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Azden PCS-300 2-Meter Hand-Held Transceiver

Cushcraft 617-6B "Boomer" 6-Meter Yagi

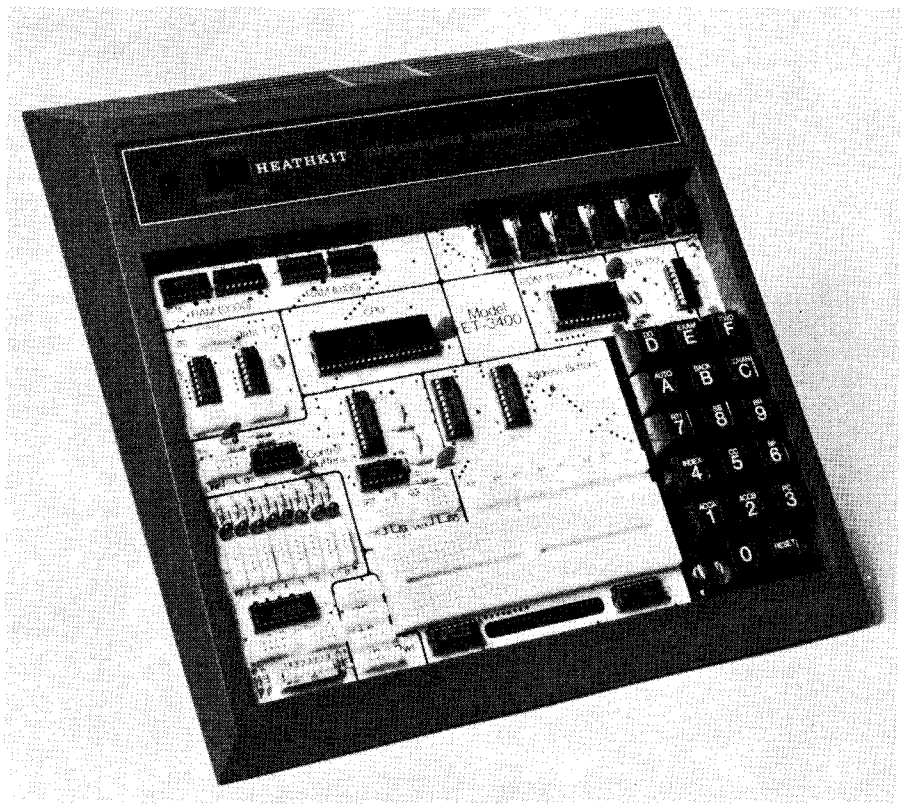
Heathkit ETS-3401 Microcomputer Training System

Product Review

Conducted By Paul K. Pagel,* N1FB

Heathkit® ETS-3401 Microcomputer Training System

The Heathkit® ETS-3401 system is a package designed to train someone with little or no knowledge of computers. It is an ambitious goal on the part of Heath — and they succeed! ETS-3401 consists of the ET-3400 Microprocessor Trainer, an EE-3401 Microprocessor Self-Instruction Course, the ETA-3400 Accessory and the ETA-3400-1 Memory Expansion IC set. My first reaction was that I needed a computer just to keep track of all these numbers, but, as with any Heathkit®, everything proceeds logically, one step at a time.



ET-3400A Microprocessor Trainer

The trainer is the "heart" of the course. With it, the student gets plenty of hands-on experience. Without it, the program would be little more than just another good book on computer basics. A Motorola MC6800 microprocessor IC is the "brains" of the trainer. A small ROM monitor controls the operation of the MC6800. The ET-3400A has 256 bytes of memory (RAM), with provisions for an additional 256 bytes (512 bytes total).

A hexadecimal 17-key pad (16 value keys plus a RESET button) provides the user with a means of entering data and instructions. The data readout system consists of six 7-segment LEDS, which display hexadecimal data. The student has tremendous flexibility while using the two together. The memory address or the contents of the memory associated with that address may be changed at will. After depressing the AUTO key, the user has but to enter the first address of the program. The student then enters the instruction (or data) for that first address. As soon as the two keys have been pushed, the trainer advances automatically to the next memory location and awaits the next two key strokes. Meanwhile, the LEDs have displayed the first address and, momentarily, the first two keystrokes, before changing to the next memory location and two blanks. After a little practice, I found it easy (a lot easier than I originally anticipated) to enter moderately long (for me) programs.

