

Heathkit of the Month:
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**Heathkit EF-2
Oscilloscope Trainer**
*"How to Understand and Use your...
Oscilloscope"*

Introduction:

One Heathkit product line I didn't plan on covering was their educational series. I never owned one of their educational kits nor even got close to one - until, that is, a month ago.

Fate delivered a Heathkit EF-2 *"How to Understand and Use Your Oscilloscope"* educational course to my garage. This kit is property of the radio club, donated along with other gear by AC6C/WA6BSV. It will be for sale at, or prior to, the October auction. But for right now I have "borrowed" it to prepare this article!

The EF-2 was first sold in 1962 for \$9.95. It consists of a test chassis you assemble (Figure 1), a bunch of electronic components that you solder special clips to their leads to allow "solderless" breadboarding, and a multi-section manual, that includes an appendix containing a bibliography and glossary. We'll discuss the manual in detail in a later section. The manual uses the Heathkit IO-12 oscilloscope as its basis; the IO-12 oscilloscope was sold between 1962 and 1968. Though the IO-12 is featured, other scopes can be used with the course. The EF-2 was sold stand-alone or bundled with an oscilloscope kit as a package. In the March 1965 catalog (see Figure 2) the bundles offered were the EF-2-3 (\$62.95) which included the 3" IO-21 scope, and the EF-2-4 (\$84.95) which included the 5" IO-12 scope. The manual could also be purchased separately for \$5.00 (\$3.00 if you bought in quantity - assumably for a class). The EF-2 continued to be available until late 1975 when it last sold for \$19.95. In those



Figure 1: Heathkit EF-2 Oscilloscope Trainer Test Chassis

later years it was also available bundled with some of the then current Heathkit scope models.

In 1962 Heathkit had seven educational kits (eight if you include Heathkit SK-50 Experimenter Electronic Workshop "19"). They were the EF-1 *"How to Understand and Use your Vacuum Tube Voltmeter"* (\$8.95), the EF-2 *"How to Understand and Use your Oscilloscope"* (\$9.95), the EF-3 *"How to Understand and Use your Signal Generator"* (\$11.95), the EK-1 Basic Electricity Kit (\$19.95), the EK-2A Basic Radio kit (Part 1), the EK-2B Basic Radio kit (Part 2) (each \$19.95 plus \$3.95 for the optional cabinet for the completed receiver), and the EK-3 Basic Transistor Kit (\$16.95).

The EF-2 Test Chassis:

To get started with the EF-2 oscilloscope trainer, the first step is to assemble the test chassis. The assembly is straight forward and soldering is required. After completing the test chassis, you next prepare numerous electronic components by adding insulation to their leads and attaching spring clips to the end of the leads (Figure 3). You also assemble various lengths of wire jumpers, again with spring clips. The kit comes with three PNP germanium transistors (GE 4JX1C707), various val-



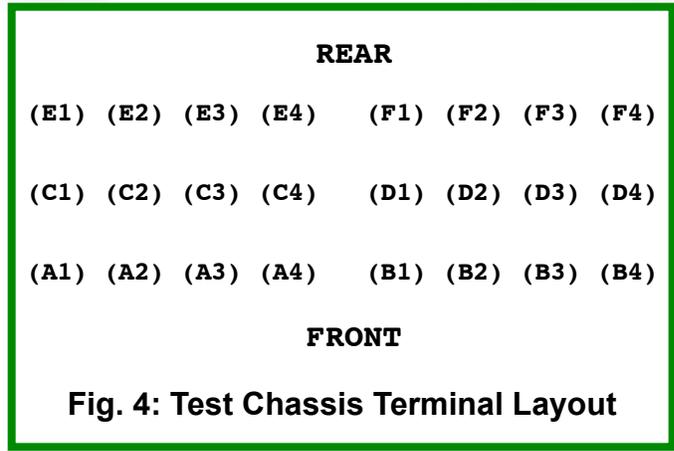
Figure 2: EF-2 and associated bundles from the March 1965 Catalog

ues of resistors (17), various values of capacitors (9), an earphone (which also acts as a microphone), and a permanent magnet (to demonstrate how a magnetic field affects the scope trace). Additional components are permanently mounted on the test chassis (two potentiometers - 100KΩ and 20KΩ, two binding posts - red and

black output terminals, a tapped oscillator coil, and a dual AA battery holder. - mounted beneath the chassis).



Figure 3: EF-2 Clip



The open test chassis measures 6-1/8" W x 9" D x 3" H and has a net weight of 1-1/2 lbs. On it are mounted six terminal strips, each with four non-solder posts. The front panel holds an **OFF ON** slide switch between two potentiometers (20KΩ and 100KΩ), each marked **MIN** at the full CCW end, and **MAX** at the full CW end. The rear panel contains two binding posts marked **OUTPUT** (red) and **GROUND** (black). Mounted on the chassis is a slug tunable tapped oscillator coil (value not given). Under the chassis is a dual AA penlight battery holder that supplies 3 volt power for all the experiments. The OFF ON slide switch disconnects the negative lead of the battery supply.

