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Product Review

Conducted By Paul K. Pagel,* N1FB

ICOM IC-730 HF Transceiver

☐ My excitement ran high as I took the IC-730 home just in time for the November Sweepstakes phone weekend. I found the instruction manual easy to read, and logically organized. Noticeably missing was much of the literally translated Japanese that seems to plague some imported equipment manuals. A few minutes of reading the manual and checking the controls was all I needed to feel ready for a contact. Front-panel controls are clearly labeled and positioned for ease of operation.

The '730 comes with most of the features now considered standard on an hf transceiver. It covers the ham bands from 80 through 10 meters, including the three WARC bands. Modes of operation are a-m, lsb, usb and cw, with PTT, VOX or semi-break-in operation possible. Controls are provided for mike gain, rf power, af and rf gain, and band selection. An agc circuit with two selectable time constants is provided, but there is no way to turn it off completely. The noise blanker can be turned on or off using a push-button switch on the front panel. (Blanking pulse width is selected as wide or narrow with a control hidden under a removable panel on the case top.) Other features include an rf speech processor, receiver incremental tuning and a digital readout for the two VFOs. There is a built-in receiver preamplifier that is helpful for pulling in weak stations. A band-pass shift control (i-f shift) helps reduce interference from strong stations on nearby frequencies. This control also changes the tone of a received signal, which results in a decrease in the intelligibility of an ssb station.

The review unit was equipped with an optional crystal calibrator and the IC-EX203 150-Hz cw audio filter. An IC-PS15 ac-operated power supply provided the necessary 13.8-V dc at 20 A. This supply is controlled by the power switch on the '730. Other matching accessories available from ICOM include an external speaker, headphones, a mounting bracket for mobile operation, a desk microphone and a hand-held scanning microphone. Additional filters are the FL-45 (500-Hz) cw crystal filter and the FL-44 ssb crystal filter. The FL-30 crystal filter will also convert the i-f shift control to a true pass-band tuning system.

Special Features

Several features of the '730 deserve special attention. A four-bit microcomputer is used to control the phase-locked-loop local oscillator. This allows selection of three tuning rates, determined by push-button switches. You can change the VFO frequency in steps of 1 kHz, 100 Hz or 10 Hz. The faster rate is ideal for tuning from one end of the band to another, and the slower rate is convenient for "fine tuning" a station. The 100-Hz rate is about right for normal tuning, but you will hear the distinct incremental frequency changes as you tune through a signal. Don't be confused, as was one mystified '730 owner that I talked to. The tuning rate refers to the digital tuning jumps, not kilohertz per turn of the knob. A LOCK button prevents changing the operating frequency — a good idea for those of us who are prone to bumping the tuning knob!

Push buttons are used to select VFO A or B, and NORMAL/SPLIT operation. Either VFO can be used independently for transceive, or they can be used in tandem for split-frequency (same band) operation. The frequency of either VFO can be written instantly into the other by using the WRITE button, but be careful. To write the frequency of VFO B into VFO A, you first select VFO A, then push the WRITE button. More than once I tried to do it the other way and found myself with two VFOs at the opposite end of the band! The frequency of VFO A can be written into memory (one frequency per band) and, if the MEMO button is engaged later, it is like having three VFOs. On "power up," both VFOs and the memory will be 100 kHz up from the bottom of the selected band. A rear-panel jack is provided for the connection of +9- to +12-V dc source, such as the optional BC-10A ac-operated supply or the car battery in a mobile installation. This will retain the operating frequency of both VFOs and the memory on each band while the rig is switched off.

The RIT function is activated with a push button; an LED near the control indicates when it is in operation. I expected the digital frequency display to change as I turned the RIT control knob, but found that, as with my analog-readout rig, the displayed frequency remains the same.

A multifunction front-panel meter serves as an S meter on receive, but can indicate a variety of information on transmit. This will depend on the setting of the front-panel meter control and the SWR/SET switch under the top-cover access panel. The front-panel button can be set to indicate ALC or RF output. With this control set for RF output, the top switch can be used to indicate relative output power or SWR.

Also found under the top cover access panel are the VOX GAIN, VOX DELAY, and ANTI-VOX controls. The cw monitor level can be adjusted here, the noise blanker pulse width selected, and the speech processor switched on or off. The crystal calibrator is turned on and the 25- or 100-kHz marker frequency is selected by means of small slide switches. Operating any of these controls will require you to study the underside of the access panel for identification of the tiny controls. You will have to peek through the opening to see which switch you are pushing.

