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Ten-Tec T-Kit 1208 6-Meter Transverter

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For years the amateur 6-meter band has been a "poor relation" of the more popular HF and VHF bands. It's just below TV channel 2, and it has a reputation as a TVI band. It's also not available to amateurs in some parts of the world. Crowding on the other VHF bands—and the fact that this is the *only* band available to the growing number of Technician licensees that occasionally supports long-distance E and F-layer propagation— has increased interest and encouraged manufacturers to provide more equipment for 6 meters. In addition to new single-band rigs, some manufacturers have begun to include 6 meters on their HF transceivers.

So, if you want to try 6 meters, all you have to do is buy a new rig! That's easy enough. Just convince your spouse or parents that you absolutely need another radio. Your boss, of course, will agree that you're worth a significant increase in salary to pay for it, too. For those of us who are satisfied with our current equipment, however, or whose families and bosses somehow don't get the message, Ten-Tec has brought out a 6-meter transverter *kit*. This is among the first of several kit offerings from Ten-Tec. A transverter allows you to use your current HF radio as an IF strip by converting the 50-MHz receive signals down to a frequency your transceiver can accept, and, on transmit, converting its output up to 50 MHz. All modulation, filtering and signal detection functions are done by the transceiver you already own. No HF radio? The price of the transverter and a used HF radio (or a new Ten-Tec Scout) can be well below the price of the lowest-priced new HF/6-meter combination radio. The transverter even works with some of the low-power transceiver kits out on the market. The Ten-Tec 1208 is an inexpensive way to explore the possibilities of a "new" band. Besides, it's a great feeling putting something you've built on the air.

Circuitry

Transverters have been around for a long time, but they're typically designed for use with very low-level signals from a transverter port on your transceiver. Unfortunately, not all of the popular HF transceivers have transverter ports. Ten-Tec designed the 1208 to work with an input signal in the 5 to 10-W range, allowing the use of most current HF transceivers as well as many QRP rigs. The transverter's attenuator network reduces the transceiver's output to the low level required internally. You can use any HF transceiver whose output can be reliably adjusted to 5 W. If you wish, you can change the value of a resistor in the attenuator section to allow operation with input power levels between 250 mW and 10 W. The specifications claim the internal attenuator is capable of handling up to 8 W of continuous input, and 10 W at a light duty cycle. For larger input signals, you can design your own attenuator, but Ten-Tec leaves that up to you.

A transverter is a *two-way* converter that works in both transmit and receive. How does it work? In simple terms, a converter combines two signals of different frequencies in a mixer. The output contains signals representing the sum and difference of the input signals, and filters remove all but the desired frequency.

In the case of the 1208, a crystal oscillator operates at 36 MHz. During receive, 50-MHz signals from the antenna are amplified by a receive preamp, then mixed with the 36-MHz signal, producing output at 14 MHz, which is fed to your transceiver. Filters in the transverter block "external" 20-meter signals from reaching your transceiver, so all you hear is the 6-meter band. On transmit, the 14-MHz signal from the transceiver is attenuated to protect the electronics, then mixed with the 36-MHz oscillator signal. The resulting 50-MHz signal is then amplified and fed to the antenna.

Because a 14-MHz signal is used at the input, it's essential that the input signal not be passed through to the output, to avoid unacceptable interference. Ten-Tec claims 14-MHz feedthrough is attenuated at least 75 dB, more than adequate to prevent problems (FCC Regulations require at least 55-dB attenuation at the rated output power).

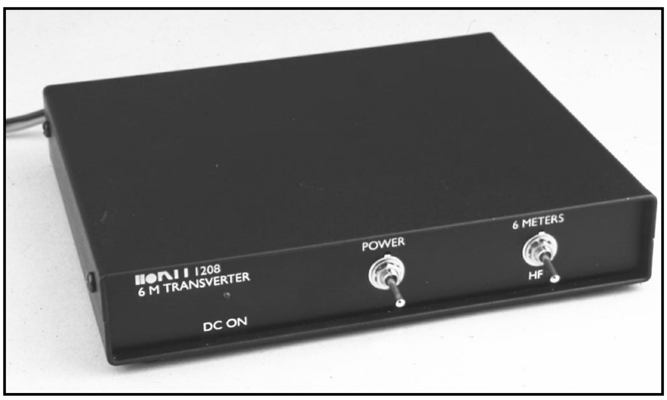
Transmit/receive switching in the 1208 is accomplished by a solid-state RF sensing circuit. There is no relay and no need for a T/R relay control signal from the HF rig. When the unit is in the HF (bypass) mode, your transceiver's signal is fed straight to the HF antenna; the unit is designed to pass the full 100-W output of a typical HF rig.

