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Conducted By Paul K. Pagel,* N1FB

Heath EE-3404 6809 Microprocessor Training Course

The Heath EE-3404 Training Course is a sequel to Heath's EE-3401 Microprocessor Course, which is a part of the Heath ETS-3401 Microcomputer Training System.[1] Included in the EE-3404 package is a preassembled 6809 adapter board, which is designed to plug into the ET-3400 (or ET-3400A) Microprocessor Trainer — also a part of the ETS-3401 system. The EE-3404 course assumes that you are quite familiar with the material in EE-3401 and have an ET-3400 (or ET-3400A) available for performing the experiments.

MC6809

The Motorola MC6800 microprocessor is the heart of the ETS-3401 System. It is an 8-bit microprocessor designed for the dedicated and the systems markets. Motorola developed the MC6809 8-bit microprocessor for the systems market only. It is essentially a "souped up" 6800. Hence, Heath's choice of approach in teaching the student to understand and use the 6809 is quite logical.

Motorola wants the 6800 users to have little trouble learning to use the 6809, so they employ the fundamental 6800 architecture in the 6809 design. Motorola also sought to have software compatibility at some level. This compatibility exists at the source-code (mnemonic) level. The 6809 does not contain dozens of new instructions, but it has over three times as many addressing modes as the 6800.

The 6809 has features that are particularly well suited for the systems market. In the 6809, a program is position independent; it will execute properly when placed anywhere within the memory address map. The 6809 allows a subroutine to be shared by several tasks at the same time. Also, the 6809 permits high-level, block-structured languages — such as Pascal, BASIC, FORTRAN and COBOL — to be compiled into more efficient and faster-running machine code than is possible with earlier processors, such as the 6800.

The Course

The EE-3404 text consists of seven chapters of study material and one chapter of experiments, along with several appendixes, contained in a large, loose-leaf binder. At the end of each of the first seven chapters, you are instructed to turn to Chapter 8 and perform certain experiments. Each of the first seven chapters contains, in addition to the text material, an introduction (overview of the chapter), the unit objectives, a unit activity guide and a unit examination at the end. Some of the chapters also have review questions. This is an extremely effective teaching method, when no "live" teacher is present to interact with the student.

The first chapter covers the 6809 fundamental concepts, with particular attention to points of departure from the 6800. For instance, the 6809 has one 8-bit register and three 16-bit registers not found in the 6800. Because less data movement between the internal registers and memory is required, the 6809 speeds data throughout.

Chapter 2 brings you to the addressing modes available with the 6809. This may well be the heart of the course, since the remaining material is largely dependent on a thorough understanding of the powerful addressing modes of the 6809.

Registers and data movement are covered in Chapter 3. Most of the instruction set is introduced in this chapter. Although the arithmetic, logic and test instructions are similar to those of the 6800, Chapter 4 shows the student how to use them with various addressing modes.

Chapter 5 covers branching and miscellaneous instructions. Of the miscellaneous instructions, the software interrupts should be of particular interest. In the 6800, there is only one software interrupt, and it is often taken up by the firmware, leaving the user without an interrupt. The 6809 has three software interrupts, which should alleviate this problem. Input and output signals are covered in Chapter 6 — again, the emphasis is on the superiority of the 6809 to the 6800. Finally, Chapter 7 presents some basics of "real world" uses of the 6809. Several different system formats are sketched.

The experiments in Chapter 8 consist of relatively short programs that are entered and run on the ET-3400 trainer with the 6809 adapter board installed. Each program is relatively short and consists of from three to 15 statements that must be entered via the hexadecimal key pad on the trainer. Most of the programs provide insight into the difference between the 6809 and the 6800. Some of them are routines that would prove useful to a designer or programmer writing a long program for use on a 6809-based system. No additional test equipment is required to perform the experiments.

Installation

The 6809 adapter module plugs into the socket normally occupied by the 6800 on the ET-3400 (or ET-3400A) trainer. Adapter installation is slightly different, depending on which version of the trainer is available. The ET-3400A works with the adapter module alone, but the ET-3400 requires a clock and reset modification to replace the 6875 clock. I have the ET-3400.

All parts for the ET-3400 modification are supplied with the course. A 16-pin DIP plug serves as the "board" for the circuit. One resistor, one electrolytic capacitor and three wires are soldered to the plug. Construction took about 10 minutes.

