MFJ

MFJ Graphical Antenna Impedance Analyzer

Model MFJ-226

INSTRUCTION MANUAL

CAUTION: Read All Instructions Before Operating Equipment !

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Important Note: Before turning on your analyzer for the first time, we strongly recommend reading through the entire manual. You will find valuable operating information along with important tips to help you take full advantage its full range of features.

The MFJ-226 is accurately calibrated at the factory and should not need recalibration for initial use.

Do not run CALIBRATE with out proper calibration loads.

The display window has a plastic film applied at the factory to protect the display window from scratches in the manufacturing process. This film can be removed if desired.

Note: To increase battery life it is recommended that you set the BACKLIGHT to AUTO and AUTO POWER OFF to ENABLE in the SETTINGS Menu (see page 6).

Firmware version V01R04

INTRODUCTION

The MFJ-226 is part of the Times Technology Series of analyzers and is a compact single-port Vector Network Analyzer (VNA) that characterizes complex RF loads in 50-Ohm systems with a high degree of accuracy. Packaged for portable use, it's easy to operate under a wide range of test conditions yet delivers many advanced features usually reserved for units costing much more. For example:

- MFJ-226 can compensate for phase rotation and losses in feedlines and test cables by using industry-standard Open/Short/Load (OSL) calibration setups.

- MFJ-226 calculates true reactance sign (plus or minus), eliminating sign ambiguity.

- The DDS stimulus generator provides continuous coverage from 1 MHz to 230 MHz.

- The DDS accepts both step-tuning and direct-frequency entry via keypad.

- The DDS features 1-Hz frequency resolution with rock-solid stability

- There are 32 memory files for capturing and downloading test data to a PC.

- MFJ-226 has extremely simple power requirements (two AA batteries, Alkaline or NiMH).

- All test results are displayed on a bright easy-to-read backlit LCD display.

- The deluxe backlit keypad has large positive-action keys for easy field operation.

- The thick-wall molded case is hand-contoured and rugged.

Whether you are putting up a simple dipole, building a complex matching network, or characterizing an unknown device, the MFJ-226 delivers the type of data you need to get the job done. A user-friendly menu system provides rapid access to all operating modes and features:

- **Single-Frequency Mode:** Presents SWR, Complex Impedance (series and parallel), and S11 scattering parameters (rectangular and polar). SWR is displayed in huge inch-high numbers clearly visible from several feet away.

- **Sweep-Frequency Mode:** Graphically plots SWR, Impedance Magnitude (Z), Resistance (R), Reactance (X), Return Loss (RL, S11), Phase Angle, and Smith Chart displays. A continuously tunable frequency marker pulls up precise alpha-numeric data.

- **Calibrate Mode:** Walks you through the Open Short Load cal setups for both specific swept frequency measurements and for the unit's global calibration procedure.

- **Settings Mode:** Offers useful options, shows battery condition and firmware revision.

- **PC-Mode:** Links the analyzer's memory files to your PC through the serial data port.

THEORY OF OPERATION

The MFJ-226 is a full-featured one-port Vector Network Analyzer (VNA). The term "vector" means it analyzes both the *amplitude* and *phase angle* of reflections returning from loads being tested in order to present complex impedance data.
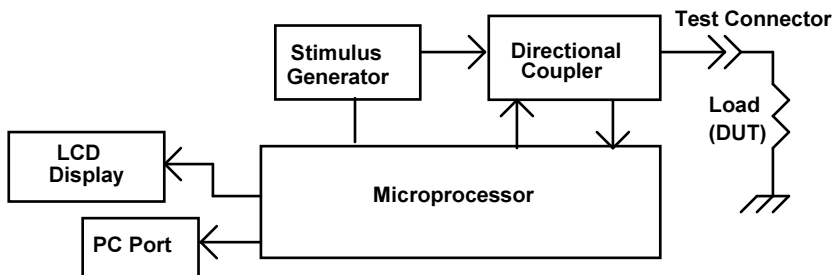
As shown in the diagram above, the analyzer's *DDS RF-Stimulus Generator* (or VFO) generates a test signal that routes through the directional coupler to the load under test. If a mismatch (impedance discontinuity) exists, a portion of that generated signal is reflected back to the load.

The *Directional Coupler* measures amplitude and phase of both the forward and reflected signals and feeds that information to the microprocessor.

The *Microprocessor* compares data from the coupler and mathematically converts it to useful engineering parameters such as SWR, complex impedance, and S11 coordinates.

Using the *Keypad* and *Menu System*, the operator can call up the specific type of data needed for display on the *LCD Screen*.