Rear-panel jacks are provided for connection of an antenna, a power cable, a key, an external speaker, a memory back-up supply and an accessory plug. The alc voltage from an external amplifier can be input through a jack provided for that purpose. There is a spring-type ground connector that aids fast connect and disconnect of the ground wire.

Receiver

An incoming signal is routed through a low-pass filter selected by the BAND switch. A preamplifier can be activated to provide about 10 dB of gain, if needed. Next, the signal proceeds to the band-pass filter as selected by the BAND switch. A high-level doubly balanced mixer combines the received signal with the first LO signal to provide the 39.7315-MHz first i-f. A signal from the second LO is combined with the first i-f signal in another high-level doubly balanced mixer to produce a second i-f at 9.0115 MHz. The MODE switch selects an a-m crystal filter only, or the additional ssb or cw crystal filters. With the FL-45 (500-Hz) cw filter installed, the CW-N position selects this filter, while the CW position selects the ssb filter. The signal now is converted to 455 kHz and is fed to either a ceramic filter in the a-m mode or a mechanical filter in the ssb or cw modes. The optional FL-44 ssb crystal

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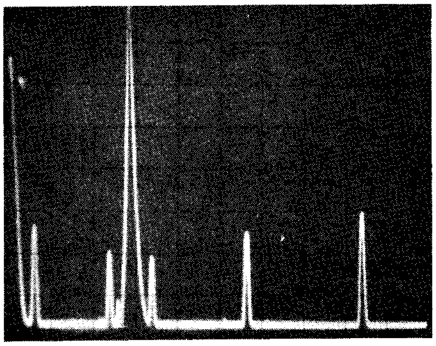


Fig. 1 — Worst-case spectral display of the IC-730. Vertical divisions are each 10 dB and horizontal divisons are each 5 MHz. Output power is approximately 90 W on 20 meters. All spurious emissions are at least 50 dB below peak fundamental output. The IC-730 complies with current FCC specifications for spectral purity.

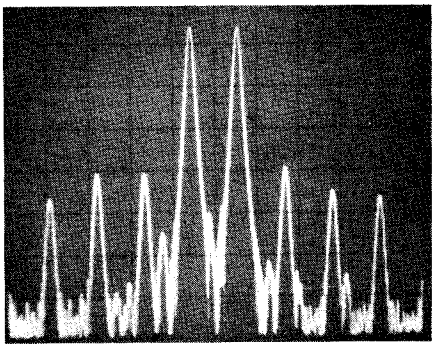


Fig. 2 — Spectral display of the IC-730 during the transmitter two-tone IMD test. Third- and fifth-order products are down 40 dB, and the seventh-order products are down 46 dB. Vertical divisions are each 10 dB, and horizontal divisions are each 10 kHz. The rig was being operated at 80-W PEP output on 20 meters.

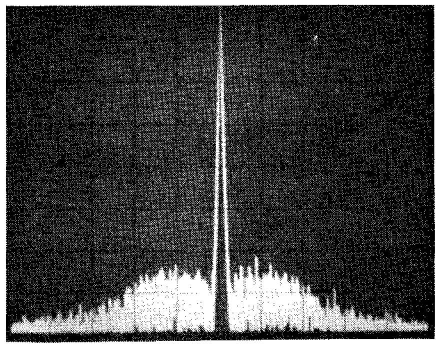


Fig. 3 — Synthesizer noise is shown in this photo. The IC-730 was producing 80 W of output power on 20 meters. Vertical divisions are each 10 dB, and horizontal divisions are each 10 kHz.

