MFJ

MFJ Vector Impedance Antenna Analyzer

Model MFJ-223

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

Table of Contents

1.0 Introduction

1.1 Features and Functions: The MFJ-223 breaks the size barrier for RF-analyzers by delivering user-friendly convenience, top-notch accuracy, and a vivid TFT multi-color display in an ultra-compact package. Although small in size, the MFJ-223 is loaded with a great selection of *Single-Frequency* and *Swept-Frequency* VNA functions.

Use the ***Single-Frequency*** mode to view *Standing Wave Ratio* (*SWR), Resistance (R), Reactance (X), and Local Interference levels (S)* simultaneously on a high-resolution analog bar-graph display. High-accuracy numerical values for SWR, R, X, and Impedance Magnitude (Z) appear on the same display. This mode also allows you to use your analyzer as a precision signal generator.

Use the ***Scan-Frequency Mode*** to graphically plot SWR, R, X, and Z. All four plots are captured as a sequence of sharply defined color graphs. Simply toggle through each screen for a complete visual analysis. There's also a tunable marker on each screen you can use to call up precise numerical values for SWR, R, X, and Z at any point along the plot. The MFJ-223 has internal memory, so there's no need to worry about lost data -- if you turn your unit off, the last measurement will still be there when you turn it on again.

The MFJ-223 is continuously tunable from 0.5 to 60 MHz with 100-Hz resolution and a wide range of tuning steps and scan widths for shaping your plots. The advanced DDS stimulus generator delivers rock-solid stability, smooth skip-free tuning, and a powerful +5 dBm test signal that overrides most strong local interference. There's also a built-in *Field-Strength Indicator* to warn when high interference levels are present.

Best of all, you can forget about swapping out dead batteries, working around NiCd cell memory, or hunting for lost wall chargers because the MFJ-223's long-running lithium-polymer power source is built right in. Simply connect to any available USB port on your computer or USB wall charger to recharge. A built-in smart-charger with LED status monitoring let's you know when the analyzer is ready to go.

We strongly recommend reading through the manual before turning your analyzer on for the first time. You'll find valuable information for setup and many important operating tips. Once you're up and running, you'll quickly discover the MFJ-223 has many user-friendly features including soft-menu labeling for the command keys and a built-in 8-page *Help Menu.* Don't forget to personalize the MFJ Boot Screen by entering your call letters or name.

1.2 Technical Specifications

DDS RF-Stimulus Generator

- Tuning Range: 0.5 - 60.0 MHz
- Tuning Steps: 100Hz, 1kHz, 10kHz, 100kHz, 1MHz
- Output Power: +5 dBm, ±1 dB typical
- Frequency Stability: <5 ppm
- Harmonic Suppression: -20 dB or better
- Scan Width and Marker Steps: See Scan Mode

Single-Frequency Measurement Mode

- VSWR Range: 1:1 to 9.9:1, analog bar and numerical readout
- Load Resistance (R): 0-300 Ohms, analog bar and numerical readout
- Load Reactance (X): 0-300 Ohms, analog bar and numerical readout
- Impedance Magnitude (Z): 0-300 Ohms, numerical readout only
- Interference Detector (S): full scale = 0 dBm, analog bar display.

Scan-Frequency Measurement Mode:

- Widths: .3 MHz, .6 MHz, 1.2 MHz, 2.4 MHz, 6 MHz, 12 MHz, 24 MHz 48 MHz
- Marker Steps: 1 kHz, 2 kHz, 4 kHz, 8 kHz, 20 kHz, 40 kHz, 80 kHz, 160 kHz
- VSWR Plot Range: 1:1 to 9.9:1
- Resistance Plot Range (R): 0-300 Ohms
- Reactance Plot Range (X): 0-300 Ohms
- Impedance Magnitude Plot Range (Z): 0-300 Ohms
- Interference Detector: 5 bar "cellphone" style display, -30 to + 20 dBm range