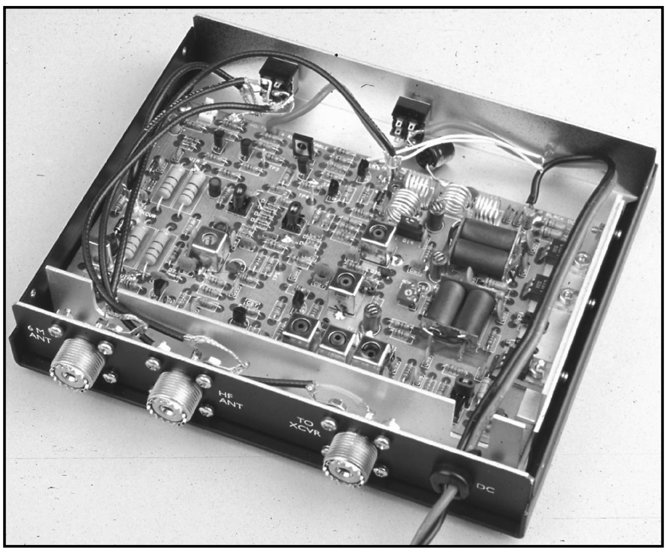
Assembly

I was looking forward to building this kit.

Bottom Line

The T-Kit 1208 is fun to build and provides a low-cost way to add 6 meters to your station's capabilities.





Although the basic idea is simple, the unit is a sophisticated piece of circuitry that includes attenuators, an oscillator, mixer, 50-MHz receive and transmit circuitry, and appropriate filters. Almost everything is mounted on a single, high-quality double-sided circuit board. Components are also of high quality.

I've built many kits in my time, including a complete SSB/CW transceiver. The classic kit makers like Heathkit and Eico went to great lengths to make the procedure as clear as possible. Large drawings were provided, and the directions took you step by step through the process. Ten-Tec has done an excellent job with the manual for the 1208; it's reminiscent of those included with the kits of yesteryear. The manual contains a number of figures that you will need to refer to frequently, so I would suggest builders make copies of these drawings and diagrams to avoid having to page back and forth.

During actual construction, I discovered that finding component locations could be difficult. Location diagrams are at the beginning of each section, but they only show a section of the board, and it's not always clear just where that section is on the board. The board isn't big, but it's packed with components. Fortunately, both the board and the full-size diagram are fully labeled.

Another quibble with the manual came up when the ARRL Lab got the unit for testing. Naturally, the Lab people first wanted to check the alignment, but the alignment procedures are spread throughout the manual, so they had to jump around in the manual to do a complete alignment. Grouping the procedures in one place and including pointers to the appropriate steps at the end of each section would be preferable.

Overall, I was impressed with the otherwise well-organized manual. It contains sections on operating and design considerations, troubleshooting and service notes, and advice on 6-meter operation. The instructions clearly identify the parts involved in each step, helping you to avoid mistakes. The parts list identifies the functions of important parts. The assembly sequence, with circuit checks at the end of each phase, gives you feedback—you know that you've got things right, or that there's a problem. Ten-Tec took the time to explain basic terminology at the start of the manual—helpful for beginners—and the book contains lots of useful reference tables.

Assembly is pretty straightforward and took me the equivalent of one weekend. I'd consider this an intermediate-level kit. You should have some experience building projects or kits before tackling this one. Ten-Tec says that you can build the unit in any order you wish, but their recommended procedure is broken down into seven phases. You set the local oscillator frequency after phase 1. After phase 2 you check transmit/receive switching. In phase 3 you align the receive circuitry and then can listen to the receiver. Phases 4, 5, 6 and 7 involve transmit circuitry, final testing and assembly.

Table 1

Ten-Tec T-Kit 1208 6-Meter Transverter

Manufacturer's Claimed Specifications	*Measured in the ARRL Lab*
Power requirements: Transmit, 3.8 A; receive, 170 mA, 11-14 V.	Transmit, 3.2 A (at 8 W typical output); receive, ≈180 mA. Tested at 13.8 V.
Size: 1.3×7.3×6.1 inches; weight: 2.5 lb.	
Frequency coverage: Receive, ≈50-54 MHz; transmit, 50-52 MHz.	As specified (determined by transceiver).
Modes of operation: Not specified.	Tested on SSB, CW, AM, FM.
Receiver	
Conversion gain: Not specified.	17.9 dB.
Noise figure: Not specified	7.3 dB.
Transmitter	
Transmit RF input: 5 W (max).	1.5 W input required for typical 8 W output.
Transmit RF output: 8 W (typical).	As specified.
Spectral Purity: Not specified.	–55 dBc at 8W output. This unit meets FCC requirements for spectral purity.

Ten-Tec has done a fine job of pointing out where you may get into trouble if you don't follow their procedure. The builder must be especially careful to follow directions for soldering shields and running wire to ensure the unit will meet FCC spectral-purity requirements. Solder joints to the board's ground plane are particularly important. The manual says just the tabs of J2—the 50-MHz output socket on the circuit board—must be soldered to the ground plane. We found, with Ten-Tec's advice, that soldering the entire circumference of the socket to the ground plane reduced the unit's spurious emissions. You will have to trim the socket's plastic base to do this, however.

The only tools you'll need typically are in the average amateur's toolbox. Although the manual says a soldering *gun* may make it easier to solder shields and balun cores to the ground plane, I found my 25-W iron easier to use and more than adequate for the task. Minimum test equipment required is an accurate RF wattmeter for HF, which can also be used for relative-power measurements on 50 MHz, and a VOM (with a current range of 1 A, to set bias) for 12-V measurements. If your meter can't handle that current range, the manual shows how to set bias using just a voltmeter. Optional equipment includes a frequency counter, 50-MHz signal source, and a dummy load. My biggest lack was a 50-MHz signal source to use for aligning the receiver. If you don't have one, the manual suggests using a 49-MHz "walkie-talkie" or cordless phone signal (preferably your own—it's now illegal to evesdrop on someone else's cordless phone conversations).

