MFJ

MFJ Antenna Analyzer 1.0 to 60.0 MHz

Model MFJ-213

INSTRUCTION MANUAL

CAUTION: Read All Instructions Before Operating Equipment

MFJ ENTERPRISES, INC.

300 Industrial Park Road
Starkville, MS 39759 USA
Tel: 662-323-5869 Fax: 662-323-6551

VERSION 1

DISCLAIMER

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

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

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1.0 INTRODUCTION

Important: Read Section-2 before attempting to use your analyzer -- applying incorrect operating voltages could result in permanent damage! Also, never apply a DC voltage to the antenna connector.

General Description: The MFJ-213 is a self-contained handheld RF analyzer that performs the following diagnostic functions:

SWR (1:1 to 9.9:1)
Complex Impedance (Z = R + jX)
Impedance Magnitude (Z in Ω)
Return Loss (in dB)
Cable Loss (in dB)
Capacitance (in pF)
Inductance (in uH)

The MFJ-213 also generates a 0-dBm RF signal that may be used to check receivers, networks, amplifiers, and antenna patterns. Operating range is:

HF: 1.00 – 60.00 MHz

The MFJ-213 uses a DDS signal generator giving a stable 0dBm signal tuned by a rotary encoder. Measurements are displayed on an easy-to-read LCD screen with optional backlighting. Power is supplied by internal AA cells, an 18650 Li-ion cell or by a regulated 12-VDC external power source (not included). Weighing just over 1.3 pounds, the MFJ-213 package fits comfortably in one hand for convenient bench work or on-the-fly testing in the field. Operation is simple, but you will need to read the manual to learn all of the unit's features and functions. The more you know the more valuable it will become as a diagnostic tool.

2.0 POWER SOURCES

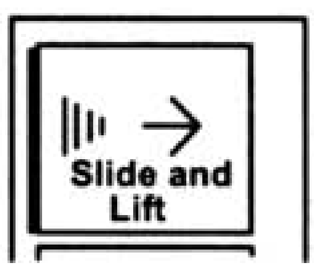
The MFJ-213 may be powered with internal AA batteries, 18650 Li-ion cell or with an external DC supply. To avoid needless damage and ensure top performance, please follow the guidelines below when choosing a voltage source.

2.1 Internal Batteries

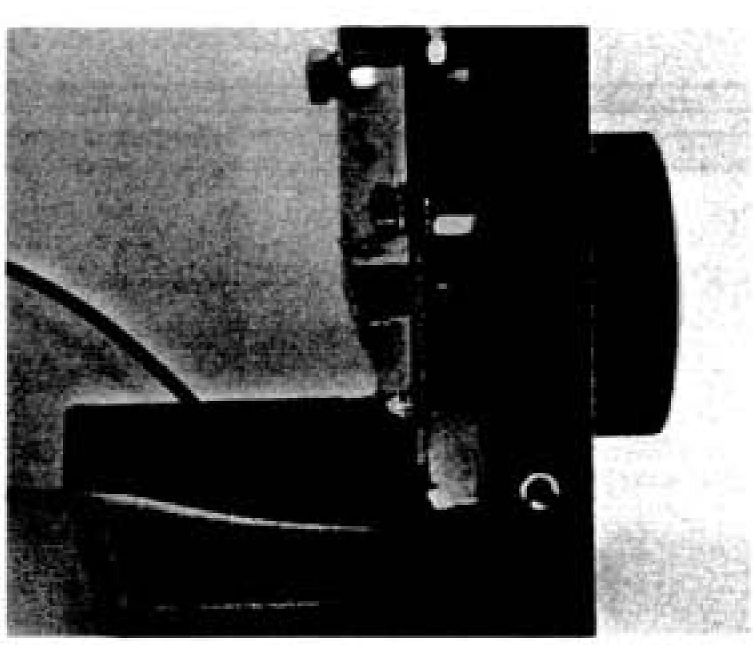
To access the jumpers and battery compartments, remove all four screws securing the analyzer's back cover and carefully open the case. To operate the MFJ-213 on batteries put the EXT PWR-BAT jumper on the PC board in the BAT position and install the batteries.

The MFJ-213 can use either AA cells or a 18650 LI-ion cell to power it on batteries.

AA Battery power requires *3 (three)* ***AA-size 1.5-volt alkaline cells***. Batteries are installed in a fully encased 3-cell plastic tray mounted inside the analyzer enclosure. Slide the battery box covers sideways to unlatch, and then lift vertically to expose the cells.



When replacing old batteries, be sure to follow the manufacturer's environmental guidelines for safe disposal. For longest battery life, always replace with a matched set of factory-fresh cells. The MFJ-213 will not charge batteries in the AA cell pack. Do not use rechargeable AA cells in the pack. The battery pack plugs into the socket on the bottom of the PC Board.

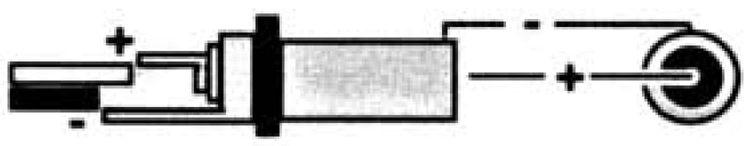


The MFJ-213 can also hold an optional rechargeable 18650 battery and charger board. This battery is inserted into a holder that is placed at the bottom of the case. Disassemble the case as listed above and insert the battery into the holder making sure the polarity is correct. This battery is recharged from the external supply through a special charging circuit (optional) that plugs into the MFJ-213. Charging time is about 10 hours using the MFJ-1312B. See the section on the charging function below for charging the battery. The battery holder has a circuit built in to prevent the battery from discharging below the minimum safe voltage. If the battery has discharged to that point or a new battery has been put in the battery must be charged above that point resetting the circuit before a Li-ion battery will function in the MFJ-213.