The MFJ-226 is compact and simple to use, but offers several advanced features that set it apart from may lower-cost analyzers. These features include OSL (Open/Short/Load) calibration, true reactance signs, continuous frequency coverage, exceptionally high DDS resolution, extensive on-board memory, a serial data port, and simple power requirements.

MFJ-226 Technical Specifications

Frequency Range:	Continuous, 1 MHz to 230 MHz
Frequency Resolution:	1 Hz
Test Port Termination	Type-N Female
Output Power	>-10 dBm typical
Harmonics	-15 dBc typical
LCD Display	128 x 64 resolution with backlight
Dimensions	6.5" (165 mm) x 3.12" (80 mm) x 1.25" (32 mm)
Weight	10 oz with batteries and UHF adapter
Power	Two (2) AA cells, Alkaline or NiMH
Computer Interface	USB serial
OSL Calibration	Male-N Open, Short, and 50-Ohm Load

LAYOUT AND CONTROLS
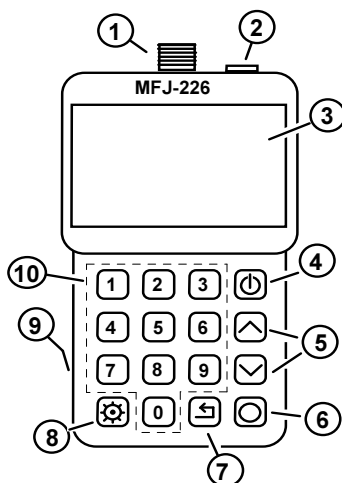
1. Analyzer Test Port: N-Female, accepts N-male for DUTs and calibration loads.

2. USB Data Port: Accepts micro-USB connector, interface with a PC for download. (Not for powering the unit or charging batteries).

3. LCD Screen: Displays menu selections, plots, and test data.

4. Boot Key: Boot key, press and hold to turn analyzer on or off.

5. Arrows (up/down): Step or scroll for menu selections and frequency tuning.

6. Enter Key: Enters menu selections and frequency setups.

7. Return (Exit): Escapes from current function, returns to previous function.

8. Mode: Sets decimal point for numerical entries, serves multiple menu functions.

9. Battery Door: Located on back, accesses tray holding two AA cells.

10. Numerical Keypad: 0-9 keys for entering frequencies or numerical data.

POWERING THE MFJ-226

The MFJ-226 requires two (2) good quality AA batteries. The battery tray door is located on the back of the analyzer case near its base. Press and slide the lid down to expose the tray.

You may use alkaline non-rechargeable or NiMH rechargeable cells. Note that NiMH cells require an external charger (the analyzer does not have one built-in). For longest life, use fresh premium-quality cells from the same manufacturer. Carefully observe polarity during installation and never remove batteries while the unit is powered up. Abruptly cutting power can disrupt the unit's normal power-down cycle and result in memory loss.

The MFJ-226 features a built-in battery indicator that must be set up for the type of battery you intend to use. See the *Settings Menu* for details.

Note the USB port does not power the MFJ-226 or charge batteries.

MENU STRUCTURE

The MFJ-226 features short circular menus that allow you to identify and access all functions quickly and easily. The *Main Menu* and its five *Sub-Menus* are shown below:

Main Menu ←

Single Freq — Sweep Freq (Plot) — Calibrate (OSL) — Settings — PC Mode

| SWR, Z
Series Imp
Parallel Imp
S11 | SWR
Impedance (Z)
Resistance (R)
Reactance (X)
Return Loss (S11)
Phase Angle
Smith Chart | All
Open
Short
Load | Backlight
Auto Power Off
Battery (Type)
Cal Data Protect
Info (System) | Host |
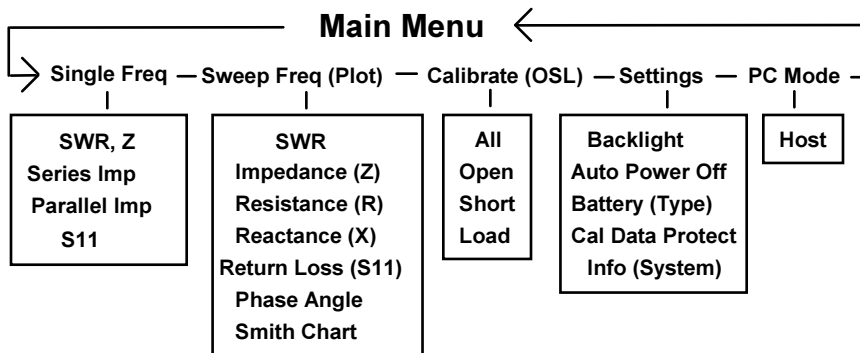
USING THE SETTINGS MODE

To check and change the analyzer's default settings, power up using the *Boot* key. After a brief opening screen, the *Main Menu* will appear. Using the *Down-Arrow* key, step to the *Settings* menu and press *Enter*.