ICOM IC-730 HF Transceiver, Serial No. 01519

Manufacturer's Claim Specifications	*Measured in ARRL Lab*		
Frequency coverage: 80 through 10 meters; WARC bands included.	As specified, plus 100 kHz above and below each band edge.		
Modes of operation: lsb, usb, cw, a-m.	As specified.		
Frequency readout: 6-digit blue luminescent display.	3/8-in.-high digits. Also analog marks on tuning knob, every 2 Hz in 10-Hz tuning position.		
kHz/turn of knob: Not specified.	100 kHz/10 kHz/1 kHz for 1 kHz/100 Hz/10 Hz tuning.		
Backlash: Not specified.	Nil.		
RIT range: ±800 Hz.	As specified.		
S-meter sensitivity (μV/S 9): Not specified.	80 m, 150; 40 m, 150; 30 m, 140; 20 m, 160; 17 m, 160; 15 m, 180; 12 m, 190; 10 m, 180.		
Receiver sensitivity: ssb/cw 0.3 μV for 10 dB S + N/N	Receiver dynamics measured with optional IC-EX203 150-Hz audio filter installed. The first number is with the internal preamp on.	*80 m*	*20 m*
	Noise floor (MDS) dBm:	−140	−140
		−134	−133
	Blocking DR (dB):	N.L.†	
	Two-tone 3rd order IMD DR (dB):	N.L.	96
		95	95
	Third-order intercept:	N.L.	+4.0
		+6.5	+9.5
Audio power output (8-ohm load): 2 W.	As specified.		
Power requirements: 13.8-V dc ±15%, negative ground. Current drain 20 A max. (at 200-W input).	Not measured.		
Transmitter rf output power: ssb, 200-W PEP input; cw, 200-W input; a-m, 40-W output maximum.	80- to 100-W output on all bands in cw mode.		
Harmonic suppression: Better than 50 dB.	Second harmonic, −54 dB; third harmonic, −50 dB (Fig. 1).		
Spurious suppression: Better than 50 dB.	−60 dB (Fig. 1).		
Third-order IMD: Not specified.	−40 dB (Fig. 2).		
Color: Black.			
Size (HWD): 3.7 × 9.5 × 10.8 in.††	As specified.		
Weight: 14.1 lb.	As specified.		

†N.L. means noise limited
††mm = in. × 25.4; m = ft X 0.3048; kg = lb × 0.454.

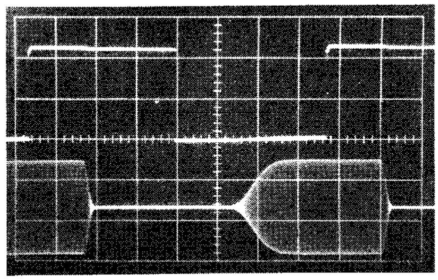


Fig. 4 — The keyed cw waveform of the IC-730 is shown. The upper trace shows actual key closure, while the lower trace shows the rf output envelope. Horizontal divisions are each 10 ms.

filter can be used to replace this mechanical filter if you desire greater ultimate rejection at the −60 dB points and a better i-f shape factor. A 9.4665-MHz LO can be shifted ±1.5 kHz by sliding the IF SHIFT control. This oscillator provides the fourth conversion in the receiver circuit, back to the second i-f of 9.0115 MHz before sending the signal on to the detector and af amplifier.

The review unit also had the 150-Hz audio filter installed. This filter is activated in either CW position, providing a very narrow passband. If you like tuning the band with a wider filter, you will have to switch to the USB mode. But this causes the operating frequency to shift 1.5 kHz. When you find a station you want to copy, and switch to the CW mode, you will have to retune the rig. I found this somewhat annoying.

The receiver proved to be quite sensitive, and displayed good dynamic range. The front end was not "crunched" by most strong, locally generated signals.

Transmitter

The '730 has a solid-state, broad-band transmitter that provides between 80 and 100 W of maximum output power into a 50-ohm load. There is no tune-up required, and the final-amplifier transistors are SWR-protected. I found that the output started to be cut back as the SWR approached 2:1. Most of the time I used a random-length wire antenna (a no. 30 wire out the window and attached to the rain gutter) and a Transmatch in a "no outside antennas" apartment. The Transmatch provided a 50-ohm load on all bands to keep the final transistors "happy."

The MIC GAIN control adjusts the level of modulation, and should be adjusted until the alc meter is moving within the bottom half of the scale. An RF POWER control adjusts the output from about 10 to 100 W. With the speech processor switched on, the MIC GAIN sets the clipping limits while the RF POWER control sets the rf drive level.

There is only one VOX DELAY circuit, so if you like to use VOX on phone and work semi-break-in cw, you will have to readjust the delay each time you change modes. This is not difficult, but can be a nuisance.

The final-amplifier transistors are cooled by a fan that runs only during transmit. A temperature-sensing circuit will switch the fan to a faster speed and keep it on continuously if the transistors reach a temperature of 167° F (75° C). The operating manual warns you to stop transmitting and investigate the cause of the overheating. The fan is fairly quiet, but I found it annoying to have it turning on and off with each cw character being sent.

The cw keying waveform exhibits an excessive delay after key up. The changes suggested in the article by Don McClure, KB2Z, "Keying Improvements to the ICOM IC-730," July 1982 *QST*, pp. 23-27, would make it a better cw rig.