To make the modification, you must disassemble the ET-3400 and remove the circuit board to get to the socket holding the 6875. After removing the 6875, you simply insert the DIP plug into the socket and reassemble the ET-3400. This procedure took less than 15 minutes.

Once the DIP plug is installed, remove the 6800 microprocessor and its ROM, and store them in the protective foam supplied. The 6809 adapter board is then inserted into the 6800 socket. Installation is then complete. If you desire to reinstall the 6800, it is accomplished by reversing these steps.

If the ET-3400A is available, installation is even simpler. There is no need for the clock and reset adapter. Thus, you need only remove the 6800 and ROM and insert the 6809 into the socket.

For either procedure, the instructions are clear. Anyone capable of handling a soldering iron and a screwdriver should have little trouble completing the installation in the ET-3400; with the ET-3400A, even less skill is required.

Evaluation

Heath assumes that you are quite familiar with the functions of the 6800. Because it had been some months since I completed the EE-3401 course, I was a little "rusty" on some of the material. After working through the first couple of chapters, I found I did not understand much of what I was covering. I reviewed the EE-3401 material. Once I had the 6800 characteristics firmly in mind, the material in this course made a great deal more sense.

The course material is well prepared, and the presentation seems well thought out. I found that the experiments really did provide a great deal of insight into the functioning of the 6809. Unlike some of the programs in the EE-3401 course, which consists of over 150 statements, the programs in this course are all short and easy to debug — again, it was "cockpit errors" that caused me trouble.

If you pass the optional final exam with a score of 70% or better, you are entitled to three Continuing Education Units (CEUs) and a Certificate of Achievement. As with the other courses in this series, Heath offers a complete money-back guarantee.

If you are already familiar with the 6800, have an ET-3400 or ET-3400A available and would like to learn about the 6809, I would recommend you give serious consideration to Heath's EE-3404. Price class is $100. More information may be obtained from the Heath Company, Benton Harbor, MI 49022. — *Peter R. O'Dell, KB1N*

KLM 7.2-2 40-METER MONOBAND YAGI

□ Low-band DXing has always been a challenge to me. There is a special thrill associated with pulling a "new one" out of the static that can't be rivaled, even on the higher bands. Unfortunately, some type of directional (preferably rotatable) array is necessary to be competitive on 40 meters. Such antennas are normally quite large, presenting mechanical problems. Smaller arrays *can* be used, but often suffer from severely reduced performance. KLM has managed to work around these limitations and come up with a 40-meter Yagi that works well, without straining your tower or pocketbook.

The 7.2-2 is a two-element Yagi (driven element and reflector) designed for the low-band enthusiast who lacks the real estate for a full-

[1]Product Review, *QST*, Sept. 1982, pp. 38-39.

*Assistant Technical Editor

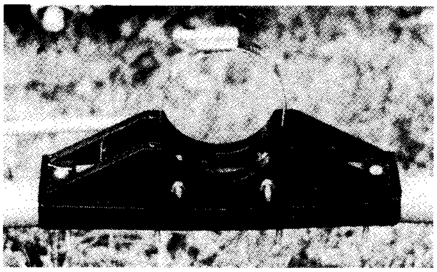


Fig. 1 — Close-up of the Lexan boom-to-element insulator.

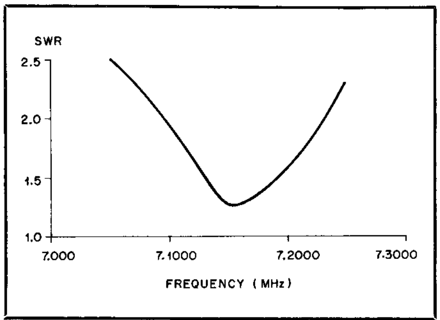


Fig. 2 — SWR vs. frequency curve for the KLM 7.2-2. For this test, the antenna was side-mounted to the tower at approximately 40 feet.

sized "monster" array. Most rotators designed for use with medium-size amateur antennas should be adequate to turn this array. Weighing in at only 46 pounds, the beam presents a 6-square-foot wind load: That's just over half the size of my KT-34XA![2] How is this possible? Linear loading is used to shorten the elements by 33% — the longest element is only 46 feet long. The 16-foot boom is constructed of 3-inch-OD aluminum tubing, which should stand up well even under adverse weather conditions.

Mechanical Details and Assembly

Although the 7.2-2 contains a multitude of parts, it is easy to assemble, thanks to a well-written instruction manual. In addition to clearly spelled-out directions, assembly details are presented by pictorials, to double-check each step. Total assembly time, from the boxes to the tower, was approximately six hours.