When the *Settings* menu opens, use the *Up/Down* keys to make selections. To modify a setting, step to the desired option and press

Enter. To go back to the *Settings* menu, press the *Return Arrow*. See menu items below:

1. Backlight: Controls screen and keypad illumination.

*Auto***:** Turns backlight off after a few seconds to conserve power.
*On***:** Turns backlight on full time.
Off: Turns backlight off full time.

2. Auto Power Off: Activates or deactivates automatic shut-down (power conservation).

Enabled: Shuts the analyzer down if no keys are pressed for 5-minutes.
Disabled: Analyzer remains on until turned off manually.

3. Battery Menu: Sets low-battery warning threshold (upper right corner of LCD screen).

Alkaline: Low-battery indicator threshold set for Alkaline cells.
Disable: Low-battery indicator threshold set for NiMH rechargeable cells.

4. Step Size Unit: Select between 1MHz to 1Hz steps.

5. LCD Contrast: Select contrast settings between 1 and 7. 3 or 4 is usually optimum.

6. Cal Data Protect: Locks global calibration data so that it can't be erased by accident.

Lock Cal Data: Protects 1-230 MHz default calibration data
Unlock Cal Data: Permits global recalibration (see *Calibration Procedures*)

Normally you will only unlock calibration data to perform a global recalibration of the instrument over its entire frequency range (See Calibration).

7. System Information: General information (no choices required):

Model: Manufacturer's model number
F/W/Ver: Analyzer processor's firmware version
Battery: Five-bar scale shows battery status (1 bar empty, 5 bars full).

ENTERING SINGLE-FREQUENCY MODE

To enter the analyzer's *Single-Frequency Mode,* go to the Main Menu and select *Single Freq* using the up/down arrows. Then press *Enter*. The SWR screen will come up.
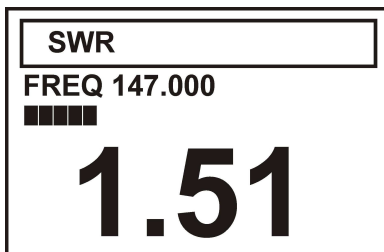
Screen 1, SWR, Frequency: The opening *Single-Frequency* screen displays *SWR*, and *Frequency*. Note that SWR readings appear in 1-inch high numerals for easy viewing. A bargraph is also displayed for a visual representation of the SWR. When SWR opens, you will need to set the *DDS* generator to your desired test frequency.

SETTING THE DDS OPERATING FREQUENCY

There are two ways to set DDS frequency -- *Direct Entry* and *Scroll/Step Entry*. The Default (or start) frequency is 1 MHz.

Direct DDS Entry: Use the keypad to enter the frequency numerically. The *Mode* key sets the decimal point (ex. 146**.**750). Press *Enter* to send your selection to the DDS.

Scroll/Step Entry: Use *Up/Down Arrows* to manually "tune" the *DDS* while watching the frequency display. Hold the key down to scroll -- or tap to step in small increments. *Scroll/step* is especially useful for finding minimum SWR or targeting a specific SWR reading. Note that the operating frequency may be modified while viewing the screen any of the four *Single-Freq* data screens.

```
┌─────────────────────────┐
│ ┌─────────────────────┐ │
│ │ SWR                 │ │
│ └─────────────────────┘ │
│ FREQ 147.000            │
│ ▮▮▮▮▮                   │
│                         │
│    1.51                 │
│                         │
└─────────────────────────┘
```

Use *Mode* to step through the three remaining *Single-Freq* screens. The menu is circular and will return to SWR. Press *Return Arrow* to escape.

SINGLE-FREQUENCY MENU

The *Single-Freq* menu opens with the SWR screen, but this mode has four additional screens. Step through them using the *Mode* key.

Screen 2. SWR Z R X Display: Displays similar to the first screen but has the SWR in smaller characters and also displays the Z R and X of the load. (Added in firmware V01R02 and is not in earlier firmware.)

Screen 3, Series Impedance: Displays the load's resistive and reactive component as two discrete elements connected in series. Also displays a true reactance sign and the inductive or capacitive value at the test frequency. This screen can also be used to determine the value of a capacitor in pF or inductor in μH at the operating frequency.

```
┌─────────────────────────┐
│ ┌─────────────────────┐ │
│ │ IMPEDANCE           │ │
│ └─────────────────────┘ │
│ FREQ: 223.500 MHz       │
│                         │
│   101.80 - j112.58      │
│            3.25pF       │
│ SERIES                  │
└─────────────────────────┘
```