Operating Impressions

I first operated the '730 during the November SS Contest. It didn't take long to really appreciate the ease of operating this rig. With low power and "no antenna," I use the "hunt and pounce" method of contesting. The two VFOs plus memory made it easy to keep tuning and working stations, while jumping back to a pileup and seeking a chance to work a particular station.

The receiver has several "birdies" on each band. Most are just noticeable with no antenna connected, and do not move the S meter. There are three birdies that cause the S-meter needle to move just perceptibly, but these are outside the band edges. One signal at 17.9460 MHz reads S4.

Initially, the review unit seemed to have low audio output, with severe distortion at high volume levels. This was noticeable with the built-in speaker or an external speaker, but not with headphones. In this condition, the rig was totally unacceptable for mobile operation. The high ambient noise level in my car requires lots of audio from the radio, and the '730 just couldn't supply it without distorting the signals to an unintelligible level. Later on, the audio amplifier failed completely and the rig was shipped back to the factory for repair. It was returned promptly, and the audio problems were cured. The rig is now a pleasure to operate while mobile.

Doug DeMaw, W1FB, tested the '730 in anticipation of taking it on a hamcation trip to Barbados. When Doug reported to several station that their frequency was jumping during the QSO, they replied that *his* frequency was *also* changing. What could this problem be? The rig went back to ICOM instead of to Barbados. This repair took about three weeks, with a report that an intermittent had developed in the VFO power supply.

What don't I like about the '730? I would prefer to have separate VOX DELAY controls for ssb and cw operation, and I would like these and other controls to be located on the front panel instead of under the top cover. I would also like to be able to select the 150-Hz audio filter when needed for cw reception. I wonder why no 160-meter position was included. These concerns may be minor when compared with the many good features of the rig.

In conclusion, the IC-730 is a pleasure to operate. It has almost every feature you could ask for, either built-in or available as an accessory. Small size makes it ideal for a mobile installation or traveling, but it will serve nicely in the fixed-station operating position also.

Price class: IC-730, $829 (including mike); IC-PS15, $149; FL-45, $60; IC-EX203, $39. Available from: ICOM America, Inc., 2112 116th Ave., N.E., Bellevue, WA 98004 — *Larry Wolfgang, WA3VIL*

HEATH COMPANY GU-1820 AC POWER SYSTEM

□ Solar-electric power has yet to negate the utility of gasoline-powered ac generators. The latter can provide plenty of watts for operating electrical items, even when the sun is not shining! They are noisy, and they consume gasoline, but they're ideal for emergency and Field Day use by amateurs. The Heath GU-1820 is no exception.

I was surprised to learn that the Heath power system was supplied in kit form. I didn't fancy myself as a mechanic or engine specialist, nor do I at present. Therefore, I was relieved to find that the engine was preassembled and adjusted. A 5-hp Briggs and Stratton engine (3600 rpm) tended to "ice the cake," since that brand has such an outstanding reputation. It was all shiny and black, just waiting to be activated by a mighty pull of the starting rope!

The manufacturer rates the alternator at 2200 W maximum. It is a single-phase, 2-pole, revolving-field, self-excited mechanism. The power factor is 1.0, and regulation is ±5%, no load to full load. The output is 120-V ac at 60 Hz. Running time is 1.75 hours per tank of fuel at one-half load (1100 W).

Assembly

An assembler commences by putting the frame together. You need some tools a bit more rugged than those designed for most radio work, so plan to have a 6- or 8-inch crescent wrench, a pair of pliers, a heavy-duty screwdriver and a socket-wrench set (if available). Watch out for skinned knuckles, for there are some sharp edges on the metal parts of the system.

The engine attaches next, then comes installation of the adaptor housing, followed by insertion of the alternator rotor. So far so good — and no confusing instructions of the kind found with kits for those swing sets, etc., that you've built for your children! If you've ever agonized over the poor language and vagaries of instruction sheets for toys and household items, you'll be delighted with the clarity of the Heath instruction manual.

Assembly of the end-bell parts (mostly electrical) is the next step. But first, the end bearing must be driven into the housing by means of a hammer and wooden rod (supplied). Do this step with care, lest the bearing not start correctly in the hole. Tap and inspect, tap and inspect, until you're sure the bearing is well into the hole and that it has gone into the housing correctly. If it becomes cocked during this step, damage (and frustration) will surely result.