Operation

The 1208 has a clean, Spartan appearance and occupies very little space. Its low profile makes it ideal to set atop your transceiver. The front panel has a power LED and just two switches—a power switch and one that toggles your transceiver's output between the HF antenna and the transverter. You connect 13.8 V, your transceiver's output, and HF and 6-meter antennas to it. It has separate HF and 6-meter antenna outputs.

Although the 1208 can receive the entire 6-meter band, Ten-Tec recommends you transmit only on the lower 2 MHz, 50 to 52 MHz. Additionally, while any 20-meter transceiver will work, if your rig transmits only from 14 to 14.350 MHz, then you will only be able to operate in the lower 350 kHz of the band (50.0-50.350 MHz). Fortunately, except for repeaters, that's the most interesting part, in my opinion. To use the *entire* range of the 1208, you need a transceiver that transmits and receives from 14 to 18 MHz.

With most transceivers, setting CW and FM output to the required 5 W is simple. If you have a reliable RF wattmeter, all you have to do is turn down the carrier control. Limiting your sideband output may be more difficult. Articles have been published about limiting SSB output with ALC modifications. I found, however, that both my Kenwood TS-440 and Yaesu FT-747 were able to operate SSB reliably at the appropriate levels, as long as I was careful. I used a PEP power meter and an oscilloscope to establish those levels. On my rig, SSB power output is controlled by mike gain, but for AM you use the carrier control (yes, a number of people still run "ancient modulation" on 6 meters). When switching from SSB to AM, I had to reset the mike gain for proper AM modulation. If you want to operate AM, remember to first set the carrier level on CW or FM. When you switch from CW or FM to AM, the carrier output of your HF rig should drop to about 1 W. This takes into account the power that goes into the sidebands during modulation; peak AM power with 100% modulation is four times the carrier power.

In this and many other areas, 6 meters is still underutilized, so one of the biggest problems I had was finding someone to talk with. Naturally, I was away during a monster band opening! Most of my contacts were made by sked. I could hear two repeaters, but the strongest one has PL, so I couldn't bring it up. The other didn't have much activity. Operating mobile on a hill in Central Connecticut, I heard the 5-W beacon on Cape Cod, more than 150 miles away!

The contacts I did make, however, reported excellent signal quality on all modes. Of course, signal quality depends as much—or more—on the transceiver used with the transverter, but the 1208 didn't alter my signal traits. Lab tests show the unit meets the FCC's requirements as well as Ten-Tec's claimed specifications. During this evaluation, I had the opportunity to use a second 1208, built by Ten-Tec. No differences between the two units were heard or reported. I wondered how the RF-sensing T/R electronics would handle SSB, and especially whether there might be some cutoff at the beginning of words. Even with careful listening, no problems were noted—the circuit works very well. There were no reported problems with CW signals, either, at the under-20-wpm speeds I used.

Except for the need to adjust power levels when switching between HF and 6-meter operation, the 1208 was very easy to use. There is, of course, nothing to prevent you from operating HF with the same power levels, adding some spice to *that* activity as well. The 8 W of output isn't much, but a 6-meter beam doesn't need to be very large, so you can make up for lack of output with a good antenna.

The Ten-Tec 1208 is a handy and economical way to check out the 6-meter band. Its small size means you don't have to build another room for it, and it works well mobile, too. It's a fun kit to build, and it should introduce many more people to 6 meters.

Manufacturer: Ten-Tec, 1185 Dolly Parton Pkwy, Sevierville, TN 37862; tel 800-833-7373. Suggested retail price, $95.

Radio Shack 22-168A Digital Multimeter

Reviewed by Mike Gruber, WA1SVF
ARRL Laboratory Test Engineer

In all my years in electronics, I've never found a handier, more useful or all-purpose tool than a good multimeter. I've used mine for electronics, automobile, appliance and home electrical repairs. From testing batteries and light bulbs to troubleshooting the family stereo, a multimeter can be indispensable to ham and homeowner alike. It's not surprising that multimeters are probably *the* most popular of electrical instruments and that there are so many models on the market. So is Radio Shack's model 22-168A multimeter with a PC interface just marketing gimmickry or real technological progress? Let's take a closer look.

