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Product Review

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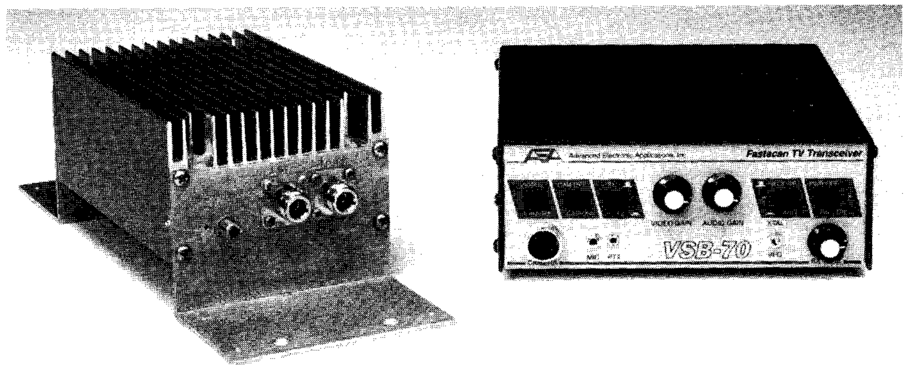
Advanced Electronic Applications Fast-Scan Television System

Reviewed by Ralph Taggart, WB8DQT, ARRL Technical Advisor



Amateur Television (ATV) activity on the 420- to 450-MHz band has grown steadily for several years.[1] Largely, this has resulted from the availability of relatively inexpensive ATV transceivers, "brick"-type amplifiers, wide-bandwidth, high-gain antennas, and the proliferation of home video equipment, especially the VCR and camcorder. Historically, the ATV market has been quite modest and most manufacturers are relatively small concerns that have carved out market segments by virtue of high-quality products and good customer service. The introduction of a complete ATV system made by AEA represents an entry by a new, larger player in a market that seems poised for significant growth.

The AEA ATV system consists of the VSB-70 video/audio transceiver, the RLA-70 mast-mounted power amplifier/preamplifier and its companion controller/power supply, the MPS-100, and the 430-16 16-element Yagi antenna. Each of these items can be used in conjunction with other equipment, but AEA markets them as a system that permits those with no previous video experience to put a medium-power ATV station on the air with relatively little effort.

THE VSB-70 VIDEO/AUDIO TRANSCEIVER

The VSB-70 is packaged in a heavy-gauge, low-profile aluminum cabinet. Its cover is secured with machine screws and threaded inserts to provide good RF shielding. A single circuit board holds the VSB-70's components.

Rear-panel connectors include a BNC jack for the antenna, an F connector that accepts a standard video cable (75 ohms) for connection to the TV set, a coaxial socket for 12-V dc power, and phono jacks for external video and line-level audio input. Front-panel connections include a 10-pin socket for interconnection to properly equipped cameras, and 3.5-mm (microphone) and 2.5 mm (push-to-talk) phone jacks for connection of a 600-ohm microphone like those commonly used with portable cassette recorders.

Front-panel push-button switches configure the system. Frequency selection is accomplished with the **F1/F2** switch. With the standard crystals, **F1** corresponds to 434 MHz and **F2** is 439.25 MHz. (These frequencies are not marked on the front panel.) Optional crystals are available for 421.25 and 426.25 MHz. The frequency switch works in conjunction with the **XTAL/VFO** switch located next to the receiver-tuning control. In the receive mode, **F1** and **F2** provide crystal-controlled operation with the toggle switch in the **XTAL** position, and variable tuning is available in the **VFO** position. On transmit, the signal is crystal-controlled at either **F1** or **F2**. If an external microphone with a control switch is connected to the microphone and PTT jacks, the microphone-mounted switch can be used to key the transmitter.

The **VIDEO/CAMERA** switch selects the video and audio sources. In the **CAMERA** position, video and audio lines from the **CAMERA** connector are routed to the modulator circuits. In the **VIDEO** position, video and audio signals are routed from the rear-panel phono jacks. External video switches can, of course, be used to connect multiple sources to the rear-panel connectors. The **CAM OFF/CAM ON** switch enables dc power to the camera socket. Video and audio gain are independently adjustable from the front panel.

Technical Highlights

The typical ATV transceiver consists of a low-power 70-cm transmitter strip, circuits for double-sideband AM video modulation and provisions to inject a 4.5-MHz FM audio (aural) subcarrier to provide sound capability using a broadcast TV receiver. These units usually also contain a tunable receive converter that provides video and audio output on broadcast TV channel 3 or 4. These low-power trans-

Table 1
AEA VSB-70 70-Cm Fast-Scan Television Transceiver, Serial No. 0020

Manufacturer's Claimed Specifications	*Measured in the ARRL Lab*
Frequency coverage: Receive, 420-450 MHz; transmit, 434.0 and 439.25 MHz standard, 421.25 and 426.25 MHz optional.	As specified.
Mode of operation: Vestigial sideband with 4.5-MHz aural subcarrier.	As specified.
Power requirement: 13.1-14.1 V dc at 1.5 A.	As specified.
Receiver	*Receiver Dynamic Testing*
Noise figure: 1.5 dB typ.	1.55 dB.
Conversion gain: Not specified.	29.5 dB.
IF output: TV channel 3 or 4.	As specified.
Transmitter	*Transmitter Dynamic Testing*
Transmitter power output: 1 W PEP.	1.6 W.
Spurious-signal and harmonic suppression: Not specified	All spurious and harmonic outputs are at least 56 dB down from peak fundamental output. Meets FCC spectral-purity specifications for equipment in its power-output class and frequency range.
Size (height, width, depth): 7.4 × 8.3 × 2.6 inches; weight, 2.2 lb.	

