Product Reviews and Short Takes

July 2013

Product Reviews:

Short Takes:

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Antenna Tuners: MFJ-9982, 51Palstar AT2K and AT2KD

Three more solutions for tuning your antenna system at legal limit power levels.

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A few months back, we reviewed a pair of legal limit tuners designed for balanced loads.[1] Here we look at three tuners with unbalanced loads (coax fed antennas) in mind. Each of these units makes use of a high-pass T network configuration with one variable capacitor in series with the input, one in series with the output and a shunt variable inductor to ground between them. This generally results in three controls on the front panel. What differentiates the Palstar AT2KD from the others is that the two capacitors are combined into one *differential* capacitor, so the AT2KD has only two tuning controls. As a differential capacitor is turned, the capacitance increases on one side while decreasing on the other.

MFJ-9982 2500 W Antenna Tuner

The MFJ-9982 is described as a legal limit tuner specified to match loads from 12 Ω (4:1 SWR) to 2000 Ω (40:1 SWR) over the continuous frequency range of 1.8 to 30 MHz. The range of complex loads is not specified, but it may be reasonable to expect it to match loads with reactive components within similar SWR limits. Most amateur antennas, after all, exhibit complex (resistive plus reactive) impedance on many frequencies.

Tuner Configuration

The MFJ-9982 shown in Figures 1 and 2 uses a T configuration with series capacitors on the input and output and a single shunt roller inductor. The tuner components are isolated from ground so that balanced loads can be tuned. A 1:1 balun on the radio side provides the transition to unbalanced coax. A built in 50 Ω dummy load handles 100 W for 10 minutes or 1.5 kW for 10 seconds.

To change to unbalanced mode, a rear panel strap is used to ground one of the balanced terminals. The strap has two connection points, a round one that fits the terminal and a slotted one to allow it to pivot without removing the wing nuts and washers. Our unit had the strap pivoting on the antenna stud where it could arc to ground if hanging from the terminal. It should be installed with the round hole on the ground stud, so that can't happen.

If strapped for unbalanced operation, two coaxial outputs, a single wire output or the dummy load can be selected from the front panel. The single wire output always goes through the tuner, the dummy load doesn't go through the tuner and the two coax connections can be switched to use the tuner or bypass the tuner.

The variable capacitors have smooth 5:1 vernier knobs that make tuning easy and provide pointer resetability to within about 1/50 of the range. The rotary inductor includes a three digit turns counter dial that provides 90 digit indications for 30 turns and can be interpolated to about ½ a division. This sounds as if it would be a lot of effort to get all three controls to a place that provides a match, and it can be. Fortunately, in many cases, only one of the capacitors requires fine adjustment.

A competent dual needle power meter offers 300 or 3000 W power ranges with average and peak power readings. It can be powered by an internal 9 V battery or an external 12 V supply. With an external supply, a switchable dial light can illuminate the meter.

[1] J. Hallas, W1ZR, "Product Review — MFJ-976 and Palstar BT-1500A High Power Balanced Antenna Tuners," *QST*, Mar 2013, pp 53-58.

Figure 1 — MFJ-9982 antenna tuner.

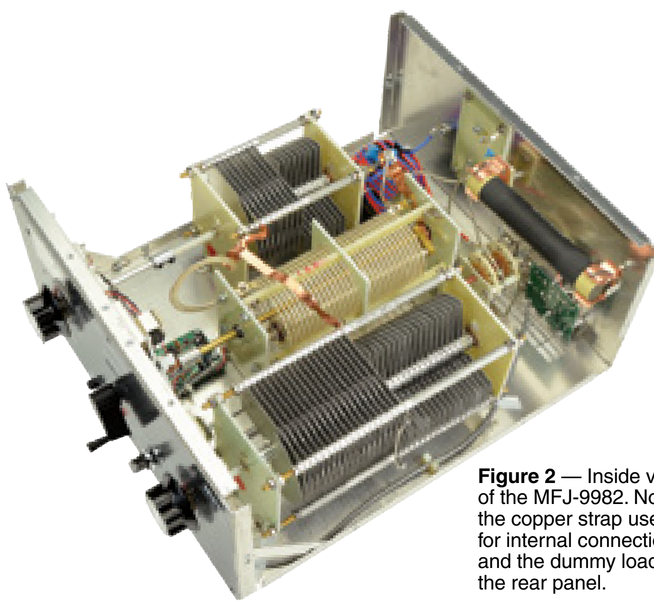


Figure 2 — Inside view of the MFJ-9982. Note the copper strap used for internal connections and the dummy load on the rear panel.

Bottom Line

The MFJ-9982 provides a good value in an antenna tuner that can match most antenna systems on most bands. The built in peak and average wattmeter is also a real plus.

Table 1
MFJ-9982 Antenna Tuner

Circuit configuration: T network.
Frequency range: 1.8 to 30 MHz.
Matching range: 12.5-2000 Ω.
Power rating: 2500 W (PEP), SSB and CW.
Measured current usage: 13.8 V dc at 41 mA (meter lamps only).
Size (height, width, depth): 7 × 13.7 × 18 inches (incl protrusions); weight: 15 lbs.
Price: $630.