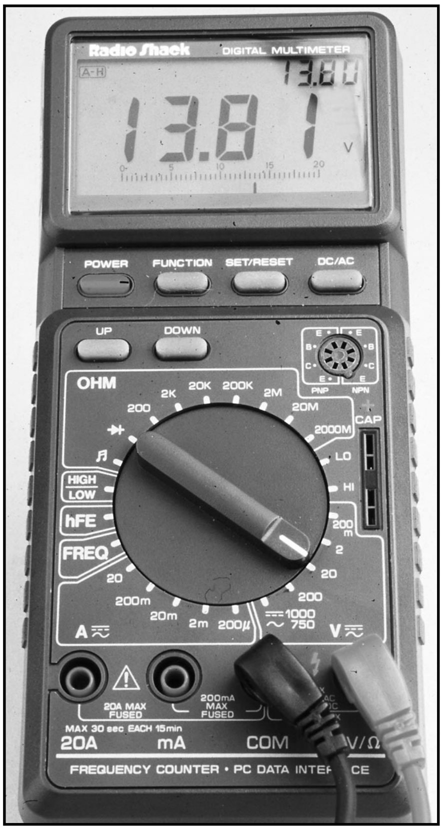
Features and Functions

The meter comes in a vinyl case about 6×7.5×2 inches. The 9-V battery is not included, but the kit does contain a pair of black and red probes with 32-inch leads, software, a manual and a 40-inch-long computer interface cable.

In addition to capacitance, resistance and ac and dc voltage and current, this meter can measure frequency, transistor hFE, capacitance and continuity. It also offers a diode-check function, a logic-test function, a relative-offset function and a dual display for specialized advanced functions that I'll discuss later. The meter has a low-battery indicator, overload and transient protection, an analog bargraph display and of course the PC interface. In fact, once I understood the full extent of its capabilities, this instrument began to look more an entire hand-held test bench than a mere multimeter!

The meter's outward appearance is typical of the hand-held DVM's (digital voltmeters) available on the market today. The case is a hard dull-gray plastic, and it comfortably fits in your hand. Most prominent are the LCD display window and a sizable function/range knob. The window is a bit larger than most, in part to accommodate the dual-display feature mentioned previously, and the big, bold primary display numerals that measure 5/8 inch high. I could even read the display without resorting to that dreaded curse of middle-age—bifocals! Although it's not backlighted, I was able to read it in relatively subdued lighting, at various viewing angles and in bright sunlight.

The display is sensibly laid out, with advanced functions indicated in the upper left-hand corner, the secondary readout in the upper right-hand corner and the bargraph running horizontally along the bottom. The primary display's units (mV, mA, etc.) are identified to the right of the readout, with a minus sign on the left when the value is negative. The selected function also appears on the left for all but voltage, current and resistance. An **AC** indication appears on the left when appropriate, but there is no similar indication for dc.



Bottom Line Box:

An accurate, economical and handy test-bench instrument that you can hang from your belt or interface with your PC for monitoring and graphing.

The function/range knob is the heart and primary control of the 22-168A. It offers seven functions (resistance, capacitance, voltage, current, frequency, hFE and logic) and 24 positions. It has a maximum resistance range of 2000 MΩ, and can measure voltage as high as 1000 V dc and 750 V ac, and current (ac or dc) up to 20 A.

Directly below the display window are four pushbuttons. In addition to a **POWER** switch are **FUNCTION** and **SET/RESET** buttons. These are for the advanced functions, including the ability to display a reading taken four seconds earlier and to hold a reading in the secondary display. A **REL**ative measurement feature lets you measure a voltage against a preset reference, and **DUAL** function lets you simultaneously measure ac voltage and frequency. The **DC/AC** pushbutton operates for all current and voltage settings.

UP and **DOWN** buttons set the reference voltage in the **REL**ative mode. An eight-hole transistor socket accepts either NPN or PNP bipolar transistors for hFE measurements. A capacitor socket can accommodate a wide range of capacitor sizes. A row of four probe jacks rounds out the meter's front panel. In addition to the usual **COM**mon and **V/Ω** terminals are two connections for the ammeter. Both the 20-A and 200-mA terminals are fused, to protect the meter.

One feature *not* included, however, is autoranging for all but frequency measurements (which I consider to be an add-on feature). This surprised me, especially since this is a microprocessor-based instrument, *and* the front cover of the manual touts it as autoranging! (Radio Shack's latest catalog correctly indicates that it's not autoranging, however.) Radio Shack says it didn't include autoranging in order to keep the cost down. Auto-ranging for voltage, resistance and current measurements would reduce operating complexity by eliminating numerous range-switch positions.

Performance

An independent metrology lab in the Boston area tested this unit's calibration accuracy "out of the box" (see Table 2). This is the same outfit that calibrates the ARRL's test equipment used for product reviews. This level of accuracy makes the 22-168A suitable for most any home application, and even some laboratory use as well.

If you're used to autoranging meters, you'll need to readjust your thinking a bit with this meter. When you encounter an unknown voltage or current, you must start measuring at the meter's highest available scale and work your way down. Exceeding the scale results in an overload reading. My ARRL Laboratory-issued DVM is an autoranging Fluke 75. Curious to know how long it would take each meter to produce a reading, I connected the product review and Lab DVMs into a commonly switched ac power source. The Radio Shack meter produced a final reading in about one second, while the autoranging Fluke needed almost two (at least as measured by a stopwatch). This is probably not significant for most applications, but demonstrates one of the trade-offs of autoranging.

The meter's frequency-measuring ability was a nice bonus. For Field Day and emergency generator use, a small, hand-held meter to simultaneously monitor ac voltage and frequency could be a real advantage. As an RF frequency counter, it is somewhat limited, however. Although it can measure frequency up to 20 MHz, the probes and associated terminals are not particularly suited for RF. The meter's input impedance at HF would also be an unknown.