101.8

3.25pF
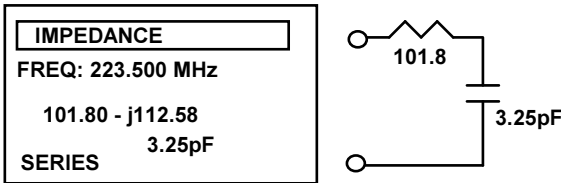
Screen 4, Parallel Impedance: Displays the resistive and reactive components as two parallel elements. Also displays true reactance plus a finite inductive or capacitive value.

```
┌─────────────────────────┐
│ ┌─────────────────────┐ │
│ │ IMPEDANCE           │ │
│ └─────────────────────┘ │
│ FREQ: 223.500 MHz       │
│                         │
│   240.10 - j194.53      │
│            1.88pF       │
│ PARALLEL                │
└─────────────────────────┘
```
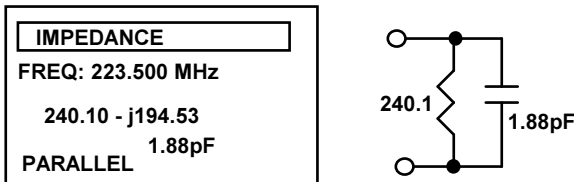
240.1

1.88pF

Screen 5, S11 Scattering Parameters: Displays Rectangular and Polar S11 representations of the load.

```
┌─────────────────────────┐
│ ┌─────────────────────┐ │
│ │ S11                 │ │
│ └─────────────────────┘ │
│ FREQ: 223.500 MHz       │
│  RECTANGULAR:           │
│       0.58  + j0.34     │
│  POLAR:                 │
│        | 0.67 |  ← 30.10│
└─────────────────────────┘
```
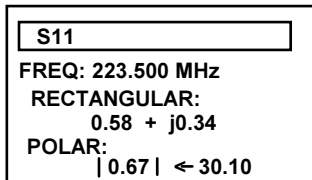
For all screens, press the *Return Arrow* to return to the *Main Menu*.

ENTERING SWEPT FREQUENCY MODE

This mode plots seven test parameters over a frequency span of your choice. Local Calibration may be used in this mode for accuracy through transmission line.

> Standing Wave Ratio (SWR)
> Impedance Magnitude (Z)
> Resistance (R)
> Reactance (-X or +X)
> Return Loss (RL)
> Phase Angle (Deg)
> Smith Chart

To select a display choice in the *Sweep-Freq Menu,* use the *Up/Down Arrow* keys to make a choice and press *Enter.* Use the *Return Arrow* to revert back to the *Menu*.

General Screen Layout: The LCD layout for all modes except the Smith Chart is shown below. A tunable marker is available for all screens and presents precise numerical data to describe any point you select along the X axis of the plot.
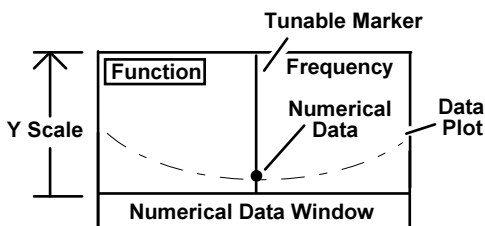
SWEPT-FREQUENCY SETUP

Swept-Freq operations require some initial setup using prompts controlled by the *Mode* key. These prompts will appear in the numerical data window at the bottom of the LCD screen. Entry items include:

Start Frequency: At the prompt, use the keypad or scroll-step procedure to create a start frequency for your sweep. The *Mode* key sets the decimal point and *Enter* applies your selection.

Stop Frequency: Same as above -- enter the sweep stop frequency.

Y Scale: Sets the amplitude range of your plot using the *UP* and *DOWN Arrows* (Ex. SWR 3:1, 10:1, 30:1, etc.).

In swept mode, there are two calibrate menu functions to perform, the *Calibrate* and *Load Cal Data*. Be sure to read the chapter describing *OSL* calibration in detail. The *Calibrate* prompts will instructs you to create an *OSL* cal-data file for the specific *frequency span y*ou wish to scan. The *OSL* calibration establishes the analyzer's calibration plane. Installing the OSL loads at the analyzer connector sets the analyzer's point of reference (zero gain, zero phase shift) at the analyzer's N connector. Installing the loads at the far end of a test cable or transmission line sets the calibration plane out at the end point to ensure accurate measurement through a line. When the cal sequence is complete, the screen will prompt you to load that data into one of four available calibrate memory files.

In the *Load Cal Data*, the OSL file you build is loaded into the microprocessor.