Once the programming is complete, Heath advises the user to examine the contents of each memory cell to make sure no mistakes have been introduced. This can be accomplished semiautomatically once the first address has been entered. The user can call the contents of each memory cell (1 byte, 2 hexadecimal numbers) to the display for checking by hitting the FORWARD or BACKWARD key. The user then can tell the microprocessor to execute the program one step at a time (SINGLE STEP). After each step, the memory location of the next step and the contents of that step appear in the LEDs. Additionally, after each step, the student can call for the display to show the contents of either accumulator or the status flags. This is a powerful learning tool, when trying to teach yourself to think like a computer!

All the microprocessor address, control and data buses are available on the front panel. This simplifies experimenting with external control circuits. Eight switches (DIP) are built-in to provide binary means for manipulating data during the experiments. A solderless, breadboard-type connector block is built-in for experimenting and designing. Built-in + 5- and ± 12-V supplies will meet the power requirements of most circuits.

I spent about 8 hours building the trainer. The instructions were complete, accurate and easy to follow. The trainer worked the first time and ever since. It is an easy kit to build.

Heath now has a new version of the trainer, the ET-3400A. According to Heath, the only difference is that the "A" meets the new FCC standards on rf emissions. Operation is the same in both units.

EE-3401 Microprocessor Self-Instruction Course

Two large loose-leaf notebooks containing several hundred pages of material, two tape cassettes, a flip chart and a bag of electronic components make up the course. Heath has done a skillful job of preparing the text to lead the neophyte through the inner workings of the computer. The first chapter deals with binary arithmetic and number systems used with computerized devices. It also covers octal and hexadecimal number systems and binary codes (BCD, ASCII, etc.). Most of the material in this chapter was "old hat" to me; I found it the most boring chapter of the course. But it is good review material for those familiar with binary fundamentals, and would be mandatory for someone not already conversant with binary techniques.

Heath provides several review questions at the end of each major section. The answers are printed on following pages. If the student does not feel he has a clear understanding of the material, Heath instructs him to go back over it until he does. Each chapter has a unit exam at the end. This is similar to the review questions, and it carries the same advice for the student dissatisfied with his performance.

Each of the eight text chapters has a list of experiments to perform from Chapters 9 and 10 using the trainer. The experiments in Chapter 9 deal with programming techniques. Those in Chapter 10 involve interfacing the trainer with external circuitry. More than one experiment may be associated with each chapter. Chapter 1 calls for experiments 1 and 2. Experiment 1 has $7C_{16}$ (124_{10}) entries — I told you the AUTO feature of the trainer is a good one! A second program requires more entries! The good news with the experiments is that they become more demanding mentally, but require fewer entries.

Chapter 2 introduces the basic concepts and jargon of computers. A hypothetical microprocessor is discussed. Heath describes the function of each of the major sections of the

*Assistant Technical Editor

μP IC. Diagrams show the routing of information between these sections and the other components outside the microprocessor. The student sees how various instructions are implemented.

Chapter 3 covers computer arithmetic. In addition to binary adding, subtracting, multiplying and dividing, the chapter contains information about two's complement arithmetic and the four basic Boolean logic operations.

Heath presents an introduction to programming in Chapter 4. The unit covers the difference between machine, assembly, interpretive and compiler languages. Other topics included are flow charts, branching, addressing for branching and flags.

Chapters 5 and 6 present the MC6800 microprocessor IC. Not surprisingly, most of the statements about the hypothetical microprocessor turn out to be applicable to the MC6800. For the most part, the points of divergence are those where the MC6800 has features more advantageous than those of the hypothetical μP. In fact, this is one of the things that I found most helpful in the course. Heath has deliberately provided some programs that will not work properly. The student has the task of finding out why they do not work and correcting them.