To test the hFE and capacitance-measuring features, I grabbed a handful of appropriate components. Of the dozen or so ubiquitous 2N2222-type transistors I checked, the hFE averaged around 150, corresponding nicely with the data sheet. This feature is not suitable for testing FETs. The capacitance test was just as easy to perform. I found the socket suitable for a wide range of capacitor types and sizes.

Documentation

The manual was adequate but not outstanding. It can be a bit tedious weeding through all the safety warnings and cautions, requirements no doubt imposed by Radio Shack's attorneys. Should you desire additional information on measurement techniques in general, a Radio Shack book, *Using Your Meter*, might be helpful. The 22-168A manual covers basic measurement techniques and provides reasonably good detail and instruction on the meter's features with the notable exception of the

Table 2
Radio Shack Model 22-168A Digital Multimeter, serial no. FH817293

Function tested	*Meter Range*	*Nominal Value*	*Measured Value*
dc voltage	200 mV	100 mV	100.0 mV
	2.0 V	1.0 V	1.000 V
	20.0 V	10.0 V	10.00 V
	200 V	100.0 V	100.1 V
	1 kV	950 V	951 V
ac voltage (50 Hz)	200 mV	100 mV	100.0 mV
	2.0 V	1.0 V	1.000 V
	20 V	10.0 V	10.00 V
	200 V	100 V	100.0 V
	750 V	600 V	599 V
dc current	200 µA	100 µA	99.9 µA
	2 mA	1.0 mA	0.999 mA
	20 mA	10 mA	10.02 mA
	200 mA	100 mA	100.1 mA
	20 A	1.0 A	1.00 A
	20 A	10 A	9.87 A
ac current (50 Hz)	200 µA	100 µA	99.8 µA
	2 mA	1.0 mA	0.998 mA
	20 mA	10 mA	10.01 mA
	200 mA	100 mA	100.0 mA
	20 A	1.0 A	0.99 A
	20 A	10 A	10.07 A
Capacitance	LO	1 nF	1.000 nF
		10 nF	10.00 nF
		100 nF	100.0 nF
Capacitance	HI	1 µF	1.000 µF
		10 µF	10.00 µF
		100 µF	100.0 µF
Resistance	200 Ω	100 Ω	99.9 Ω
	2 kΩ	1 kΩ	1.001 kΩ
	20 kΩ	10 kΩ	10.01 kΩ
	200 kΩ	100 kΩ	100.1 kΩ
	2 MΩ	1 MΩ	1.001 MΩ
	20 MΩ	10 MΩ	10.01 MΩ
	200 MΩ	100 MΩ	99 MΩ
Frequency	1 Hz	1 Hz	0.001 kHz
	10 Hz	10 Hz	0.010 kHz
	100 Hz	100 Hz	0.100 kHz
	1 kHz	1 kHz	1.002 kHz
	10 kHz	10 kHz	10.01 kHz
	100 kHz	100 kHz	100.3 kHz
	1 MHz	1 MHz	1.001 MHz
	10 MHz	10 MHz	10.01 MHz
	19.5 MHz	19.5 MHz	19.52 MHz

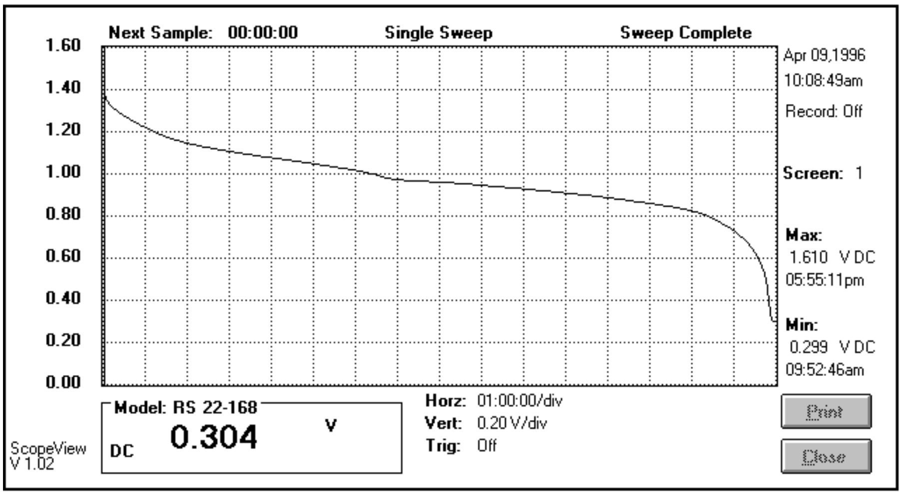


Figure 1— A cell-discharge graph made using the Radio Shack 22-168A multimeter and the supplied *Windows* software. This graph shows a 16-hour plot with sampling every two minutes.

PC interface, its most remarkable feature.

PC Interface

The PC interface lets you receive, record, log and graphically present the meter's measurements. Sample rates as fast as one per second can be taken and plotted. The resulting voltage-versus-time display is similar to an oscilloscope display, except a sweep can last from several minutes to many days. The RS-232C interface cable has a nine-pin female connector on the computer end and a five-pin plug on the other that inserts into a socket on the instrument's side. The cable plugs into a serial (COM) port on your PC.