First, check each part against the parts list. This ensures that nothing is missing, while familiarizing the builder with each component before it is called for.

The boom is supplied in two 8-foot sections. One section is swaged, for insertion into the other. Two ¼-inch-diameter, 3½-inch-long bolts run through the boom, holding the two pieces together.

Next, the elements are assembled. Constructed from telescoping tubing decreasing in size from ¼ to ½ inch in diameter, each element consists of four additional 3/8-inch-diameter by 11-foot linear-loading tubes. These tubes are attached to the approximate midpoint of each element half, and fold back toward the boom. While this adds complexity to the construction of the elements, it allows significant mechanical advantages (weight reduction, decreased turning radius and wind loading) over conventional half-wave designs. Lexan insulators are used to maintain spacing between linear loading sections, and aid overall mechanical stability.

The elements are attached to the boom next. A hefty Lexan insulator, shown in Fig. 1, is used as the element-to-boom bracket. Element halves seat in semicircular channels atop the insulator, and are held in place by a pair of no. 10-32 screws. Each screw runs through the 1¼-inch-OD element and the insulator, providing mechanical rigidity.

The matching section is assembled last. Approximately 6 feet long and constructed of two 3/8-inch-diameter aluminum tubes, it mounts to the front of the boom and is fastened in three places: on the boom with a self-tapping sheet-metal screw, and on two of the previously mentioned no. 10-32 element-mounting screws. A 560-pF, 2500-V capacitor attaches to the outer tip of the matching tubes. Unfortunately, this is the weak point in KLM's design — the capacitor can be damaged if high power is applied to the antenna with an SWR greater than 2:1. KLM recommends the use of a transmitter power output of no more than 200 W under these conditions. After destroying the first capacitor, I noticed the warning in the instruction manual, and took heed. A friend with a similar antenna (KLM's three-element version) cured this malady by replacing the 2500-V capacitor with a 7500-V unit.

No tuning is necessary after construction — the matching section dimensions for each segment of the 40-meter band are given on the instruction page. Just set it, and forget it! I set the antenna for the middle of the band and, with the antenna side-mounted to my tower at 40 feet, obtained the SWR curve shown in Fig. 2.

Operation

The KLM 7.2-2 has been in service at W1OD, and has survived the bulk of two New England winters with no problems. Signal reports have been gratifying, and prompted me to enter the CW section of the ARRL November Sweepstakes in the A (low-power) category. To say the least, I was amazed at the performance difference between the Yagi and my doublet. Signals that are in the noise with the doublet jump up to Q5 copy with the beam. Checks with numerous stations indicate that using my barefoot rig (100-W output) with the beam is just as potent as the kW (input) into the doublet. Not a bad deal!

If you would like to have a 40-meter signal that will get through the pileups without the need for a separate support structure, check out the KLM 7.2-2. It might be just what you're looking for! The beam is available from KLM Electronics, P.O. Box 816, Morgan Hill, CA 95037. Price class: $400. — *Michael B. Kaczynski, W1OD*

THE MPS CW MACHINE II

□ With so much computer software presently available to amateurs, it's hard to know which package will best fit your needs. Recently, I had the opportunity to use the MPS CW Machine II software designed for the TRS-80® microcomputer. This program is available on disk and will run with TRSDOS or NEWDOS. It requires a minimum memory of 32 kbytes and one or more disk drives, and is easily converted for use with the Model 3.

The instruction booklet contains explanations of all the program functions, directions for connecting your rig to the computer (complete with schematics) and important program line numbers for making modifications. It is well written and helpful.

The CW Machine II will transmit CW at speeds between 10 and 100 WPM, and can receive at speeds between 10 and 155 WPM. Best copy occurs within 10 WPM of the selected rate. Tapes generated on an Apple® computer were used to verify the receive rate of the MPS software. The transmit rate was calculated by measuring the time necessary to send text stored in memory. Default values for the send and receive rates are 25 WPM, but can be changed at any time with a keyboard command. Included in the program parameters are key-debounce times for receive and transmit. The debounce time can be adjusted to suit your keyboard or typing ability.

Previous versions of this program were equipped with a 250-character type-ahead buffer that has now been increased in size to 3200 characters. The most recent 256 characters remaining in the buffer are displayed at the bottom of the screen during the transmit mode, and during receive when in the split mode. The buffer contents are corrected easily with the left-arrow key.