ARRL Lab Resistive Load and Loss Testing

SWR	Load (Ω)		160 m	80 m	40 m	20 m	10 m
4.33:1	11.5	Power Loss%	NT	10	10	NT	11
		SWR	—	1.0	1.0	—	1.6
2:1	25	Power Loss%	7	4	NT	7	10
		SWR	1.0	1.0	—	1.9	1.0
1:1	50	Power Loss%	5	4	3	7	9
		SWR	1.0	1.0	1.0	1.9	1.0
2:1	100	Power Loss%	3	2	1	2	7
		SWR	1.0	1.0	1.0	1.0	1.5
4:1	200	Power Loss%	2	2	2	2	8
		SWR	1.0	1.0	1.0	1.0	1.8
7.6:1	380	Power Loss%	5	3	3	6	11
		SWR	1.0	1.0	1.0	1.0	2.0
16:1	800	Power Loss%	2	2	4	8	18
		SWR	1.0	1.0	1.0	1.0	1.2

Note: Roller inductor contacts were intermittent during initial testing. See text.

Frequency	Short	Open	
1.8 MHz	NT	NT	Will tune 2000 Ω resistive load 160-10 meters.
3.5 MHz	Yes	NT	
7.0 MHz	NT	NT	
14 MHz	Yes	NT	Yes = will tune into open or short circuit.
28 MHz	NT	Yes	NT = no tuning solution.

High Power ARRL Lab Testing

Tests performed with 1500 W PEP keyed CW, 40% duty cycle, 10 minutes (see March 2013 *QST*, p 58 for details).
High impedance test (20:1 SWR complex load): 160, 20, 10 meters: Passed, ran cool.
Low impedance test (25 Ω resistive load): 160, 20, 10 meters, Passed, ran cool.

Operating the MFJ-9982

The MFJ-9982 is relatively easy to set up and operate. There are three coax connectors on the rear panel, one for the input and two for unbalanced antennas. An insulating block includes the two terminals for balanced feed lines, each equipped with wing nut terminals. Single wire antennas are to be connected to the upper balanced line terminal and fed against the tuner's GROUND terminal.

Using the tuner is relatively straightforward. The manual provides two suggested starting points for each band at 50 and 600 Ω resistive loads. Once there, apply a small amount of power and move each control for the best match as indicated on the reflected power scale of the meter. It is important to set the meter to AVERAGE power for adjustments; if set to PEAK, the delayed needle movement masks changes in tuning.

For some loads, a null in reflected power is found quickly. For other loads it can take a lot of back and forth adjustment to reach a matched setting. As the manual notes, in many cases more than one matched setting can be found, and the one with the least inductance is usually most efficient. It can be a tedious process and you will want to record the settings for each segment of each band in order to return to them whenever you want to change antennas, bands or modes.

Our '9982 came from the factory with a rotary inductor that made intermittent contact, making it virtually impossible to successfully adjust to different loads. It was sent back to MFJ under warranty and returned making good contact, although the resulting cranking force was higher than that of the other tuners in the review. While testing at home, I found that I was having trouble with resetability and determined that the turns counter indicator was slipping. Upon opening the cabinet, it was evident that the nylon gear that drove the counter was not meshed sufficiently with the mating gear on the inductor shaft. By loosening two screws on the drive housing, I was able to pivot the assembly and engage the gears. It worked satisfactorily after that, and was considerably quieter in operation. MFJ has since advised that they are addressing these issues in production.

On the Bench

The MFJ-9982 was able to match all the resistive loads we tested, ranging from 11.5 (4.3:1 SWR) to 800 Ω (16:1 SWR), on all bands as shown in Table 1. As is often the case, the loss near the edges of the operating impedance ranges was higher than for those closer to a matched condition. This tuner passed all our high power tests without problems.

We found that a shorted output could be tuned on 80 and 20 meters, while an open could be tuned on 10 meters. This is not an unusual result, but it does argue for carefully recording tuner settings for each band, antenna and mode. If the tuner settings suddenly change without a good reason, be sure to check for a disconnected antenna, breakage or a short in the system before applying full power. An antenna current meter or a field strength meter can be used to make sure that power is leaving the tuner and going where it should. Dissipating 1.5 kW in a small box is a prescription for melted tuner components.

On the Air at W1ZR

I have a 135 foot dipole, center fed with about 100 feet of 450 Ω window line. While each station's antenna system will exhibit different characteristics on different bands, this is a typical application for an antenna tuner. The 50 Ω SWR of my antenna alone (no attempt at matching) runs the gamut from 2.9:1 on 28.5 MHz to 86:1 on 160 meters, as measured at the tuner interface. The MFJ-9982 was able to reasonably match this antenna on all amateur bands, including 160 meters — somewhat to my surprise.

For unbalanced loads, I tested with my dummy load, a triband Yagi that includes a 6 meter coupled resonator, a 17 and 12 meter coupled resonator dipole and the balanced antenna above, fed through an external 4:1 balun. The tuner was able to match all loads on all appropriate bands. I was able to confirm that this tuner does not operate on 6 meters, in keeping with its specifications — never hurts to check.