The software comes in *DOS* and *Windows* versions. There's enough information in the manual to install either program, but no details on how to use them. For that, you must rely on a README file and a series of help menus instead. Better documentation might have made the whole process easier.

After using both programs, I developed a preference for the *Windows* version. It was a bit easier to use, provided better graphics and had more features. The program requires a '386 or better processor, a minimum of *Windows 3.0* and at least 1.43 Mbytes of disk space. It offers three modes. The *Meter* mode is primarily a reproduction of the meter's LCD display with storage, max/min save and a stopwatch feature. The *Logger* mode takes and records samples at a user-selectable rate. The data output for this mode can be read by many standard spreadsheet programs. The *ScopeView* mode provides an oscilloscope-like display. Visually, I found it the most impressive of the three functions. We immediately found a use for the *ScopeView* program in the Lab. We were testing a number of rechargeable alkaline cells for a *QEX* article, but our test fixture required that a busy dedicated computer be tied up for many hours. The 22-168A came to the rescue! Figure 1 shows the results. The *DOS* program, called *Graphic,* features two options. *Measure* and *Sheet* are similar to the *Logger* and *ScopeView* counterparts and can be run with or without a mouse.

Conclusions

The 22-168A provides many features you would expect of an instrument in its price class, plus some you might not. The PC interface can be a real plus, especially where you need to monitor varying conditions over a relatively long period. Simultaneous frequency and voltage measurements are also a nice plus, and the usual DVM features—plus frequency counter, transistor hFE and capacitance measuring—provide a portable test bench for many uses.

Manufacturer: Radio Shack, Fort Worth, Texas. 800-843-7422. Available at Radio Shack stores nationwide. Price: multimeter (22-168A), $129.99; service manual (MS-22-168A), $7.20; book, *Using Your Meter* (62-2039), $5.99.

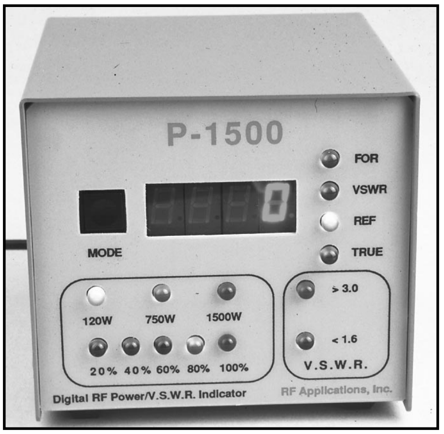
RF Applications Inc P-1500 Digital RF Power/VSWR Indicator

Reviewed By Rick Lindquist, KX4V
Assistant Technical Editor

If you operate HF, chances are you own an SWR meter or "bridge" as they're sometimes called. Perhaps it also functions as a wattmeter. But chances are that you've also wondered about its accuracy, especially if it didn't cost much. Most low-cost meters won't measure power accurately unless the SWR is unity, and even then, the typical analog scale leaves a lot to be desired. Besides, measuring RF power is a dicey business, and wattmeter and VSWR readings can vary widely from one meter to another.

The US-made RF Applications P-1500 not only helps nudge stragglers into the digital age, it also gives a good account of itself in terms of measuring how much power you're putting out and the nature of the VSWR situation at the meter's insertion point along the feed line. And here's the kicker: It can measure power from the QRP level (at least 1 W) all the way up to legal limit. Try *that* with the typical analog meter! Not only that, but the P-1500 is autoranging, so you never have the annoyance of having to change power ranges or to "set" the meter for maximum forward power. Of course, because the P-1500 uses a CMOS microprocessor and other active devices, it requires an external 12 to 16-V power source capable of providing at up to 200 mA. Reverse-polarity protection is built-in.

This sturdy little box ($3^{1}/_{2}\times4\times4$ inches) has a no-nonsense look to it. An approximately $1^{1}/_{2}\times^{1}/_{2}$-inch red LED display window dominates the front panel. It has four segments. A square **MODE** button to the left of the display lets you step through the P-1500's four functions: **FOR**ward, **VSWR**, **REF**lected and **TRUE**. A vertical row of green LEDs indicates the mode. In practice, once you're "tuned up," you'll probably set the meter to read your **FOR**ward power or your **TRUE** power, which is the difference between forward and reflected power as measured by the device. All readings are peak readings, a big plus for the SSB op.



For VSWR measurements (the manufacturer says it can measure VSWR up to 19:1!), the unit displays the first number of the ratio. The P-1500's manual correctly points out that what this device displays as VSWR may not "reflect" the actual situation at your antenna's feedpoint when you consider feed-line losses and other factors in the typical ham installation.

Below the readout are more LEDs. In the left-hand group, LEDs on the top row indicate the power range the meter detects: 120 W, 750 W or 1500 W. The lower row of LEDs is designed to simulate, in rough fashion, an LED bar-graph type display, indicating what percentage of the range—in 20% steps from 20% to 100%—the actual, measured power output represents. For example, if you're running 450 W, the meter's yellow 750 W LED illuminates, and the first three green LEDs on the lower row should come on, indicating 60% of 750 W. By changing an internal jumper, you can set the P-1500's bar graph up for a 250-W scale, ideal for 200-W class MF/HF transceivers. While the five LEDs were adequateas a coarse display, a multi-segment display with calibration marks would have been more useful.

