Product Review Column from *QST* Magazine

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Advanced Electronic Applications AEA SWR-121 HF Antenna Analyst

JPS SSTV-1 DSP Filter for Slow-Scan TV

MFJ-1796 Half-Wave Vertical Antenna

AEA SWR-121 HF Antenna Analyst

Reviewed by Steve Ford, WB8IMY

The Problem

No matter how carefully you assemble and install an antenna, you often discover that its resonant frequency is outside your favorite portion of the band (or it may be outside the band entirely!). The result is a substantial mismatch and an unacceptably high SWR at the frequencies you wish to operate. Depending on the type and amount of coax you're using, a high SWR can result in substantial RF loss in your cable. What started as 100 W at your transceiver may be only a few watts at your antenna.

RF loss in your coax isn't all you have to worry about. Modern transceivers are designed to work with 50-Ω loads. If the impedance at the input of the coax becomes significantly greater or lower than 50-Ω—which it will do if a serious mismatch exists—the transceiver automatically begins reducing output power. Deviate too far from 50 Ω and the transceiver may shut down altogether.

One way to deal with this problem is to measure the SWR at various frequencies and manually plot the results on a sheet of graph paper. By playing "connect the dots," you plot an SWR curve and see the frequencies at which your antenna offers the lowest SWR.

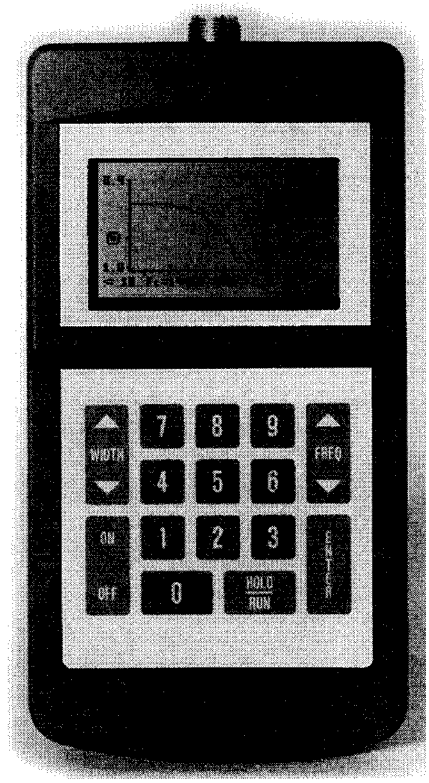
With this information in hand, you dash outdoors and tweak your antenna to "move" the low-SWR portion of your graph to the part of the band you desire—or so you hope. Then you make more measurements and replot your SWR curves.

The Solution: the SWR-121

Advanced Electronic Applications (AEA) offers a creative solution to this problem with their SWR-121 Antenna Analyst. The SWR-121 is a microprocessor-controlled frequency synthesizer with an accurate low-power SWR bridge. It steps a 5-mW pulsed signal through the frequency bandwidth you desire and measures the SWR at many points along the way. It displays the result as a graph plotted on an LCD screen. No SWR meters, graph paper or transmitter adjustments are necessary.

The SWR-121 is built to withstand punishment. The case is very rugged. It would clearly survive a hard fall, although you'd have to hope that it didn't land on its LCD screen. At approximately 4×2×8 inches, the SWR-121 can be held easily with one hand. When you install the batteries, its total weight is less than two pounds.

There are two SWR-121 models available. The SWR-121 *HF* covers 1 to 31.999 MHz. The SWR-121 *VHF/UHF* covers 120 to 175, 200 to 225 and 400 to 475 MHz. We tested the HF version for this review.



You connect your coaxial cable to the SWR-121 through a standard SO-239 connector located on the top of the case. There is an in-line jack for using an external dc power source. You'll also find a jack for connecting a serial cable to your PC—more about this feature in a moment.

Using the SWR-121

You activate the SWR-121 by pressing and holding the front-panel **ON** button for several seconds. The AEA logo appears, followed by the graphical display.

From here it's a piece of cake. You enter the center frequency in kilohertz at the keypad, then select the width of the sweep (in terms of the frequency difference indicated by two adjacent tick marks on the horizontal scale). The width can be anything from 0 (single-frequency measurement) to 22 MHz. The center frequency is always shown at the center of the horizontal axis. It's marked by a tiny notch in the axis and displayed numerically below the graph.

Now the SWR-121 begins its sweep. Depending on the frequency width selected, the sweep can take as long as nine seconds. A graph begins to appear on the display, tracing from left to right. The vertical axis indicates the SWR and it scales itself automatically. The SWR-121 can display an SWR as high as 65.1:1. Unless you press the **HOLD** button, the SWR-121 will continue to sweep and redraw the curves as necessary. Unlike other antenna analyzers, you get to see the SWR over an *entire range*, not just at one frequency.

My first application of the SWR-121 was to adjust a 20 and 15-meter parallel dipole antenna. It was fascinating to watch the SWR-121 display the SWR curves for each band. By watching the results on the SWR-121, I was able to tweak the 15-meter antenna for lowest SWR. Then, I increased the sweep width and saw the effect of my adjustments on the 20-meter antenna.