2.2 External Power Supply

To operate the MFJ-213 on an external power supply plug in an external power supply onto the EXT PWR jack on the top of the unit..

Powering the MFJ-213 externally requires a well-filtered 12V DC supply such as the MFJ-1312D capable of delivering **12** to **15 VDC** under varying load conditions. Current drain ranges from 30 mA to 180 mA, depending on operating mode, frequency range, and whether or not the display backlight is on. The unit's external power jack is located on the front panel and accepts a standard 2.1-mm power plug. ***Positive voltage (+) must be applied to the connector's center pin.***



2.1 mm

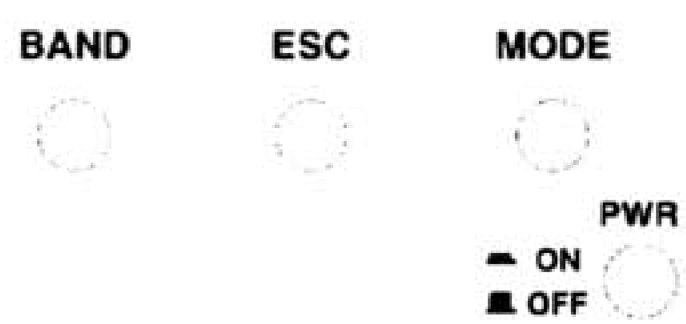
<u>Important Warnings</u>: Reverse polarity or excessive voltage could permanently damage the MFJ-213! To avoid damage:

1. Never connect an AC transformer or positive-ground power source

2. Never install or remove batteries with external power connected

3.0 OPERATING MODE

Once you have suitable power (battery or external), you're ready to explore the analyzer's basic operating features. Begin by pressing the red **PWR** button on.



3.1 Main Menu Screen

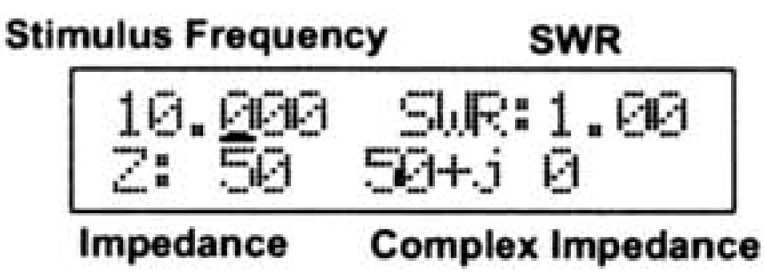
The individual functions are listed on the main screen and are selected by rotating the TUNE/SELECT knob then pushing the TUNE/SELECT knob to select the function. To exit from any of the functions press the ESC button to return to the Main Menu Screen.

```
1.Antenna 2.Loss
3.LC-meter 4.Chr
```

```
5.BTlk
Scroll and Press
```

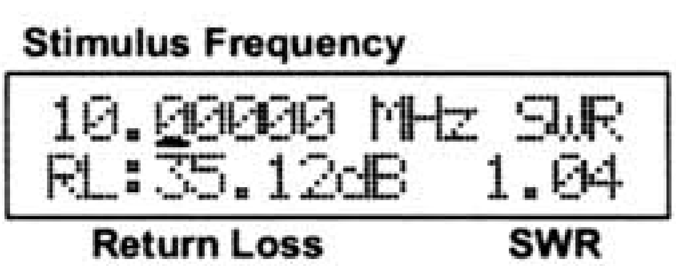

3.1.1 Antenna Analyzer Mode (1.Antenna)

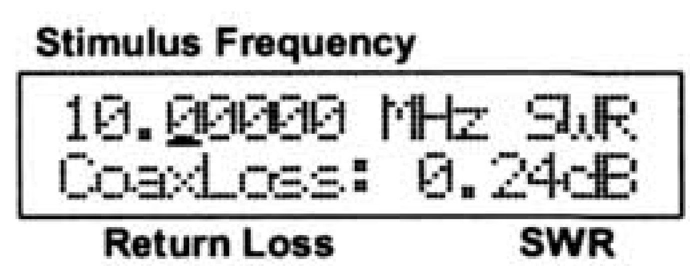
The MFJ-213 may be used to measure the impedance, complex impedance and SWR of an antenna connected to the antenna connector in this function. There are 3 sub-modes selected with the **MODE** button. Default is the impedance measurements. The next mode reads the external power supply voltage (Pv) when connected to an external charger and the battery voltage (Bv) when batteries are installed. When the external supply or internal batteries are not installed then those numbers are not valid. The third mode is a measurement of external noise that can cause erroneous readings.



3.1.2 Return Loss (2.Loss)

This function on the MFJ-213 reads the return loss and SWR of an antenna connected to the antenna connector. There are two modes in this function. The default is return loss and the next mode selected by pressing the **MODE** button is cable loss. The cable loss is measured by connecting the cable to the antenna connector and leaving the other end open or unterminated. This mode is for 50 ohm cables.