[1]If you're interested in learning more about ATV, see Chapter 20 of *The 1992 ARRL Handbook*.

ceivers (typically providing 1-3 W PEP output) are adequate for local communication when used with an effective antenna system. Linear amplifiers can be used to increase the power output for working over longer paths and taking best advantage of the opportunities provided by band openings.

The VSB-70 transceiver, functionally equivalent to similar units from other manufacturers, reflects a considerable R&D effort to produce a unit that more closely emulates broadcast TV standards than other current equipment. In the first major departure from current ATV practice, the VSB-70 integrates transmit and receive-converter functions in a single unit. Taking advantage of components refined by the commercial video industry, the transmitter chain begins by producing a high-quality composite video signal on broadcast TV channel 3 or 4. Channel selection is done via a jumper on the circuit board. The following discussion assumes that channel 3 has been selected.

The local-oscillator (LO) chain is controlled by one of two crystals. LO injection and the 61.25-MHz composite video signal drive a mixer, resulting in (after filtering) a composite video signal at 439.25 or 434 MHz. This signal is then amplified in a two-transistor class-A final amplifier that produces a nominal 1 W PEP output. The video circuits provide the ability to "stretch" the transmitted sync pulses (increasing their amplitude relative to the video waveform) to overcome the nonlinearity typical of many solid-state power amplifiers. This feature is not required for use with the AEA RLA-70 amplifier, but it is useful in optimizing power output with many of the general-purpose brick amplifiers that are available.

The receiving circuit employs a low-noise GaAsFET preamplifier. Local-oscillator injection on receive comes either from the transmitter LO chain (for crystal-controlled reception at 439.25 or 434 MHz) or a varactor-tuned LO source, controlled by a front-panel potentiometer, that provides reception across the entire 70-cm band.

In addition to breaking new ground with a commercial ATV transverter, AEA has opted to produce a unit that generates a near-broadcast-standard vestigial sideband (VSB) signal, in contrast to the double-sideband (DSB) signal produced by most ATV transmitters. Video modulation of a typical 70-cm transmitter produces both upper and lower video sidebands. Assuming the system injects a 4.5-MHz FM sound subcarrier, the resulting signal bandwidth exceeds 9 MHz. Although the power density is not very high out beyond 1 MHz from the carrier frequency (except in the vicinity of the aural subcarrier, 4.5 MHz above and below the carrier frequency), the lower video/aural sideband is essentially wasted since TV sets are designed to demodulate the upper video sideband.

To conserve spectrum and minimize the potential for adjacent-channel interference, the FCC requires that broadcast TV stations utilize VSB techniques that suppress the lower sideband. This is *not* equivalent to single sideband: VSB signals retain the carrier and a significant amount of LSB energy adjacent to the carrier frequency. Lower-sideband products farther from the carrier are suppressed significantly, however. In the VSB-70, the LSB audio subcarrier (4.5 MHz below the carrier frequency) is more than 40 dB down from the USB aural subcarrier.

Vestigial sideband has been used relatively infrequently by amateurs, with the exception of in-band 70-cm ATV repeaters, where extreme measures are required to isolate the wideband input and output signals. The most common approach has been to utilize a very sharply tuned, multipole interdigital filter at the transmitter output. These filters are bulky and, due to the precise nature of their construction and tuning, are basically single-frequency devices. Effective VSB filters start at about $250, and a repeater installation may use one at the transmitter and another at the repeater input for maximum isolation.

In the AEA VSB-70, the video-modulated channel-3 signal is DSB, just as in typical 70-cm ATV transmitters. The output of the channel-3 generator is passed through a surface acoustic wave (SAW) filter to suppress the LSB signal components. Careful control of bias and operating conditions of the subsequent amplifier stages is required to retain the VSB signal characteristics, but the end result is a near-broadcast-standard VSB signal from the VSB-70.

Operation

The 14-page VSB-70 instruction manual describes installation and use. It also includes a schematic, parts layout diagram, and a complete technical description. The manual is clearly written, easy to read and adequate in terms of setting up and operating the system. Although the system has been designed to be easy to use without any prior understanding of TV video and signal formats, a few additional pages on such topics would be a welcome addition. Such material would serve to bring the new ATV operator up to speed on terminology likely to be encountered on the air. All necessary connectors are supplied and installing the VSB-70 is no more complex than putting a typical VHF FM transceiver on the air.

The VSB-70 has no high-SWR protection circuitry. The instructions explicitly state that the unit must not be operated in the transmit mode without a load and that the transmission-line SWR must be under 1.8:1. This presents a bit of a practical dilemma for new 70-cm operators. Although no-tune antennas can probably be assumed to meet this specification, the integrity of the feed line, connector problems and moisture in the feed line can all adversely affect SWR. The VSB-70's 1-W PEP output is a bit too low for SWR measurements using common SWR meters. Given the dire warnings in the manual, newcomers will surely experience a sense of adventure the first time they place the VSB-70 in the transmit mode!