All this was done while standing beneath the antenna with the feed line connected to the SWR-121. There was no need to run back in the house and observe what was happening at the transceiver. I simply made my adjustments and read the results. The SWR-121 would be especially handy for adjusting antennas in difficult-to-reach locations, such as on rooftops or towers. *ARRL Antenna Book* editor Dean Straw, N6BV, found the SWR-121 quite useful in solving a

Table 1
AEA SWR-121 HF Antenna Analyzer, serial no. 108

Manufacturer's claimed specifications	***Measured in ARRL Lab***
Frequency range: 1 MHz to 31.999 MHz	1 MHz to 31.999 MHz
Temperature drift: Not specified.	At 14 MHz: No measurable drift after 15 minutes from a cold start at room temperature. No measurable drift while varying the ambient temperature from 40°F to 90°F.
Output power: 5 mW.	3.6 mW (max).
Power requirements: 12-16 V dc (8 AA alkaline batteries or external supply).	195 mA with battery supply; 75 mA in "hold" mode
Size: (height, width, depth) 2.25×4.3×8.5 inches; weight, 1.6 lbs (including batteries)	

long-standing problem; see his sidebar "On the Tower with the AEA SWR-121."

The display quality is good, even in bright light. My only nit to pick with the display is the fact that the center-frequency notch on the horizontal access is difficult to see. *QST* Managing Editor, Al Brogdon, K3KMO, had a few comments concerning the autoscaling SWR display; see the sidebar "No More Guilt." The SWR-121 also provides an audible SWR indication through a series of beeps. This is great when you're making coarse adjustments and simply need to know if you're heading in the right direction.

The display fades as the batteries become weaker. (The SWR-121 requires eight AA batteries, and it seems to consume the batteries at a rapid rate!) The unit does have a battery-saver mode that kicks in if the keyboard is idle for more than four minutes. If you plan to use the SWR-121 for extended periods, I'd recommend an external power supply or high-energy lithium batteries.

In addition to SWR, the SWR-121 measures return loss. Return loss is determined by how closely the load impedance matches the transmission line characteristic impedance. With a perfect match, the return loss is infinity; with an open or shorted lossless line, it becomes 0 dB. You can learn more about return loss in the 1995 *ARRL Handbook*, Chapter 26; associated equations and table appear in Chapter 30.

The SWR-121 measures the return loss for the center frequency you enter. The result is displayed in dB in the lower-right corner of the screen. The manual describes a procedure to determine your line loss using the SWR-121. Connect it to one end of your feed line and leave the other end disconnected. The measurable return loss range is 0.3 to 50 dB.

Getting Your PC Into the Act

If you own an IBM-PC computer or compatible, you can control the SWR-121 remotely and do other clever things. The optional communication software package (SWR.COM) will run on any PC using DOS 3.1 or later. You can also run the software from *Windows* as a DOS application.

The software communicates with the SWR-121 through your computer's COM ports at 9600 bit/s. A serial cable (included with SWR.COM) attaches to your computer and the SWR-121.

When the system is up and running, your computer keyboard emulates the keypad on the SWR-121. Although the SWR-121 may be several feet away, you can set its measurement parameters as though you were holding it in your hand. Beyond the remote control capability, I like the fact that you can display up to six SWR curves at once. You can sweep your antenna system, make some adjustments and then sweep it again. By displaying the old and new curves side by side, you get a clear picture of the effects your adjustments have had on the system.

On the Tower with the AEA SWR-121

I first had a chance to play with the AEA SWR-121 HF Antenna Analyst at a July 4 poolside party at the home of my Windham, New Hampshire, neighbor Ed Parsons, K1TR. Ed first demonstrated the SWR curve of his AI1H broadband 80-meter dipole across the band. That in itself was impressive, but then he punched a few buttons on the little unit and quickly showed me the SWR curve for his triband Yagi first on 20, then 15 and finally 10 meters, without having to fire up his transmitter and without causing interference to anyone at all.

I had a definite use in mind for the device the next weekend when I borrowed one from ARRL HQ. For some time, one of my triband Yagis had been acting a bit strangely. It was hard to put my finger on it, but the 90-foot high TH7DX didn't seem to hear very well on 15 meters compared to the others at 30 and 60 feet on the same tower. Down in the shack, the shape of the 15-meter SWR curve for the 90-foot antenna across the band was different from the other two; it did not exhibit the characteristic "double-humped" curve of a log-periodic feed system. Although the SWR curve was not really bad, it was different.

I put the HF Antenna Analyst in my bag and climbed up to the 90-foot level. I had prepared a short coax jumper with an integral W2DU-style current balun so that I could connect to the TH7DX feed point easily. Up at the antenna the shape of the curve across the band still was different from the other tribanders. The problem was in the antenna itself. Hopeful that I could find the problem without having to take down the entire antenna, I resorted to a process of elimination. After securing my climbing belt and double-checking it, I grabbed each element I could reach by hand to see if anything changed.

I used a very useful mode of operation AEA built into the analyzer — I took it out of sweep mode and chose a mid-band frequency of 21.200 MHz. The HF Antenna Analyst was then used as an audible SWR indicator, since a beeping audio tone changes as the SWR changes—the tone goes lowers as the SWR goes lower. That way, I could lean out from the tower and grab elements on the TH7DX while listening to hear any change of pitch and without even having to look at the LCD readout. More specifically, I was looking for when there was no change in tone, because that would indicate where there was an open circuit in an element. Lo and behold, grabbing the left-hand side of the driven element number two *didn't* cause a change in tone!

