Review: The MFJ-223 Vector Impedance Antenna Analyzer
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The MFJ-223 is MFJ's latest entry in the antenna analyzer market. Its TFT multi-color display provides a large amount of information on a very compact screen, yet it is extremely easy to read. A single-frequency display or a variety of swept frequency ranges may be viewed. Information provided includes unsigned complex impedance, impedance magnitude and SWR. The MFJ-223 comes with a UHF/Female-to-BNC/Male adapter.

Figure 1: The MFJ-223 Start-Up Screen

Table 1 shows the basic performance measurements of the MFJ-223. The frequency accuracy was excellent and drift was undetectable, however the harmonic output did not quite meet all specifications. The output level remains constant (±1dB) over the full frequency range making the MFJ-223 accurate enough for receiver sensitivity testing when used with a good step attenuator. And the 100Hz minimum tuning step is fine enough for performing most receiver narrow filter measurements.

Table 1 - MFJ-223, serial number n/a

Manufacturer's Specifications	***Measured Performance***
Frequency range: 0.5–60 MHz, continuous	As specified.

SWR measurement range: 1:1–9.9:1 (*99.99:1)	As specified.
Frequency steps: 100Hz, 1kHz, 10kKz, 100kHz, 1MHz	As specified.
Impedance range: R = 300Ω (*999.9Ω) |X| = 300Ω (*999.9Ω) Z = 300Ω (*999.9Ω)	See text & Table 2
Output power: +5 dBm, ±1dB typical.	As specified. See Table 3
Impedance and SWR accuracy: Not specified.	See Table 4
Drift: Not specified.	See text.
Harmonic & spurious suppression: >20 dB	3.5MHz: 2nd -15dB, 3rd -19db 14MHz: 2nd -18dB, 3rd -21dB 28MHz: 2nd -20dB, 3rd -27dB 50MHz: 2nd -20dB, 3rd -25dB

Power requirements: Internal 3.7V 1800mah LiPo battery.
Size (HxWxD; including protrusions): 3.5×2.7×1.0 inches
Weight (including batteries): 5.1 oz.

*Note: The parameters in parenthesis are the specifications given in the MFJ-223 internal Help Menu. I listed these as they differ from the printed specifications.

Table 2 displays the open-circuit output impedance of the MFJ-223. This gives an indication of the impedance magnitude you can accurately measure as a function of frequency. This is important when using the impedance measurement to determine the value of an inductor or capacitor. I.e., you want to use a measuring frequency such that the component reactance is well below the MFJ-223 output impedance for best accuracy. As the MFJ-223 maximum reading is 999.9 ohms, the output impedances on the lower frequencies were determined using parallel resistance calculations.

Table 2 – MFJ-223 Open Circuit Output Z

Frequency	Output Z
3.5 MHz	4000Ω
14 MHz	2000Ω
24.9 MHz	885Ω
28 MHz	767Ω
50MHz	480Ω

Table 3 tabulates the output power level versus frequency. The MFJ-223 meets its 5dBm ±1dB typical specification across the full frequency range.

Table 3: MFJ-223 Output Power vs frequency

	160M	80M	40M	20M	15M	10M	6M
Power (dBm)	5.45	5.40	5.21	4.78	4.40	4.00	4.00

Table 4 displays the MFJ-223 impedance, reactance and SWR measurements compared to measurements made on an Array Solutions VNA2180. The loads are PL-259 connectors with internal resistors connected to the supplied UHF/BNC adapter. As you can see, the accuracy of the MFJ-223 mostly suffers at low impedances that result in SWR greater than 2:1. However,

low impedance SWR readings of 2:1 SWR or better, and high impedance readings up to 10:1 SWR are pretty accurate.