Power Management

- Power Source: Built-in 3.7-V, 1800-mAh Lithium Polymer battery
- Charge Controller: Smart charger, LED charging-status indicator
- Voltage Monitor: On-screen DVM, plus battery condition icon
- Charger Source: Any USB port, analyzer accepts Micro-USB plug
- Power Savers: Auto-off timer, manual Run/Stop RF-generator control

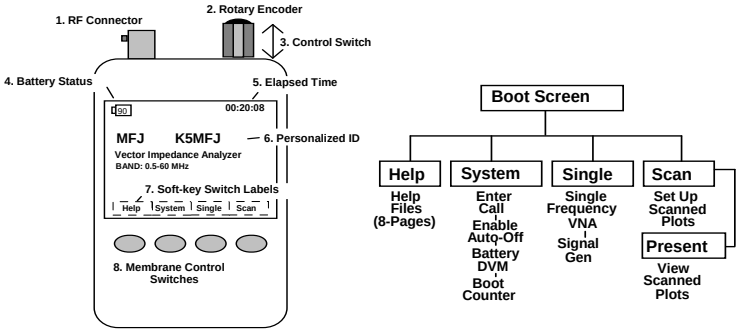
Interface

- RF Connector: BNC, PL-259 with adapter
- Battery Charge Connector: Micro-USB
- Screen: 2-inch high-output color TFT
- Function Keys (4): Membrane, with on-screen (soft-menu) identifiers
- Tuning: Rotary encoder with press-in tuning-step selection
- ID Tag: Programmable call letters or name, up to 8 characters.

Weight and Dimensions

- Case: High-impact black molded
- Size: 2.7" wide x 3.5" high x 1.0" deep (6.86 cm x 8.9 cm x 2.54 cm)
- Weight: 5.1 oz (.144 kg)

1.3 Layout and Controls



1. RF Connector: BNC-female. Use any SO-239-to-Male BNC adapter when testing with PL-259 connectors (MFJ-7708 or equivalent).

2. Rotary Encoder: Tunes DDS frequency when setting up tests, positions marker when reviewing plot data, and scrolls for some system set-up functions.

3. Encoder Control Switch: Turns unit on and off, selects tuning steps, and scrolls through some setup menu choices. When used for power-off function, the *Boot Screen* must be displayed.

4. Battery Status: Indicates battery power remaining, warns when the battery is running low.

5. Elapsed Time: Displays running time for the current operating session.

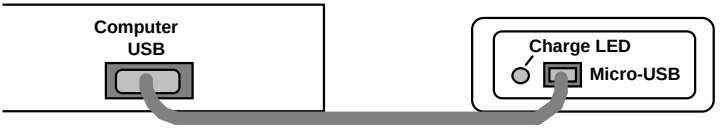
6. Personalized ID: Displays owner's call letters or name (see Chapter 2.4 for entry instructions).

7. Soft-Key Switch Labels: Displays the analyzer command-key assignments (key assignments change for different operating modes).

8. Membrane Control Switches: Enters command instructions into the analyzer's processor.

2.0 Power Source and Initial Setup

2.1 Charging the Battery: The MFJ-223 is powered by a 3.7-V 1800-mAH Lithium Polymer battery that comes pre-installed. To recharge, use a *micro-USB-to-standard-USB patch cable* (MFJ-5431 or equivalent). The analyzer can be recharged from any standard computer USB slot capable of delivering 5.0 volts at 500 mA. The analyzer's Micro-USB charging jack is located on the bottom of the unit. *Be sure to charge the battery fully before turning on and operating your analyzer for the first time.*



To monitor the charge cycle, check the status LED located to the left of the charging jack (LED not visible unless charging is in progress). *Red LED* signals normal charging, *Green LED* indicates when charging is complete, and *Flashing LED* warns of a charging fault (battery or power-source problem).