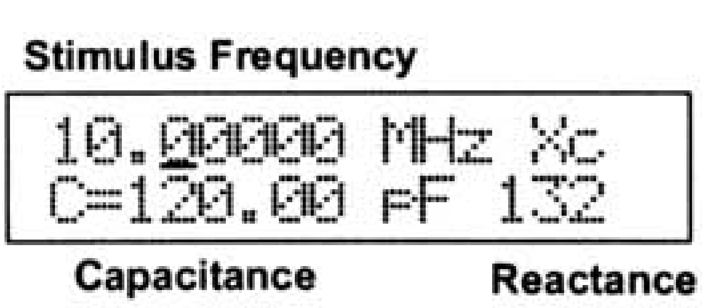


3.1.3 L/C Measurement Mode (3.LC-meter)

The MFJ-213 may be used to measure the value of unknown capacitors and inductors. To measure L/C values, select this function, connect the device to be tested to the antenna jack and follow the procedure outlined below:

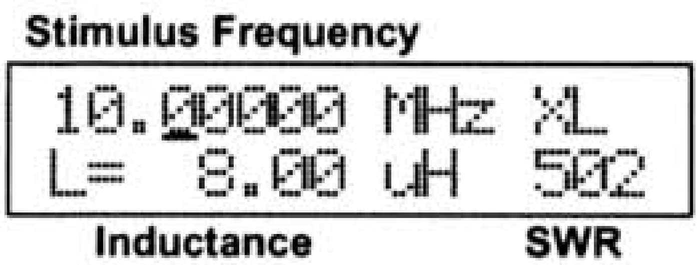
Measure Capacitance

If the display does not indicate Xc in the top line and C= in the second line press the **MODE** button till this mode is selected. The capacitance at that frequency is displayed and the capacitive reactance is displayed to the far right.



Measure Inductance

Press the **MODE** button till the display indicates XL in the top line and L= in the second line this mode is selected. The inductance at that frequency is displayed and the inductive reactance is displayed to the far right.



3.1.4 Li-ion Battery Charge (4.Chr)

Charging the Li-ion battery is done using a special charger (optional) plugged into the MFJ-213. The external power supply must first be plugged into the unit for the charger to function. Note just plugging the external supply will not charge the battery. To charge the Li-ion battery if installed you rotate the **TUNE/SELECT** knob to this function then press the **TUNE/SELECT** knob in. The charging circuit will come on displaying CHARGING and will run till fully charged.

3.1.5 Bluetooth link (6.BTlk)

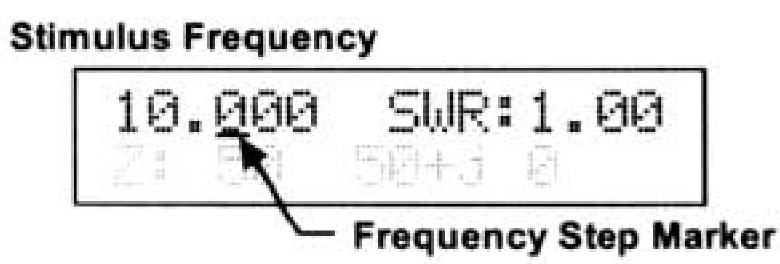
This is an option that is plugged into the MFJ-213 allowing you to link the MFJ-213 to an android device. See the installation instructions with this option on installation and use.

4.0 FREQUENCY SELECTION

The MFJ-213 covers the **HF** region **(1.5-60 MHz)**

4.1 Variable Tuning

The MFJ-213 tunes continuously from 1.500 to 60.000 MHz by *turning* the **TUNE/SELECT** knob. The tuning speed can be selected by *pushing* in the **TUNE/SELECT** knob to select which digit to increment. The frequency displayed on the LCD display will have a bar under the digit that will be incremented and pushing in the knob advances the bar to the next digit between 1 KHz and 1 MHz in the Analyzer mode and 10Hz and 1 MHz in the other modes.



4.2 HF-Band Selection

You can select each of the amateur bands instead of turning the tuning knob by pressing the **BAND** button.

Before moving on to the next section, take time to review the MFJ-213's basic set-up procedures. Operation becomes second nature quickly, but should you need it, there's a supplemental "quick guide" in the back for reference (Section 8.0). The remainder of the manual will focus on general instructions and helpful tips for making accurate measurements.

5.0 ACCURACY LIMITS

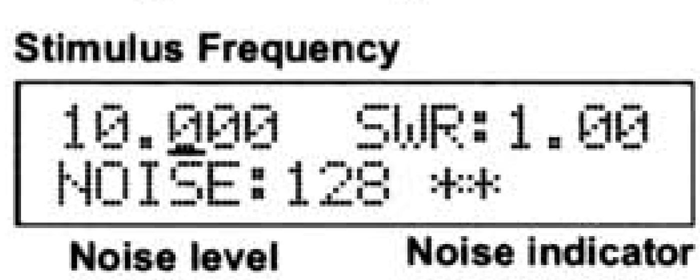
The MFJ-213 will serve as your "eyes and ears" when working with RF systems, and it can deliver results that rival units costing thousands of dollars. However, all handheld analyzers share certain limitations, and being aware of them will help you to achieve more meaningful results.

5.1 SWR Measurements and Local Interference

The MFJ-213 (and other hand-helds) uses a broadband diode detector that is open to receiving signals across the entire radio spectrum. Most of the time, the unit's built-in stimulus generator is powerful enough to overcome any lack of front-end selectivity and override stray pickup. However, a powerful transmitter located nearby *could* inject enough RF energy into the detector to disrupt readings. If this condition occurs, performance will become erratic and SWR readings may appear higher than they really are.

5.2 Checking for Local Interference

Unlike many analyzers, the MFJ-213 has an onboard function for identifying local interference. In the 1.Antenna function simply switch to the third mode and note the readings you obtain with the antenna connected. If a strong signal (>100) registers on the display, then suspect interference. If the interfering source can't be turned off or your antenna can't be moved to a different location, you may need to use a station transceiver and a thru-line directional Wattmeter to complete the adjustments.



5.3 Detector Linearity and Accuracy

Diode detectors typically become non-linear at very low voltages. Because of diode non-linearity, it's not uncommon for two identical analyzers to show slightly different readings when checking a load with very low SWR (or low RF-return voltage). For example, one analyzer may read 1.2:1 while another reads 1.1:1 when checking the same antenna. The MFJ-213 is electronically compensated to minimize detector error, but be aware of the potential for minor differences.

