as far as possible (two feet at the minimum) from other conductors.

Always insulate counterpoise wires and keep them away from accidental contact with animals, people, RF sensitive devices, and wiring. Try to position the counterpoise wires in a straight line. Wrapping a wire up in a ball or zig-zagging them wildly just to "fit in" enough wire will not improve the ground.

A counterpoise wire ***must be well insulated***, particularly when using an antenna with a single wire feeder. For best performance, several wires a quarter-wavelength long on different frequencies should be connected together at the COUNTERPOISE post of the MFJ-934.

When counterpoise wires are located indoors, they can be laid on a floor under a carpet, placed in an attic, or stapled to a basement ceiling. If you place the counterpoise under the carpet or where someone may contact it, be sure to use well insulated wire and multiple counterpoise wires. Insulate the far end of the counterpoise wire(s) with electrical tape to prevent accidental contact.

When counterpoise wires are used outdoors, only place them high enough to walk under. Use multiple wires spaced a few feet apart (at minimum).

DANGER: Touching a counterpoise wire while transmitting can cause an RF burn. The wire must be well insulated and the end properly insulated.

Adjusting The Artificial Ground

The goal of artificial ground adjustments are to obtain maximum RF ground current. The current is measured by placing the front panel FORWARD CURRENT switch in the GROUND position. Maximum current is achieved when any reactance in the ground connection is tuned out. This is accomplished by adjusting the GROUND MATCHING knobs labeled "INDUCTANCE" and "CAPACITANCE". Always set the capacitance knob to "2" before starting this procedure!

1.) Set the CAPACITANCE knob to "2" and the INDUCTANCE knob to "A". Depress and lock the meter's red Forward CURRENT button.

2.) Apply a small amount of RF carrier from the transmitter and rotate the INDUCTANCE switch until maximum ground (Forward meter) current is obtained.

Note: If the needle goes off the scale reduce power. If the meter does not deflect, increase transmitter power. Adjust the transmitter power to keep the meter "on scale".

3.) Adjust the CAPACITANCE knob for maximum current.

4.) If the CAPACITANCE knob produces maximum current at "0", rotate the INDUCTANCE switch one letter higher (clockwise). The ideal setting for the capacitor is at one or two.

After maximum RF current is reached, re-tune the antenna tuner section for minimum SWR.

Failure To Obtain A Ground Current Reading

If a ground current reading can not be obtained at full transmitter power, the counterpoise or ground may not be effective at the operating frequency. If no RFI problems exist, set the CAPACITANCE to zero and the INDUCTANCE to "A" and operate. If you experience RF in the shack or other problems, alter the counterpoise or add a different length wire. See the beginning of this section for details.

There are also cases where very little deflection of the ground current meter are a result of a well designed antenna not producing unwanted ground currents. Some antennas that minimize ground current are beams, dipoles, half-wave verticals, and quarter-wave verticals with good grounds. Even though the meter may not indicate much current, the MFJ-934 can still reduce RF at the operating position, TVI, telephone interference, etc. If even the slightest ground current peak can be detected, the artificial ground is helping.

Tuning Out Reactance of Long Ground Leads

If the station ground has a long lead, connect it to the COUNTERPOISE binding post of the MFJ-934. Connect the station ground bus and accessories to the GROUND post. **Do not reverse these wires.** Follow the same procedure for maximizing RF Ground Current described in the preceding "Adjusting the Artificial Ground" section. After maximum RF current is reached, you may need to re-tune the antenna tuner section for minimum SWR.

WARNING: This unit does NOT provide a dc or ac safety ground through the COUNTERPOISE terminal. A separate wire from the station ground bus to an electrical or earth ground must be used.

TVI and RFI Hints

It is possible for RF to flow down power cables into the house wiring. This may cause TVI, Stereo, VCR or other RFI problems. As a precaution, a ferrite core can be clamped around power leads. The MFJ-701 RFI-FREE CHOKE KIT makes it easy to eliminate common RFI problems. Please call for price.