Installation of the electrical wiring and parts comes next. The end bell contains nearly all of the wiring, an electrolytic capacitor, the brushes, a rectifier, a circuit breaker and ac outlet plugs. Once these components are in place you can install the stator for the alternator. Then, some final wiring is done. It consists of connecting the leads from the stator to the appropriate terminals in the end bell. It is necessary also at this juncture to polarize the alternator. The task is a simple one, consisting of attaching a 6- to 15-V dc source to the brushes while observing the proper polarity. This job takes about 15 seconds.

Finally, the end bell is bolted in place and some adhesive-backed labels are affixed to specific parts of the system. My, what a pretty sight the completed power system presented as I stood back and admired my work (and gingerly touched my skinned knuckles). I was anxious to "gas up" and pour in some oil so I could see if it actually would function. More on that later.

Some Problems

The first two alternator rotors had to be sent back to the factory because of damage. The end of the rotor that contains the slip rings for the brushes to contact is made of plastic. The first two units had broken plastic face plates, owing to improper packaging for shipment. The third and final rotor was packed very well, and it was in perfect condition. I assume that Heath has corrected the packaging problem after receiving our recommendations.

I experienced difficulty with the plastic insert (item B5) that mounts in the end bell to secure the brushes. The electrical terminals are affixed to the insert piece by means of sheet-metal screws. The latter must be inserted with great care (and I was careful), for as they develop threads in the plastic the insulating block can become chewed up by the screw. This will result in poor electrical joints; the sheet metal screw may vibrate loose in time. I stripped one of the holes and had to use the next larger size sheet-metal screw to ensure integrity in that part of the system. Use caution when doing this step! I think a better technique would be for the supplier to tap the holes in the plastic insert for, say, a no. 8-32 thread. Then, no. 8-32 bolts could be used to secure the brushes. If there is a weak link in the chain, I'd say this part of the system is it.

My final difficulty came during initial testing of the system. Upon starting the engine, my pulse hastened in anticipation of having ac

Heath Company GU-1820 Portable AC Power System

Manufacturer's Claimed Specifications	*ARRL Evaluations*
Engine type and rating: 5 hp, 4 cycle, Briggs & Stratton.	As specified.
Output voltage: 120 ac (nominal) at 60 Hz.	As specified.
Circuit voltage: 20-A reset circuit breaker.	As specified.
Frequency regulation: 4 Hz max., no load to full load.	As specified.
Voltage regulation: ±5%, no load to full load at rated 3600 rpm.	No rpm check made, but regulation as stated.
RFI: Contains RJ-8 resistive spark plug.	No RFI noted when frame of unit grounded and generator operated 100 ft from radio antenna.
Running time: 1.75 hours per tank of fuel at half load (1100 W).	Not tested
Carrying method: Half-cradle handles.	As specified.
Weight: 84 pounds (38 kg) with oil and fuel in unit.	Not checked.
Dimensions (HWD): 15 × 16 × 31 in. (380 × 410 × 790 mm).	As specified

voltage available for my soldering gun, my test appliance. What ho? No power was available! A check of the output receptacle showed "zero volts." I removed the end bell, started the generator again and found that the missing voltage had appeared. Back went the end bell into position; no output voltage again! After removing the end bell once more, I spotted a damaged wire that had been squeezed between two metal surfaces. The insulation was punctured, and a short circuit resulted. The manufacturer warns against pinching the leads, but it's hard to ensure they're in the clear when the end bell is bolted on. I recommend considerable care when attaching the end bell.

The instruction booklet for the gasoline engine does not specify how much oil is required. It instructs the user to fill the chamber with oil, so I assumed I was supposed to bring the oil level up to the top of the filler hole, or nearly so. That's what I did. The system seems to run nicely, and there's no splatter of oil on the garage walls to indicate that I erred in my decision.

Final Coments

The last step in making the system ready to use is to set the governor for the proper speed to ensure the correct line frequency. This requires an electric clock and a watch with a sweep second hand. The process is a simple one and can be accomplished in a short period. Assembly time for me was approximately five hours. A person with better mechanical aptitude than I could doubtless do the job much faster.

The unit runs smoothly and starts easily.[1] It appears to be excellent for use during camping trips and Field Day exercise, and when emergency power is needed for communications during storms and other acts of God. Proof of field performance came when AK4L/VE1CER of the ARRL staff borrowed the generator for a DXpedition to St. Paul Island (VE1SPI operation, July 1982). The plan was to use two 1200-W gasoline generators borrowed from the Nova Scotia government, plus the GU-1820. Some of the crew doubted that the Heath unit — though rated at 2200 W — would do the job, owing to the small size.