During the charge, a built-in smart-controller monitors battery condition and sets the best charge mode and rate. If the battery is depleted below 2.9 volts, the charger supplies a 50-ma trickle-charge until the 2.9-volt threshold is restored. It then increases to a 500-ma constant-current rate until the level reaches 4.2 volts. At that point, the controller switches into the constant voltage mode and tapers the charge down to shutoff.

If your analyzer is being stored and not in regular use, *recharge it every 2-3 months* to maintain battery health. Also, charge fully before putting it away for extended periods.

Important Charging Note: *Charge the battery before operating your analyzer for the first time, before storing, and at 2-3 month intervals while in storage.*

2.2 Processor Reset: The MFJ-223 operating system is immune to disruption from most glitches and EMP interference. However, in the unlikely event of a system crash, you can reset

the processor by locating the small reset-switch access hole located on the left side of the case (about 1-inch down from the top). To reset, insert the end of a paperclip or stiff wire into the hole and press gently.

2.3 Turning Analyzer On and Off: To apply power, press and hold the *Rotary Encoder* knob down until you hear a sequence of beeps, then release. This delay of about 3 seconds protects against accidentally turning the analyzer on while in transit or during routine handling. When the analyzer turns on, the *Boot Screen* will appear on the display.

Use the same procedure to turn the analyzer off. Press and hold the *Encoder Knob* down until you hear the beep sequence, then release. *Note that the Boot Screen must be selected before the analyzer will shut down.* When other screens are displayed, the Encoder is assigned to perform other functions and the on-off function is disabled.

Important Operating Note: *The Boot Screen must be displayed in order to turn the analyzer off using the Rotary Encoder Switch.*

2.4 Enter Call Sign or Name: You may personalize your analyzer by posting call letters or a name (up to eight characters) on the *Boot Screen*. To program these in, power up the analyzer and follow the procedure below:

- Press the switch labeled *System* to bring up the system menu.
- Press *Select* to toggle between *Auto-Off* and *Callsign*. Select *Callsign*.
- Press the *Encoder Knob* to toggle the curser to the start (or left) position.
- Rotate the *Encoder Knob* to scroll in your first character
- Press the *Encoder Knob* to move to the second character.
- Continue building the sequence until your call or name is entered.
- Press *Exit* to return to the MFJ Boot Screen and view your entry.

If you don't wish to enter a call or name, simply leave the field blank. To remove an existing entry, overwrite with blank spaces.

2.5 Auto-Off Function: The MFJ-223 has an optional automatic-shutdown timer that conserves battery power during long activity lapses and prevents discharging the battery if the analyzer is left on by mistake. Your data current remains in memory when the analyzer shuts down, so nothing will be lost.

To activate (or to defeat) the *Auto-Off* function, use the following procedure:

- Press the key labeled *System* to bring up the *System Menu*.
- Press *Select* to toggle between *Auto Off* and *Callsign*. Select *Auto Off*.
- Rotate *Encoder* clockwise to activate it, counterclockwise to deactivate it.
- Press *Exit* to return to the *Boot Screen*.

2.6 System Screen: In addition to facilitating setup, the *System Screen* posts other information such as the name and revision of the current operating firmware, the text language, reactance mode, and a battery DVM. It also counts the number of times your analyzer has been booted since new (or since reset).

2.7 Help Menu: To access the analyzer's eight-page *Help Menu*, bring up the *MFJ Boot Screen* and use the following procedure:

- Press the *Help* key to bring up the *Help-Contents* page
- Select a specific page using the *S-Prev* and *S-Next* keys, then press *Enter*
- Alternatively, press *Enter* then *Next* to scroll through all 8 pages sequentially
- Press *Top* to return to page 1 or *Exit* to escape back to the MFJ Boot Screen

2.8 Overload Precautions: Never connect your analyzer to a feedline or device carrying a DC-bias voltage. If in doubt, check the line with a voltmeter. Also, before connecting to outdoor arrays, always short the coax plug momentarily to discharge any accumulated static buildup. In addition to DC

and static discharge, high RF levels will also damage the coupler. Never connect to a transceiver that could accidentally transmit into the analyzer, and always check the interference display when testing in high-RF areas. *Disconnect immediately if high pickup is indicated.*