Calibrate: Use the *Up/Down Arrow* keys to open one of four storage files available to store your setup. The screen will then instruct you to install the *Open*, *Short*, and *50-Ohm* calibration loads in sequence. *Before attempting a calibration, be sure to read the Calibrate chapter for additional information about "Local" and "Global" calibration procedures and the analyzer's flash memory structure.*

Load Cal Data: Use the *Up/Down Arrow* keys and choose a file number (1-4) for your new data file and press *Enter* to transfer it into the processor. Press the *Return Arrow* to exit if the storage file you selected is invalid.

SAVING TEST DATA

In addition to four cal-data files, the MFJ-226 has 32 data files available to save plots for later upload onto a PC as CSV files.

Save File: To save a plot, use the *Up/Down Arrow* keys to select one of the 32 file locations and press *Enter*. If there is older data in the file, your new data will overwrite it. This data will be retained when the analyzer is powered down and may be recalled.

Grid: Set to yes to impose grid lines to overlay your plot screens.

SWEPT DATA SCREENS

SWR Screen: Each swept plot is identified in the upper left-hand corner, and the tunable marker frequency appears to the right. Use the *Up/Down Arrow* keys to step or scroll across the display's frequency range. The numerical test data corresponding to the marker location appears in the data window below (Ex. SWR is 1.24:1 at the marker).

```
┌─────────────────────────────────┐
│ ┌─────┐   14.100000 MHZ         │
│ │ SWR │                         │
│ └─────┘                         │
│                                 │
│                                 │
├─────────────────────────────────┤
│ 1.24                            │
└─────────────────────────────────┘
```
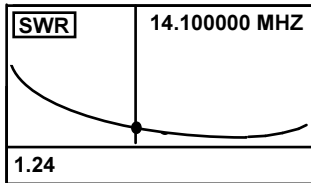
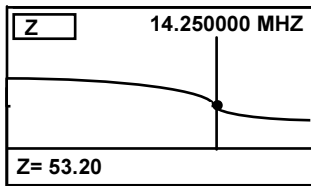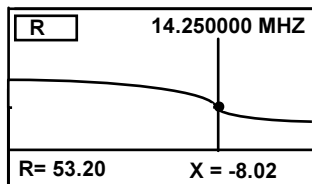**Impedance Magnitude Screen (Z):** This plot displays changes in Impedance Magnitude (Z) across the plot's frequency span.

```
┌─────────────────────────────────┐
│ ┌─────┐   14.250000 MHZ         │
│ │  Z  │                         │
│ └─────┘                         │
│                                 │
├─────────────────────────────────┤
│ Z= 53.20                        │
└─────────────────────────────────┘
```

Resistance Screen (R): The *Resistance* plot shows shifts in the load's resistive component as a function of frequency. Note that a corresponding reactance value and sign also appear.

```
┌─────────────────────────────────┐
│ ┌─────┐   14.250000 MHZ         │
│ │  R  │                         │
│ └─────┘                         │
│                                 │
├─────────────────────────────────┤
│ R= 53.20      X = -8.02         │
└─────────────────────────────────┘
```

Reactance Screen (+X or -X): The *Reactance* plot tracks both reactive value and displays sign to accurately identify if the load is capacitive or inductive. The resistive component is also shown.

```
┌──────────────────────────────┐
│ ┌───┐        14.250000 MHZ   │
│ │ X │                        │
│ └───┘                        │
│                              │
│                              │
│   R = 53.20      X = - 5.32  │
└──────────────────────────────┘
```
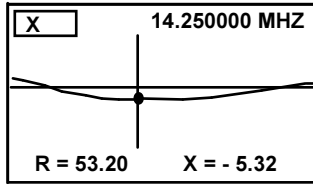
Return Loss (S11): The *RL Plot* shows the ratio of reflected power to forward power expressed in dB across the frequency span. The higher the return loss ratio, the lower the load's SWR.

```
┌──────────────────────────────┐
│ ┌────┐       14.250000 MHZ   │
│ │ RL │                       │
│ └────┘                       │
│                              │
│  14.87 DB        -55 DEG     │
└──────────────────────────────┘
```
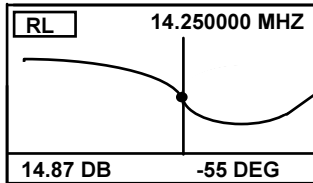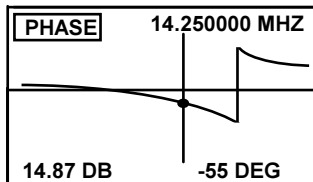
Phase Angle (Deg): When a test signal (incident wave) is transmitted to the load under test, the returning signal (reflected wave) will rarely return in phase. This screen plots the phase angle and amplitude ratio between the incident and reflected wave.

```
┌──────────────────────────────┐
│ ┌───────┐    14.250000 MHZ   │
│ │ PHASE │                    │
│ └───────┘                    │
│                              │
│  14.87 DB        -55 DEG     │
└──────────────────────────────┘
```