The six terminal strips are mounted front to back in two columns of three rows marked A

A1	100K Pot Min	D1	Post/+3V Gnd (blk)
A2	100K Pot Wiper	D2	free
A3	100K Pot Max	D3	free
A4	free	D4	free
B1	free	E1	Post Out (red)
B2	20K Pot Min	E3	free
B3	20K Pot Wiper	E2	free
B4	20K Pot Max	E4	-3V Power
C1	Coil Low	F1	Post/+3V Gnd (blk)
C2	Coil Tap	F2	free
C3	Coil High	F3	free
C4	-3V DC Power	F3	free

Table I: Dedicated and Free Posts

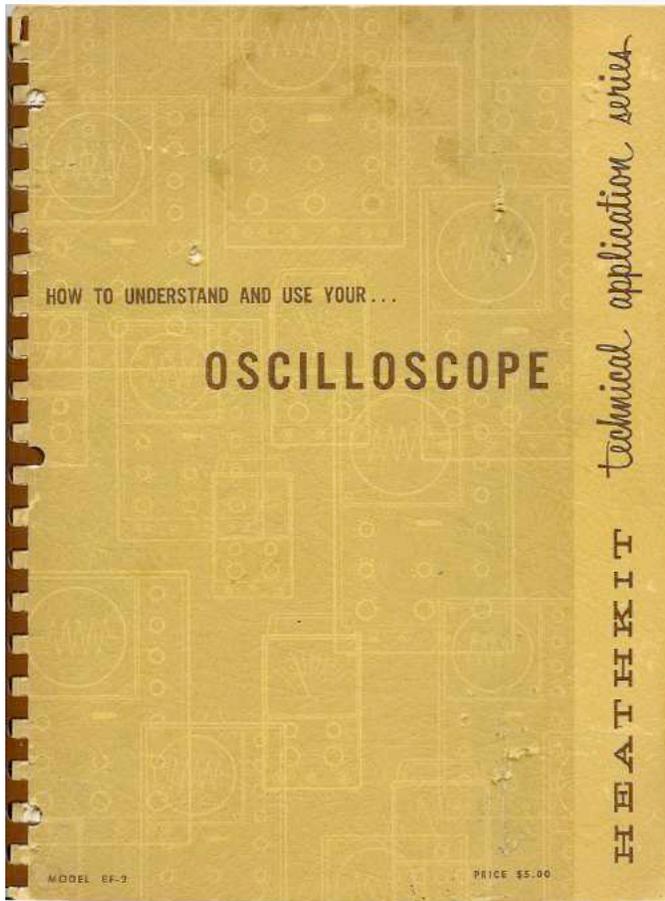


Figure 5: Spiral Bound Manual

through F. Each post on a terminal strip is marked 1 through 4. See figure 4.

Fourteen of the 24 terminal strip posts are dedicated to components such as power, ground, the coil and the pots, the other ten are free to be used as tie points. Dedicated posts are listed in Table I. Since this test chassis uses PNP germanium transistors, the power is supplied from the negative battery terminal and the ground binding post and terminal posts are connected to the positive battery terminal.

The EF-2 Manual:

The manual (Copyright 1962) that comes with the EF-2 contains six parts followed by the appendix. It is 174 pages long, and many of the pages are foldout showing details, waveforms and schematics.

Part I is entitled: *An Introduction to the Oscilloscope*. It is six pages in length giving an over-

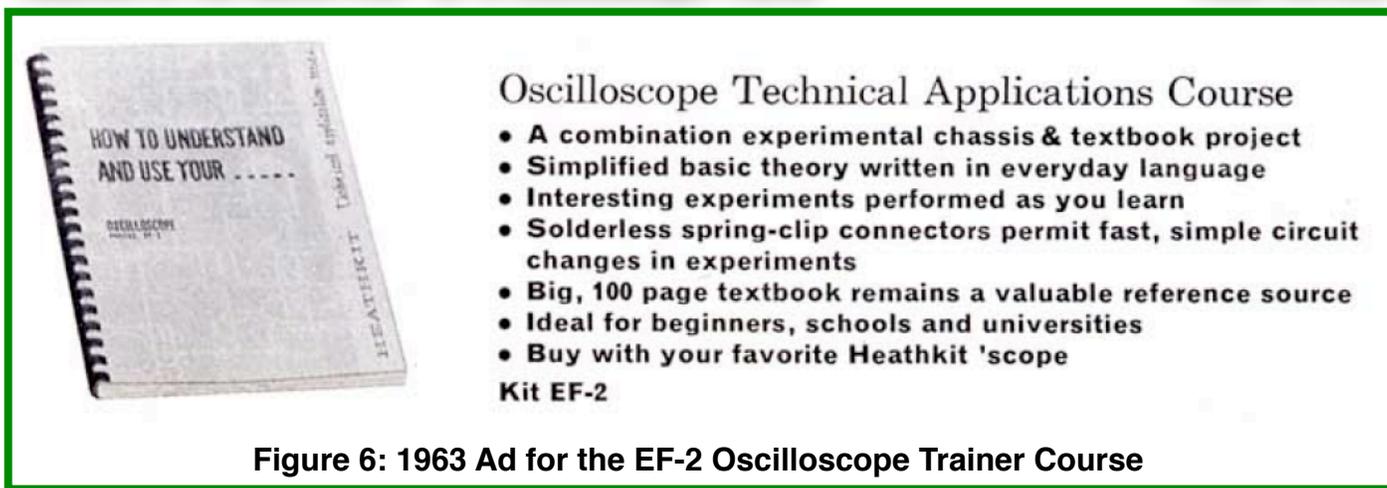
view of the oscilloscope and includes one experiment requiring only a scope to perform.