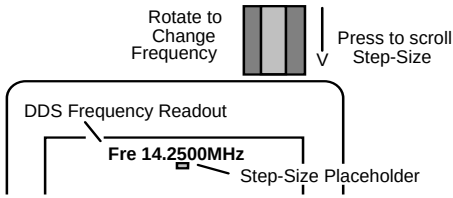
***Important Protection Warning**: Never connect a DC voltage or static-charged coaxial line to the analyzer.*

3.0 DDS Frequency Entry

3.1 Tuning: The MFJ-223 tunes continuously from 0.5 to 60 MHz with a choice of five tuning rates. All selection is done using the *Encoder* and *Encoder Switch*:

Rotary Encoder: Rotate the encoder knob to change frequency. Each encoder indent shifts frequency by one tuning increment. Use smaller increments for in-band tuning and larger increments for rapid shifts or band changes.

Encoder Switch: Depress the encoder switch to scroll through the five available tuning rates. They are: 100-Hz, 1-kHz, 10-kHz, 100-kHz, and 1-MHz. A highlighted placeholder appears below the analyzer's digital frequency display to designate the selected increment (see below).



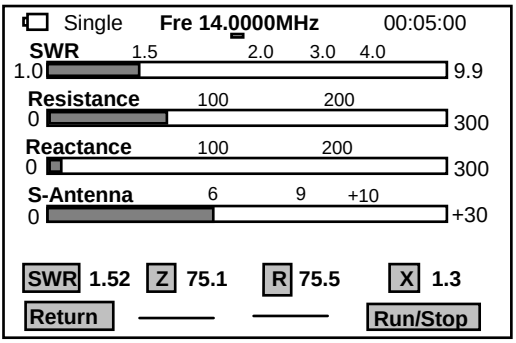
3.2 Rounding Off the Display: When you change the DDS step size (or increment), the new step will be added to -- or subtracted from -- the analyzer's *current frequency setting.* For example, if the current frequency is *3.920 MHz* and you select a *1-MHz* increment, rotating the encoder knob clockwise will advance the frequency from ***3****.920* to ***4****.920* > ***5****.920* > ***6****.920...etc.* in 1-MHz hops. As an alternative, you may choose

to *round off* the existing frequency before entering a new larger increment. For example, you might tune from ***3.92****0* up to ***4.00****0 MHz* first, then switch to the *1-MHz* step. Now the analyzer will step from ***4.****000* to ***5.****000* > ***6.****000* > ***7****.000...etc.* Rounding off isn't mandatory, but some users find it helpful.

3.3 Practicing Entry: If DDS tuning is a new experience, we recommend spending a few minutes practicing step-size selection and frequency entry before heading out into the field to make antenna measurements. Most users develop a feel for DDS tuning quickly and enjoy its seamless mobility.

4.0 Single-Frequency Test Mode

4.1 Single-Frequency Screen Layout: In single-frequency mode, pressing the *Run/Stop* key sends a steady CW carrier to the antenna under test. The analyzer's directional coupler then samples the incident (forward) and reflected (reverse) power values and sends this data to the processor for conversion into a visual display. The three top analog bars display approximate *SWR*, *Resistance* (R) and *Reactance* (X). More precise numerical values for SWR, R, X -- and also *Impedance Magnitude* (Z) -- appear at the bottom of the screen (see below).



With the generator running, you may change frequency on the fly using the *Encoder* while watching the display for key points of interest such as resonance (X = 0), minimum SWR, and the antenna's 2:1 bandwidth limits. You may also use the analog bars to provide continuous feedback when adjusting tunable

circuits or matching networks. Pressing Run/Stop again toggles the generator off.