Smith Chart Screen: The Smith Chart is a very popular tool for visualizing complex impedance relationships in transmission lines and antenna systems as a function of frequency. Note that the Smith Chart frequency marker is displayed as a cross-hair that follows the load's impedance parameters in both the X and Y axis. Normalized numerical data defining the marker position is displayed to the right-hand side of the plot.

```
┌─────────────────────────────┐
│ ┌───────┐   14.015840 MHz   │
│ │ SMITH │                   │
│ └───────┘        0.1793     │
│                             │
│      ────────────  -54.89   │
│                     DEG     │
│                             │
└─────────────────────────────┘
```
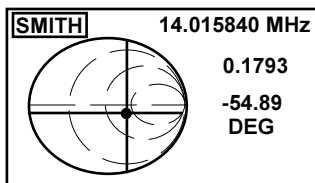
CALIBRATION

NOTE: DO NOT try to run the global CALIBRATE procedure without a set of good calibration loads. DO NOT UNLOCK the CAL DATA PROTECT except during the *Global* CALIBRATE procedure.

The MFJ-226 is accurately calibrated at the factory and should not need recalibration for initial use.

The MFJ-226 uses *Open/Short/Load* (or *OSL*) calibration to maintain high accuracy for its *Global Calibration* -- and for *"Local Calibration"*. *Local* calibration is used in place of *Global Calibration* to eliminate amplitude and phase errors in test cables or transmission line for specific *Swept-Frequency* tests. The OSL calibrate procedure will be familiar to many with RF-engineering backgrounds because it is *the* industry standard procedure for setting up professional laboratory-grade analyzers.

The OSL (*Open/Short/Load)* "load set" consists of three coaxial terminations (typically built into connectors). One connector is a calibrated OPEN (O) to represent an infinitely high impedance. The second is a calibrated SHORT (S) to represent zero impedance. The third is a precision (non-reactive) 50-ohm load (L) to represent 1:1 SWR. The analyzer measures all three loads at close frequency intervals to establish the electronic calibration (or reference) plane of the analyzer. The *Cal Plane* represents the point in a transmission system where the analyzer encounters no intervening losses or phase shift between the detector and the load being tested. Because phase shift and loss both change with frequency when traveling through transmission line, the analyzer's calibration data set must

include measurements taken at as many frequencies as possible. The Microprocessor and DDS handle the "resolution" task automatically. Calibration will be only as good as the load set used. Poorly made loads will add errors to the calibration causing the unit to loose accuracy especially in the VHF range.

High RF Fields may interfere with antenna measurements. You can check the accuracy with known loads to verify that the MFJ-226 is still calibrated.

Global Calibration File

All of the MFJ-226 analyzer's calibration data is stored in flash memory. Five cal-memory slots are available. One contains the *Global* calibration file. The *Global* file covers the entire 1-MHz to 230-MHz frequency span. Normally, the *Global Cal* establishes the reference plane at the analyzer's N connector. By default, the *Global Cal* applies to all *Single-Frequency measurements.* It also applies to *Swept-Frequency* measurements *unless you preempt it by loading in a Local-Cal file from one of the four remaining memory slots.* The letter "G" may appear in the upper-left corner of the LCD screen when *Global Cal* is applied. The letter L appears in the upper left corner of the LCD screen when *Local Cal* data is used.

Building a Local Calibration File

Local calibration is normally used for measuring loads through a transmission line when you do not want to introduce the cable's loss or phase shift into your data. To perform the *Local Cal*, you will connect the OSL loads out at the far end of the cable. During the *Local Cal* procedure, the analyzer compensates out losses and phase shift in the cable and thereby shifts its reference plane out to the load.

Memory slots numbered 1-4 are reserved for building and saving *Local Cal* files. To build a file, use the entry procedure outlined below and follow the on-screen prompts.
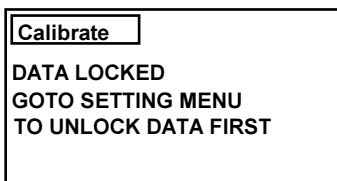
- Press the *Mode* key until the *Calibrate* prompt appears onscreen, then press *Enter*.
- Select one of the four storage slots and press *Enter.* .