I loosened the clamp holding this element to the boom, gingerly pulled it out and lowered it to a vertical position. I then secured it temporarily to the tower with electrical tape. Now what? How am I going to find the problem up here on the tower? I reasoned that since the antenna was fine on both 20 meters and 10 meters, but acted up only on 15 meters, that the problem must somehow lie in the 15-meter trap.

So I carefully disassembled the 15-meter trap up on the tower, and found a loose screw. I tightened down the screw and put the element back into its clamp. Success! The SWR curve was now just like the other two tribanders. I climbed down and checked out the performance of the 90-footer compared to the other antennas. It now acted like it should.

So, now I feel very competitive on 15 meters, and I have put almost completely out of mind any concern that the other traps on the antenna might have loose trap screws...I can't reach them anyway, so why worry? The AEA HF Antenna Analyzer helped me save the day. —*Dean Straw, N6BV*

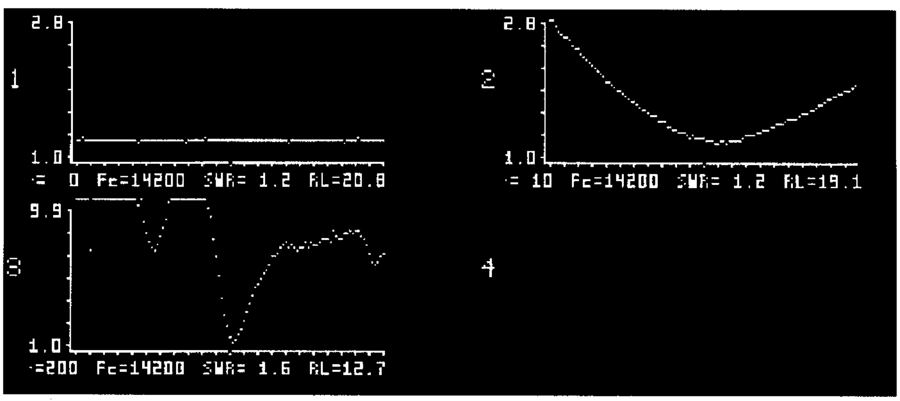


Figure 1—Three sweeps of my 20-meter dipole using the SWR.COM software. Plot 1 is a single-frequency measurement at 14.200 MHz. Note that the SWR is approximately 1.2:1. In plot 2, I expanded the sweep width to 1.1 MHz. Now you can see the SWR curve throughout the entire 20-meter band, as well as above and below (from 13.650 to 14.750 MHz). Plot 3 was taken with the SWR-121 set to its maximum 22-MHz sweep. The 20-meter band appears as a sharp dip near the center of the display. Notice the additional dip showing up at 9 MHz.

It's also possible to save your SWR plots for future comparison. Sweep your antenna system and save the curve(s) to disk. Come back in a few months or a year and sweep it again. Within seconds you can compare the curves and see how your system has changed over time.

In Figure 1 you'll see the results of three SWR-121 sweeps of my 20-meter dipole. Once all three plots were complete, I pressed the **PRINT SCREEN** key on my keyboard and printed the curves on my printer. This is convenient when you want to compile a logbook of your antenna activities, or when you want to show your friends what you've been up to.

Conclusion

It's fair to say that the SWR-121 is probably the ultimate antenna-measurement tool for Amateur Radio applications. There is a stiff price to be paid for this level of quality and convenience, though. If you're a ham who does a lot of antenna building and testing, you can probably justify the cost. An SWR-121 is also a good investment for clubs (make the SWR-121 available for members to use and keep it handy for Field Day). The average ham who toys with his or her antennas only a few times a year—if that much—may find the price of an SWR-121 a little hard to swallow.

Manufacturer's suggested retail price: SWR-121 (HF) $399; SWR-121 (VHF/UHF) $469; SWR.COM software $75. Manufacturer: Advanced Electronic Applications, PO Box C2160, Lynnwood, WA 98036-2160, tel 206-774-5554.

Table 2
SWR Accuracy of AEA SWR-121

Load	*Freq. (MHz)*	*Measured SWR*
50 Ω resistive	3.5	1:1
(Calculated SWR 1:1)	14	1:1
	28	1:1
25 Ω resistive	3.5	1.9:1
(Calculated SWR 2:1)	14	1.8:1
	28	1.8:1
100 Ω resistive	3.5	2:1
(Calculated SWR 2:1)	14	1.9:1
	28	1.9:1
Reactive, nominal	3.5 (2.5:1*)	2.5:1
50 Ω – *j*50 Ω	14 (2.8:1*)	2.8:1
(nominal SWR 2.62:1)	28 (2.5:1*)	2.4:1
Reactive, nominal	3.5 (2.6:1*)	2.7:1
50 Ω + *j*50 Ω	14 (2.5:1*)	2.4:1
(nominal SWR 2.62:1)	28 (2.6:1*)	2.6:1

*Actual value of test load measured with an HP-8753C network analyzer.

No More Guilt

All hams know that it's Very Bad Practice to swoosh a transmitter (or transceiver) across a band to find the point of minimum SWR (ie, the antenna's resonant frequency). But it's very tempting to do so, especially when adjusting mobile antennas. When you start adjusting the length of the tip on a new mobile whip, you have no idea where the antenna is resonant. Neither do you know how far in frequency the resonant point will move for a given adjustment of the tip length.

I must admit that I have sometimes been a frequency-swoosher, but only at times when propagation on the band I was using was shut down, and with the minimum power necessary to make the SWR meter read upscale (perhaps 1 W output). Even at that, I always felt guilty.