VSB-70 receiver performance is excellent (see Table 1). The VSB-70's noise figure is good enough that none of my 70-cm preamps noticeably improve its receiver performance.

Intermodulation products can vex ATV operators if there are local UHF broadcast stations or high levels of FM activity in the 440-450 MHz portion of the band. No converter is likely to be free of such spurious products under all conditions, but the VSB-70 is certainly equal to the best converters I have used.

One great feature of the VSB-70 is its flexibility in receiver-frequency selection. The **F1/F2** switch lets you quickly shift between the two crystal-controlled frequencies, and the **XTAL/VFO** toggle switch provides a continuous-tuning option. Shortly after putting the unit into service, I had the opportunity to take advantage of this flexibility during a relatively rare winter band opening. A station in Cincinnati (about 225 miles away) was transmitting at 439.25 MHz while another station in northern Kentucky (about 250 miles out) was transmitting at 434 MHz. With the **XTAL/VFO** toggle switch in the **XTAL** position, I could monitor both stations by simply switching between F1 and F2. The variable tuning control is useful for local work, optimizing color while minimizing interference from FM repeaters, but the crystal-controlled option is nice for long-haul paths where you want to monitor a frequency without the uncertainties of optimizing VFO tuning.

One of the striking aspects of putting the transmitter section on the air for the first time is the high image quality on the station TV receiver. Most transceivers create a distorted image because you're looking at the 70-cm output signal, typically via overloaded converter circuits. With the VSB-70, you're watching the composite video signal generated on channel 3, and there is no overloading or distortion. This makes it very easy to set up a transmitted scene for optimum lighting, composition and video gain. In effect, the TV receiver functions as a large-screen viewfinder. The system does not monitor the 70-cm output signal; that typically requires an RF line sampler and monitor to do an adequate job. Such monitoring is not necessary with the AEA system but is desirable if you are driving an external amplifier other than the RLA-70.

The video modulator shows excellent linearity when used with a wide range of video sources. Image quality is entirely a function of source quality. Measured power output under video modulation ranged from 400-500 mW, consistent with a peak output of 1 W on sync peaks. Out to a distance of about 8 miles, the system consistently received P5 signal reports (noise free). Over paths ranging from 15-20 miles, signal reports varied from P3 (significant snow but good picture detail) to P4 (slight noise/snow), depending on the path and the equipment at the receiving end.

The VSB-70 worked well throughout the evaluation period. One of the outstanding areas of performance of the VSB-70 is its subcarrier sound system. ATV systems inject the aural subcarrier along with the video signal, in contrast to the independent sound transmitters employed by broadcast TV stations. In many cases, this amateur practice results in a situation where the sound quality varies, is difficult to tune properly, and tends to drop into the noise with anything other than an extremely strong signal. The VSB-70 audio quality is excellent, tuning is not critical, and usable audio can be obtained with an extremely weak signal. During the review period, three hams in my area purchased VSB-70s, with the sound quality being a major factor in their decisions to do so. During a marginal opening, while testing the RLA-70 amplifier with Jim, K9OMA, over a 100-mile path, my 2-meter FM voice transmissions simply were not making it. My video signal, however, ranged from P2 and P3, and Jim was able to copy the audio subcarrier without difficulty! The VSB-70 makes the audio subcarrier practical for long-haul, point-to-point work, and that's a major achievement.

Table 2

AEA RLA-70/MPS-100 70-Cm Preamplifier and Linear Power Amplifier, Serial No. 0013

Manufacturer's Claimed Specifications	*Measured in the ARRL Lab*
Frequency coverage: 420-450 MHz.	As specified.
Power requirement: RLA-70, 28 V dc at 5 A max (supplied by MPS-100 power supply); MPS-100, 120 V ac, 50 or 60 Hz.	As specified.
Preamplifier	*Preamplifier Dynamic Testing*
Noise figure: 1.5 dB typ.	1.8 dB.
Gain: 10 dB typ.	12.8 dB.
Power Amplifier	*Power Amplifier Dynamic Testing*
Power output: 50 W min.	65.4 W.
Gain: 20 dB min at 0.5 W input.	Not measured.
TR switching: RF-sensed or contact closure (24 V dc open-circuit, 40 mA closed-circuit).	As specified.
Spurious-signal and harmonic suppression: Not specified.	All spurious and harmonic outputs are at least 56 dB down from peak fundamental output. Meets FCC spectral-purity specifications for equipment in its power-output class and frequency range.

Size (height, width, depth): MPS-100, 4.5 × 10.5 × 6.75 inches; weight, approx 12 lb; RLA-70, 4 × 4.6 × 13 inches including mounting flanges; weight, approx 5 lb.

THE RLA-70 POWER AMPLIFIER/ PREAMPLIFIER AND MPS-100 POWER SUPPLY

The VSB-70's 1-W PEP output is adequate for local work, but more power is desirable for long paths and for working stations during band openings. Almost any 70-cm linear power amplifier can be used with the VSB-70, but AEA has obviously put considerable engineering effort into making the most of the capabilities of the transceiver and the integrated system. The rationale behind the use of a remote power amplifier/preamplifier is to eliminate the effects of feed-line loss between the transceiver/power supply and the remote amplifier. Properly installed, the short feed line between the antenna and the RLA-70 shouldn't degrade the amplifier's 50-W nominal power output or receiver noise figure by any more than a few hundredths of a decibel.