4.2 S-Antenna Bar: The S-Antenna bar warns when your antenna is being energized by powerful external signals from a nearby transmitter. It also indicates when the analyzer's DDS generator is running, but its primary function is to detect interference when the generator is stopped. A full-scale reading means power in excess of 0-dBm is being fed back into the analyzer from an external source. *In this event, disconnect the analyzer immediately to avoid damaging the coupler.* Although marked in S-units, the meter is not logarithmic, so any reading exceeding S2 or S3 could potentially interfere and cause inaccurate readings.

Overload Warning: *When testing, check the S-Antenna bar with the generator turned off to see if disruptive RF levels are being picked up by the antenna.*

4.3 Single-Frequency Setup: To enter the *Single-Frequency* mode from the *Boot Screen*:

- Press the *Single* command key. The bar-graph (labeled *Single)* will appear.
- Connect the test antenna to the analyzer and check the *S-Antenna* scale.
- Use the *Encoder* to select a step and tune to your first test frequency.
- Press the *Run/Stop* key to start the DDS stimulus generator running.
- *Tune* as needed to explore the antenna's measurements of interest.
- [ ] Press the *Run/Stop* key again to terminate the test run.

The *Run/Stop* function conserves battery power, allowing the analyzer to operate for extended periods without recharging.

4.4 DDS Signal Generator: The analyzer's test generator may also be used as a highly accurate RF signal generator for aligning receivers, tuning networks, or driving amplifier chains. Typical output power level is +5 dBm (±1 dB) with 20-dB or better harmonic suppression. Frequency resolution is 100 Hz from 0.5 to 60.0 MHz with <5 ppm error. Anytime the analyzer is in *Single-Frequency* mode and the Run/Stop key is

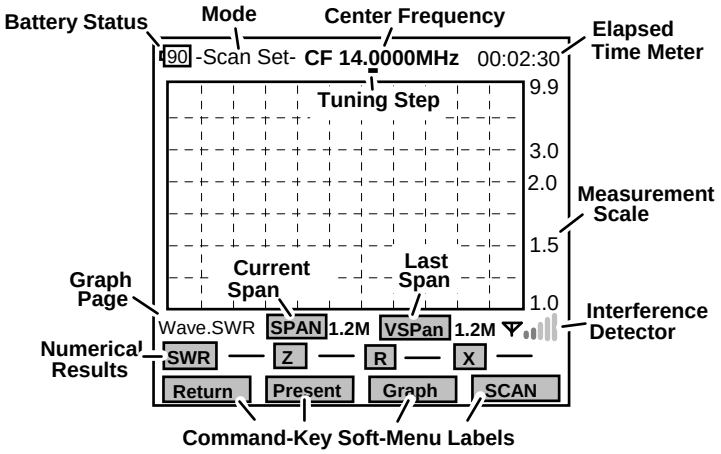
activated, a test signal will be generated. Note that the +5 dBm power level may be too high for some sensitive preamplifier or mixer stages and could damage them. The use of a wide-range step attenuator is strongly recommended when using the analyzer for any alignment procedure.

Important Signal Generating Warning: *Avoid overdriving sensitive circuitry with the analyzer's stimulus generator.*

5.0 Scan-Frequency Mode

5.1 Scan Overview: In *Scan-Set* mode, the DDS generator steps rapidly across a preset range of frequencies and samples reflected power at each stop. The scan's *Center Frequency* and *Tuning Step* are entered the same way as they are for a single-frequency test, via the *Encoder.* Along with *Center Frequency*, you'll program in a *Scan Width*. *Scan Width* determines the span of frequencies covered during the test. A choice of eight scan widths are available, ranging from 300 Hz to 48 MHz. Narrow scans are best for plotting low-frequency mono-band antennas while wider scans are more useful for broadband high-frequency antennas and multi-band arrays. Each scan is initiated manually and takes roughly 3-5 seconds to complete. When done, the analyzer switches from *Scan-Set* mode to *Present* mode. In *Present* mode, four graphic plot files are available for viewing (wave.SWR, wave.Z, wave.R, and wave.X). Numerical data gathered at each sample frequency can also be viewed using the analyzer's tunable marker function to tune back and forth across the plot.