When Steve, WB8IMY, asked me if I wanted to try the AEA SWR-121 Antenna Analyst, I said I'd be glad to experiment with using it to adjust some of my mobile antennas. Wow! It works great!

I hooked the Analyst up to my motorcycle antenna—a Hustler with a two-band top and resonators for 40 and 20 meters. The Analyst was soon plotting *Handbook*-style dotted-line SWR tracings. As it turned out, my mobile antenna was resonant at two frequencies slightly removed from where I had originally tuned it, so it was indeed time to retune.

I retuned the 40-meter resonator to 7.030 MHz—short work with the Analyst—then the 20-meter resonator to 14.025 MHz. As usual, because of the interaction between the two resonators, the 40-meter resonant frequency moved a bit when the 20-meter resonator was adjusted. But a second adjustment to each of the two resonators brought them both right on the desired frequency.

Then I turned on the TS-140S and tuned it to 3.640 MHz to listen for the Analyst's little pulses. With no antenna on the TS-140S, which is about four feet from the mobile antenna, and its RF and AF gain controls set to maximum, I could just barely hear little bitty pulses quickly kerchunking in and out of the passband—sort of a Baby Woodpecker effect.

One minor problem with the Analyst is that the microprocessor can (and does) assign irrational values to the top tick mark on the SWR scale (the bottom tick mark is always 1.0). The two maximum values assigned in the examples of Figure 1 are SWR = 9.9 and 2.8. With the former, the intervals between tick marks is 1.48; with the latter, 0.3. Neither is especially good for easy interpolation, so it's difficult to read the SWR at a given frequency. If the microprocessor would assign a top value of either 4, 7 or 13, interpolation would be easier, with the tick marks then at intervals of 0.5, 1.0 or 2.0, respectively.

The bottom line: Mobile antenna adjustment with the SWR-121 was fast and accurate, the graphical display of antenna SWR gave me confidence in the results, and—perhaps best of all—I didn't feel guilty!—*Al Brogdon, K3KMO*

JPS SSTV-1 DSP Filter for Slow-Scan TV

Reviewed by Ralph E. Taggart, WB8DQT

HF slow-scan television (SSTV) operation is conducted in the same subbands used for voice. The 20-meter band is by far the most popular for SSTV communication, and there has been a major increase in the number of SSTV operators. This influx of new SSTV stations coincides with unusually crowded conditions on 20 meters as we approach the minimum in the 11-year solar cycle. While there has always been the potential for mutual interference between SSB and SSB/SSTV operators, the situation is probably now the worst since the FCC authorized HF SSTV operation in 1968.

Advances in digital signal processing (DSP) technology are currently revolutionizing how we process voice and data signals. DSP filter units can be remarkably effective in minimizing the impact of SSTV signals on voice transmissions, but stock units do not provide much reduction in the impact of SSB interference to SSTV transmissions.

The SSTV Signal Format

The SSTV signal consists of a mid-range audio tone or *subcarrier* whose frequency is varied to convey picture data. All SSTV modes (and fax modes as well), transmit information on image brightness (in both monochrome and color formats) by varying the subcarrier frequency from 1500 Hz (black, or minimum brightness) to 2300 Hz (white, or maximum brightness). In addition, most modes (with the exception of the AVT SSTV modes and fax) also transmit synchronizing pulses to start the image and trigger each line. These synchronizing pulses are created by shifting the subcarrier frequency down to 1200 Hz for short intervals. As SSTV modes diversified during the last decade, another element, the vertical interval signal (VIS) code was added to new and existing SSTV signal formats. The VIS code involves shifting the subcarrier between 1100 Hz and 1300 Hz in a simple serial data format (1200 Hz is used for start and stop bits). The short VIS data sequence, transmitted at the start of the frame, can be used to automatically set the receiving display equipment to the proper mode for the picture to follow.

Allowing for bandwidth considerations, the SSTV signal occupies a range of frequencies from slightly below 1100 Hz to just above 2300 Hz. In modern HF receivers and transceivers, a combination of RF and audio filtering is used to set the audio bandpass to a typical value of 300 to about 2600 Hz in SSB modes. DSP filtering can be used to sharpen the skirts of the audio bandpass but usually doesn't tighten it significantly (in normal SSB operation) because of the potential for the loss of speech intelligibility.

Thus, when SSTV signals are received, speech products or tones below the SSTV bandpass (between 300 and 1100 Hz) and above it (between 2300 and 2600 Hz or higher) are passed with no significant attenuation. Obviously signals that fall within the SSTV passband (1100 to 2300 Hz) can cause interference, but so can the signals above and below this range. The reason is simple. SSTV demodulators typically start with one or more audio limiter stages (or their equivalent in software) to remove the effects of signal fading and receiver AGC effects. If audio products outside of the SSTV video passband (but within the receivers SSB audio passband) are comparable in level or stronger than the desired SSTV signal, they can saturate or "capture" the audio limiter. The effect is quite similar to the "capture effect" when using FM on VHF or UHF. The end result is that the SSTV demodulator input is dominated by the interfering signals or tones and the desired picture data is degraded or completely obliterated.