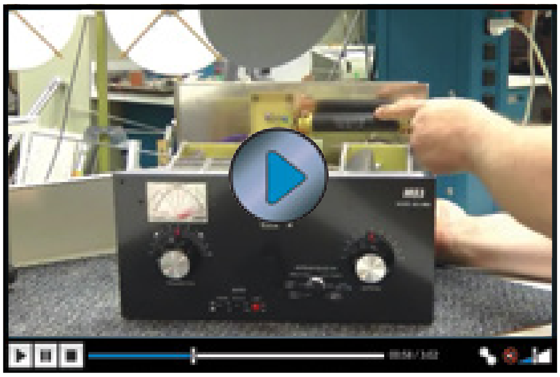
My procedure was to start from the manual's recommended 50 Ω settings and first tune with my dummy load. The tuned settings were generally close to the suggested settings, once I figured out that my inductor counter started at 100 rather than 000, and after I fixed the slipping digits. I then used those settings as a starting point for other loads. I first tuned at 10 W output, then trimmed up the adjustments with 100 W. I found the tuner's SWR meter to be in close agreement with the three digit digital indicator on my transceiver. The wattmeter read somewhat high, about 125 W for a 100 W signal. The manual describes the meter calibration procedure.

While the MFJ-9982 is very flexible in antenna configurations that can be matched, changing from unbalanced to balanced operation requires access to the strap on the rear panel — inconvenient in some stations.

Documentation

The MFJ-9982 comes with a 13 page manual that includes instructions on tuning procedure with suggested starting points for each band and a schematic diagram. There is also an *Antenna System Hints* section with antenna and feed line lengths to avoid, along with other suggestions.

Manufacturer: MFJ Enterprises, PO Box 494, Starkville, MS 39762, tel 800-647-1800; **www.mfjenterprises.com**.



See the Digital Edition of *QST* for a video overview of the MFJ-9982 Antenna Tuner

Palstar AT2K and AT2KD 2000 W Antenna Tuners

The Palstar AT2K (Figures 3 and 4) and AT2KD (Figures 5 and 6) are so similar that it makes sense to describe them together. Both models cover 160 through 10 meters plus 6 meters and are rated to match impedances from 20 (2.5:1 SWR) to 1500 Ω resistive (30:1 SWR) on 160 through 10 meters. Lower impedances can be matched at reduced power. The 6 meter tuning range is not specified.

Tuner Configurations

The two tuners are essentially identical except for the different capacitor configurations. Both have the same metering and provide switching for three coax lines. One coax output is identified for use with an external balun for a balanced load, but otherwise is the same as the others, so it is usable with a third coax fed antenna if desired. Another coax output bypasses the tuner for use with a matched antenna, also an ideal spot for a dummy load.

The AT2KD is about an inch narrower than the AT2K because of the single, but larger, capacitor. The capacitors in both are driven by 6:1 vernier drives, but the capacitance indictors are different. The AT2K has moving dial scales, while the AT2KD has a moving pointer that is read against silkscreened numbers on the panel. Both provide a resolution of 100 divisions, although the AT2KD scale has smaller numbers — a bit tough on my bifocals.

Both units have an excellent dual needle average and peak reading wattmeter. The wattmeter has a PEAK-HOLD button that maintains the peak reading for 2 seconds so you can read it more easily — very nice feature. Meter calibration is in close agreement to my transceiver, which has been checked carefully.

On the Bench

Both units were able to match all the resistive loads we tested, ranging from 25 to 800 Ω, on 160 through 10 meters as shown in Tables 2 and 3. The efficiency of this tuner was quite

Figure 3 — Palstar AT2K antenna tuner.

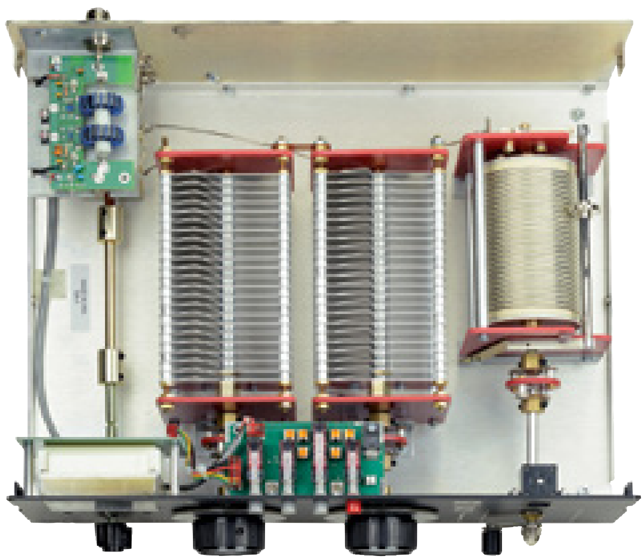


Figure 4 — Inside view of the AT2K tuner. Note the two separate variable capacitors, the usual configuration for a T network tuner.

Bottom Line

The Palstar AT2K and AT2KD are rugged, well built and easy to use antenna tuners that can match most antenna systems on most bands. The AT2KD has the edge on quickly tuning to a match, while the AT2K offers a wider tuning range on 6 meters. Either one would be a great addition to any shack.

good, with some loss at the lower impedances on the lower bands. Tables also show the loss of the AT2KD with optional baluns for balanced line.

Both tuners passed our high power, low impedance tests without problems. During the high power, high impedance tests, both tuners exhibited arcing on 160 meters, the AT2K at 1400 W and the AT2KD at 750 W. Both tuners passed on the other bands, although the AT2KD tripped the amplifier's SWR protection after 3 minutes of continuous operation at 1500 W on 10 meters. Note that our high impedance load (20:1 SWR) presents a complex impedance, while Palstar specifications are for resistive loads, so the tuners may handle more power with a different load.