On the lower right-hand side of the front panel, two LEDs in the **V.S.W.R.** box simply indicate if the SWR is below 1.6:1 (green) or above 3:1 (red). Neither LED glows if the SWR is between those two values. In operation, these LEDs quickly alert you to problems or the need to tweak your antenna tuner. This means that even if you're looking at **FOR**ward power instead of **VSWR** on the digital display, you'll know right away when a high-SWR condition arises.

On the rear panel are two SO-239 input/output connectors labeled **EXCITER** and **ANTENNA**. The directional coupler is not detachable from the display portion of the unit, a potential disadvantage in some installations. There's also a ground terminal. Once you've connected a power source, the rest is as simple as hooking up any other SWR bridge or wattmeter between the transmitter and the antenna system (or tuner).

Measurement accuracy with the P-1500 takes a couple of factors into account. The first is the ±10% accuracy of the device itself. The second is the error introduced by the eight-bit analog-to-digital (A/D) converter. This approach limits you to 256 codes

Bottom Line

A rugged, simple-to-use station accessory that instantly tells you all you need to know about your power output and VSWR.

Table 3
RF Applications Inc P-1500 Digital RF Power/VSWR Indicator, serial number 601175

		Measured in the ARRL Lab			
		Before recalibration		**After recalibration**	
Frequency	*P-1500 (W)*	*Actual (W)*	*Error (%)*	*Actual (W)*	*Error (%)*
3.5 MHz	51	51	0.3	55	7.3
	101	97	4.3	109	8.0
	251	223	11.2	250	0.4
	996	834	16.3	938	5.9
	1500	1245	17.0	1406	6.3
14 MHz	51	51	0.7	56	9.8
	101	96	5.5	106	5.2
	251	224	10.8	251	0.08
	996	861	13.6	951	4.6
	1500	1274	15.1	1406	6.3
28 MHz	51	52	1.5	56	10.0
	101	99	2.1	110	8.5
	251	229	8.7	263	4.8
	996	881	11.5	1002	0.6
	1306	1135*	13.1	N/A	N/A
	1230	N/A	N/A	1259	2.4

*Maximum power available.

over each range (120, 750 and 1500 W), so the display cannot indicate every single value from 0 W to 1500 W. Instead, it shows power in noncontiguous steps like 101, 104, 107 etc. The step size not only increases as you increase power within each of the ranges, but it continues to rise in succeeding ranges. In the ARRL Lab, we found that at 14 MHz it took a little more than 2 W to get the P-1500 to display a reading of 1 W, and a bit more than 6 W to get a 5-W reading. On the lowest scale, the step size is 1 W between 1 and 10 W, but the manufacturer says it can be as much as 3 W at the upper end of the lowest scale. The step size rises to as high as 12 W on the 1500-W scale. In other words, the P-1500 is satisfactory for most low and high-power measurements but probably not accurate enough for QRP purists. (Besides, it's not designed to measure power output less than 1 W.)

On the *initial* ARRL Lab tests, the unit's accuracy fell within its specified margin of error (and taking into account the estimated ±2.5% accuracy of our test setup) for measurements up to around 225 W. Above that, the worst-case error was 17%, and the meter consistently read high. We contacted the manufacturer, who suggested we recalibrate the unit.

The calibration procedure is easy, *provided you have a known output power* to apply to the P-1500. You must adjust two potentiometers inside the box for forward and reverse power. By doing this, the manufacturer claims, you can obtain ±5% accuracy—approximately what we expect to get from the Bird Model 43 analog wattmeter or the Bird 4391 digital wattmeter in the ARRL Lab—plus or minus resolution error. After calibrating our unit at mid-scale, we did not obtain this level of accuracy at all power levels, but it came within 10% on the three bands we tested it on (see Table 3).

RF Applications says it has upgraded its internal calibration procedure to take multiple power levels into account. The company says its 5% accuracy claim after recalibration applies to a given frequency and power.

I especially liked the fact that I could use the same meter for both low-power and high-power operation without so much as touching a knob, very handy for my style of casual operating. This way, you never worry about damaging the meter when switching from a low-power transmitter to the "big" rig or your linear. The digital readout also eliminates parallax error and squinting at the meter face, too. There's no guessing with the P-1500's bright, large digits. And a mere "dit" is enough to trigger the meter and give you a reading, so it's possible to tune for minimum SWR with a minimum of QRM.

Manufacturer: RF Applications Inc, 9310 Little Mountain Rd, Mentor, OH 44060; tel 216-974-1961; fax 216-974-9506. Manufacturer's suggested retail price: $219.95; P-1500P power supply, $16.95.

Azden HS-03 Headset

By Glen Swanson, KB1GW
Educational Programs Coordinator

These days, as personal computer keyboards and related accessories (the ubiquitous mouse, for example) have begun to crowd the often-limited space on the typical ham shack desk, we find little room left over even for necessities like a desk mike. Just where *do* we put the mike, when the PC keyboard demands prime desktop real estate directly in front of us?