Female N connectors are used for RF input and output. Because the RLA-70 is rated to deliver full output with 500 mW of drive, the RLA-70 can develop full output with feed-line losses of up to 3 dB between the VSB-70 and RLA-70. Assuming a 3-dB line loss, 50 W at the antenna is equivalent to using a 100-W amplifier in the shack. Also, the VSB-70/RLA-70 arrangement improves receiver noise figure by 3 dB in the same system. This is one of the most significant attributes of the remote-amplifier system.

Packaging, Controls, and Interfacing

The RLA-70 system consists of two components: the MPS-100 power supply/control unit and the weather-sealed RLA-70 power amplifier/preamplifier. The amplifier case includes a heat sink and flanges for mast mounting. The case is completely weatherproofed with silicone sealant. The N connectors for RF input and output and F connector for remote TR switching are located at one end of the amplifier so that it can be mounted with all connections facing downward. An optional sun shield is available for use in areas where sunlight may overheat the amplifier.

Technical Highlights

The MPS-100 includes a 28-V regulated power supply and control circuits. It applies dc power to the output N connector through an RF choke. The supply is rated at 6 A and nominal current demand in TV service is in the 4- to 5-A range. Additional components are included to provide 13.8-V regulated dc (up to 2 A) for the VSB-70 transceiver and a camera. The **TRANSMIT** indicator operates based on the dc current drawn by the remote amplifier. An **OVERLOAD** indicator is activated when the voltage across the regulator circuit (an indication of total current drain) reaches the maximum safe level.

The RF preamplifier in the remote RLA-70 amplifier uses a dual-gate MRF966 GaAsFET. The RF power amplifier is a two-stage class-AB design using a 2N6439 as the output device. The TR-switching relay is normally activated by the RLA-70's integral RF-sensing circuit, which switches at drive levels above about 200 mW. The amplifier can be manually TR-switched by grounding the center conductor of the RLA-70's F connector. (For SSB and CW use, manual switching is usually used to prevent unnecessary relay cycling.) Another relay bypasses the preamp and power-amplifier circuits when the SWR-protection circuit senses an SWR over 2.5:1.

If a conventional amplifier is driven by a transceiver such as the VSB-70, the amplifier output will contain a significant LSB component as a result of intermodulation products. By using relatively sophisticated transistor biasing in the RLA-70, AEA has minimized regeneration of unwanted LSB products in the amplifier.

Installation

The MPS-100/RLA-70 package includes a complete set of RF connectors, a coaxial power connector to permit the VSB-70 power cable to be interconnected to the MPS-100, and mounting hardware to secure the RLA-70 to the antenna mast. The 9-page operating manual doesn't contain as much of a technical description as the VSB-70 documentation, but does include a schematic for both units. The manual clearly states that breaking the amplifier's weather seal voids the warranty. The manual also prominently mentions the biohazards associated with the high RF output at 70 cm. Although the amplifier is rated at only 50 W PEP, ERP in the antenna's main lobe is more than 1 kW with AEA's 430-16 Yagi—a potentially hazardous RF level at 70 cm. It's good to see that AEA takes this seriously.

Operation

The advantage of setting the receiver noise figure prior to the feed-line losses is immediately obvious. At my station, it improved weak-signal copy by at least one P unit.

Fifty watts of RF at the antenna appears to represent a very practical power level. Noise-free (P5) pictures out to about 20 miles are routine, even over obstructed paths. Long-term comparisons of signal levels, given the daily variation in band conditions common at 70 cm, showed that the difference between the 150-W amplifier in the shack and the 50-W mast-mounted RLA-70 was perceptible, but insignificant in practical terms.

The RLA-70 succeeds admirably in providing a simple approach to getting an effective ATV signal on the air. Its 50-W power level isn't excessive for local work, yet is adequate to work real DX when the band is open. Those new to ATV will appreciate this simplicity but experienced operators may feel somewhat isolated from the remote amplifier system. Unless you take the trouble to install a remote directional coupler between the RLA-70 output and the antenna, there is no practical way to measure your actual power output and SWR. The MPS-100's **TRANSMIT** indicator is not simply switched on and off—its brightness is roughly proportional to power output—but like many such simple indicators, it is sensitive to SWR. It's brighter during a rainstorm, for example, than in dry weather. Monitored over the long term, however, it provides a crude indication of normal and abnormal system operation.

If the RLA-70's high-SWR-shutdown circuit activates, you must cycle the MPS-100's power switch to restore operation. This occurred only once during the evaluation period, during an ice storm that had deposited a very thick glaze on the antenna. The RLA-70 shut down almost immediately when I transmitted into it. The circuit operates effectively to protect the amplifier, but doesn't offer much feedback to the operator. The only indication of the shutdown is that the **TRANSMIT** indicator doesn't come on when the transmitter is keyed. The system comes back on line when the power switch is cycled and, although shutdown occurred only once and under extreme conditions, the incident heightened my sense of isolation from the remote system.

The **OVERLOAD** indicator never activated when I operated the amplifier with the VSB-70 transceiver as the driver, but will indicate overdrive if driven by more than a few watts of FM or SSB from another source. The amplifier appears to produce excellent results in these other modes if drive is kept below the point where the LED begins to illuminate. Because AM linear operation is perhaps the most demanding mode for any amplifier, this is not surprising. The RLA-70 provides the advantages of a remote preamplifier and power amplifier when used with almost any 70-cm FM or multimode transceiver, but only at the appropriate drive levels.