During the five-day operation, the operators had just over 12,000 QSOs, and the GU-1820 provided power for most of the contacts. The other power plants were old and hard to start, but from the first pull of the starter rope, the '1820 provided excellent service. The usual load for the Heath generator was two 100-W hf-band transceivers and a linear amplifier running at 400 W of output power (plus some table lamps).

If you've been considering a power plant, this may be the one to consider. Manufactured by the Heath Company, Benton Harbor, MI 49022. Price class: $480. — *Doug DeMaw, W1FB*

[1]Initial starting of the engine is difficult, owing to the lack of fuel in the carburetor and supply lines. After several yanks on the starting cord, I decided to remove the spark plug and drip about 6 drops of gasoline into the cylinder head. The plug was replaced, and the engine started on the first pull of the rope.

TET HB-35T TRIBAND ANTENNA

☐ This review has been delayed for a considerable time in an effort to resolve what, in my opinion, appeared to be mechanical problems with the antenna. During this period of evaluation (about seven months), the antenna has been raised and lowered at least six times; on two occasions, twice in one day. I am now quite familiar with and I like the antenna. It really performs. If you're thinking of purchasing one, there are some things you should know about it.

The HB-35T offers five elements on 10 and 15 meters, and four elements on 20 meters, on a 24-foot 7-inch boom. The first director functions only on the two higher frequency bands. Driven out of phase, the two rearmost elements are connected by phasing rods to a small piece of plastic midway between the two elements. Supplied originally, this was a piece of circuit board with the crossover etched into it. The manufacturer reports that this was not well received by some amateurs, though I saw nothing wrong with it, and it served its purpose. However, a replacement is being offered to all HB-35T owners, and the new crossover is now made by means of metal links crossing over and under the plastic. The two driven elements are responsible for the generous bandwidth offered by this antenna.

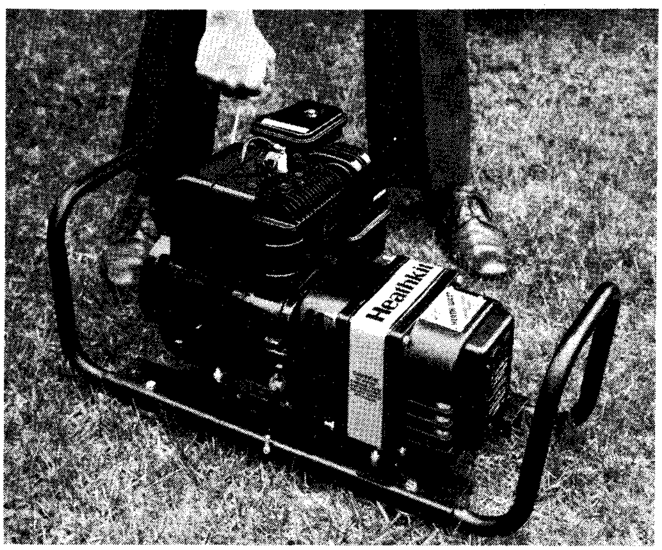
The manufacturer initially supplied triangular plastic wedges to fit between the boom and the U bolts at each element, and at the boom-to-mast mounting point. Apparently these were not entirely satisfactory, as replacements have been supplied to all purchasers, and present production has been updated to include wedges made of aluminum stock.

Disappointment

When first erected on the tower, the HB-35T showed a dismal and disappointing SWR of about 7:1 across each band. The tower was lowered, and the antenna was thoroughly inspected. I suspected that the coaxial balun supplied by the manufacturer might be defective, but, before replacing it, I decided to try something else first. When installed initially, the balun was strapped securely to the boom with nylon electrician's straps in front of the forward driven element. Could this balun somehow be coupled capacitively to the boom? The straps were removed, and the balun was stood on end, with only one strap holding the balun to the boom. The resultant SWR curves are shown in Fig. 5. A telephone conference with the manufacturer disclosed that 25% of the HB-35T antennas sold have evidenced the same problem.

Why not all of them? I don't know. Perhaps some other method of securing the balun to the boom was used. On a subsequent raising, the elements were mounted below the boom, and the balun was permitted to hang down slightly below the boom. This situation produced an SWR response almost identical to the one shown. The manufacturer says nothing about this potential problem in the instructions, and has not acted on my suggestion that the problem could be eliminated by a change in the instructions to indicate that the elements should be mounted below the boom. Apparently, the manufacturer intends to handle such problems on a case-by-case basis. Should you purchase this antenna, you now know what to do. The suggestion has been made to the manufacturer that a truss be provided to support the boom so that all the elements might be in a direct line. While this is not a serious matter, there is some sag in the boom. The manufacturer has indicated that there are no plans to provide a truss at this time.