5.4 Calibration-Plane Error

The analyzer's *calibration plane* is the point of reference where all measurements have the greatest accuracy *(gain reference=0 dB, phase shift = 0-degrees).* For basic hand-held units like the MFJ-213, the calibration plane is *fixed at the antenna connector.* As such, any measurement made through a cable will displace the load from the calibration plane and introduce some amount of error. For SWR readings, error is mainly caused by losses in the cable. Specifically, SWR will read somewhat lower through a length of cable than with the analyzer connected directly to the direct load because the forward and reflected stimulus signals are attenuated in the feedline. The more loss there is in the cable, the greater the error. Most of the time, this inaccuracy isn't a problem because the SWR you measure with the analyzer is the same SWR the radio will encounter when connected. However, if you wish to know the antenna's *actual feedpoint SWR* for documentation purposes, the analyzer should be connected directly to the feed point through a short pigtail.

Calibration-plane error has a much more significant impact when attempting to measure impedance values because of phase rotation in the cable. In fact, impedance readings can swing dramatically, depending on the cable's electrical length and the severity of the load's mismatch with reference to 50 Ohms. *For accurate impedance data, always connect the analyzer directly to the antenna or device you're testing using the shortest lead possible.*

5.5 Sign Ambiguity (± j)

Most hand-held analyzers (including the MFJ-213) lack the processing capability to calculate the reactance sign for complex impedance (**Z** = **R** ± **j**). By default, the MFJ-213 displays a plus sign (+ **j**) between the resistive and reactive values, but *this sign is merely a placeholder and not a calculated data point.* Although the analyzer's processor can't calculate sign, it can often be determined with a small adjustment of the TUNE control. To determine sign, TUNE *the analyzer up-frequency slightly* --

(1.) *If reactance* ***decreases***, the sign is likely to be (-) and the reactance capacitive ($\mathbf{X_C}$).

(2.) *If reactance* ***increases***, the sign is likely to be (+) and the reactance inductive ($\mathbf{X_L}$).

6.0 ANTENNA MEASUREMENTS

Excellent tutorials are available in ARRL Handbooks and other League antenna publications to help you master the art and science of constructing and adjusting effective antenna systems. Informative introductory material may also be found on line, but choose carefully. Not all web material is well edited or accurate (especially items discussed in chat rooms and forums). Here are some general guidelines to help you get started.

6.1 Antenna Connectors

The MFJ-213 uses a SO-239-female (or UHF) connector. Stacking multiple adapters together places unnecessary stress the analyzer's connector and increases the possibility of measurement error.

6.2 SWR

Standing Wave Ratio (SWR), sometimes referred to as VSWR, is the most widely used format for checking tuning error and impedance mismatch between antennas and radios. The MFJ-213 is calibrated to work on the 50-ohm impedance standard used by amateur and commercial two-way equipment (Zo=50). Unless a different cable impedance is specified by the antenna designer for matching purposes, always use 50-Ohm cable of known quality when making up transmission lines and patch cables.

WARNING: ***Never apply external dc voltages or strong RF signals to the analyzer's antenna connector or permanent damage will result. Also, never connect the output of a transmitter to your analyzer.***

6.3 Measuring SWR

Here is the recommended procedure for the checking antenna SWR with the MFJ-213:

(1.) Turn the unit **ON** and select the **Antenna** function **(Section-3)**.

(2.) Select the desired **Frequency (Section-4)**.

(3.) Connect the antenna to the analyzer (**Antenna** connector)*.

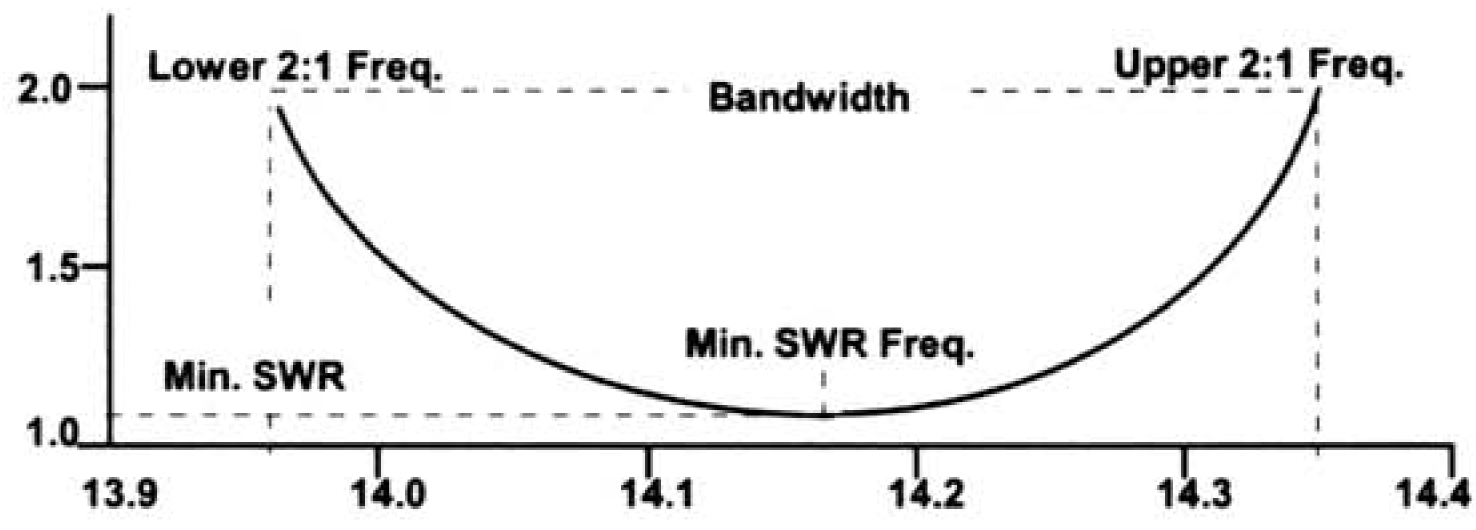
(4.) Rotate the **Tune** knob to find the lowest **SWR** reading and write it down.