THE 430-16 WIDEBAND 70-CM YAGI ANTENNA

The 430-16 antenna is a fairly conventional 16-element Yagi using a 10-foot boom made of three lengths of swaged aluminum tubing. The boom sections are secured by stainless-steel machine screws and nuts. The 14 directors and reflector, constructed of well-finished aluminum rod, are mounted using a procedure commonly used in UHF beams: The elements mount through the boom using a pair of plastic shoulder washers and are retained with stainless-steel keepers that slide over the elements.

Promotional photographs show this antenna constructed of square aluminum tubing, but current models are constructed from conventional round stock. The driven element is unique in that it is constructed in a butterfly shape, using heavy aluminum rod. The rod ends fold back on themselves and are welded in place. The driven element is centered on a substantial machined aluminum block secured to the boom with a machine bolt that engages a threaded hole in the block. Large plastic shoulder washers insulate the element where it emerges from the block. A 4:1 balun made of a half-wavelength loop of coaxial cable is equipped with F connectors that mate with connectors installed on the aluminum block. A female N connector on the block provides for connection or the feed line. Both the balun and feed-line connectors should be weatherproofed and taped for maximum protection.

The Yagi is rated at 250 W and comes with all the necessary mounting hardware. Assembly is straightforward and perhaps easier than many designs because the driven-element assembly is put together at the factory. It requires no tuning or matching adjustments.

I installed the antenna at a height of approximately 25 feet. A hundred feet of Andrew half-inch Heliax was used as the primary transmission line with a flex loop made of 8 feet of Belden 9913. Far less elaborate than the installations of hard-core ATV operators, where high towers and 7/8-inch Hardline are the rule, this system is fairly typical of what new operators on the band might use.

The AEA antenna has wide frequency response and a clean pattern. The main lobe is well-defined, but not so sharp as to present practical difficulties in orienting the antenna. The 430-16 presents an SWR below 1.1:1 at 440 MHz and less than 1.3:1 at the band edges. The antenna provides the expected gain increase over a smaller Yagi located at the same site.

Summary

One objective of AEA's approach to the integration of their TV system components was to provide a near-turnkey approach to setting up an ATV station. This objective has certainly been realized. Both the VSB-70 transceiver and 430-16 antenna are competitively priced and do a very effective job. The good performance of the VSB-70 alone makes it a great way to enter the ATV scene.

The MPS-100/RLA-70 combination is obviously the most expensive component of the AEA system. Is it cost-effective? From the transmitting end, a fair market comparison would involve a 100-W brick amplifier and a suitable ac-operated power supply. This combination will provide the same antenna-system ERP, assuming 3 dB of transmission-line loss. There is no doubt that such an installation can be purchased for less than the cost of the AEA amplifier system. The two are not equivalent, however, if you also factor in receiver performance. An installation equivalent to the MPS-100/RLA-70 combination would also require a remote GaAsFET preamplifier at the antenna with provisions for powering the preamp and performing the necessary RF switching at the 50-100 W power level. This comes close to eliminating the financial differential between the two systems. The value of the compact and simple AEA system—which includes remote-system control and protection circuitry—versus a more conventional component approach is a matter of personal preference, but weighs heavily in the case of newcomers to 70 cm who want to have an effective signal without the complexity of a system built from many separate parts.

If VSB capability is desirable to you, the price edge clearly belongs with the MPS-100/RLA-70 in the medium-power range. Filters capable of providing the 20-30 dB of lower sideband aural-subcarrier suppression easily raise the total system cost to a level comparable to, or even exceeding, that of the AEA system.

AEA sees the potential for considerable growth in amateur television. As in most areas of Amateur Radio today, the new ATV market will demand well-engineered, modular systems that can be put on the air without the need for extensive ATV background. AEA is providing this market with just such a system.

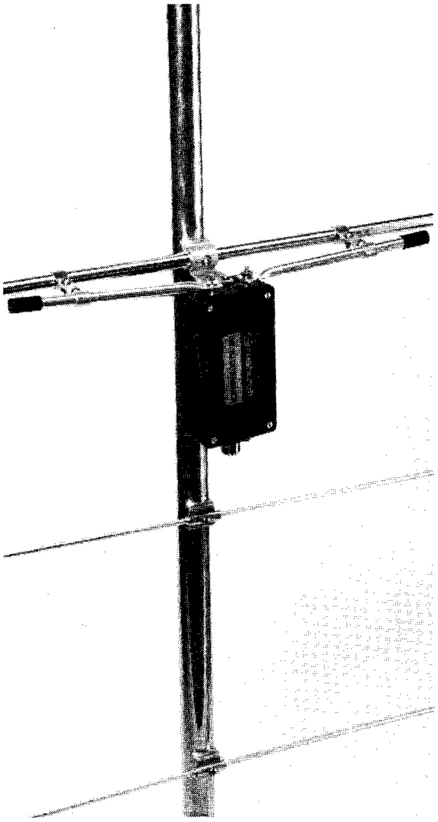
Manufacturer: Advanced Electronic Applications, Inc, PO Box C2160, Lynnwood, WA 98036-0918, tel 206-775-7373. Manufacturer's suggested retail prices: VSB-70, $379; RLA-70/MPS-100, $699; 430-16, $119.