One concern with the AT2KD was that we found that it would match both shorts and opens on some bands as shown in Table 3. The precautions described in the MFJ-9982 section should be taken with the AT2KD.

Operating the AT2K and AT2KD

Both units offer very smooth operation in both the variable inductor and variable capacitor(s). The inductor goes end-to-end in 279 turns, each having a digit on the turns count window. I could estimate to half a turn for a resolution of 568 positions. This combined with the 100 divisions on each capacitor scale makes for easy resetability if you record your settings.

Table 2
Palstar AT2K Antenna Tuner, s/n 19731

Circuit configuration: T network.
Frequency range: 1.8 to 50 MHz.
Matching range: 20-1500 Ω with resistive load (1.8-30 MHz).
Power rating: 2000 W (PEP), 1500 W (single tone).
Measured current usage: 13.8 V dc at 21 mA (meter lamps only).
Size (height, width, depth): 5.6 × 14.7 × 13.2 inches (incl protrusions); weight: 13 lbs.
Price: $550.

ARRL Lab Resistive Load and Loss Testing

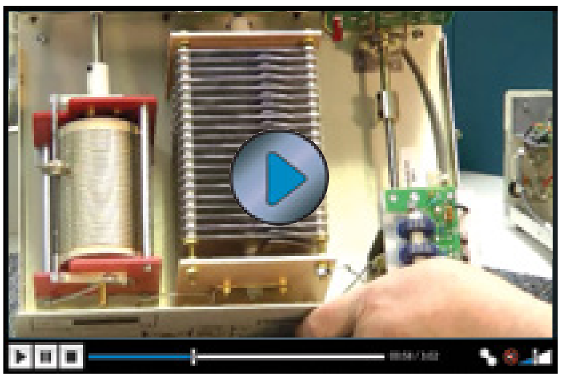
SWR	Load (Ω)		160 m	80 m	40 m	20 m	10 m
2:1	25	Power Loss%	15	11	7	5	5
		SWR	1.0	1.0	1.0	1.0	1.0
1:1	50	Power Loss%	7	5	4	3	6
		SWR	1.1	1.1	1.0	1.0	1.1
2:1	100	Power Loss%	7	3	2	2	4
		SWR	1.0	1.0	1.0	1.0	1.0
4:1	200	Power Loss%	4	6	4	5	11
		SWR	1.0	1.0	1.0	1.0	1.1
7.6:1	380	Power Loss%	8	7	7	8	11
		SWR	1.0	1.0	1.0	1.0	1.0
16:1	800	Power Loss%	5	10	7	9	14
		SWR	1.0	1.0	1.0	1.0	1.0

Frequency	Short	Open	
1.8 MHz	NT	NT	Will tune 1500 Ω resistive load 160-10 meters.
3.5 MHz	NT	NT	
7.0 MHz	NT	NT	
14 MHz	NT	NT	
28 MHz	NT	NT	NT = no tuning solution.

High Power ARRL Lab Testing

Tests performed with 1500 W PEP keyed CW, 40% duty cycle, 10 minutes (see March 2013 *QST*, p 58 for details).
High impedance test (20:1 SWR, complex load): 160 meters, arcing at 1400 W; Passed at 1250 W, warm to the touch.* 20, 10 meters: Passed, mildly warm.
Low impedance test (25 Ω resistive load): 160, 20, 10 meters, Passed, ran cool.

*Note: This tuner may meet the manufacturer's specs, but we cannot verify this since the high impedance load is complex, not purely resistive as the manufacturer's specifications assume.



See the Digital Edition of *QST* for a video overview of the Palstar AT2K and AT2KD antenna tuners.

Figure 5 — Palstar AT2KD antenna tuner.

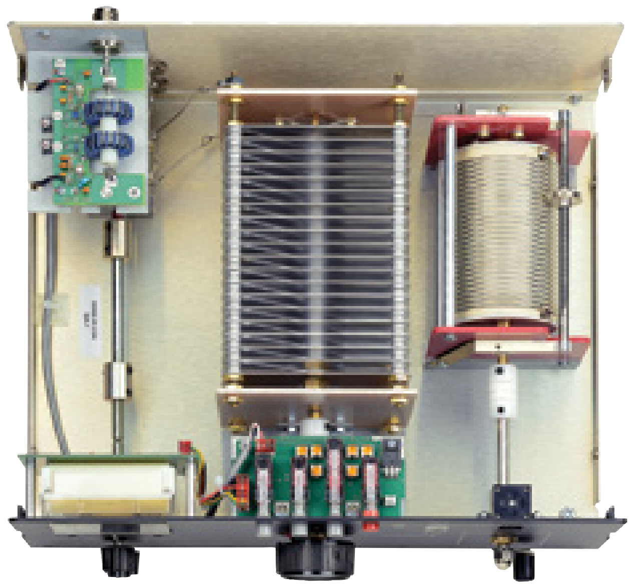


Figure 6 — Inside view of the AT2KD tuner. Note the single variable differential capacitor. While the differential capacitor is wider than either of the capacitors in Figure 4, the result is a narrower unit that tunes with two rather than three controls.