(5.) Rotate **Tune** to either side of minimum SWR and note the **2:1 SWR** points.

*When testing large ungrounded antenna systems such as HF dipoles, momentarily short the feedline center pin to ground to bleed off static buildup before connecting to the analyzer.

6.4 SWR, Bandwidth, and Resonance

The amateur-radio industry's standard for maximum SWR is 2:1. Most modern transceivers operate safely and deliver full power within this mismatch range. The antenna *bandwidth* is the frequency interval between its two 2:1 SWR points. This specification, along with *minimum SWR* and *minimum SWR frequency,* is often included on antenna specification sheets. Note that *minimum SWR* is sometimes wrongly confused with *resonant frequency.* The technical definition for *resonance* is *the frequency where inductive and capacitive reactance cancels, leaving a purely resistive load* ($\pm j = 0$). The minimum SWR and resonant frequencies may be close, but they rarely coincide.



6.5 Antenna Tuning

Where possible, make adjustments to your antenna that will yield SWR readings under 2:1 over the frequency range where you normally operate. If the minimum-SWR frequency measures low in the band (or below the band edge), your antenna is probably too long and will need to be shortened. If the Minimum SWR frequency is too high, it should be lengthened. To calculate the required change in length:

(1.) Write down the *desired minimum SWR frequency* (ex: 14.200 MHz)

(2.) Use the analyzer to measure the present *minimum SWR frequency* (ex: 14.050 MHz)

(3.) Divide the present *frequency* by the *desired frequency* (ex 14.050 ÷ 14.200 = .989)

(4.) Multiply the *present length* by the result (33.3 feet x .989 = 32.94 feet)

Note that this formula applies to full-sized antennas, but not to elements shortened by coils, traps, or capacitive hats.

6.6 Antenna matching

If your antenna doesn't exhibit 1:1 SWR at the minimum SWR frequency, then some mismatch is present relative to 50-Ohms. For simple dipoles and ground-independent verticals, mounting height above ground may be the primary cause. Generally, it's best to ignore SWR readings under 2:1 and mount these antennas as high as possible where they'll perform best. For antennas that feature adjustable matching networks (Yagis etc), SWR can usually be improved by following the manufacturer's antenna setup instructions. Note that matching and tuning settings may interact, so readjustment of both the antenna's element length and matching network may be needed to obtain best results.

6.7 Matching antennas through a tuner (ATU)

If your antenna can't be tuned or matched to an acceptable SWR level by making physical adjustments, then an external antenna tuner (ATU) should be installed. The MFJ-213 may be used in conjunction with the tuner to make adjustments without the need to transmit test signals over air. Simply connect the analyzer to the tuner input (radio side) through a short patch cable. Select the **Analyzer** mode, set up the **Band**, and **Tune** for the desired frequency of operation. Then, adjust the antenna-tuner's controls following the manufacturer's recommendations until SWR approaches 1:1. Remove the analyzer, reconnect the radio, and the load will be pre-matched to the radio's 50-Ohm operating impedance.

6.8 Antenna Impedance Readings

The MFJ-213 displays *complex impedance* and *impedance magnitude* readings on the same screen with the *SWR* reading. However, when measuring through coax, remember that *the impedance readings are phase-shifted values* appearing at your end of the cable and not the actual feedpoint impedance of the antenna itself (Section-5.4). As a "work-around" strategy, it's possible to measure the antenna's *actual impedance* remotely if the feedline is cut to an exact electrical half wavelength. In a half-wavelength line, the phase shift is a full 360 degrees, which electrically rotates the analyzer's calibration plane back into alignment with the load. However, this strategy only works at one frequency and errors compound quickly if your cable is multiple half-wavelengths long. As a practical matter, unless you have an advanced working knowledge of transmission-lines, Smith charts, and impedance matching theory, it's best to ignore impedances and rely on SWR for routine antenna-system adjustments.

6.9 Unpredictable SWR

A change in feedline length shouldn't shift your antenna's *minimum-SWR frequency* or have much impact on the *SWR* readings. If it does, suspect a significant mismatch between the antenna and coax, or more likely, poor isolation between the feedline and the antenna. Isolation problems typically occur when *unbalanced* coax line is connected directly to a *balanced element* such as a dipole or a loop, and the outer surface of the coax shield literally becomes a part of the antenna. If the length of the shield happens to presents a low impedance path, it can load the element significantly and shift the *minimum-SWR frequency* unpredictably. It will also introduce needless mismatch, divert transmitted RF back toward the operating position, causing RFI problems in the residence, and increase unwanted noise pickup in receive mode. The best way to decouple the outer surface of the shield from the antenna element is with a balun. Current-type baluns work best because they have higher power-handling capability and less loss than other types. An effective current balun could be as simple as a few loops of coax taped together at the feedpoint, but for best common-mode rejection, a Guanella-style balun wound on a ferrite core is recommended.

7.0 ADVANCED FUNCTIONS

Here are some of the MFJ-213 advance functions. Note that some of these procedures involve connecting component leads to the unit's Antenna connector. For these connections, we suggest making up a very short UHF-male coaxial pigtail or obtaining a *UHF dual binding post adapter* to prevent damage the center-contact of the analyzer connector.