Note that calibration data and DDS frequencies are linked together in a "data set". If you decide to alter the frequency range of your plot *after* establishing a *Local Cal* set, the processor will recognize the shift and *automatically reject* the *Local Cal*, reverting back to *Global Cal..* Likewise, if you save a *Local Cal* data set into memory and reload it at a future time, the original DDS frequencies will automatically be pulled up as part of the set.
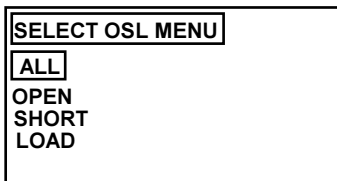
Executing Global Calibration

The analyzer's *Global* calibration data is normally locked to ensure it cannot be accidentally erased or overwritten by a *Local Cal* entry. However, it is a good idea to check the calibration and recalibrate your analyzer if needed periodically as a normal preventive maintenance procedure. In addition, in some circumstances, you may wish to alter the *Global Cal* to compensate for a specific test cable or test fixture. In that event, *always re-calibrate before returning the analyzer to general use!* To execute a *Global Cal:*
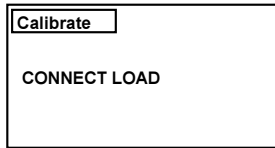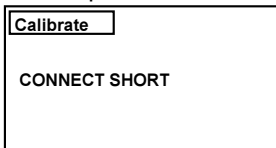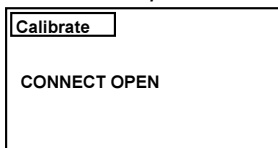
- Go to the *Main Menu* and select the C*alibrate* option. When you do, a "Data Locked" message will come up and direct you to go to the *Settings Menu*.

```
┌─────────────────────────────┐
│ ┌──────────────┐            │
│ │ Calibrate    │            │
│ └──────────────┘            │
│                             │
│ DATA LOCKED                 │
│ GOTO SETTING MENU           │
│ TO UNLOCK DATA FIRST        │
│                             │
│                             │
└─────────────────────────────┘
```

- Go to the *Settings* menu and elect to unlock the *Global* data.
- Return to the *Main Menu* and select *Calibration* again.
- Select the *ALL* option and perform the *OSL Calibration* (OSL).

```
┌─────────────────────────────┐
│ ┌──────────────────┐        │
│ │ SELECT OSL MENU  │        │
│ └──────────────────┘        │
│ ┌──────┐                    │
│ │ ALL  │                    │
│ └──────┘                    │
│  OPEN                       │
│  SHORT                      │
│  LOAD                       │
│                             │
└─────────────────────────────┘
```

The program will provide you with step-by-step prompts for executing the entire *Open/Short/Load* cal procedure:

```
┌────────────────────┐  ┌────────────────────┐  ┌────────────────────┐
│ ┌──────────┐       │  │ ┌──────────┐       │  │ ┌──────────┐       │
│ │ Calibrate│       │  │ │ Calibrate│       │  │ │ Calibrate│       │
│ └──────────┘       │  │ └──────────┘       │  │ └──────────┘       │
│                    │  │                    │  │                    │
│  CONNECT OPEN      │  │  CONNECT SHORT     │  │  CONNECT LOAD      │
│                    │  │                    │  │                    │
│                    │  │                    │  │                    │
└────────────────────┘  └────────────────────┘  └────────────────────┘
```
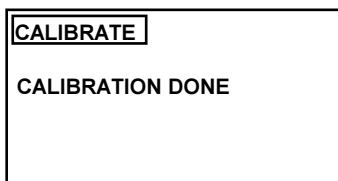
Note that *Global Cal* requires sampling a very large number of frequencies between 1 MHz and 230 MHz, so each stage of the procedure can take several minutes to complete. Also, by selecting the *ALL* option, you must complete the entire cal procedure as one continuous operation. Follow the prompts without interruption or

without returning to the main menu. Alternatively, you could perform each step independently bringing up each of the three individual prompts, but keep in mind that the cal must always be completed to the same calibration plane under the same conditions or it will introduce serious measurement error. When applying the loads:

- Connect the *OPEN* load when requested and hit *Enter* to start the cal run.
- When complete, remove *OPEN* and connect the *SHORT*. Tap *Enter*.
- When complete, remove *SHORT* and connect *LOAD*. Tap *Enter*.

Upon completion, the new *Global Cal* will lock in place automatically and the analyzer will be ready to use. The MFJ-226 can be re-calibrated at any time. If you suspect your measurement results may be inaccurate for any reason, a *Global* recalibration will eliminate the analyzer as the source of the problem.

```
┌─────────────────────────────┐
│ CALIBRATE                   │
│                             │
│ CALIBRATION DONE            │
│                             │
│                             │
└─────────────────────────────┘
```

CALIBRATION LOAD SET

The Calibration Load Set is more than a resistor to stick in the connector, no connector and a piece of wire. You may get fair results with these but the accuracy will suffer. A known *Good* dummy load can be used in a pinch to check calibration if needed.

There are a number of web sites that show construction of loads but basically they are an "N" connector that has a precision 49.9 ohm or 50.1 ohm 1% resistor connected between the center pin and the case ground with as short leads as possible. Precision chip resistors would be even better but are harder to work with. Do not use the precision load for a dummy load. It will not handle any power.