It is recognized that an early model of this antenna was made available for review. However, Figs. 2, 4 and 5 of the instruction



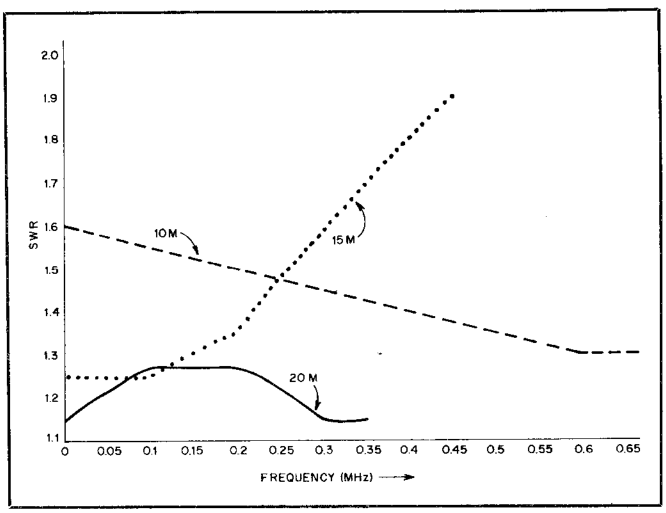


Fig. 5 — SWR curves of the TET HB-35T.

TET HB-35T Triband Antenna

Manufacturer's Specifications

Power capability:	3 kW
Nominal feed impedance:	50 ohms
Maximum element length:	27 ft 6 in.
Turning radius:	18 ft 10 in.
Suitable mast size:	1-1/2 to 2 in.
Weight:	49.5 lb.
Wind surface area:	8.1 square ft.
Wind load at 80 mi/h:	162 lb.

sheets were missing, and were not supplied until sometime later, well after the antenna was installed. I can feel for the inexperienced amateur who may be putting together his first triband array, and who runs into such a situation. It is frustrating and completely avoidable. (Simple household accessories frequently come with better instructions than those accompanying complex amateur antennas costing hundreds of dollars.) It is a general failing of most antenna manufacturers. The manufacturer advises that the HB-35T instructions are now complete.

So much for the gripes. It is impossible to make an element-dimension error. The tubing is drilled just where you are to insert a self-tapping screw to pin the sections together. Metric socket or open-end wrenches are a big help. Short of these, a small adjustable wrench may be used. The hardware is stainless steel, including the U bolts, and should be trouble-free for many years.

Comments

What do I like about the antenna? Just about everything else. The antenna exhibits excellent bandwidth. It has a rugged construction, and has survived a severe New England winter with no apparent deterioration in physical integrity or electrical performance. In the final analysis, it is an excellent DX antenna with countless foreign stations commenting favorably on the signal from W1SE while operating "barefoot," as well as at the legal power limit. The HB-35T is available from: TET Antenna Systems, 1309 Simpson Way, Suite F, Escondido, CA 92025. Price class: $330. — *Lee Aurick, W1SE*

INSTANT SOFTWARE ELECTRONIC BREADBOARD PROGRAM

□ No one knows for sure who first came up with the idea. It was during the early days of Amateur Radio; an enterprising young ham with more enthusiasm than dollars wanted to test a new circuit. His bankroll would not stand the price of a metal chassis just to test an idea. What would serve as a substitute? Of course! A few minutes later, he was securing the major components of his project to his mother's breadboard. A couple of hours later, when terminal strips, wires, resistors and capacitors had been carefully connected in place, the unit was ready to test. History does not record the name of this brilliant young man, nor do we know the results he obtained. But the concept of using a breadboard for circuit prototyping was born.

In recent years, a number of manufacturers have introduced products that make circuit prototyping easy. All you need are the components and some hookup wires — no solder needed! What could be easier?

Now you can prototype linear circuits without solder or hookup wire. You don't even need the components! The Electronic Breadboard allows the user to design and simulate linear electronic circuits on a computer, and to evaluate voltages, currents, impedance and frequency response of the circuits. To run the program, you need a Radio Shack TRS-80® microcomputer, Model I or III, level II, with at least 16 K of memory. This program was not intended to analyze digital circuits, or ones that include reverse-biased transistors. Using this program you can: add or remove components, determine the voltage at a particular point in the circuit or at all points in the circuit, set the operating frequency for ac or dc operation, analyze circuit operation while using linear or logarithmic frequency sweeps, calculate the impedance at a particular point in the circuit, save and load circuit designs via cassette tape, and calculate the current through all voltage sources.