Heath compares and contrasts the block diagram and the programming model of the MC6800. This helps make clear the functioning of the instruction set, which is covered in detail. Extended and indexed addressing can be used with the MC6800; Heath demonstrates why these methods make a more versatile computer. The text points out that the memory stack of the MC6800 is superior to the cascade stack found on many other microprocessors; it also covers the instructions associated with the stack. Subroutines and instructions associated with them constitute another portion of the discussion. The text covers other pertinent operations, including input/output and interrupts. At points, I felt overwhelmed by the amount of new information in each paragraph. Repeated reading and doing the experiments did much to alleviate these feelings.

The final two chapters of the text portion, 7 and 8, discuss interfacing. As Heath points out, there are basically two things that you can do with a computer: program it and interface it. The text defines 3-state logic, and explains the need for it. Heath covers the MC6800 control lines and timing relationships. Memory devices (RAM), address decoders and readout devices are analyzed. The Peripheral Interface Adapter (PIA), one of the most important devices that can be interfaced with a computer, is covered in detail.

Interfacing experiments (Chapter 10) associated with Chapters 7 and 8 use the bag of electronic components, and are among the best that I have seen. One of the first involves loading data into a RAM with the DIP switches on the trainer. George Collins, KC1V, has told me some "war stories" about loading massive programs into computers with switches. This short experiment has given me a much deeper appreciation for what he is talking about.

Heath has given me a deeper understanding of and an appreciation for the "easy way" by first making me do it the "hard way." Some of the experiments involve numerous connections. The resulting "rat's nest" of wires is enough to send me running for a bottle of aspirin. All the experiments worked — after I found my wiring mistakes. That was an education, too!

Once the course is completed, the student has the option of taking a final examination. If the student scores a passing grade of 70% or better, he earns 8.0 Continuing Education Units (CEUs) and a Certificate of Achievement. A classroom version of the course is also available.

ETA-3400 Memory Accessory

The ETA-3400 turns the trainer into a full-fledged personal computer, lacking only more sophisticated input/output devices. It contains a 32- × 8-bit ROM programmed to provide seven outputs selecting various expansion functions. The RAM memory expansion is made up of eight 1K × 4-bit memory ICs. Two of the ICs come with the ETA-3400 itself, while the other six ICs make up the optional ETA-3400-1 kit. Alone, the ETA-3400 has 1 kilobyte of user memory; with the expansion ICs, the total comes to 4 kilobytes. The trainer by itself has 512 bytes of memory.

A Peripheral Interface Adapter (PIA) handles the input/output functions. It has two 8-bit bidirectional data ports and four control lines. Each line can be programmed to act as an input or an output. One port connects to a terminal device, while the other connects to a cassette tape recorder.

The terminal input can be configured for an RS232 standard connection or for a 20-mA current loop. A builder has the option of connecting to an ASCII keyboard and a video display or to a Teletype-style ASCII keyboard and printer. Alternatively, he can write a program that would allow connection with a Baudot Teletype machine. Heath does not supply any information on this.

Another ROM installed in the ETA-3400 carries the instructions for Tiny BASIC, an abbreviated version of standard BASIC. With this provision, the user has the option of running programs found in the popular literature without extensive modifications. I have not been able to use this feature, because I do not have a terminal attached to the computer yet. I did perform the diagnostic tests listed in the assembly manual, and all seems well.

Construction is simple and straightforward. It took me about 8 hours to assemble the ETA-3400 and another 2 hours to modify the trainer to function with it. The modifications to the trainer consist of removing the four RAM ICs from the trainer, adding a 40-pin connector, and changing a few components affecting the clock (oscillator) frequency and stability. Although this improves the functioning of the computer, it affects the outcome of some of the experiments in Chapter 10. Heath advises the student to finish the experiments (and the remainder of the course) before modifying the trainer and attaching the ETA-3400. The Trainer can be used independent of the ETA-3400 by removing the 40-conductor connecting cable and reinstalling the four RAM ICs on the Trainer.

I would recommend the ETS-3401 Microcomputer Training System to anyone wanting a fundamental understanding of computers. (With today's trends, that may be anyone wishing to remove the top cover from an amateur transceiver.) The course is well written, logical and thorough. It compares quite favorably with the "three-day seminars" costing two to three times as much. On the other hand, if your primary interest is simply running game programs, the ETS-3401 may not be your best bet. It's not a toy — it's an education (and fun)!