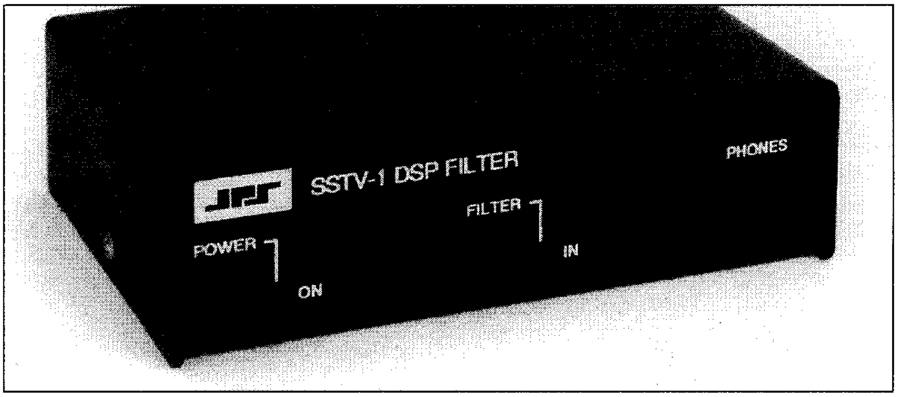


Table 3
JPS SSTV-1 DSP filter, serial number 010156

Manufacturer's Claimed Specifications	*Measured in ARRL Lab*
Power requirements: 11 to 16 V dc @ 500 mA peak.	170 mA at 12.7 V (with 2 V input signal).
Audio input: 22 Ω or 47 kΩ; 100 mV to 2 V RMS.	Not measured.
Input-to-output delay: 6 ms.	As specified.
Filter bandwidths: 1050 Hz to 1350 Hz and 1500 to 2300 Hz at –6 dB.	At –6 dB points: 1039 to 1370 and 1507 to 2303 Hz.
Ultimate attenuation: 60 dB.	As specified.
In-band ripple: <1 dB.	Approximately 0.5 dB maximum.
Audio output: <0.5% distortion at 0.5 W output; 2 W at 10% distortion into 8 Ω.	0.5% THD at 1.4 W; 10% THD at 2.3 W into 8 Ω.
Size (height, width, depth): 1.7×6×4.3 inches; weight, 2 lbs.	

The JPS SSTV-1 DSP Filter

Given the flexibility inherent in DSP technology and the rapid rise in the number of SSTV operators, it was inevitable that someone would implement a DSP filter tailored to the needs of SSTV operators. JPS Communications, which manufactures a diverse line of DSP accessories, has done just that with their model SSTV-1 DSP filter. This is a single-mode device targeted directly to the SSTV/fax market. Because it is a single-mode unit, the unit is attractively priced compared to multifunction models, which, despite their usefulness in other modes, are less than optimum for SSTV.

The SSTV-1 is housed in a small, heavy, thick-walled two-piece aluminum cabinet. The manual is small and sparse (18 pages) but entirely adequate given the simplicity of installation and use. A reasonably comprehensive troubleshooting guide is included, as well as a schematic. The details of the DSP processor and the A/D and D/A converters are not documented, but the circuit diagram does include all the analog and digital support circuits.

The unit must be powered from an external dc supply (11 to 16 V, not supplied) via a coaxial jack on the rear apron (mating plug supplied). The unit is protected against the application of reverse polarity.

The only other rear-apron items are a grounding lug and RCA phono jacks for **AUDIO INPUT** and **SPEAKER OUTPUT**. The audio input, with a nominal impedance of 22 Ω, can be connected to an accessory audio or data output jack on the HF equipment or paralleled with an external speaker using a **Y** connector. I used the phone-patch audio output on my venerable FT-101E with no loading problems. If all your audio output options are high impedance, clipping one resistor in the SSTV-1 circuit board (detailed in the manual), will convert the unit's input impedance to 47 kΩ.

Although the audio output jack is labeled **SPEAKER OUTPUT** and will drive a low-impedance load, I suggest that the output be connected directly to the input of your SSTV demodulator and that you rely on the internal or external speaker of your transceiver/receiver for normal voice reception.

The front panel is sparse, but there are relatively few operational options with a dedicated unit like the SSTV-1. There is a push-button **POWER** switch (with an LED indicator) for switching the unit on and off. A second **FILTER** switch, with a companion LED indicator, is used to select the filter options, which will be discussed in the next section. A ¼-inch **PHONES** jack for headphone use completes the front panel. Installed as I have suggested, there is little reason to use the **PHONES** jack unless you suspect a cabling problem when the unit is first placed in service.

Test Results

When the front-panel **POWER** switch is off, audio/SSTV signals are switched through the unit just as if the filter was not in place. With the **POWER** switch on, one of two possible filtering modes is selected via the **FILTER** switch, the only other control on the front panel.

With the filter switched out, the unit provides a fairly effective voice-bandwidth filter comparable to the SSB bandpass mode in many other DSP processors. The passband in this mode is flat to within 1 dB from about 200 to 2600 Hz. Signals are down almost 12 dB at 80 and 3000 Hz.