7.1 Stimulus Generator as a Signal Source

When operated in Analyzer mode, the MFJ-213 generates a 0 dBm CW carrier (1 mW). See section 3.1.1 for setup procedures. Output will vary slightly, depending on frequency and operating voltage, but typically holds to within 1-2 dB of the rated power level over the analyzer's frequency range. Harmonic suppression averages -20 dBc. A quarter-wave stub or low-pass filter may be installed if greater harmonic suppression is required for a specific application. Frequency stability and carrier purity are sufficient for testing filters, mixers, low-power amplifier stages, and for checking antenna patterns when a range antenna is connected to the analyzer output. The stimulus generator may also be used for producing lower-level signals with a suitable precision RF attenuator installed in line. When connecting the generator directly to active circuitry, always insert a coupling capacitor to prevent DC voltages from back-feeding into the bridge circuit and destroying the detector diodes. Also, avoid connecting the stimulus signal directly to sensitive preamps or receiver circuits that could be damaged by an un-attenuated 1-mW signal.

7.2 Measuring Unknown Capacitance

To measure capacitance, connect the unknown component to the **Antenna** connector (usable range is from approximately 15 pF to 1200 pF). To enter the **Capacitance** mode, begin with the analyzer at the main menu and select the **LC-meter** function (see Section 3.1.3). The screen will display the approximate value of the unknown capacitor in pF along with the stimulus frequency where the measurement is being made. The best accuracy is typically obtained in the 4 to 9 MHz range, which may be selected using the **BAND** button and the **TUNE** knob. Note that any capacitor and lead combination that approaches self-resonance at the stimulus frequency will trigger the C = ***Xc >1.5KΩ*** message and will be un-measurable. Attempt to re-measure at a lower frequency.

7.3 Measuring Unknown Inductance

To measure inductance, connect the unknown component to the **Antenna** connector. To enter the **Inductance** mode, begin with the analyzer at the main menu and select the **LC-meter** function then press the **MODE** button to select the inductance mode(see Section 3.1.3).The screen will display the approximate value of the unknown inductor in uH along with the stimulus frequency where the measurement is being made. The best accuracy is typically obtained in the 2 to 9 MHz range, which may be selected using the **BAND** button and the **TUNE** knob. Note that any inductor approaching self-resonance at the stimulus frequency will trigger the $L = X_L > 1.5K\Omega$ message and will be un-measurable. Try to re-measure at a lower frequency.

7.4 Determining Cable Velocity Factor

If you have coax cable with an unknown velocity factor, you can determine it quickly using the following procedure:

(1.) Set the MFJ-213 up in **Analyzer** mode (Section-3)

(2.) Set the frequency to around 20 MHz (Section-4)

(3.) Make a 1/4-λ stub from *9 feet* of the unknown cable and connect it to the analyzer (other end open)

(4.) Rotate **Tune** for minimum *impedance magnitude* reading. Write down the frequency (in MHz)

(5.) Divide 246 by this frequency to find the free-space 1/4-λ wavelength in feet $(L = 246 \div f\ MHz)$

(6.) Divide 9 (the actual length) by free-space 1/4-λ wavelength to get the Velocity Factor $(VF = 9 \div L)$

Note that there is nothing magical about the 9-foot stub length, other than it falls conveniently within the limits the tuning range. Other lengths could be used. Shorter stubs will yield poorer accuracy and long ones may needlessly waste useful cable.

7.5 Tuning a ¼-Wave or ½-Wave Coaxial Stub

To accurately tune a coaxial stub, begin by calculating the *free-space length at the stub's intended operating frequency:*

For 1/4-λ in inches = *2951 ÷ MHz*

For 1/4-λ in feet = *246 ÷ MHz*

For 1/2-λ in inches = *5902 ÷ MHz*

For 1/2-λ In feet = *492 ÷ MHz*

Next, multiply the *free-space length* times your cable's *velocity factor.* Finally, add at least 10% to this length for a margin of error (better too long than too short). Cut the cable to this initial length. Connect one end of the cable to the analyzer's **Antenna** connector. For a 1/4-λ stub, leave the far end open. For a 1/2-λ stub, short the far end. Next:

(1.) Set the MFJ-213 to **Antenna** mode (Section-3)

(2.) Initially, set the **Band** and **Tune** for the *desired stub frequency* (Section-4)

(3.) ***Tune** down in frequency to find lowest *impedance-magnitude* reading (a 1/4-λ open or a 1/2-λ short look like a short or low impedance load).

(4.) Write your *measured frequency* down.

(5.) Divide the measured *frequency* by the *desired stub frequency* to obtain a correction factor

(6.) Multiply the *present stub length* by the *correction factor* to get the *desired stub length.*

(7.) Re-cut the cable to that length.

> *Note that the impedance value may not drop to zero, but it will begin to increase again as you continue to tune past the null. If the null reading is broad, choose a frequency at the center.

(4.) Rotate **Tune** for minimum *impedance magnitude* reading. Write down the frequency (MHz)

(5.) Divide 246 by this frequency to find the free-space 1/4-λ wavelength in feet *(L = 246 ÷ f MHz)*

(6.) Divide 9 (actual length) by free-space 1/4-λ wavelength to get the Velocity Factor *(VF =9 ÷ L)*

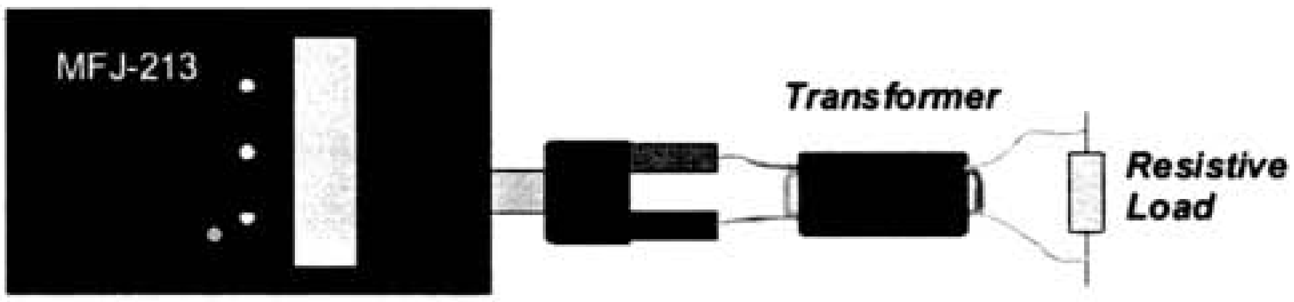
Note that there is nothing magical about the 9-foot stub length, other than it falls conveniently within the limits of Band E's tuning range. Other lengths could be used. Shorter stubs will yield poorer accuracy and long ones may needlessly waste useful cable.