The ET-3400 Trainer and the ETA-3400 Accessory can be wired for 117- or 234-V ac operation. The Trainer is 3-1/2 × 12-1/8 × 11-3/4 inches (HWD),[1] and weighs 4 pounds. The Accessory is 3-1/2 × 11-1/4 × 13 inches (HWD), and weighs 6 pounds. Price classes for the units are: EE-3401, $100; ET-3400A, $225; ETA-3400, $175; ETA-3400-1, $50. Package price: $480. Additional information may be obtained from the Heath Company, Benton Harbor, MI 49022. — *Peter O'Dell, KB1N*

AZDEN PCS-300 2-METER HAND-HELD TRANSCEIVER

☐ Move over, Atari: The Azden PCS-300 is here! This small 2-meter fm hand-held transceiver has a multitude of attractions, including CMOS microprocessor (μP) control, eight memory channels, a pleasing keyboard actuation tone, full 2-meter coverage, an LCD readout with S/RF meter, a DTMF key pad and programmable scanning.

"Taking the controls" of this rig perhaps can be accomplished best by examining the symmetrically placed operating controls and functions. The rotary POWER switch/VOLUME control is easily maneuverable by even the largest and clumsiest fingers. A PL TONE switch (push button) controls the optional tone encoder.

The 16-button keyboard functions as a full DTMF encoder. The HI/LO power switch selects transmitter output of either one or three watts. A rotary SQUELCH control switch, identical to the VOLUME control switch, has a TONE position from which the squelch will open only for signals accompanied by a certain designated subaudible tone frequency (using the optional board). An external microphone with a PTT jack and an accompanying earphone jack share a dust-cover cap for protection when they are not in use. The TX-OFFSET switch has four positions (MW [memory write], +M [plus offset], −M [minus offset], and S [simplex]), and allows for the use of nonstandard offset frequencies, which is handy for MARS operation. This

[1]mm = in. × 25.4, m = ft × 0.3048, kg = lb × 0.454.

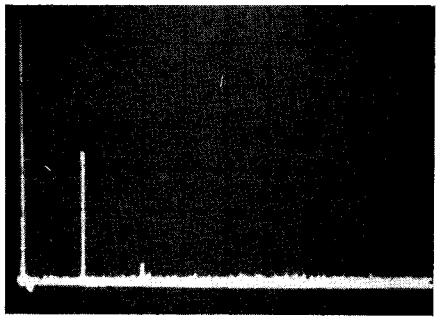


Fig. 1 — Spectral display of the Azden PCS 300. Vertical divisions are each 10 dB; horizontal divisions are each 100 MHz. Output power is approximately 3 watts at a frequency of 146 MHz. All spurious emissions are at least 62 dB below peak fundamental output. The fundamental has been reduced in amplitude approximately 35 dB by means of notch cavities; this prevents analyzer overload. The Azden PCS-300 complies with current FCC specifications for spectral purity.

switch selects a memory channel independent of the eight regular ones, and it can store an offset value that may be as small as zero or as large as 7.995 MHz. A BNC antenna connector completes the layout of the top of the PCS-300. Azden warns not to transmit with the antenna twisted or held in your hand — the antenna impedance will be affected!

Attractive Appearance

The '300 is attractive, compact and light. It is as wide as, and just a little longer than, a dollar bill. The built-in electret microphone and the internal speaker are located above the readout. Both are disconnected when an external microphone is used. (Though certainly typical for audio in most hand-held transceivers, the sound quality of the PCS-300 wasn't as natural as I would like — some voices were too "tinny" for my taste.)

The display is the focal point of this radio, and obviously was designed with users in mind. It is large and can be read easily, even in bright sunlight. The frequency display indicates the lower four operating frequency digits; for example, 5.450 means 145.450 MHz. When an offset is used, the display shows the transmit frequency during transmit, and the receive frequency at other times. An incandescent lamp (its switch is located on the bottom front panel) lights up the display. The lamp remains on for about 20 seconds, then turns off to preserve the batteries (the display flashes on and off when the charge is getting low). The lamp is useful at night, though I still haven't figured out how to change frequencies safely while driving.