Table 4: Impedance and SWR measurements

		MFJ-223	VNA2180
Load (VSWR)	Frequency	SWR Z/R/|X|	SWR Z/R/X
50Ω (1:1)	3.5 MHz	1.03/49.2/49.1/1.5	1.01/49.6/49.6/-0.28
	14 MHz	1.04/49.1/49.1/1.7	1.02/49.6/49.6/-0.89
	28 MHz	1.05/48.9/48.9/2.5	1.04/49.7/49/7/-1.8
	50 MHz	1.08/48.6/48.5/3.6	1.07/49.7/49.6/-3.1

		MFJ-223	VNA2180
Load (VSWR)	Frequency	SWR Z/R/|X|	SWR Z/R/X
5Ω (10:1)	3.5 MHz	100/5.1/0.0/5.1	10.3/4.86/4.85/0.13
	14 MHz	100/5.3/0.1/5.3	10.28/4.88/4.86/0.42
	28 MHz	19/5.9/2.6/5.3	10.27/4.94/4.87/0.84
	50 MHz	33.9/7.6/1.5/7.5	10.14/5.14/4.93/1.45

		MFJ-223	VNA2180
Load (VSWR)	Frequency	SWR Z/R/|X|	SWR Z/R/X
10Ω (5:1)	3.5 MHz	11.74/10.2/4.4/9.3	5.13/9.75/9.75/0.18
	14 MHz	9.22/10.3/5.5/8.6	5.11/9.81/9.79/0.58
	28 MHz	6.4/10.4/7.9/6.7	5.10/9.87/9.80/1.14
	50 MHz	7.4/11.6/6.9/9.3	5.07/10.0/9.88/2.05

		MFJ-223	VNA2180
Load (VSWR)	Frequency	SWR Z/R/|X|	SWR Z/R/X
12.5Ω (4:1)	3.5 MHz	6.86/12.9/7.6/10.4	4.01/12.48/12.47/0.28
	14 MHz	6.93/13.0/8.7/9.6	3.98/12.61/12.57/0.96
	28 MHz	4.69/13.2/10.8/7.5	3.94/12.83/12.72/1.73
	50 MHz	5.18/14.4/10.0/10.3	3.89/13.24/12.91/2.95

		MFJ-223	VNA2180
Load (VSWR)	Frequency	SWR Z/R/|X|	SWR Z/R/X
16.6Ω (3:1)	3.5 MHz	4.36/17.1/12.1/12	2.98/16.77/16.77/0.03
	14 MHz	3.98/17.1/13.1/11	2.97/16.82/16.82/0.23
	28 MHz	3.40/17.1/15.1/8.1	2.97/16.83/16.82/0.49
	50 MHz	3.59/17.6/14.5/10.0	2.95/16.97/16.94/0.96

		MFJ-223	VNA2180
Load (VSWR)	Frequency	SWR Z/R/|X|	SWR Z/R/X
25Ω (2:1)	3.5 MHz	2.28/25.5/23.1/10.8	1.98/25.28/25.28/0.09
	14 MHz	2.21/25.5/23.6/9.7	1.98/25.31/25.31/0.23
	28 MHz	2.04/25.5/24.8/5.7	1.97/25.37/25.36/0.42
	50 MHz	2.09/25.9/24.6/8.0	1.96/25.48/25.47/0.73

Load (VSWR)	Frequency	MFJ-223 SWR Z/R/|X|	VNA2180 SWR Z/R/X
100Ω (2:1)	3.5 MHz	2.03/98.8/97.0/18.8	1.99/99.24/99.23/-1.2
	14 MHz	2.03/98.6/96.9/18.2	1.99/99.13/99.0/-5.09
	28 MHz	1.99/96.7/94.9/18.7	1.99/98.79/98.3/-9.81
	50 MHz	2.00/92.1/87.6/28.3	2.00/97.63/96.17/-16.87

Load (VSWR)	Frequency	MFJ-223 SWR Z/R/|X|	VNA2180 SWR Z/R/X
200Ω (4:1)	3.5 MHz	4.04/194.3/187.6/50.8	3.99/199.2/199.1/-6.14
	14 MHz	4.01/191.9/184.3/53.4	3.98/197.5/196.0/-24.28
	28 MHz	3.95/177.9/162.4/72.4	3.99/193.1/187.7/-45.19
	50 MHz	3.94/148.4/116.8/91.5	4.00/181.9/167.7/-70.51