There are 18 single-keystroke commands that control the program. They are accessed easily, and the options are well prompted. Should you forget them, one command recalls the entire menu.

Connecting the TRS-80 to Your Rig

The cassette interface is used to connect the computer to your rig. Audio output from the radio goes directly from the speaker to the cassette audio input. The instructions show several transmit options, the simplest of which uses the cassette-motor on/off relay contacts in the computer. This method is not recommended for continuous or heavy-duty operation. Instead, the audio output from the computer should be used to switch an external relay, or transistor, that in turn keys the transmitter.

Line Numbers

The programmer has conveniently included lines in the BASIC program that can be extended to create permanent messages. The maximum length of each of these messages is 128 characters. A keyboard command will transmit any of the permanent or temporary (created each time you run the program) messages (up to nine) whenever you wish. You can also change any of the messages (permanent or temporary) at any time.

Data for operating the program is also included in one of the program lines. By changing the data, you change the program start-up parameters. For example, you can set the program to initiate whatever receive or transmit speed you desire. The start-up data also includes space length and debounce times.

Operation

The program is easy to use. It is written with the contester and high-speed operator in mind. The split-screen function and large input buffer are particularly nice features. Being able to view the active memory buffers and create general messages make operating fun and efficient. The only problem I found while running the program is that the cursor continues to move even though it is not copying CW. This means that information on the screen will disappear while the machine waits for input.

[2]kg = lb × 0.454; mm = in × 25.4; m = ft × 0.3048; m² = ft² × 0.0929.

The operating speed can be changed during transmit or receive without changing modes, so you don't miss a thing. You can even have the computer send random code practice. I would recommend this system to anyone who owns a TRS-80 microcomputer.

The MPS CW MACHINE II is available from Micro Pro Systems, Rte. 2, Box 533, Cumming, GA 30130. Price class: $25. — *Jonathan Towle, WB1DNL*

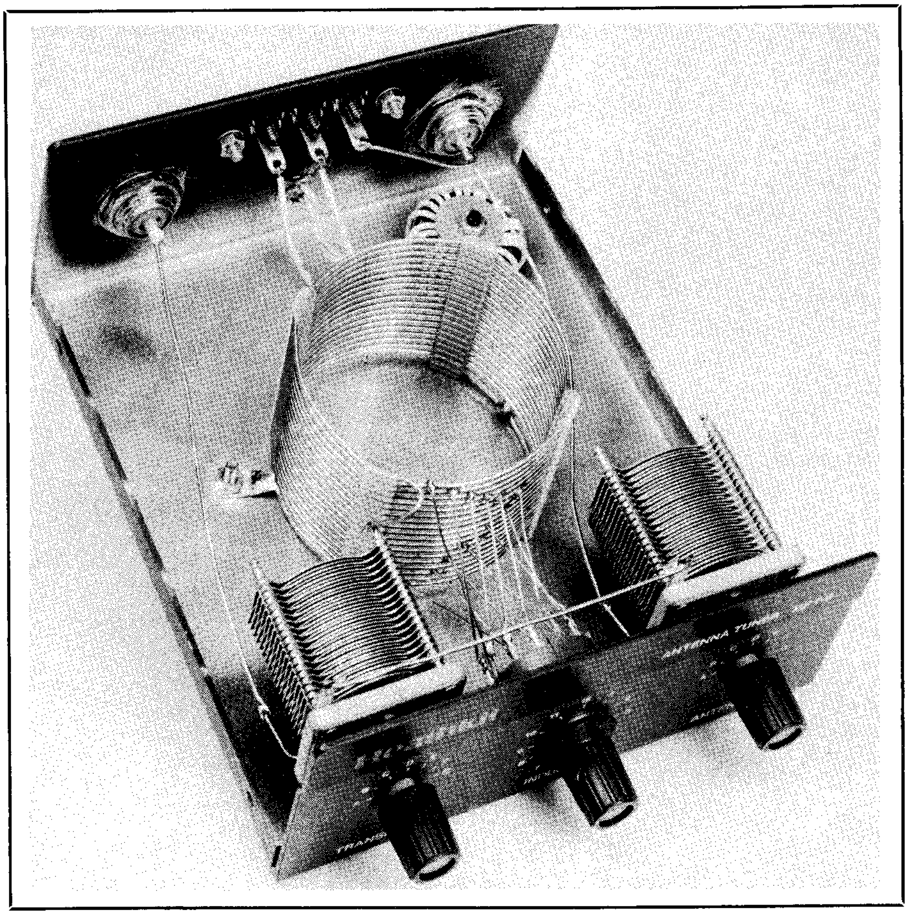
HEATH HFT-9 ANTENNA TUNER

☐ Heath's HFT-9 is a bare-bones antenna-matching network designed for the QRP operator. Rated for 50-W maximum power handling capability, the HFT-9 will work with coaxial lines, random-length end-fed wires or balanced feeders. During construction, the kit builder may select either 80-10 or 160-15 meter operation.