Table 3
Palstar AT2KD Antenna Tuner, s/n 18934

Circuit configuration: T network (differential, see text).
Frequency range: 1.8 to 50 MHz.
Matching range: 20-1500 Ω with resistive load (1.8-30 MHz).
Power rating: 2000 W (PEP), 1500 W (single tone).*
Measured current usage: 13.8 V dc at 21 mA (meter lamps only).
Size (height, width, depth): 5.8 × 13.2 × 12 inches (incl protrusions); weight: 12 lbs.
Price: $550; optional 1:1 and 4:1 baluns, $90 each.
*Two other areas of the manual warned not to exceed 1000 W, single tone.

ARRL Lab Resistive Load and Loss Testing

SWR	Load (Ω)		160 m	80 m	40 m	20 m	10 m
2:1	25	Power Loss%	14	8	6	5	8
		SWR	1.0	1.0	1.0	1.0	1.0
1:1	50	Power Loss%	9	4	4	2	5
		SWR	1.0	1.0	1.0	1.0	1.0
2:1	100	Power Loss%	6	2	2	2	3
		SWR	1.0	1.0	1.0	1.0	1.0
4:1	200	Power Loss%	4	2	2	2	4
		SWR	1.0	1.0	1.0	1.0	1.0
7.6:1	380	Power Loss%	6	6	6	7	9
		SWR	1.1	1.0	1.0	1.0	1.2
16:1	800	Power Loss%	4	3	4	7	12
		SWR	1.7	1.0	1.0	1.0	1.6

With optional 1:1 balun

SWR	Load (Ω)		160 m	80 m	40 m	20 m	10 m
2:1	25	Power Loss%	33	24	20	16	28
		SWR	1.0	1.0	1.0	1.0	1.0
1:1	50	Power Loss%	21	14	11	11	21
		SWR	1.0	1.0	1.0	1.0	1.0
2:1	100	Power Loss%	14	8	6	4	11
		SWR	1.0	1.0	1.0	1.0	1.0
4:1	200	Power Loss%	10	8	6	4	11
		SWR	1.0	1.0	1.0	1.0	1.0
7.6:1	380	Power Loss%	13	6	6	7	14
		SWR	1.1	1.0	1.0	1.0	1.0
16:1	800	Power Loss%	11	7	7	10	14
		SWR	1.0	1.0	1.0	1.0	1.0

With optional 4:1 balun

2:1	100	Power Loss%	7	4	4	4	8
		SWR	1.0	1.0	1.0	1.0	1.0
4:1	200	Power Loss%	4	4	4	7	10
		SWR	1.0	1.0	1.0	1.0	1.3
7.6:1	380	Power Loss%	8	10	12	16	20
		SWR	1.1	1.0	1.0	1.0	1.2
16:1	800	Power Loss%	9	8	14	22	33
		SWR	2.4	1.0	1.0	1.0	1.1

Frequency	Short	Open	
1.8 MHz	Yes	NT	Will tune 1500 Ω resistive load 160-10 meters.
3.5 MHz	Yes	NT	
7.0 MHz	Yes	Yes	
14 MHz	Yes	Yes	Yes = will tune into open or short circuit.
28 MHz	NT	Yes	NT = no tuning solution.

High Power ARRL Lab Testing

Tests performed with 1500 W PEP keyed CW, 40% duty cycle, 10 minutes (see March 2013 *QST*, p 58 for details).
High impedance test (20:1 SWR, complex load): 160 meters, arcing at 750 W; Passed at 700 W, cool to the touch. 20 meters: Passed, cool to the touch. 10 meters: SWR trip after 3 minutes; passed at 900 W, warm to the touch.*
Low impedance test (25 Ω resistive load): 160, 20, 10 meters, Passed, ran cool.

*Note: This tuner may meet the manufacturer's specs, but we cannot verify this since the high impedance load is complex, not purely resistive as the manufacturer's specifications assume.

On the Air at W1ZR

I used both tuners with all my antennas described previously and a dummy load. I was able to obtain a solid 1:1 match on sensible MF and HF antennas. There is no question that on a number of antenna/band combinations the AT2KD found its match more quickly with the two controls, although some came in about as quickly with the AT2K. In all cases, I started with the suggested values in the manual, which were quite close to the settings needed for my dummy load.

The one difference that I found between the tuner capabilities was on 6 meters. Both would tune a 50 Ω dummy load and trim up my coupled resonator Yagi on 6. The AT2K was able to also match my Zepp with 4:1 external balun to 1:1, but the best the AT2KD could do was a 3:1 match. This is not surprising, since the AT2K had both capacitors at a fairly low value for its match, a condition that the AT2KD cannot achieve. All in all, I prefer the AT2KD because of the ease in tuning each new antenna. I suspect that with settings recorded, there would be very little operational difference between the two as long as I didn't plan to use a linear with a high impedance load on 160 meters.

For either tuner, having the balun as an external option offers a potential configuration advantage compared to an internal balun. Many amateurs choose to transition from unshielded balanced line to coax at some distance from the station operating position to avoid problems with coupling from the feed line to other cabling and allow easier routing of cables. The downside, of course, is that the coax is generally mismatched and thus may introduce loss. Still, if top quality low-loss coax is used and the length is short (10 feet or less is a good target), the loss is usually not significant on HF.