5.2 Screen Layout: Before going through the specific setup instructions for conducting a test, take a moment to look over the scan-mode screen's general layout. Being familiar with the location and color-coding scheme for the various display elements will help you to locate specific features more quickly. To bring up the *Scan-Set* screen from the *Boot Screen* for inspection*, press the* <u>Scan</u> command key. The screen is also shown in the figure shown below:



- **Top Line:** The analyzer's current operating mode (either *Scan-Set* or *Present*) appears between the battery status and digital frequency display. *Scan-Set* is used for setting up and initiating scans, while *Present* is used to display results. In set-up mode, the frequency display shows center frequency (CF), and in presentation mode it shows the tunable-marker frequency (MK).

- **Grid:** This is the visual presentation area for plot files. Note the calibrated measurement scale that appears to the right of the grid.

- **First Line Under Screen:** The *Graph* page (or wave-file) designator shows which plot is currently selected for display (SWR, Z, R, or X). The *SPAN* box next to it shows the currently entered *Scan-Width* (this value can be reset). V*SPan* shows the width used for the previous scan (can't be reset). The *Interference Detector* on the right side warns of strong interfering signals (see 5.3).

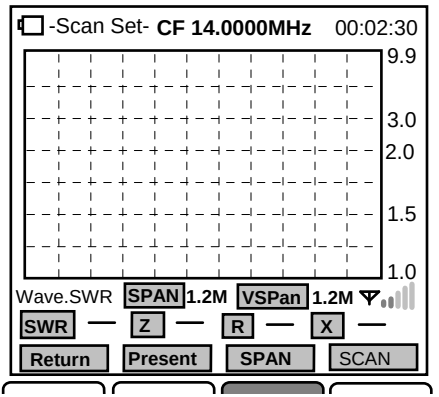
- **Middle Line Under Screen:** Displays numerical data for SWR, Z, R, and X in *Present* mode. These fields are normally blank in setup mode.

- **Bottom Line:** Shows soft-menu labels for command keys. Labels change for *Scan-Set* and *Present* modes -- see specific instructions in 5.5 and 5.6.

5.3 Interference Detector: The cell-phone style signal bars appearing in the lower right-hand corner of the screen warn of potential RF interference. Like the *S-Antenna* bar, they show deflection during scan runs, but the primary function is to warn of high interference levels with the DDS scanner is turned off. The scale is logarithmic with a range of -30 to +20-dBm (each bar indicates a 10-dB increment). When more than one bar is illuminated, interfering signals may be present. *When three or more bars are illuminated, disconnect the antenna line immediately to protect the analyzer's coupler.*

Signal Overload Warning: *Before initiating scans, always check the interference meter for powerful external signals.*

5.4 Scan-Set Entry Procedures:



In *Scan-Set* mode, the four command keys are assigned the following functions:

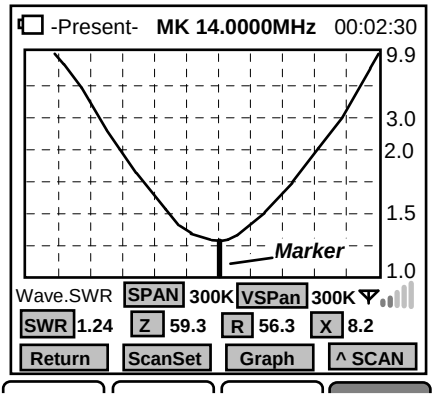
[Return] Returns analyzer to the *Boot Screen*
[Present] Toggles the analyzer between *Scan-Set* and *Present* mode
[Span] Scrolls to select scan width: (.3M, .6M, 1.2M, 2.4M, 6M, 12M, 24M, 48M)
[SCAN] Turns on DDS generator and initiates *Scan*

- To enter from the *Boot Screen*, press *Scan*.