Pushing the **FILTER** switch in enables the SSTV-1's slow-scan filtering mode. JPS has implemented a dual bandpass filter, optimized to the SSTV signal format. The first bandpass filter has cut-offs at 1050 and 1350 Hz to pass the sync (1200 Hz) and VIS (1100 and 1300 Hz) signals. The sync/VIS passband is flat to within 0.5 dB from 1100 to 1300 Hz. At 1400 Hz, attenuation is almost 18 dB, providing useful rejection in the narrow audio "window" between the sync and

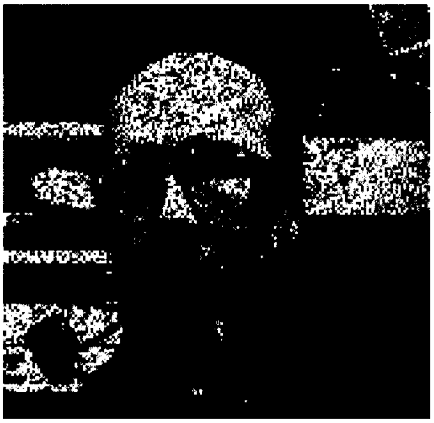


Figure 2—This image is the result of mixing an S-7 FAX-480 image with an S-9 heterodyne with a frequency of 900 Hz. Image display was initiated with the filter in the circuit; otherwise, the image could not have been displayed. The filter was then switched out of the circuit, resulting in a black display, with no trace of image data, as a result of capture of the SSTV limiter by the offending 900-Hz tone. The filter was then switched back in for the remainder of the frame. Other than some minor noise-like artifacts (discussed in the text), the filter was completely effective in eliminating out-of-band interference that would normally have eliminated any chance of displaying the image.

video passbands. At the low-frequency end, attenuation rises to about 26 dB at 1050 Hz and exceeds 30 dB from about 950 down through 100 Hz.

The second bandpass window covers the video spectrum from 1500 to 2300 Hz. The actual passband in the unit tested was a bit tighter. Measured attenuation was 6.8 dB at 1500 Hz and under 0.5 dB between 1700 and 2200 Hz. At 2300 Hz attenuation rose to slightly over 5 dB. Given the dynamic range of most SSTV limiters, the modest attenuation at the black and white ends of the video range is not significant with moderate to strong SSTV signals. It can, however, create an anomaly when receiving comparatively weak SSTV signals. JPS recently introduced a version of the SSTV-1 with low attenuation between 1500 and 1700 Hz. If you need this feature, specify it when ordering.

Given the sharp filter response, accuracy in tuning the video signal is an important consideration. The LED indicator associated with the **FILTER** switch on the front panel set up to function as a 1200-Hz sync-tuning indicator and will flash when SSTV sync pulses are present. If you tune carefully for the brightest pulses, the incoming SSTV signal will be properly tuned. The AVT SSTV and conventional HF fax formats don't use 1200-Hz sync pulses, so the indicator will not function with such signals, although it may flash intermittently with noise or QRM.

On the Air

The unit was initially installed at the SSTV operating position and used for about a week. The unit was then transferred to the test bench. At this stage, one SSTV source (ViewPort VGA system) was used to modulate an extremely low-powered SSB exciter that was routed to the FT-101E receiver through a step attenuator. A Pasokon SSTV system was used to demodulate the SSTV signals from the receiver. This set-up permitted precision control of the received SSTV signal level and permitted the SSTV signal to be mixed with varying levels of real-world noise, heterodyne tones of varying frequency and amplitude, and actual samples on on-the-air SSB chatter and splatter. In short, the bench-testing phase permitted real-world simulation of a number of worst-case simulations under controlled conditions, compared with hit-and-miss and poorly controlled situations that occur when actually operating SSTV.

All DSP processors have a delay between signal input and signal output as a result of the processing overhead inherent in the hardware and the software algorithms. The measured delay in the unit tested was between 5 and 6 ms. If you begin display with the **FILTER** switch out and then push it in at some point in the picture, the output delay is clearly evident. It will create a one-line disruption in triggered SSTV modes (such as the various Robot color modes), but, in the more useful synchronous modes (Scottie, Martin, AVT, and FAX480), the offset persists as long as the filter is in the circuit, shifting the entire display to the left the equivalent of the width of the line sync pulse. The result is quite distracting. The only way to avoid the effect of output delay is to switch the filter in before the picture starts or to leave it on for the entire operating session. Leaving the unit on at all times is entirely practical.

One of the first tests I performed was to mix wideband noise with the video signal at the input of the SSTV demodulator. In this configuration, the filter was moderately effective in reducing the impact of noise on the image. In contrast, on-the-air testing failed to demonstrate any significant noise reduction, an observation confirmed in the bench-testing phase. The noise output from a modern HF receiver is *not* wideband noise, but rather is noise largely confined to the 300 to 2600-Hz signal passband established by the RF and audio filtering incorporated into the receiver. The filter does reduce the audio passband by approximately 50%, but that represents only a 3-dB reduction in the noise power spectrum. In terms of the peak noise voltage, the reduction is only 1.5 dB. Statistical analysis of image pixel brightness distribution confirmed that the filter was indeed doing its job, but the reduction in noise as perceived by the eye was to small to be significant. Noise reduction can be significant if the receiver does not provide SSB-bandwidth filtering.

The performance of the SSTV-1 in eliminating interference falling outside of the SSTV signal passband is quite spectacular, as shown by the accompanying photograph. A FAX-480 image was transmitted from the ViewPort VGA system and set to an S-7 signal level on the FT-101E. An S-9 heterodyne with a frequency of 900 Hz was then introduced. This frequency is well within the SSB passband and would not normally be attenuated by the receiver circuits or external DSP units in an SSB compatible modes. The heterodyne tone controlled the FT-101E's AGC and the SSTV signal was difficult to hear and highly distorted when monitored on the station speaker. Display was initiated with the filter in the circuit and then was switched out for several seconds before re-engaging the filter. With the filter out, the interfering tone completely captures the input limiter, reproducing as black with no trace of the image data. When the filter was switched in, a good-quality image was displayed. At both the black and white ends of the signal spectrum, there are extremely short signal drop-outs as a result of the finite dynamic range of the SSTV limiter circuit. These effects are hardly objectionable, compared to no image at all with the filter disengaged.