Load (VSWR)	Frequency	MFJ-223 SWR Z/R/|X|	VNA2180 SWR Z/R/X
300Ω (6:1)	3.5 MHz	6.13/283.1/262.6/105.7	6.01/300.2/299.95/-13.09
	14 MHz	6.12/270.5/240.6/123.5	6.01/295.1/290.24/-53.55
	28 MHz	5.96/232.2/184.2/141.5	6.01/282.1/265.73/-94.84
	50 MHz	5.91/176.6/110.7/137.6	6.01/252.13/213.88/-133.5

Load (VSWR)	Frequency	MFJ-223 SWR Z/R/|X|	VNA2180 SWR Z/R/X
400Ω (8:1)	3.5 MHz	8.21/371/336/157	8.01/399/398/-27
	14 MHz	8.09/339/286/182	7.98/386/374/-96
	28 MHz	7.93/263/178/194	7.99/355/317/-160
	50 MHz	7.88/183/90/160	7.97/293/219/-195

Load (VSWR)	Frequency	MFJ-223 SWR Z/R/|X|	VNA2180 SWR Z/R/X
500Ω (10:1)	3.5 MHz	10.3/441/377/228	9.89/493/491/-39.5
	14 MHz	10.1/391/304/246	9.85/470/449/-139
	28 MHz	9.86/284/167/230	9.81/418/358/-217
	50 MHz	9.67/192/80/174	9.75/330/226/-240

Notes:

[1]The MFJ-223 does not indicate inductive loads (+jX) or capacitive loads (–jX).

[2]The SWR Loads were measured on an Array Solutions VNA2180 by the reviewer.

[3]The VNA2180 was calibrated with an N/BNC adapter and precision BNC calibration loads (open/short/50Ω) so the calibration reference plane is the same for the VNA2180 and the MFJ-223.

Power Requirements

The MFJ-223 is powered by an internal 3.7V rechargeable Lithium-Polymer battery. A standard micro-USB A/USB A cable (not included) attached to your computer or any standard USB charger is required for charging. The MFJ-223 internal smart charger sets the charge rate (50-500ma) and mode (constant current or constant voltage) depending on the state of the internal

battery. A red LED charge indicator turns green when charging is complete. After a full charge the MFJ-223 will operate for several hours before recharging is required. A menu enabled auto-off feature powers-off the unit after 10-minutes of inactivity.

Using the MFJ-223

Turn on the MFJ-223 by depressing the rotary encoder for about 3-seconds. After a series of beeps a start-up display will let you select a help menu, the system menu or single or swept menus - all from soft keys. The Help menu permits you to select a variety of help topics and review the MFJ-223 specifications. The System menu permits setting a start-up message (my call is shown), enables or disables the auto-off feature, and displays the MFJ-223 software version and battery voltage. I found the well-written 19-page printed manual easier to use than the on-screen menus. I found most functions to be very intuitive. Further, as you change functions, soft key labeling changes as well and helps guide you through the settings.

The single-frequency display (Figure 2) will normally be used when checking or adjusting an antenna. Set the desired frequency by pushing the rotary encoder to select the tuning increments, and then turn the encoder to select the desired frequency. Pressing the Run/Stop soft key starts a continuous reading of the antenna parameters. The actual measurements of SWR, Z, R and |X| are displayed at the bottom of the screen. However the bargraphs make it easy to make antenna adjustments as you can adjust the antenna while watching them dynamically change.