Other Functions

Indicators (+600 and −600) show when a standard offset is in use. If an offset would cause an out-of-band transmission, the radio goes to the simplex mode even if the offsets are activated. "+" and "−" indicators are used when nonstandard offsets are employed. MM indicates memory mode, and the S/RF S-bar LCD indicator shows relative signal strength when receiving and relative output when transmitting. M ADRS is provided by the same eight-bar indicator; the memory channel being used is indicated by flashing of the corresponding memory address bar (which also occurs when receiving a strong signal). For example, if 6.79 is in memory 3, then the memory address bar directly above 3 will flash on and off, independent of the S/RF indications.

The bottom front of the PCS-300 includes a KEY LOCK switch, which prevents accidental change of frequency, and a SCAN MODE switch, which directs the scanner to look for either busy (B) or vacant (V) channels. Located on the bottom of the radio, the charging terminal connects to the NiCd battery charger. The belt hanger, logically, is on the back of the radio.

Fun to Use

Operating the PCS-300 is where the fun begins. The 16-key pad, which directs all the μP control functions, produces an electronic "beep" every time a key is pressed to let you know that the μP has received the command. In the transmit mode, this function is disabled, and the key pad operates as a DTMF encoder pad. Put the KEY LOCK switch ON to prevent changing frequencies, instead of accessing a number, while using autopatch.) Frequency is changed by the 5K UP and 5K DOWN keys. When one holds either of these keys for longer than 1/2 second, the frequency will move continuously up or down at the rate of eight channels per second. As with all the UP or DOWN keys, it is easier to depress the key for the required time for continuous frequency change, and release the key as the desired frequency is approached. Then, merely actuate the key a few times to reach the goal frequency. The 100K UP and 100K DOWN keys move the frequency up or down by 100 kHz; they do not affect the MHz digit. The MHZ UP key changes megahertz upward only from two to nine, and does not affect the 100-kHz and 5-kHz digits. "Upward only" must be emphasized, because I became accustomed to pressing a DOWN button to change the 100- and 5-kHz digits, and automatically pressed the key below the MHZ UP key to try to decrement the frequency in MHz steps. That didn't work because that key is the BAND SCAN key — not the desired function. The BAND SCAN key initiates scanning in 5-kHz steps between the two preprogrammed limit frequencies. The lower-limit frequency is in memory seven, and the upper limit is in memory eight. A M ADRS key changes the memory address from channel one through channel eight.

No matter what frequency or memory is in use, the MI CALL key calls the contents of memory channel one. M WRITE places the displayed frequency into the memory channel indicated by the memory address bar. Don't forget to include ±600 when you store the desired frequency using this function. M SCAN actuates scanning of the eight memory channels, and any busy channel stays on for six seconds before scanning proceeds.

Sound complicated? It isn't really. I chose to put the W1AW repeater frequency, 145.450 (−600), in memory one and several other local repeater and most-used simplex frequencies in the other memories. All I had to do to find out what was going on locally was to use the M SCAN function. I could always stop at an interesting channel by pressing M CALL and then M ADRS. To continue scanning, I simply pressed M SCAN again. The programmable scan limits are a real convenience: One doesn't have to scan the entire nearly 8-MHz-wide band. For example, 5.000 to 7.399 could be programmed in memories seven and eight to hear the most-used 2-meter fm segments. If scanning for busy channels, the scanner stops for six seconds, then goes on. If you want to stay on that busy channel, press either the 100K UP, 100K DOWN, 5K UP or 5K DOWN buttons. To begin scanning again, press the BAND SCAN key, and on it goes. I would have liked the function to begin scanning once more at the point where I had stopped it, but the scan proceeds each time from the limit set in memory seven. To prevent accidental transmissions or "sitting on the microphone button," a transmit lock switch is provided on the transmit bar.

Comments

What didn't I like about the Azden PCS-300? Of major significance was the poor-quality transmit audio. On-the-air reports confirmed that my transmissions sounded terrible. A few internal audio output adjustments fixed that, and my voice quality (and ego) was back to normal. The schematics included in the manual gave little information. Another annoyance was the low (0.023-μV) squelch sensitivity. Some signals broke squelch, even with the control set at its highest level. After three weeks of use, two loose screws were found rattling around inside. Luckily, any disasters were avoided; replacement of the screws was quick and easy. I have also developed a penny-pinching preference for a rechargeable, individual NiCd battery system instead of the sealed NiCd packs the Azden uses.