Repeated testing indicated that interference falling outside of the filter passband was essentially eliminated. The SSTV-1 has no capability to eliminate in-band interference. Some of the JPS literature suggests the elimination of in-band interference, probably as a result of the rejection of signals in the very narrow window between and sync and video passbands. While there is useful attenuation over this narrow frequency range, this does not justify claims for significant in-band signal rejection. The present state of the art provides no ready solution to interference falling within the SSTV sync/video passband. Fortunately, the vast majority of real-world interference problems involve signals that fall entirely or at least partially outside of the video/sync window; in such cases, the results with the SSTV-1 can range from useful to truly spectacular.

In summary, the JPS SSTV-1, moderately priced by current DSP filter standards, is an extremely useful accessory for serious SSTV and fax operations. There is still no substitute for courtesy and mutual consideration. Unfortunately, the crowded nature of our bands seems to promote less-than-courteous behavior by both SSB and SSTV operators, each toward the other. When that happens, a filter like the SSTV-1 can certainly help. Just keep in mind that problems that technology can't fix can often be resolved by a combination of patience and diplomacy!

Manufacturer's suggested retail price: $160. Manufacturer: JPS Communications, PO Box 97757, Raleigh, NC 27624; tel 919-790-1011, fax 919-790-1456.

MFJ-1796 Half-wave Vertical Antenna

Reviewed by James D. Cain, K1TN

The Top 10 Reasons Why *Not* to Use a Multiband HF Vertical Antenna:

Number 10: You like to spend your bucks on a big antenna selector switch.

Number 9: You feel that throwing a rock attached to a string over tree limbs is cheaper exercise than a NordicTrack.

Number 8: You are only interested in operating one band.

Number 7: You want to operate at *both ends* of the bands.

Number 6: You have a tower with full-sized antennas.

Number 5: You have enough land to put up a center-fed wire antenna.

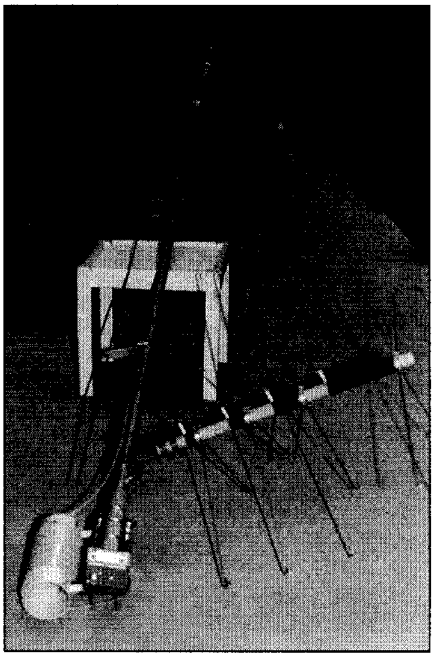
Number 4: You can't *afford* a commercially made multiband vertical.

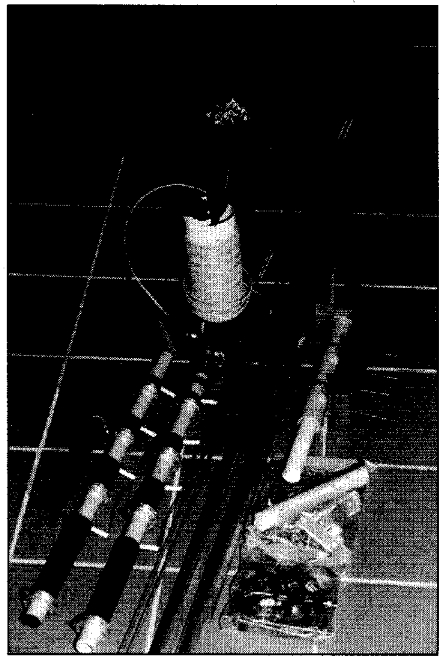
Number 3: You don't even *operate* the HF bands.

Number 2: You don't even have room for a *vertical.*

And the **Number 1** reason not to use a multiband, *trap* HF vertical antenna:

You run 10 kW output!!!!





The MFJ-1796 vertical as it comes out of the box (left). The tiles are 8 inches square. Two hours later, it's fully assembled and ready for installation and tune-up.

Table 4

MFJ-1796 Half-wave Vertical Antenna

Manufacturer's Claimed Specifications	***ARRL Evaluation***
Frequency of operation: 2, 6, 10, 15, 20, and 40-meter amateur bands.	As specified.
Power rating: 1500 W PEP	Tested at 1000 W.
2:1 SWR bandwidth: Not specified.	40 meters, 55 kHz; 20 meters, 235 kHz; 15 meters, 285 kHz; 10 meters, 360 kHz; 6 meters, 470 kHz.
Height, 12 feet; weight, 15 lbs.	