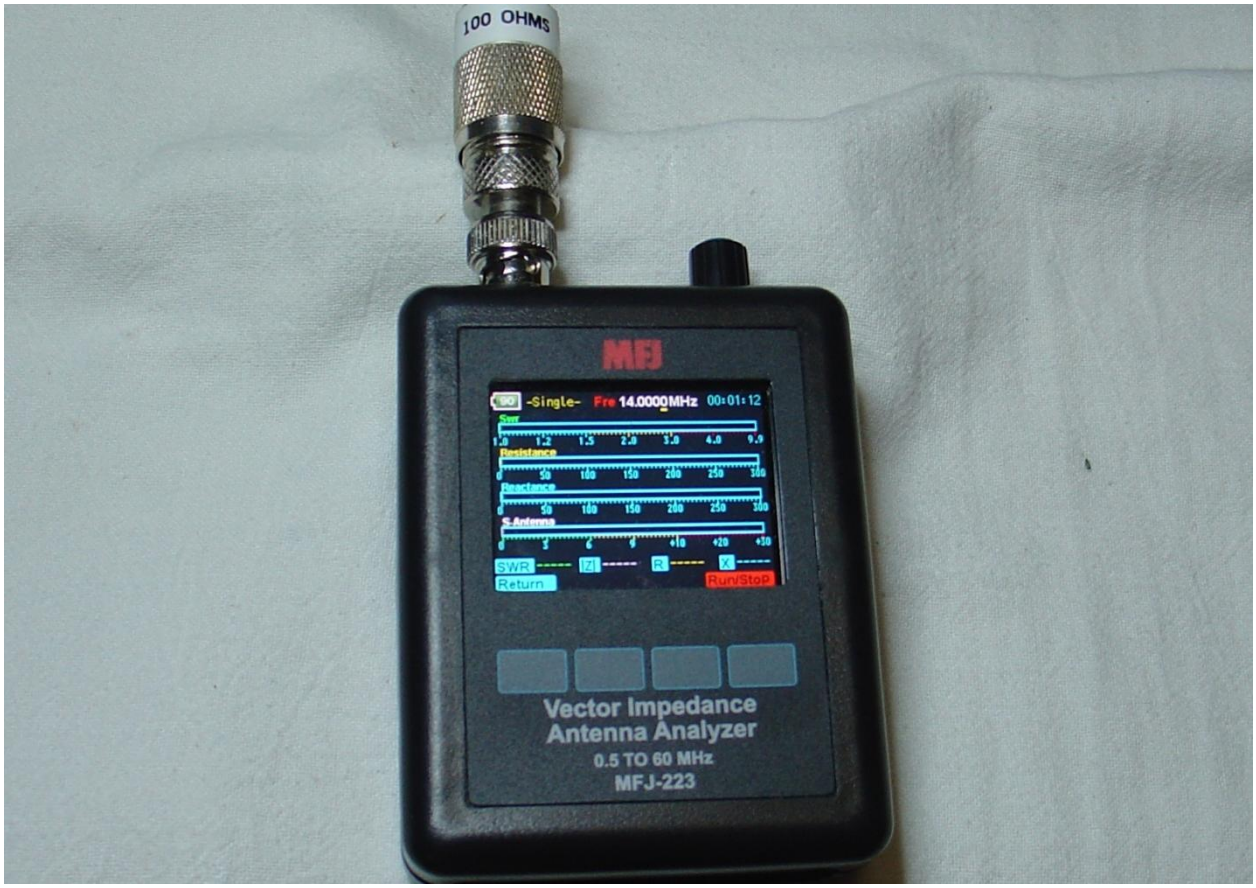

Figure 2: MFJ-223 Single-Frequency display

Finally, you'll notice the "S-Antenna" bargraph. This is a unique feature of the MFJ-223. When the DDS signal source is on (measurements are being made), this typically shows an S6-S8 level. However, when the DDS source is off, this also gives an indication of external RF signals that can distort accuracy (greater than S2) or even damage the MFJ-223 (greater than S+20).

The scan mode is convenient for looking at individual band SWR centering, and even permits multi-band antenna resonance checks. You can select only fixed swept bandwidths of 300kHz, 600kHz, 1.2MHz, 2.4MHz, 6MHz, 12MHz, 24MHz and 48MHz. The digitally displayed data corresponds to the center frequency of the display as selected by the rotary encoder. Figure 3 is a 300kHz sweep of the 20 meter band where I adjusted my tri-band dipole for lowest SWR at 14.07MHz. This gave me a reasonably low SWR in the CW (my preferred mode) portion of the band, as well as in the lower part of the phone band. Figure 4 shows a broader (24MHz) scan showing the antenna resonances on the 20-, 15- and 10-meter bands.