Good Overall

What did I like about this radio? — everything else! The Azden PCS-300 shows good adjacent-channel rejection of signals, and the radio is quite stable. The receiver, in general, is as good as or better than other similar radios I have used. Having had some experience with other μP-controlled, hand-held transceivers, I was surprised and pleased that this μP didn't go wild in normal use and even in extremes of temperature. Admittedly, I am far from immune to the flashy features of the rig;

Azden PCS-300, Serial No. 81001

Manufacturer's Claimed Specifications	*Measured in ARRL Lab*
Frequency Range: 142.000 to 149.995.	As specified.
Mode of operation: Fm.	As specified.
Current drain: 40 mA in receive mode — no input signal; 800 mA in Hi transmit mode; 400 mA in Lo transmit mode; 0.01 mA in memory backup (with power switch off).	Not measured.
Size (HWD): 7.24 x 2.55 x 1.75 in.	As specified.
Weight: 1.4 lb.	As specified.
Transmitter power output: Hi — 3.0 W; Lo — 1.0 W.	Hi — 3.1 W; Lo — 1.0 W.
Spurious radiation: Better than −60 dB.	See Fig. 1.
Receiver 1st i-f: 10.7 MHz; 2nd i-f; 455 kHz.	As specified.
Receiver sensitivity: Better than 0.2 μV for 12 dB SINAD.	0.2 μV (20 dB quieting).
Squelch sensitivity: Less than 0.15 μV.	0.023 μV.
Audio output: More than 200 mW (8-ohm load and 10% distortion).	500 mW.

in fact, using the PCS-300 is almost comparable to a good game of Space Invaders or Pac-Man. These flamboyant features, combined with the solid basics this 2-meter radio has, make the '300 a joy to use. Even better, I don't have the feeling that next year the radio will be passé. The PCS-300 is manufactured by Japan Piezo Co., Ltd., and distributed by Amateur-Wholesale Electronics, Inc., 8817 S.W. 129 Terrace, Miami, FL 33176. Price class: $290. — *Carol L. Colvin, AJ2I*

CUSHCRAFT 617-6B "BOOMER" 6-METER YAGI

☐ Over the past several years, I have seen a revolution in commercially manufactured amateur vhf antennas. The new generation of computer-designed, long-boom Yagis offers forward gain and front-to-back ratios that were unheard of a few years ago. Evidence of this fact is the great number of operators making successful contacts on the more difficult propagation modes (EME, tropo scatter) using small antenna arrays.

On 6 meters, the primary interest of serious operators is the antenna performance over terrestrial paths. The use of ionospheric and/or meteor scatter will increase in the coming years as we head for the bottom of the solar cycle. Antenna gain is an important factor when determining scatter system range.

Cushcraft's latest Yagi for 6 meters is the 617-6B, a six-element, computer-designed, long-boom Yagi that appears to have good forward gain and front-to-back ratio. Called a "Boomer," this Yagi is by no means portable! Its boom is 34 feet long, 2 feet longer than the full-size Cushcraft "Skywalker" 20-M Yagi.