Documentation

Both tuners come with similar well written and illustrated 19 page manuals with a schematic, meter calibration instructions and useful instructions on tuning procedure, along with suggested starting points for each band. There are also suggestions on what to do in order to tune antennas that are not within range. The manual recommends cleaning the inductor turns every 4 to 6 months with isopropyl alcohol and they even provide cotton swabs for the purpose.

Manufacturer: Palstar, Inc, 9676 N Looney Rd, Piqua, OH 45356; tel 800-773-7931; **www.palstar.com**.

Array Solutions VNAuhf Vector Network Analyzer

Reviewed by Phil Salas, AD5X
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Previously I had the opportunity to review the Array Solutions VNA2180 Vector Network Analyzer.[2] I found the VNA2180 to be a highly accurate instrument that permitted me to analyze circuits in my home lab to accuracy levels I haven't seen since the measurement capabilities of my pre-retirement microwave lab! However the VNA2180 is limited to a maximum frequency of 180 MHz and much of my tinkering involves projects above this, and so I wanted something that covered up to at least 450 MHz. Enter the VNAuhf, a 5 kHz to 1200 MHz vector network analyzer.

The VNAuhf is an extended frequency range version of the VNA2180. Table 4 compares the differences between these two products. The complete VNAuhf specifications may be found on the Array Solutions website.

First — A Word About Calibration

Like any VNA, the VNAuhf must be calibrated using calibration standards so setup cables and connections and VNA imperfections can be removed from the measurement process. The VNAuhf calibration kit includes precision short and open terminations, a precision 50 Ω load, and two 14 inch LMR-240 cables with N male connectors. The terminations and load consist of N-male-to-SMA-female adapters with the appropriate SMA termination or load attached.

The short is close to ideal over the VNAuhf 1200 MHz frequency range. The open is more critical, as fringing capacitance leads to errors at higher frequencies. This fringing capacitance is measured and removed as part of the calibration process. Because the same type of adapter is used for the open and short, the reference plane between the two is very similar over the VNAuhf frequency range.

The most critical calibration item is the precision broadband 50 Ω termination. Thanks to friends in the microwave lab of a local company, I measured the Array Solutions 50 Ω termination on an HP/Agilent 8722D vector network analyzer. The SMA 50 Ω termination return loss exceeded 40 dB through 1200 MHz. When the SMA termination was installed on the N-to-SMA adapter (the actual calibration load), the worst-case return loss was 32 dB at 1200 MHz (SWR ≈ 1.05:1), improving to better than 40 dB return loss below about 650 MHz (SWR ≈ 1.02:1) — a very good load indeed!

Preparing to Use the VNAuhf

The VNAuhf software runs under recent versions of *Windows*. No software installation is required — the software can run directly from a folder, flash drive or CD. Included with the VNAuhf are the calibration kit, a 120 V ac power supply and a USB interface cable. A padded carrying case is optional.

After downloading a zip file from **www.w5big.com** which includes the latest software and manual, extract the software and run the program. You will need to set up the proper COM port. When the VNAuhf USB cable is plugged into the computer, the *Vista*, *Windows* 7 and *Windows* 8 operating systems will automatically find the correct USB driver for you. Older versions of *Windows* may require you to load the proper driver, available online. Set the COM port in the VNAuhf setup menu, and then close and restart the program.

Calibration is easy, as you simply attach the appropriate termination when prompted. Once calibrated, there is no need to recalibrate each time you use the instrument. Recalibration is necessary only if you change the measuring setup.

Using the VNAuhf

My first test investigated the performance of a ¼ wave 2 meter ground plane antenna on 2 meters and 440 MHz (70 centimeters). Since the 70 centimeter band is approximately three times the frequency of the 2 meter band, I wanted to evaluate the standard 2 meter 19 inch whip as a ¾ wave whip on 70 centimeters. Figure 7 shows the measured SWR and return loss performance. As you can see, the SWR in the repeater part of the 70 cm band is about 2.5:1. This is not too bad, and is tolerated by many dual-band transceivers. One could better optimize the antenna for both bands by using the VNAuhf to trim the 2 meter whip for resonance a bit higher in frequency. This would improve the

[2]P. Salas, AD5X, "Array Solutions VNA2180 Vector Network Analyzer," Product Review, *QST*, Mar 2011, pp 57-59.

Bottom Line

The Array Solutions VNAuhf is an accurate lab-grade instrument that covers up to 1200 MHz, yet is priced to be affordable for the sophisticated home experimenter.