7.6 Checking Coax Cable Impedance

To check a length of coax cable for impedance error, connect one end to the analyzer and terminate the far end with a precision (non-inductive) 50-Ohm resistive load. The cable will need to be at least 1-λ long at 30 MHz for this test. Set the MFJ-213 up for **analyzer** mode and tune to 30 MHz. Rotate the **Tune** between 15 and 60 MHz while watching the *Impedance Magnitude* reading. If the cable is 50 Ohms and in good condition, there should be little change in the impedance magnitude readings. If there are significant fluctuations, the cable is either not 50 Ohms or is badly contaminated. If readings cyclically swing between 25 Ohms and 100 Ohms, the cable is 75-Ohm coax.

7.7 Testing RF Transformers

Broadband HF-matching transformers wound for the 12.5 to 200 Ohm range may be tested using the MFJ-213. Connect the 50-Ohm (primary) side to the analyzer connector using a short pigtail or binding post adapter, and attach the appropriate resistive load across the secondary side (always use a non-inductive resistor).



Next:

(1.) Set the MFJ-213 up in **Analyzer** mode (Section-3)

(2.) Set the **Band** to the desired frequency range (Section-4)

(3.) Rotate **Tune** across the frequency range and note **SWR**. Change bands, as needed.

At the low and high ends of the transformer's frequency response range, SWR and reactance will climb to unacceptable levels (< 1.2:1 is ideal). HF tuned *transmission-line transformers* may be tested in similar fashion by connecting one end directly to the analyzer and terminating the far end. However, only precision RF terminations with known impedance characteristics should be used above 50 MHz. Set up the analyzer for the desired range and sweep the band of interest using the Tune control. Transmission-line transformers are "frequency specific" and have much more limited frequency response.

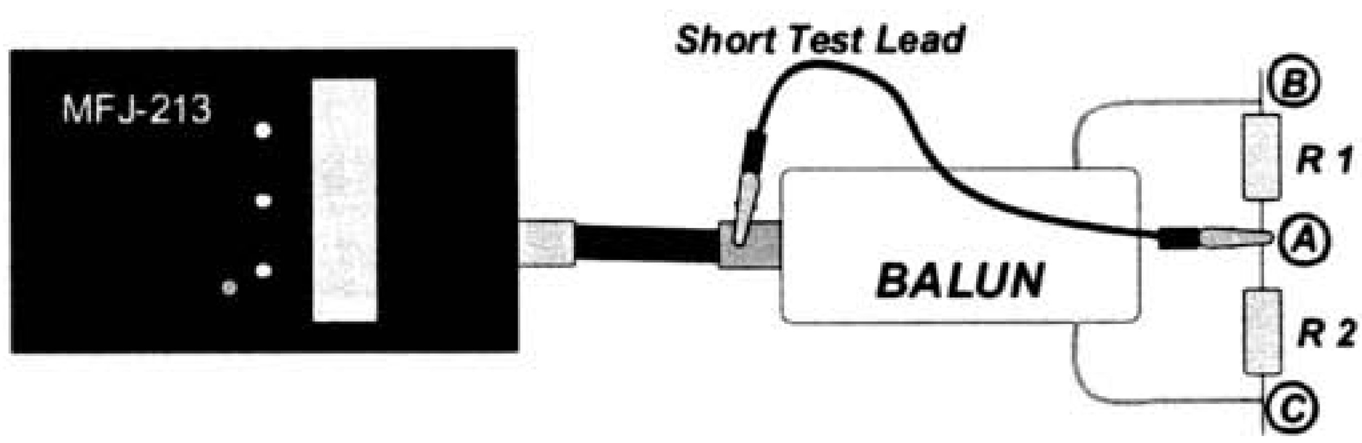
7.8 Checking HF Baluns

A well-designed balun will have low SWR *and good balance* over its operating range. The MFJ-213 can test both of these qualities using the setup shown below. Configure the unit to operate in **Analyzer** mode in the **HF** range. Connect the input (unbalanced) side of the balun to the analyzer's antenna connector. Connect a center-tapped resistive load to the balanced side (R1,R2 = 25Ω for 1:1 baluns, R1,R2 = 100Ω for 4:1 baluns). Using the **Tune** and **Band** controls:

(1.) Sweep the balun for SWR with the test lead disconnected from the load.

(2.) Connect the test lead to the mid-point (A) and re-sweep. There should be minimal change.

(3.) Connect it to either side (B) (C). SWR will go up, but should go up equally on both sides.



NOTES:

8.0 QUICK GUIDE TO ANALYZER CONTROLS AND FUNCTIONS

Power:

Use only 1.5-V Alkaline batteries or 18650 Li-ion battery. External power must be 10.8-12.5 Vdc, well regulated. Power plug: 2.1-mm, positive (+) to center pin.

Power Up:

Press PWR, wait for the Main Menu to come up.