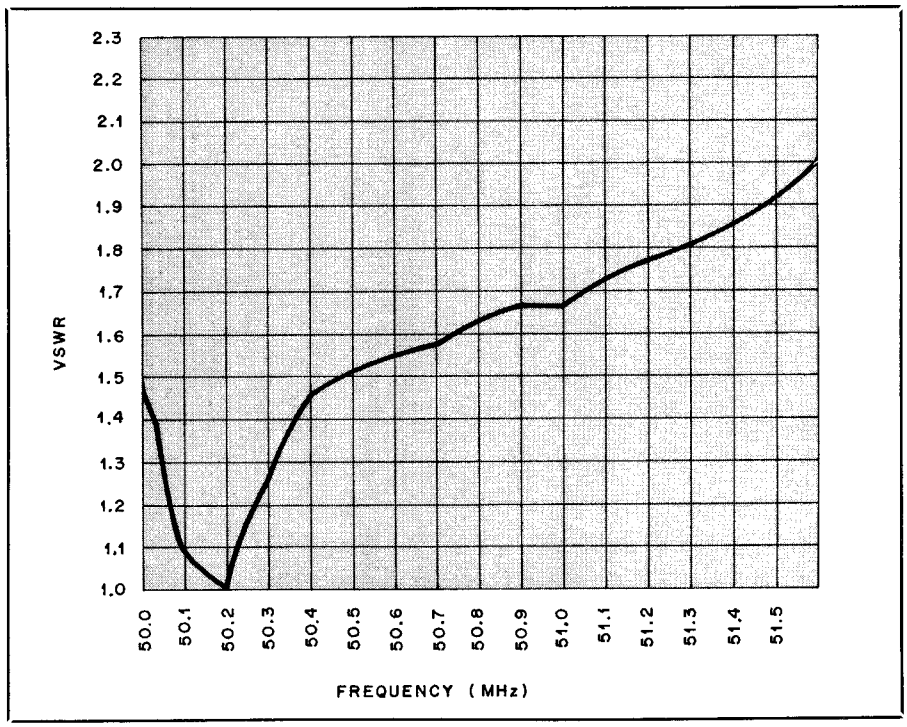


Fig. 2 — VSWR curve of the 617-6B.

Construction

The Boomer arrived in a single shipping box. (Luckily, Murphy did not strike — all the hardware was accounted for!) Construction took approximately 2-1/2 hours. Each boom and element section is premarked at the factory to speed assembly. Hose clamps hold the boom sections together, and U bolts clamp the elements to the boom. Two sections of tubing are used as boom struts to keep the 0.058-inch-wall boom from sagging. A T-match is used to feed the driven element, and a coaxial balun transforms the balanced feed to the unbalanced coaxial line.

The antenna material is 6063-T832 aluminum, and stainless steel clamps are supplied. Plastic end caps are provided for each of the elements and the boom. The SO-239 connectors have protective plastic boots, and a silicone compound used to keep out moisture and prevent corrosion is supplied.

Installation and Operation

After construction, the Yagi was placed on top of a 40-foot tower on the roof of the ARRL Hq. building. The thin-wall boom lowers the weight of the Boomer to just 26 pounds; I brought it up on the tower and clamped it down myself. Only one mechanical weakness was noticed during the installation: Hose clamps are used to secure sections of the boom together; if these hose clamps are not extremely tight, the boom can twist easily, causing the elements to become misaligned.

How does the Boomer perform? To say it in a single word — "fantastic." I was very impressed with the forward-gain and front-to-back ratio characteristics. During the 1982 January ARRL VHF SS, I used the Boomer in conjunction with a 250-watt amplifier and exciter. During the contest I had no trouble working stations in Illinois and Ohio on scatter — not bad for low transmitter power. The antenna has been on the Hq. tower for several winter months, and none of the hardware has corroded. Performance remains the same as it was the day it was put up.

The Boomer is not for everyone. The limited bandwidth would discourage fm operators, and the large size could be prohibitive to hams living on some city lots. But for those wanting a potent signal on 50 MHz, the Boomer certainly justifies the bill. Price class of the 617-6B Boomer is $260. It is manufactured by Cushcraft Corp., P.O. Box 4680, Manchester, NH 03108 — *Gerry Hull, AK4L*

New Products

MOTOROLA HIGH-POWER 900-MHz TRANSISTORS

☐ Motorola has introduced a new 24-V dc, 900-MHz power transistor series. This new line includes the MRF890, a 2-W, 9-dB minimum gain predriver; the MRF892, a 14-W, 8.5-dB driver; and the MRF894, a 30-W, 7-dB final amplifier. These new rf transistors are fully characterized across the 804- to 960-MHz frequency range, and are intended for large-signal, common-base amplifier applications in industrial and commercial cellular fm radiotelephone equipment.

The three devices are designed for ease of interstage matching, and feature all-gold metallization and emitter ballasting for increased reliability and ruggedness. All devices have guaranteed gain performance at 900 MHz and collector efficiencies of 55% minimum, and will withstand 30:1 VSWR load-mismatch conditions at rated output power and supply voltage. For more information, contact Tom Bishop at Motorola Semiconductor Products, Inc., P.O. Box 20912, Phoenix, AZ 85036, tel. 602-244-6394. — *Paul K. Pagel, N1FB*