Table 4
VNAuhf vs VNA2180 Key Performance Specifications

Parameter	VNAuhf	VNA2180
Frequency range	5 kHz to 1000 MHz (usable to 1200 MHz)	5 kHz to 180 MHz
Output into 50 Ω (programmable)	–13 dBm to –33 dBm	+7 dBm to –13 dBm
Impedance measuring range	5 kΩ	10 kΩ
Port B return loss	20 dB minimum	30 dB minimum
Max interference input while measuring	0.1 V RMS (–7 dBm)	1.4 V RMS (+16 dBm)
Dynamic range	90 dB/200 MHz 70 dB/500 MHz 60 dB/1 GHz	100 dB/50 MHz 80 dB/160 MHz

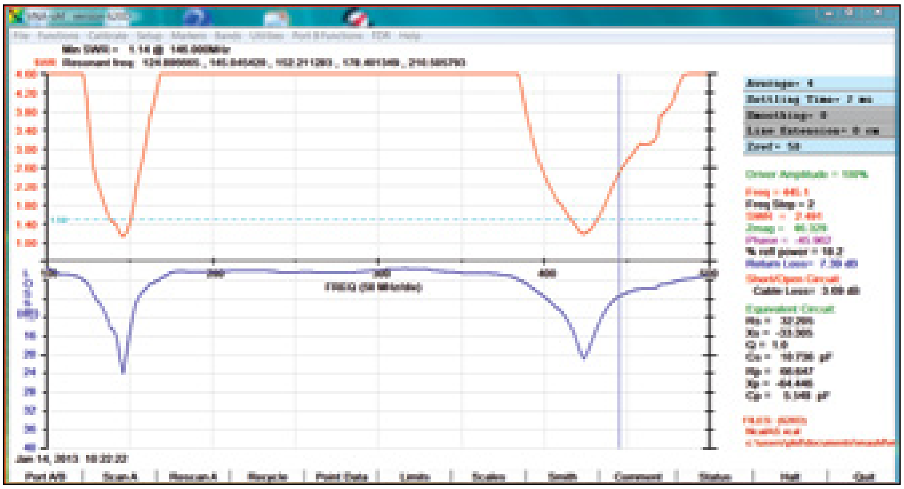


Figure 7 — SWR and Return Loss evaluation of a 19 inch whip on both 2 meters and 440 MHz.

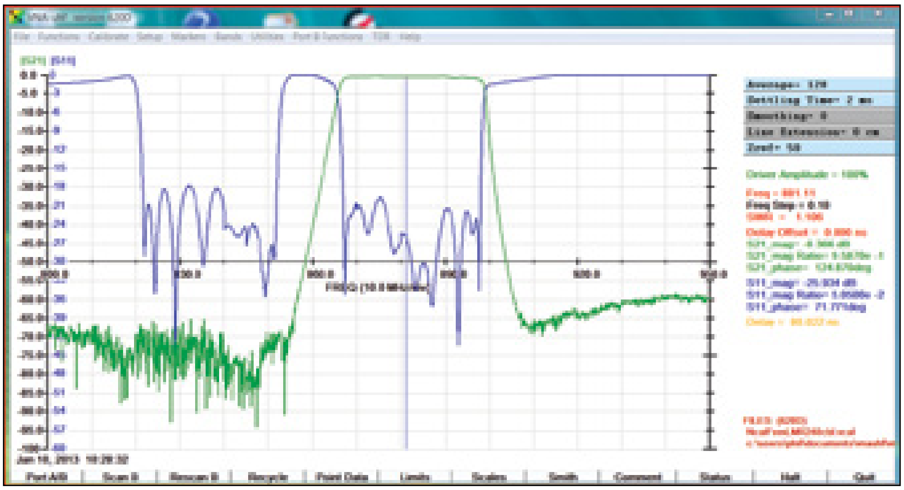


Figure 8 — Cellular duplexer performance measured by the VNAuhf.

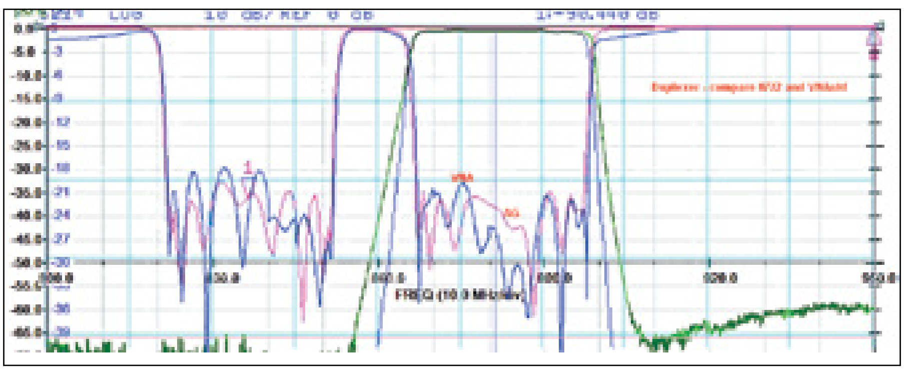


Figure 9 — VNAuhf and Agilent 8722D performance overlay

445 MHz performance while still giving good 2 meter performance.

Next I looked at a much higher frequency device to assess the extended range capability of the VNAuhf. I was fortunate to acquire an 800-900 MHz cellular duplexer, thanks to Brad Wick WØCO. I connected the duplexer antenna port to the VNAuhf PORT A and the duplexer TX port to the VNAuhf PORT B, and I terminated the duplexer receive port in the precision 50 Ω load. The VNAuhf measured performance is shown in Figure 8. The duplexer transmit and receive return loss is shown by the blue curve, and the transmit insertion loss and TR isolation is illustrated by the green curve. The actual duplexer TR isolation is much greater than that indicated, but the measurement is limited by the 60-70 dB dynamic range of the VNAuhf at these high frequencies.