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**; through Compuserve at 76206,1763; or by email to 76206.1763@Compuserve.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.

Tuning Chart

You may wish to remove this page and place it near the tuner. Insert your own values for each frequency according to your station.

Freq MHz	Transmitter	Inductor	Antenna	Ground Cap.	Ground Ind.
1.8	4-1/2	A	4-1/2		
1.8	1	B	1		
2.0	5\1/2	A	5-1/2		
2.0	3	B	3		
3.5	9	B	9		
3.5	6	C	6		
3.5	4	D	4		
3.75	7	C	7		
3.75	5	D	5		
3.75	3	E	3		
4.0	7	C	7		
4.0	6	D	6		
4.0	4	E	4		
7.15	8	F	8		
7.15	6	G	6		
10.1	9	G	9		
10.1	8	H	8		
14.2	9-1/2	H	9-1/2		
18.1	9-1/2	I	9-1/2		
18.1	8-1/2	J	8-1/2		
21.2	9-1/2	J	9-1/2		
21.2	7	K	7		
24.9	9	K	9		
28.5	9-1/2	K	9-1/2		

FULL 12 MONTH WARRANTY

MFJ Enterprises, Inc. warrants to the original owner of this product, if manufactured by MFJ Enterprises, Inc. and purchased from an authorized dealer or directly from MFJ Enterprises, Inc. to be free from defects in material and workmanship for a period of 12 months from date of purchase provided the following terms of this warranty are satisfied.

1. The purchaser must retain the dated proof-of-purchase (bill of sale, canceled check, credit card or money order receipt, etc.) describing the product to establish the validity of the warranty claim and submit the original of machine reproduction or such proof of purchase to MFJ Enterprises, Inc. at the time of warranty service. MFJ Enterprises, Inc. shall have the discretion to deny warranty without dated proof-of-purchase. Any evidence of alteration, erasure, of forgery shall be cause to void any and all warranty terms immediately.

2. MFJ Enterprises, Inc. agrees to repair or replace at MFJ's option without charge to the original owner any defective product under warrantee provided the product is returned postage prepaid to MFJ Enterprises, Inc. with a personal check, cashiers check, or money order for **$7.00** covering postage and handling.

3. MFJ Enterprises, Inc.will supply replacement parts free of charge for any MFJ product under warranty upon request. A dated proof of purchase and a **$5.00** personal check, cashiers check, or money order must be provided to cover postage and handling.

4. This warranty is **NOT** void for owners who attempt to repair defective units. Technical consultation is available by calling (601) 323-5869.

5. This warranty does not apply to kits sold by or manufactured by MFJ Enterprises, Inc.

6. Wired and tested PC board products are covered by this warranty provided **only the wired and tested PC board product is returned.** Wired and tested PC boards installed in the owner's cabinet or connected to switches, jacks, or cables, etc. sent to MFJ Enterprises, Inc. will be returned at the owner's expense unrepaired.

7. Under no circumstances is MFJ Enterprises, Inc. liable for consequential damages to person or property by the use of any MFJ products.

8. **Out-of-Warranty Service:** MFJ Enterprises, Inc. will repair any out-of-warranty product provided the unit is shipped prepaid. All repaired units will be shipped COD to the owner. Repair charges will be added to the COD fee unless other arrangements are made.

9. This warranty is given in lieu of any other warranty expressed or implied.

10. MFJ Enterprises, Inc. reserves the right to make changes or improvements in design or manufacture without incurring any obligation to install such changes upon any of the products previously manufactured.

11. All MFJ products to be serviced in-warranty or out-of-warranty should be addressed to **MFJ Enterprises, Inc., 300 Industrial Park Road, Starkville, Mississippi 39759, USA** and must be accompanied by a letter describing the problem in detail along with a copy of your dated proof-of-purchase.

12. This warranty gives you specific rights, and you may also have other rights which vary from state to state.