After positive experiences with the Cushcraft R-5 and R-7 "ground-independent" verticals, I offered to try an MFJ-1796. The 1796 inevitably will be compared to other "ground-independent" antennas (notably the Cushcrafts and the more recent Butternut models). These verticals do not require an on-ground radial system or an extensive wire counterpoise.

The MFJ-1796 does not cover the three new bands (at 10.1, 18, and 24 MHz). It covers only the traditional 40, 20, 15, and 10 meter amateur bands, plus 6 and 2 meters. The Cushcraft R-5 leaves off 40 meters but does work on 17 and 12. The R-7 does them all between 7 and 28 MHz. Both Cushcrafts cost considerably more than the MFJ, though. If you want more bands, check out the MFJ-1798, which includes 80 meters and the new bands.

I have never had much luck with ground-mounted verticals. In my experience, a decent horizontal wire antenna will kick the stuffings out of a vertical nearly every time. A few years ago I visited a nice fellow who was the guru of verticals at the time. He had thousands, millions, of buried wires in his back yard. I came home and immediately buried about a hundred more radials under the multiband vertical in my front yard, but I still didn't get out for beans. [See the discussion on page 2-36 of the 17th edition of the *ARRL Antenna Book.* New England soil does not help vertical radiation because of far-field losses.—*N6BV*]

The contest and DX community has now discovered something about quarter-wave verticals (this crowd uses phased wire vertical arrays for 80 and 160 meters): You can do just as well—or better—with a few elevated radials as with a whole bunch of buried radials. These operators have proven that the way to go is to get the base of the vertical up off the ground and to run the counterpoise wires out from the base above ground, as well.

So what? you say.

Uh.... So what are these commercial, multiband "ground-independent" verticals, such as the MFJ, if not raised verticals with raised counterpoises? Okay, so they aren't full-sized and they have all the compromises of multiband antennas. Well, their manufacturers (especially MFJ) argue that these antennas get the RF up in the air where it counts. And they may be right. These antennas do work.

They work at least as well as a ground-mounted multiband vertical with lots of radial wires. That is to say, most received signals are two or three S-units down from my comparison antenna, a 180-foot-long center-fed wire 40 feet above the ground. I had an R-7 up as I began testing the MFJ, and the two were virtually equal on the bands they share.

The MFJ uses an entirely different design, however. It's an L-shaped vertical dipole. Shortened, of course, using ordinary coils, with thick, stiff wires acting as capacitance spokes for each band. Since it's a dipole, the MFJ's feed point is in the middle, getting the RF "higher up." As MFJ says, the top, RF-hot half of the dipole has its coils at the top to increase efficiency (so do the Cushcraft units).

Identical coils and spokes on the bottom half are folded over, horizontal, to make the overall length just 12 feet.

Twelve feet on 40 meters! This is just over half the length (height) of the R-7. Yet the MFJ seems to work just about as well, though over a narrower frequency range. This is a very small antenna for 7 MHz, but it does get out (I used both the R-7 and the MFJ mounted about 8 feet above ground).

Unlike some antennas, you can see exactly what you get. The loading coils are right there, simply wire wound around fiberglass rods. (Early versions of this antenna used ceramic insulators. MFJ switched to fiberglass for greater strength.) There is no black box of a matching network. The MFJ uses a simple wire-wound coaxial balun at the (physical) bottom of the antenna, then 6 feet of coax to the center feedpoint. The MFJ, being a form of shortened dipole, has a feedpoint impedance closer to 50 Ω than an end-fed halfwave vertical, although the SWR bandwidth is only 55 kHz on 40 meters (see Table 4).

The MFJ's simple design and use of noncorrosive parts (aluminum and stainless steel) should ensure a long, trouble-free life under ordinary conditions. I found a couple of glitches. Holes drilled in standoff brackets were too small to clear the (6 and 2-meter) rods that pass through them.

As time went along, I developed more respect for this antenna. In the beginning I was more than skeptical, maybe because the antenna was so simple in design and so small. Yet it turned out to be a good performer on all bands—even 2 meters, where it greatly outperformed my H-T's rubber antenna.

But this sort of antenna isn't for someone with *space*. Who is it for? Or what is it for? It's for the balcony, chimney, or even window sill of an apartment. It's for a mobile home. It's for a backyard too small for a wire antenna. It's for a week's vacation at a cabin or in a tent. It's for a trip to the Caribbean.

Finally—tuning the MFJ. Here's the big bugaboo. As the instructions say, you need access to the entire antenna to tune it, which is done by pruning the spokes around the loading coils. If you mount the antenna on an 8-foot mast, that puts the top coils 20 feet up. Meaning you have to take down the antenna to prune those spokes.

I borrowed an SWR analyzer (a wondrous device, by the way) but still had to take the vertical down at least a dozen times, and it's still not "perfect." I ran out of both steam and patience. The Cushcrafts are a big improvement over this.

Finally, a word about safety. These "ground-independent" antennas have a lot of protruding, sharp wires and rods. Cushcraft puts a warning sticker on each rod; MFJ bends the end of each one into a hook. As with any ground-mounted antenna, you simply must (1) wear eye protection when building and tuning them, and (2) get them away from areas where somebody might walk into them.

So what's the verdict? This is a $200 ground-independent vertical that will get you on segments on four HF bands when there's room for nothing else except a small transmitting loop antenna.

Manufacturer's suggested retail price: $200. Manufacturer: MFJ Enterprises, Box 494, Mississippi State, MS 39762; tel 601-323-5869, fax 601-323-6551.