Next I took the duplexer to the local microwave lab and measured it on the HP/Agilent 8722D. The difference in the TR isolation is due to the 80-90 dB dynamic range of the HP/Agilent VNA. In order to look at the difference between the VNAuhf and HP/Agilent 8722D, the two curves were overlaid as shown in Figure 9.

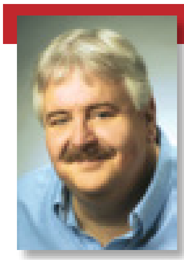
As you can see, the return loss and insertion loss data is very close between the two instruments. This is excellent correlation, especially considering that the Agilent 8722D setup included extremely expensive precision loads and cables (good to 40 GHz), whereas the VNAuhf utilized the Array Solutions lower-frequency loads and cables.

Of course, there are many other applications for the VNAuhf. Circuit and antenna design and evaluation are obvious. As an example, I've been using it to precisely calibrate attenuators, and characterize the directivity and coupling of UHF couplers purchased on popular online auction sites.

Conclusion

The VNAuhf is an accurate instrument suitable for both personal and industrial lab environments. Software and firmware updates are available for download at no charge. The software can be run in demo mode to get a feel for the product prior to purchasing. For additional measurements and applications, refer to the VNA2180 and AIMuhf reviews previously published in *QST*. Additional information is also available at **www.w5big.com**.

Manufacturer: Array Solutions, 2611 North Beltline Rd, Suite 109, Sunnyvale, TX 75182; tel 214-954-7140; **www.arraysolutions.com**. Price (US version): VNAuhf $1895; VNA-PC carry case, $49.



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Comet CMX-2300 Dual SWR/Power Meter

In the CMX-2300, Comet offers a convenient solution for the ham who operates HF and VHF, yet doesn't want the hassle of wrestling with separate SWR/power meters.

The CMX-2300 provides twin cross-needle meters in a single case. Each meter has two needles: one to indicate forward power and another to indicate reflected power. The needles cross each other over a vertical nomograph where you simultaneously read the resulting Standing Wave Ratio (SWR).

The left hand meter covers 1.8 to 200 MHz at three power levels: 30, 300 and 3000 W. The right hand meter measures 140 to 525 MHz at 20, 50 or 200 W. The meters are completely independent, along with their individual power settings. There is no need to switch between one and the other when you're transmitting at HF or VHF. This is a powerful convenience factor in a multitransmitter station.

The CMX-2300 case measures 9.9 × 3.9 × 5.4 inches with the meter bezels dominating the layout for easy viewing. The meters become illuminated when you supply 11-15 V dc to the input jack on the back panel. I found the lighting to be unusual, but in a pleasant way. The meters glow in a multicolored scheme that is quite striking in a darkened room. In normal light the meters present a beige background.

The enclosure is somewhat heavy at more than 3 pounds, but I suspect this is intended to help stabilize the CMX-2300. There are four SO-239 coaxial jacks on the back panel; HF in and out plus VHF in/out. When you have four cables connected to the CMX-2300 the extra weight helps keep the meters from tilting upward. For this review I had LMR-400 cables attached to the VHF side and Belden 9913 on the HF side. For the input connections I used right-angle SO-239/PL-259 adapters because the meter was positioned next to a wall and I couldn't spare the additional room required to gently curve the cables. In this configuration the CMX-2300 was able to keep all four of its rubber feet firmly on the shelf surface.

It is interesting to note that there are two BNC connectors on the rear panel of the CMX-2300. These are ports for sampling either VHF or HF RF for use with a station monitor, frequency counter, etc. Both ports provide 30 dB signal attenuation.

In normal lighting you hardly notice anything out of the ordinary about the CMX-2300 meters. But turn down the lights and you'll see a remarkable change.

The rear of the CMX-2300. Note the BNC ports for sampling attenuated RF.

Also on the rear panel is a switch to select average or peak power reading for the meters. This switch affects the behavior of both meters. In other words, you can't have one meter reading average power and the other displaying peak power.

Using the CMX-2300

I found the CMX-2300 to be extremely simple to use. Once I had the meter connected, all I ever had to do was occasionally toggle the power switches if I happened to kick on an amplifier on either band. I enjoyed being able to monitor output power and SWR at a single glance, even after jumping from, say, a conversation on 15 meters to a little satellite work on 2 meters and 70 centimeters.

The ARRL Lab measured the accuracy of the unit used in this review and discovered some deviations from the forward/reflected power specification (+/- 10% at full scale) at the highest and lowest ends of the frequency range. On 160 meters the CMX-2300 power readings were about 25% low. On 70 centimeters the CMX-2300 reads about 30% high. Otherwise, the meter met its accuracy specifications on all other bands. Insertion loss was measured at 0.2 dB or less, except on 70 centimeters where it rose to 0.5 dB.

Since we did not perform measurements on several CMX-2300s, we can't say if this behavior is typical of all units. I performed a few tweaks of the internal potentiometers and was able to make substantial improvements using a Bird wattmeter as my reference.

Capable Convenience

The accuracy issues notwithstanding, I found the CMX-2300 to be a handy item in the shack. It is a rugged, well-built meter that adds an extra dimension of operating convenience.

Distributed in the United States by NCG Inc, 15036 Sierra Bonita Lane, Chino, CA 91710; **www.cometantenna.com**. *Available at many Amateur Radio dealers. Suggested list price: $224.95.*