CUSHCRAFT 13B2 2-METER "BOOMER" YAGI ANTENNA

Reviewed by Zack Lau, KH6CP

Looking for a 2-meter antenna with good gain and a clean pattern to reduce interference? The 13B2 not only provides both, but offers improvements in materials and assembly over older Cushcraft models.

The 13B2's 2.2-wavelength boom, just over 15 feet long, is made of a 6-foot center section of 1-1/4 inch aluminum and 1-1/8-inch end sections of 4 and 6 feet. Hose clamps and #8 stainless-steel hardware hold the boom sections together. The boom-to-mast bracket accepts 1.5- to 2-inch masts. The aluminum-rod elements mount to the boom with small aluminum brackets and stainless-steel screws and nuts,



13B2 feed-point detail.

just like other Cushcraft 2-meter Yagis made over the last several years. The 13B2's wind load is rated at 1.8 square feet and its turning radius is 8.9 feet.

The antenna employs stainless-steel hardware, except for the screws that secure the cover of the plastic balun enclosure. (Even if these screws rust, they'd be much easier to remove from the plastic box than from a metal one.) The feed-line connector is a four-hole, flange-mount female UHF type (SO-239). Those who prefer to use N connectors can easily replace the SO-239 with a UG-58 female N connector. I consider this an improvement over earlier Cushcraft antennas, which used driven-element assemblies that were difficult to modify.

The 13B2's **T** match undoubtedly helps keep the pattern clean, and seems to be an improvement over the gamma match. The latter was apparently named by H. H. Washburn, W3MTE, in September 1949 *QST*, because half a **T** looks like the Greek capital letter gamma, Γ. Washburn realized that it wasn't as good as the **T** match he was trying to build, saying, "This was ten-meter 'phone, not radar." Of course, on today's busy amateur bands, a good pattern is usually a great asset.

Although the 13B2 is well made, it shares a problem with older Cushcrafts I've used—many of the pieces have sharp edges. It would be nice if they were better finished, though I doubt that many amateurs would appreciate the increased cost of doing so.

Documentation

The assembly documentation that comes with the 13B2 is considerably better than older Cushcraft manuals. For instance, the 13B2's manual gives tuning settings for the driven element. You simply assemble the antenna according to the dimensions and see how the antenna works in your location. If it doesn't behave as the documentation says it should, it's probably being affected too heavily by objects around it. The manual for my older Cushcraft 7-element 2-meter Yagi instructed users that the match was adjusted at the factory, but to tune the antenna once it was installed. No dimensions were given. I like the new method much better, since any location that requires extensive retuning undoubtedly affects the pattern as well. This way, you can more easily determine if you've mounted the antenna in a location that adversely affects its performance.

Installation and Use

As the SWR specifications and my measurements indicate, this antenna exhibits an SWR of under 2:1 over the entire 2-meter band. Tuned as the manual suggests, the antenna's SWR is best at the low end, but is easy to retune for other parts of the band. The antenna is rated at 2 kW.

Those installing the 13B2 vertically polarized should note that the drain holes in the balun enclosure are appropriately located for horizontal polarization. New holes are needed to ensure moisture drainage in vertically polarized installations. Sealing the box is not recommended—when this is done, water condenses in the box, causing corrosion.

The rule of thumb for mounting antennas for different bands on the same mast is to space them half the boom length or half a wavelength for the higher-frequency antenna, whichever is greater. For the 13B2, this is 7.5 feet—no problem if you planned on using a 10-foot mast, but a rude shock if you wanted an antenna just a few feet above that HF array. One solution is to use a smaller antenna that doesn't need as much room to work properly. The situation probably isn't as bad with cross-polarized antennas, but analyzing what's happening can be difficult, even with computer-modeling software. If you don't have a choice, mount the 13B2 as far from surrounding antennas as you can. Unusual SWR or bandwidth characteristics will tell you if the antennas are interacting too heavily.

Summary—And a Word on Antenna Selection for Packet Radio

So, how does it play? In the January VHF Sweepstakes, one of the first contacts I made on 2 meters was with VE3ASO, about 300 miles away. Not bad for about 7 watts of SSB. For normal DX work, the clean pattern really makes a difference, as having the QRM go away when you turn the beam lets you hear the stations on the same frequency but with different beam headings.

The 13B2 is a good choice in a medium-sized 2-meter Yagi if you want a clean pattern and can give the antenna both the vertical and horizontal space it needs to work properly. The antenna travels well, is small enough to carry to some portable locations (although it's big enough that it needs to be mounted on a guyed mast), and provides enough gain for serious weak-signal work from a home station—especially for those who can't, or don't want to, step up to a longer-boom 2-meter Yagi.

For general-purpose packet-radio use, you should consider installing an omnidirectional antenna with some gain, such as a collinear vertical. The basic reason for this is that packet works best when you can hear other stations transmitting on your frequency so your transmitter doesn't trash others' packets. The 13B2 is fine for one-on-one packet activity, but I can't recommend it (or any other beam) for checking into a busy packet bulletin-board system. For non-packet FM, as well as SSB, CW and other modes, the 13B2's clean pattern and good gain will serve most users well.

Manufacturer: Cushcraft Corp, 48 Perimeter Rd, Manchester, NH 03108, tel 603-627-7877, fax 603-627-1764. Manufacturer's suggested retail price: $135.