Main Menu Screen:

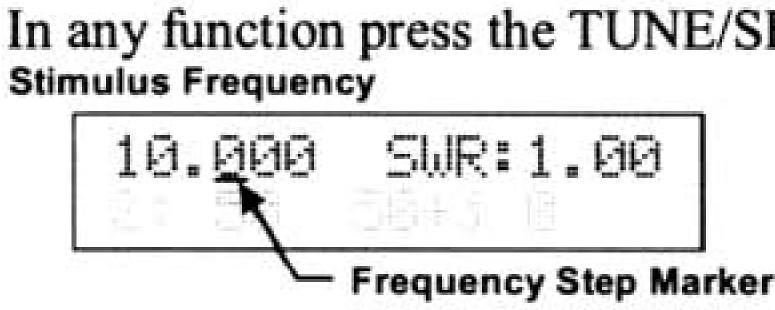
Rotate the Tune knob to select the desired Function then press to select the function.

```
1.Antenna 2.Loss
3.LC-meter 4.Chr
```

```
5.BT1k
Scroll and Press
```

Set Up Stimulus Frequency:

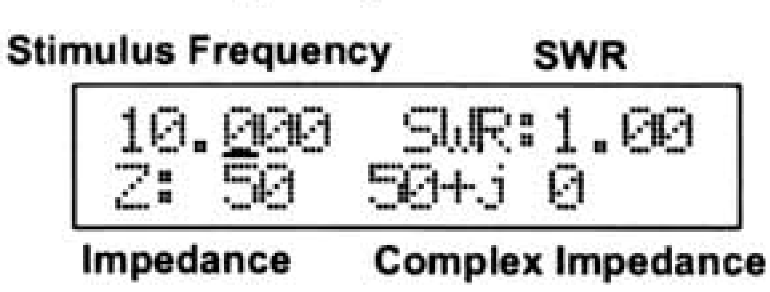
In any function press the TUNE/SELECT knob to set the step size.



Press the BAND button to select the amateur band if desired.
Turn the TUNE knob to set the exact frequency desired.

Analyzer Function Screen (1.Antenna):

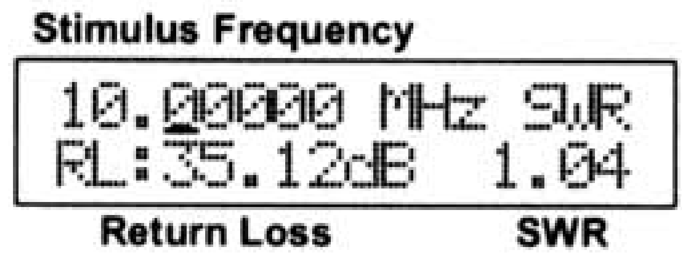
Connect the antenna to the Antenna connector.
Set the frequency and read the results.



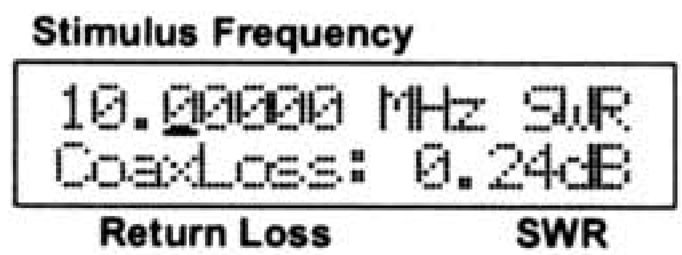
Return Loss Function (2.Loss):

Connect the antenna to the Antenna connector.
Set the frequency and read the results.

Return Loss Mode



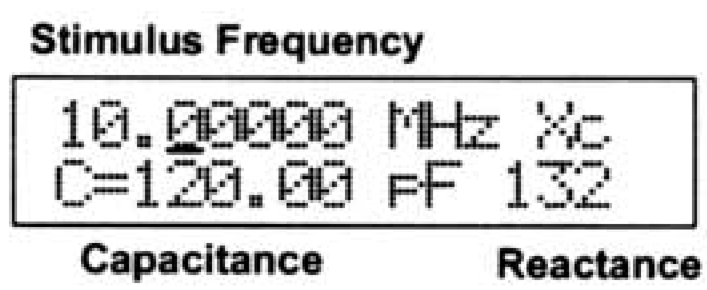
Coax Loss Mode



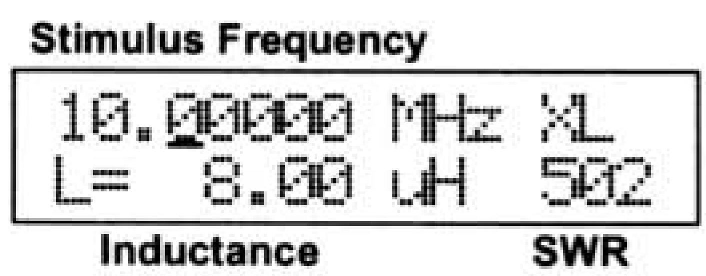
L/C Function (3,LC-meter):

Connect the capacitor, inductor or unknown load to be measured to the Antenna connector.
Select the frequency to test at.
Measure the results.

Measure C Mode



Measure L Mode



Charging Function (4.Chr):

Plug in external power supply.
Select 4.Chr and charging will start and backlight will turn off.
When fully charged the display will indicate CHARGING COMPLETE.

Technical Assistance

If you have any problem with this unit first check the appropriate section of this manual. If the manual does not reference your problem or your problem is not solved by reading the manual, you may call *MFJ Technical Service* at 662-323-0549 or the *MFJ Factory* at 662-323-5869. 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 facsimile (FAX) to 662-323-6551; 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. Also include the firmware version number of your unit.

12 MONTH LIMITED 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 or machine reproduction of 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, or 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 warranty, provided the product is returned postage prepaid to MFJ Enterprises, Inc. with a personal check, cashiers check, or money order for $12.00 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 an $8.00 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 (662) 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.

MFJ

MFJ ENTERPRISES, INC.
300 Industrial Park Road
Starkville, MS 39759

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Version 1