The HFT-9 employs two variable capacitors and a tapped inductor in a T network. The inductor is switched by a small, plastic-encased rotary switch. To select 160-15 meter operation, an additional 100-pF fixed capacitor is wired in parallel with each of the variables. A 4:1 toroidal balun is used for tuning balanced feeders.

The kit took about an hour and a half to build. Heath has prepared an excellent instruction manual, complete with detailed drawings, so there were no unanswered questions during construction. The instruction manual also includes several pages of tips to help the amateur use the tuner.

In the ARRL lab, we measured the HFT-9's insertion loss at a respectable 0.3 dB. The matching network handled the rated 50 W into a 50-ohm dummy load with no complaints. During on-the-air tests, the HFT-9 successfully matched a variety of coax-fed, long-wire (including a random length of hookup wire thrown across the ARRL lab floor) and open-wire-line-fed antennas.



Good performance at a modest price makes this tuner a station accessory to consider for the QRP operator, while its compact size and light weight make it a natural for portable operation. The HFT-9 measures 2-5/8 × 5-1/2 × 7-1/2 in (HWD) and weighs 1-1/2 lb. Manufacturer: Heath Co., Benton Harbor, MI 49022. Price class: $55. — *Mark Wilson, AA2Z*

New Products

MOTOROLA MC145450 1200-BAUD MODEM

☐ This silicon-gate CMOS FSK modem is TTL compatible and can be pin programmed for Bell 202 or CCITT V.23 operation. The 22-pin DIP IC derives internal timing from an external 3.6864-MHz crystal. In the Bell 202 mode, the main channel can receive data at up to 1800 bit/s, while the back channel can send at baud rates up to 150 bit/s. For V.23 application, the chip is Mode 2 compatible for a baud rate of up to 1200 bit/s on the main channel and up to 75 bit/s on the back channel.

A logic-controlled mode input selects the frequency pair used for modulation and demodulation, as well as the transmit and receive baud rates. The clear-to-send ($\overline{CTS}$), which goes low in response to a high-to-low transition on the request-to-send (RTS) line, can be delayed under logic control in eight steps from zero to 426.6 ms. Additional functions include logic-controlled self-test, transmit test, answer-back and soft turn-off functions.

The MC145450 is less than $10 in quantities of 1000. For further information, contact your nearest Motorola sales office or local distributor. — *Paul K. Pagel, N1FB*

SNYDER ANTENNA CORPORATION WIRE

☐ Take heart, urban dwellers! There is an antenna wire that is relatively immune to the deteriorating effects of air pollution and moisture. Not only that, this wire is strong and it resists stretching with time. (Soft-drawn copper tends to stretch after it has been aloft for a period, causing SWR changes.) The Snyder wire doesn't stretch a measurable amount.

What makes the Snyder wire so special? Well, it contains seven strands of zinc-plated steel over which the manufacturer has wound 12 strands of pure copper wire. The bundle is the electrical equivalent of 14-gauge copper-clad steel wire. Despite this rugged format, the wire is quite flexible and does not tend to coil up and strike at the user as a snake might do! This is not true of straight copper-clad steel wire of the single-conductor variety.

Another positive feature of the wire is the use of insulating jacketing. The outer cover is "tubed" rather than extruded. As a result of this fabricating technique, the wire is easier to strip than the extruded type. Also, the overall flexibility of the Snyder wire is excellent. Snyder's jacket material is ultraviolet resistant, which makes it a good bet for longevity in the presence of weather effects and sunlight.

To avoid the possible problems of electrolysis between the copper and steel conductors, solder all conductors together at the ends of the antenna elements. The manufacturer recommends the use of a noncorrosive sealant at the open ends of the antenna wire, once the radiator has been cut to length and has undergone the final trimming process. This will prevent dirt and moisture from entering the jacket. I used epoxy cement for this purpose when I erected my 80-meter dipole that used the Snyder wire. Although I live in a rural