Using a *GOOD* dummy load *may* work for the load BUT the termination plane is unknown and will throw the calibration off.

The OPEN is more than leaving the connector off. It can be an "N" connector that the center pin and insulator are glued or clamped in place with the connector assembly, giving a termination at the same

level as the load resistor. For HF this may not be much of a difference but VHF and UHF this could be a drastic difference.
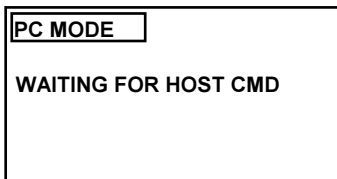
The SHORT is more than sticking something in the connector to short it out. The calibrated short can be an "N" connector that is assembled with the center pin and insulation and a brass or copper washer soldered to the center pin and clamped to the connector case with the normal connector hardware. This moves the plane of the short to the same plane as the open and the load.

USING YOUR PC TO COMMAND THE ANALYZER

Computer Software Control

A PC host program is available for controlling the analyzer and displaying measured data. The program is part of the Times Technology Series and can control other analyzers in the series. The driver and PC Host program is posted on the MFJ web site. Be sure to install the program before connecting the analyzer to your PC. Follow the driver installation instructions included with the drivers to allow the MFJ-226 to connect to your computer.

To link your analyzer to the PC, step through *Main Menu* and select *PC Mode*. Then, press *Enter*. This will bring up a "Waiting for Host CMD" message.

```
┌─────────────────────────────┐
│ PC MODE          │          │
│                             │
│ WAITING FOR HOST CMD        │
│                             │
│                             │
└─────────────────────────────┘
```

Connect the MFJ-226 to the USB cable and computer. Launch the program. It will automatically find the MFJ-226 and connect. Once the COM port of the MFJ-226 is click on *START*. The button will become *Running*. Click on it again to stop the function. Click on *Quit* to exit the program.

Enter the *START* and *STOP* frequencies or the *CENTER* frequency and *SPAN* width. Span width will choose the nearest width. The maximum number of points measured is 127 and can be set less. You can select MHz or KHz frequency input at the top right of the screen.

Select the mode and with the slider on the left of the screen set the scale.

To save in CSV format click the *Save to File* and enter the information in the *Save As* window.

To load data from the MFJ-226 click on the *Load from T200* button and select the data file to retrieve.

To print the graph from the screen press the print button (v1.0.0.48) and select the printer to print to.

The CSV file that the program saves has a listing of the Start and stop frequencies along with the number of points measured. The data is in 4 columns and is the point number, the frequency, the S11 magnitude, and the S11 phase angle.

Manual Control via Computer

This mode can be used for making custom data capture and control routines.

Set the MFJ-226 as above to select the PC Mode.

To permit communication, the serial port between the MFJ-226 and the PC should be configured as follows:

> Baud Rate = 115200
> Parity Bit = None
> Data Bits = 8
> Stop Bit = 1

To command the DDS to tune to a specific frequency, transmit a six-digit frequency in ASCII characters over the serial port. To initiate a measurement at that frequency, send the ASCII character 'S'. You should then receive a null-terminated ASCII data string. This string presents the measured magnitude and phase angle in degrees separated by a comma. The same result will be displayed on both the PC and the analyzer's LCD display.

Send another 'S' to repeat the previous measurement at the same frequency, or issue a new six-digit frequency to tune the analyzer to a new frequency.

Sending and ASCII character 'D' brings the analyzer back to its initial state, displaying the "Waiting for Host CMD" message.

FIRMWARE UPDATE PROCEDURE

MFJ will provide access to firmware updates as they become available. Your MFJ-226 may be updated via the USB interface with the following procedure:

◆ Install fresh batteries before attempting the download. It is important to maintain operating power during the transfer.
◆ Do not turn power off or remove the batteries at any time during the firmware update.

Your PC must be running Windows 7 or newer to perform the update.

To update:
1. Download and install the Windows Firmware Update Program. Follow the instructions included with the tool.
2. Download the latest update and save in a convenient location. If it is in a zip file then extract it to a convenient location.
3. Connect the USB cable to the computer and the MFJ-226
4. Put the MFJ-226 into Firmware Update mode by holding the function key (lower left with the gear icon) in and press the power button. It will display Firmware Update.
5. Launch the Update Tool. It should list the device and the port it is connected to.
6. Open the file by clicking on the button then browsing to the new firmware update file which ends in .ENC The Format should be something like "MFJ-226VxxRxx.ENC"
7. Click on the update button and the update should start.
8. Once finished turn off the MFJ-226 and click on the quit button to close the program.

9. 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.