No matter what your level of electronics expertise, you can use The Electronic Breadboard. The beginner can practice Ohm's law problems, while the more advanced user may design a matching network for use in a new amplifier.

Capability

Resistors, inductors and capacitors, as well as current and voltage sources, can be simulated by the program. Page 18 of the program documentation booklet says, "By definition, a current source is considered to have infinite resistance so the current will not affect the resistance. On the other hand, an ideal voltage source, which the program is working with, has zero resistance." For active components you can choose operational amplifiers or bipolar transistors. Transistors must operate in their linear range — that is, never in cutoff or saturation.

Before you run the program, you should make a sketch of your circuit, numbering all nodes. The procedure for doing this is explained clearly.

It takes quite a while to load a complicated circuit. It is nice to be able to save a circuit on cassette for further analysis at a later time. When a circuit is loaded from a cassette, you have the option of increasing the number of nodes or voltage sources.

A simple command calls to the screen a list of all components in the circuit under evaluation. Working with 16 K of memory will allow solution of circuits in which the sum of nodes and voltage sources is less than 16. You could consider, for example, a 14-node circuit with one voltage source. There will be sufficient memory remaining for the circuit to contain 40 components. If your computer has more memory, you can add more nodes, voltage sources and components.

Current and voltage sources can be defined as dc or ac generators. Response tests can be run at a single frequency or in one of two sweep modes. In a linear sweep, the difference between test points is always the same; in a logarithmic sweep, the difference gets larger as the frequency increases.

When you call for a linear frequency sweep, you will have to define the minimum and maximum frequencies and the increment (step size) between test points within those limits. You will then select the node you want to examine during the sweep. Next, you select a graphic or tabular output of the results. Tabular results indicate frequency, voltage and phase at the selected node. Graphic results will show data for either voltage or phase at the selected node. While in the graphic mode, if you wish to return to the command mode, simply hold down the "S" key until you return. You will want to know that! I tried a graphic display of output from a cw audio filter; it took 53 minutes to compute and display the results. I should have read the documentation first!

Documentation

Just nine short pages give you all the information you need to run the program. Don't stop when you get to page 10! Beginning at that point, there is a section entitled "An Introduction to Electronics." It looks pretty simple at the start, and it is; but hidden throughout that part is some pretty important information.

A word of caution is in order. The documentation is not well written and there are errors. On page 14, the equivalent resistance for a pair of resistors is given as

$$R_{EQ} = \frac{R_1R_2}{R_1R_2} \qquad \text{(Eq. 1)}$$

The correct formula is

$$R_{EQ} = \frac{R_1 + R_2}{R_1R_2} \qquad \text{(Eq. 2)}$$

The formula for resonant frequency is given on page 22 as

$$f = \frac{1}{2\pi}\sqrt{LC} \qquad \text{(Eq. 3)}$$

The proper formula is

$$f = \frac{1}{2\pi\sqrt{LC}} \qquad \text{(Eq. 4)}$$

In a discussion of imaginary impedance, the documentation says, "This is the mathematical 'imaginary,' where the impedance still exists but is just not directly observable." The word "imaginary" does not refer to the observability of the impedance at all; rather, it refers to the number scale that is used to represent it mathematically. Confusing? Read on!

Fig. 21 in the booklet shows an operational amplifier application. A plus sign is placed near the inverting input of the op amp. For those of us who are used to electronic terminology, this can be confusing! This is either mathematical terminology or an error. In the former case, the plus indicates the summing input; the inversion is ignored.

I ran into a program output that is not explained in the documentation. Under some conditions during ac circuit analysis, the program gave an ADMITTANCE UNDERFLOW error message and returned to the command mode. Evidently, the situation had the possibility of significant computational error. For that reason, you may not be able to run a frequency response on some circuits.

You could go to the public library and find the formulas necessary to perform the calculations that this program does. For less than the cost of the program, you could buy a scientific calculator to help you with the mathematics. If you already have your own computer, the calculator would not be necessary. While research and step-by-step problem solving would make you smarter, using The Electronic Breadboard is easier. It also leaves less chance for you to make an error.

The Electronic Breadboard is available on cassette for the Radio Shack TRS-80® Model I and Model III from Instant Software, Inc., Peterborough, NH 03458. Price class: $50. — *C. L. "Chuck" Hutchinson, K8CH*