One nice feature of the swept display is that the last display is saved in memory when you turn off the MFJ-223. This permits you to recall your last scan display for review if desired.

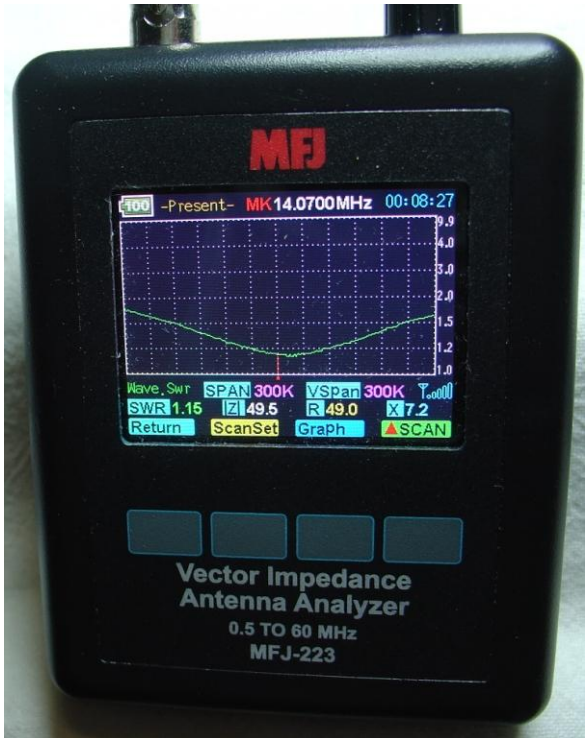

Figure 3: Single band (20M) scan

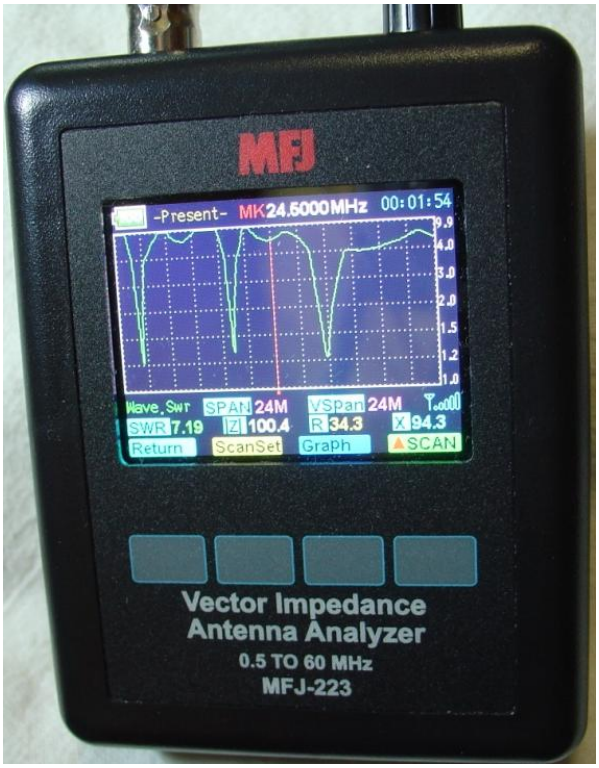

Figure 4: 20/15/10M trap dipole scan

Conclusion

The MFJ-223 is a very compact, easy to read antenna analyzer. It works well, however the inaccuracy at low impedances should be kept in mind. Besides providing normal antenna analyzer single frequency information, the MFJ-223 also provides swept graphical displays. And its ease-of-operation makes it very convenient for most antenna work from HF-6 meters.

Manufacturer: MFJ Enterprises, Inc., www.mfjenterprises.com.