Many, like me, have gone the headset route, relegating our trusty desk mikes to a secondary position (usually a box of things destined for some future flea market), and I keep the PC keyboard on the desktop in front of me. These days, I find myself wearing a headset for most—if not all—of my operating. For CW or just listening, I can simply swing the headset's boom-mike up and out of the way.

Bottom Line

Looks good, feels good, sounds great on the air! And, as a bonus, it helps solve your desktop "space management" problem, too!

Just what is a headset, anyway? In the Amateur Radio world, "headset" describes what is essentially a pair of headphones with a small adjustable boom-mounted mike attached, almost like an aircraft pilot might use. A headset like this puts the mike just a whisper away from your lips. Using VOX or a foot switch leaves your hands free for that all-important PC keyboard in front of you, a must for contesting, for example. This review examines just such a headset, the Azden HS-03.

The Azden name may not leap to mind when thinking of contest-related accessories, yet here we find one of their products aimed at contesters (and others) who seek a ready-made combination boom-mike/headset. Let's check it out.

The Azden HS-03 boomset is lightweight, just over 5 oz (6.5 oz, including cordset and plugs). It's about the size of the popular Heil HC-10 headset, yet has features similar to the Heil ProSet. The Azden has a black, thinly padded adjustable headband,

and black, soft-vinyl, fully padded ear pads. A stiff wire-like boom terminates in a small, round, black-plastic enclosure for the mike element.

The earpieces on the Azden HS-03, 2.75 inches in diameter, allow limited horizontal and vertical movement. The earpads on the HS-03 do not block *all* exterior noise, so you still can hear what's going on around you when you're wearing them. The thin metal boom for the mike runs through a knob on the left ear pad that lets you adjust the pressure needed to move the boom—unscrew the knob for less tension, tighten it for more. It was easy to find a setting that allowed me to move the boom around without having it seem too loose.

The black cordset on the HS-03 is the flat and flexible three-wire type, and it's roughly four feet long. The headphone plug is a 1/4-inch, three-conductor type, and the mike plug is a 1/8-inch mono type. Heil uses the same plugs, so any Heil adapters for various brands of radios should work just fine with the HS-03. I used the HS-03 with my (blue) ICOM cable from Heil, and they worked great together. Azden says the headphone impedance is 20 Ω, and the mike impedance is 500 Ω.

According to Azden's Communications Division Manager Sid Wolin, K2LJH, the audio characteristics of the dynamic mike element built into the HS-03 are "similar to the Heil HC-5 mike element." My on-air testing showed that most ops felt that the Azden headset made casual QSOs more enjoyable, due to its broader audio response, as compared to the crisp audio provided by the HC-4 (or DX) mike element in my Heil ProSet. The instruction sheet supplied with the Azden HS-03 headset indicates that the mike's frequency response is 300 to 4000 Hz, with a 6 dB rise at 2500 Hz. I used the Azden HS-03 for both casual and contest QSOs. On-air audio reports were uniformly good. By the way, it would be a simple job to replace the stock mike element with the likes of a Heil HC-4 element.

Accessories

Accessories for the HS-03 headset include the PTT-01 (Universal Push-to-Talk Switch) and the PTT-02 (Universal VOX Switch). These small black-plastic units let you control your radio via either PTT only (with the PTT-01) or with PTT or VOX (with the PTT-02). Each requires a 9-V battery. A slide switch at one end of each unit turns it off or selects different operating modes. Both units offer a way to tailor your transmit audio, too. The four-foot-long pigtail cable can be terminated with a suitable plug for your transceiver.

Plug your HS-03 into the mike jack on the PTT-01, and you can remotely control the PTT line of your transceiver. This accessory also has a built-in preamplifier with a recessed level control. A slide switch lets you choose **OFF**, **LOCAL** or **DX** settings. The **LOCAL** setting is supposed to provide a flat frequency response, and the **DX** setting has a 6 to 8-dB rise at 2 kHz. When I tried the **DX** preamplifier setting on HF, other ops reported that it sounded tinny. The **LOCAL** setting seemed best for casual operating.

The slide switch on the PTT-02 offers **OFF**, **PTT** and **VOX** positions. The PTT button on the PTT-02 is a toggle. Press it to key the radio, press it again to return to receive. A recessed output level control, and a second (recessed) control let you adjust a 2-kHz equalizer. (As with the PTT-01, a tool is provided for these adjustments.) The equalizer is supposed to be 0 dB to 8 dB. On HF, the equalizer added some "punch" to the HS-03's audio. Since the PTT-02 provides VOX for virtually any radio, it could be wired for use with a hand-held. This might be handy while doing tower work, for instance, so you could enjoy hands-free communication with your ground crew.

Conclusions

The Azden HS-03 works well, is comfortable to wear, and looks good, too. The Universal VOX and PTT boxes are handy accessories. The Azden HS-03 deserves a serious look if you're in the market for a lightweight boom-microphone headset.

Manufacturer: Azden Communications Division, 147 New Hyde Park Rd, Franklin Square, NY 11010; tel 516-328-7501; fax 516-328-7506. Manufacturer's suggested retail prices: HS-03 Headset, $69.95; PTT-01, $40; PTT-02 (for VOX), $50.