- Choose a convenient *Tuning Step* using the *Encoder Switch*.
- Set your desired *Center Frequency* (CF) using the *Rotary Encoder*.
- Scroll with the *SPAN* key while watching the *SPAN* box to select a scan width.
- To initiate the scan, press the *SCAN* command key.

When you press *Scan,* the soft-menu label turns red while the scan is in progress. Allow it to finish -- when complete, the label turns back to green. Any previous scan data is overwritten by the new scan data and the analyzer switches automatically from *Scan-Set* to *Present* mode. Note that the *Encoder* becomes assigned to the Marker (MK) function in *Present* mode.

5.5 Present Procedures:



In *Present* mode, the four command keys are assigned the following functions:

[Return] Returns to the *Boot Screen.*
[Scan Set] Returns to *Scan-Set* so you may enter new setup information.
[Graph] Scrolls through graphic plots for SWR, Z, R, and X (wave. files).
[Scan] Initiates a re-scan using the current analyzer setup.

- To view SWR, Z, R, and X plots in sequence, scroll with the *Graph* key

- To check numerical data at any scan-stop on any plot, rotate *Encoder*
- To return to *Scan-Set* mode to enter a new setup, press *ScanSet**

*After reviewing your plots, you may wish to expand or compress them by using a wider or narrower scan width (*SCAN*), or you may wish to move them left or right on the screen by shifting and entering a new center frequency (CF).

5.6 Retrieving Data From Memory: The analyzer's previous scan data remains in memory, even when the analyzer is turned off. If you wish to recall it, do the following:

- From the *Boot Screen,* press *Scan*. The analyzer switches to *Scan-Set* mode.
- From Scan-Set, press *Present*. The analyzer switches to *Present* mode.

The marker function will be activated and your numerical data will be recalled. To scroll through the screens, press *Graph*. Note that the trace for your first plot (SWR) will not actually appear on the screen until you cycle through Z, R, and X. If you wish to set up a new test, press *ScanSet* and re-enter the Scan-Set Mode. If you turn the analyzer off without initiating a new scan, your old data will continue to be retained in memory.

6.0 Measurement and Accuracy Limitations

6.1 General: The MFJ-223 will serve as your eyes and ears when working with RF systems. However, all handheld analyzers share certain limitations, and being aware of them will help you to achieve more meaningful results.

6.2 Local Interference: Like most hand-held units, this analyzer uses a broadband directional coupler that is open to receiving signals across the entire radio spectrum. Most of the time, the unit's built in +5 dBm RF generator is powerful enough to overcome the lack of front-end selectivity and override stray pickup. However, a powerful transmitter located nearby could inject enough RF energy through the antenna under test to overload the directional coupler and disrupt readings. If this condition occurs, performance may become erratic and SWR readings may appear higher than they really are.

6.3 Coupler Loss and Directivity: Simple broadband couplers of the type used in the MFJ-223 may exhibit accuracy limitations, especially at the higher end of the analyzer's frequency range. Although accurate enough for amateur radio applications, they typically lack the high degree of precision and linearity needed for testing antennas and RF devices to commercial or laboratory standards.

6.4 Calibration Plane Error: The *Calibration Plane* is the point of reference where all measurements have the greatest accuracy (Gain Reference = 0dB and Phase Shift = 0 degrees). For a basic handheld like the MFJ-223, the calibration plane is fixed at the RF connector. Any time a transmission line is installed, it displaces the load from the calibration plane and introduces error. For SWR readings, the error is mainly caused by loss in the cable (more loss means greater the error). Generally, this condition isn't a problem because your radio and the analyzer both see the same reduction in SWR. However, if you're documenting antenna-SWR for design purposes, the analyzer should be connected directly to the feedpoint through a short pigtail to minimize error.

Calibration-plane error has far more significance for measuring impedance because of phase rotation in the cable. In fact, impedance readings may swing dramatically, depending on the cable's electrical length and the severity of the load's mismatch referenced to 50 Ohms. For meaningful impedance data, always connect the analyzer directly to the DUT using the shortest cable possible.