OAK HILLS RESEARCH 40-METER QRP TRANSCEIVER KIT

Reviewed by Jim Kearman, KR1S

Oak Hills Research produces a small but growing line of kits for Amateur Radio enthusiasts, including a pair of single-band CW transceivers, the QRP 40 and QRP 20, for 40 and 20 meters, respectively. These little rigs feature VFO control, receiver-incremental tuning (RIT), superhet receivers with crystal filters, and 12-V dc operation. The QRP 40 is reviewed here.

Building the kit is not much different from building a project published in a book or magazine, but without the time it takes to hunt down all the parts. Parts are packaged in a handful of plastic bags. The instruction manuals are several photocopied pages, which consist mostly of checklists and part-placement drawings. If your previous kit-building experience was with Heathkits and you haven't done much home building, you'll find the kit challenging.

The transceiver circuit board is densely packed, and some care is required to correctly place all components. What I found hardest was reading the values marked on the monolithic capacitors, which are packed together in one bag. I needed a fluorescent lamp with a large built-in magnifier to complete the task. Once I had sorted the capacitors, I taped them to a piece of cardboard, on which I wrote their values in large print.

To make building the kit even more like home-brewing, I also had to wind several toroidal coils and transformers. According to Oak Hills proprietor Dick Witzke, KE8KL, some builders have had difficulty winding the toroids. In response to this difficulty, Oak Hills Research now winds the toroids. The Ten-Tec cabinet supplied with each kit comes painted and ready to use, with control and connector labels in place and all the necessary holes punched. These two features save quite a bit of time compared to doing it yourself.

Aligning the transceiver requires very little equipment. A frequency counter is useful for setting the VFO frequency, but you can also use an accurately calibrated receiver. You compress or expand the winding on the VFO's toroidal inductor to set the VFO tuning range. Some means of measuring RF voltage is also handy, but alternatively, a QRP wattmeter can be used for transmitter alignment. You can use a signal generator or a transmitter connected to a dummy load to provide a weak signal to align the receiver.

Circuit Description

The transceiver uses a 5-MHz VFO and a heterodyne crystal oscillator. It tunes "backward"; as VFO frequency increases, operating frequency decreases. The VFO tuning capacitor has a built-in reduction drive. The receiver mixer and product detector are NE602 ICs. The transmitter mixer is an MC1496 IC. A single buffer stage after the transmit mixer drives the final amplifier. Five 9-MHz crystals are supplied with the kit. Four of the crystals are packed together, for use in the receiver IF filter. Oak Hills selects these crystals for the 1-kHz IF-filter bandwidth. The fifth crystal is for the BFO. BFO frequency can be adjusted slightly.

A two-pole, active band-pass filter provides audio selectivity. The center frequency of this filter is about 800 Hz. (Almost every ham I know prefers to copy CW at a pitch of about 400 to 500 Hz, but equipment manufacturers still haven't caught on.) You can change this filter's center frequency by replacing C34, C35, C37 and C40 with larger values (to lower the frequency). If you do, you'll want to use a different transmitter-frequency offset so you can properly zero beat the stations you call.

While you're at it, adjust the transmitter's sidetone-oscillator frequency to match the filter's center frequency. Having the same sidetone frequency makes it easier to zero beat because your ears become accustomed to that frequency. Sidetone oscillator output enters the audio chain after the filter, so you can use a different sidetone pitch if you prefer (that way, the sidetone signal won't be attenuated by the audio filter).

Automatic gain control (AGC) voltage is derived from the audio stage after the

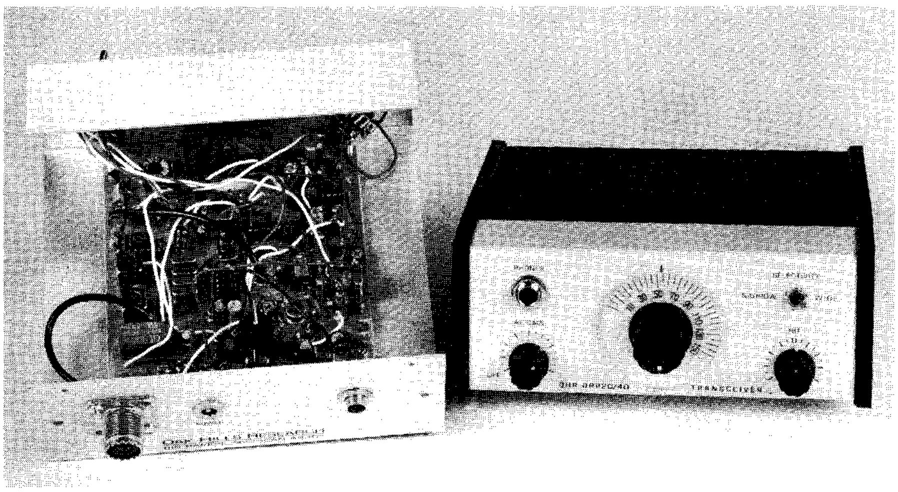


Table 3

Oak Hills Research 7-MHz QRP Transceiver Kit

Manufacturer's Claimed Specifications	*Measured in the ARRL Lab*
Frequency coverage: 150 kHz of the 40-meter band.	139 kHz.
Mode of operation: CW.	As specified.
Power requirement: 12 V dc at 60 mA on receive and 800 mA on transmit.	At 13.8 V: Receive, 99 mA max; transmit, 1.13 A.
Receiver	*Receiver Dynamic Testing*
Sensitivity: Not specified.	Minimum discernible signal (noise floor) with NARROW IF filter: −129 dBm.
Dynamic range: Not specified.	Blocking dynamic range (NARROW IF filter):* 108 dB.
	Two-tone, third-order intermodulation distortion dynamic range (NARROW IF filter):* 83 dB.
Third-order input intercept: Not specified.	−4.5 dBm.
Receiver audio output: Not specified.	0.14 W at 10% THD into 8 Ω.
Transmitter	*Transmitter Dynamic Testing*
Transmitter power output: 3 W typ.	4.1 W max.
Spurious-signal and harmonic suppression: Not specified.	Meets FCC requirements. See Fig 1.
CW-keying characteristics: Not specified.	See Fig 2.

Size (height, width, depth): 2.25 × 6.25 × 6 inches; weight, 1.6 lb.

*Blocking and third-order IMD dynamic range measurements were made at the ARRL Lab standard signal spacing of 20 kHz.

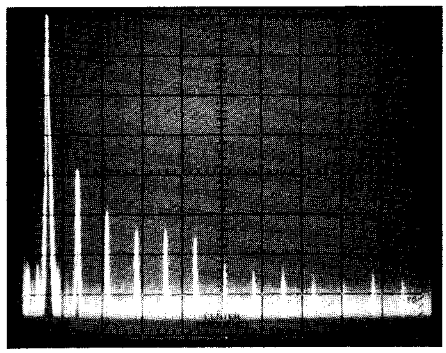


Fig 1—Oak Hills Research QRP 40 worst-case spectral display. Horizontal divisions are 10 MHz; vertical divisions are 10 dB. Output power is approximately 2.9 W at 7.2 MHz. All harmonics and spurious emissions are at least 38 dB below peak fundamental output. The QRP 40 complies with FCC spectral-purity requirements for equipment in this power-output class and frequency range.

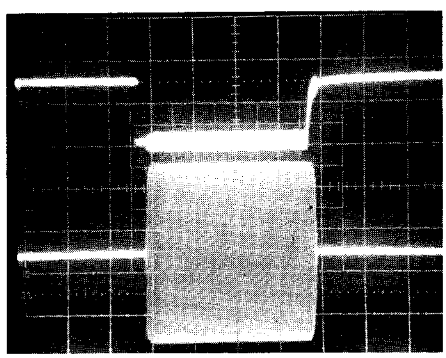


Fig 2—Semi-break-in CW-keying waveform for the Oak Hills Research QRP 40 transceiver. The upper trace is the actual key closure; the lower trace is the RF envelope. Horizontal divisions are 5 ms. The transceiver was being operated at 3.6 W output at 7.2 MHz.

active filter. Audio output from the LM386 amplifier is adequate for driving low-impedance headphones. Receive audio is replaced with a sidetone signal when you key the transmitter. A stereo headphone jack allows use of stereo or monaural headphones. Speaking of connectors, Oak Hills thoughtfully supplies an SO-239 antenna connector, rather than the phono connector sometimes supplied with low-cost, low-power equipment. A double-pole, double-throw relay handles transmit-receive switching. The transceiver doesn't offer *full* break-in, but the transition time is short enough that most operators won't notice.

Will This Thing Get Out?

If you haven't experienced the excitement of making contacts with tiny, low-power equipment you built yourself, building one of these kits is only half the fun you have to look forward to. Performance is generally quite good: the receiver audio is clean and hiss-free, the CW waveform sounds good on the air, the rig doesn't click or pop when you key it, and the AGC is pleasant. Receiver sensitivity is very good for equipment in this price class, as are the radio's blocking and IMD dynamic ranges. All in all, this radio sounds and feels a lot like my Heath HW-9.

You'll be pleasantly surprised at how many stations will copy you well enough for a QSO with this radio. On 40 meters you'll do best during the day, when QRM is lower than at night. QRP activity on 40 centers around 7040 kHz, but don't be afraid to answer any station you hear calling CQ.

Its small size makes this rig ideal for portable operation. If you simply must drill a hole or two in a cabinet, there's room for a keyer inside the cabinet. Add headphones, a paddle, a battery and a dipole and you've got a complete ham station that will fit in a lunch box. Thinking about Field Day? This transceiver will give you plenty of action on Field Day or a weekend camping or backpacking trip.

If you've never built a kit or a homebrew project, this transceiver is an excellent way to get started. Or perhaps you've been wanting to simplify your station or try QRP operating. These kits are simple enough to build that anyone who knows how to solder should be able to get one on the air. I feel that this kit represents a good value. See you on 7040 kHz!

Manufacturer: Oak Hills Research, 20879 Madison St, Big Rapids, MI 49307. Prices: QRP 20 and QRP 40 kits, $149.95 each.

Feedback

☐ In our review of the Drake R8 receiver in March 1992 *QST*, we listed the suggested retail price ($899) for refurbished units, not for new radios. Drake currently sells new R8s for $979 plus $10 shipping and handling in the US; factory-refurbished units are occasionally available for $899. Contact John Schlipp at R. L. Drake Company, PO Box 3006, Miamisburg, OH 45342, tel 513-866-2421, for details.—*NJ2L*