6.5 Reactance Sign Ambiguity: Most handheld analyzers, including the MFJ-223, lack the processing capability to directly calculate the reactance sign for complex impedance (Z = Rs ±j).

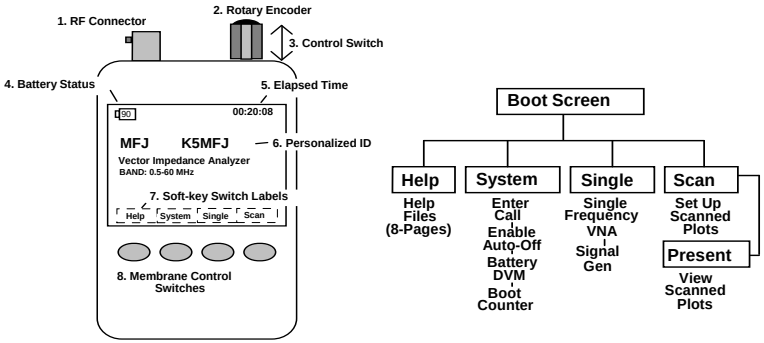
7.0 In Case Of Difficulty: Note that the MFJ-223 has no user-adjustable alignment controls. Opening the analyzer case to perform unauthorized procedures could void your warranty. If unit fails to operate properly, please check the suggestions below before contacting MFJ for service or replacement.

- **Analyzer won't turn on:** Battery may be fully discharged. Plug in to charger, confirm red charge light comes on, and check unit again after a couple hours.
- **Analyzer functions or display acts erratically:** Reboot the processor (see Chapter 2.2 for reboot instructions).
- **All tests show very high or intermittently high SWR:** Check the condition of the analyzer's BNC jack plus, any adaptors you may be using to transition to the BNC jack, or condition of antenna connector and coax.

If you are unable to resolve the problem, please follow the specific procedures outlined in the Warranty section for further assistance.

8.0 Quick Start and Review of Analyzer Functions:

- **Charging:** Accepts micro-USB plug on base of unit. Connect to USB port, charge until red LED turns green**. Charge fully before first use.**
- **Turn On/Off:** Press *Encoder Knob* down, wait for beep, and release. Turn off the same way. *Boot Screen* must be selected when turning off.



- **Commands from *Boot Screen*:** *Help* opens help index. *System* opens *System* page. *Single* opens *Single-Frequency* test functions. *Scan* opens *Scan-Frequency* set-up and presentation functions (see chart above).
- ***Help Menu* Commands:** *Exit* returns to Boot Screen. *S-Prev* scrolls to previous page, *S-next* scrolls to next page, *Enter* brings up highlighted page. Once a page is selected, keys can scroll pages without returning to index.
- ***Frequency Control*:** Press *Encoder Knob* to select tuning step (step size indicated by bar under frequency display). Rotate *Encoder Knob* to change frequency.
- ***Single-Frequency* Command Keys:** *Return* exits to *Boot Page*. *Run/Stop* starts and stops RF generator. *S-Antenna* scale warns of interference.

- ***Scan-Set* Command Keys:** *Return* exits to *Boot Page*. *Present* toggles analyzer to *Present* mode (shows data from the last scan completed). *Span* scrolls through available scan widths (see SPAN box for current selection). *Scan* activates the RF-generator sweep. When scan complete, analyzer switches to *Presentation* mode automatically and activates tunable marker function (MK). Small bar-graph at lower right of screen warns of interference.
- ***Present* Command Keys:** *Return* exits to *Boot Screen*. *ScanSet* returns analyzer to *Scan-Set* mode to accept a new scan setup. *Graph* scrolls through four "wave" plot files (*SWR*, Z, *R*, and *X*). See lower left side of the screen for the current *wave* file. *^Scan* repeats the scan with current setup entries. *Rotary Encoder* tunes marker (MK) across display to recover numerical data for SWR, Z, X, and R at any point along the plot.

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

MFJ-223 Manual
Version 1