Part II is entitled: *Test Chassis and Parts Assembly*. This is the step-by-step assembly instructions including troubleshooting and warranty information. It also gives instructions for breadboarding up a two transistor audio oscillator on the test chassis. This helps familiarize the user on how to use the test chassis for breadboarding. The oscillator will be used in some of the early experiments in the next section.

Part III is 60 pages long and is entitled: *Basic Principles of Electronics*. It covers: *Electricity - The Flow of Electrons, Ohm's Law, DC and AC, Capacitors, Inductance and Impedance, Semiconductors, Vacuum Tubes and Oscillators* in eight chapters as named above. In this section you will perform 14 experiments as you breadboard different circuits and make measurements on your oscilloscope.

Part IV is entitled: *Oscilloscope theory*. In its five chapters (54 pages) you will study the workings of the cathode ray tube (CRT), the power supply and high voltage CRT circuitry, the sweep circuit, oscilloscope amplifiers, synchronization theory and practical operation. Years ago I read a book published by Tektronix that delved deeply into oscilloscope circuitry and the ways to increase the amplifier response to get a good waveform display at the higher frequencies. While not nearly as in depth as the Tektronix book, the chapter in this Heathkit manual covers many of the more crucial aspects of improving an amplifier's high frequency response. In Part IV you will conduct five experiments including removing the cover from your oscilloscope to explore the different sections. Typical schematics of sections of an oscilloscope are given. Heathkit used the IO-12 oscilloscope for the images as well as the schematic details.

Part V is entitled: *Oscilloscope Maintenance*. It covers the general principles of troubleshooting



Oscilloscope Technical Applications Course

- A combination experimental chassis & textbook project
- Simplified basic theory written in everyday language
- Interesting experiments performed as you learn
- Solderless spring-clip connectors permit fast, simple circuit changes in experiments
- Big, 100 page textbook remains a valuable reference source
- Ideal for beginners, schools and universities
- Buy with your favorite Heathkit 'scope

Kit EF-2

Figure 6: 1963 Ad for the EF-2 Oscilloscope Trainer Course

as well as making the internal adjustments needed occasionally to keep your scope performing at its best. This part is just two chapters and eight pages.

Part VI is entitled: *Oscilloscope Applications*. Here is where you learn how to use your oscilloscope as a tool. Its eight chapters have the following titles: *Waveform Measurement, Accessories and Special Oscilloscopes, Use of the Oscilloscope in Radio-TV-FM Service Work, Audio and HI FI Applications, Amateur Radio Transmitter Applications for Your Oscilloscope, The Oscilloscope As a Teaching Aid, Waveform Photography, and Medical Applications*. This 28 page section includes numerous waveform drawings as well as alignment and troubleshooting procedures.

Finally the last 5 pages of the manual are an appendix dedicated to a bibliography and glossary of terms.

Conclusion:

If you work through the manual you will end up not only learning a lot about how to use your oscilloscope and get a good understanding of how the scope works, but you will also receive a good refresher course on electricity and electronic theory.

As you do the experiments in the book you will build an audio oscillator (Figure 7), a radio frequency oscillator, a two-stage audio amplifier, an AM transmitter and more.

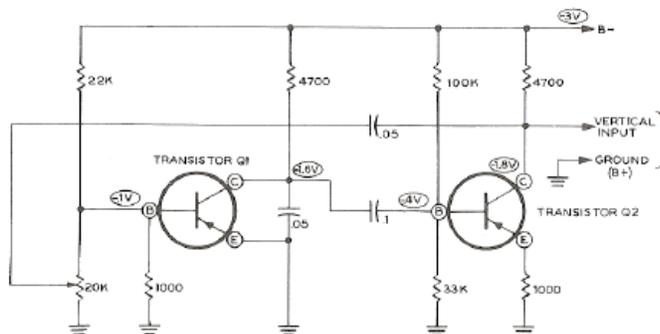


Figure 7: You will breadboard this audio oscillator for the first few experiments

The last ad I could find for the EF-2 was the Winter 1976 catalog (1975/1976). The EF-1 and EF-3 kits continued to be sold. the probable reason for the demise of the EF-2 was two-fold. First, Heathkit began releasing solid-state scopes, making a lot of the course material obsolete; and second, Heathkit was beginning to release a new series of educational kits.

73, from AF6C



Remember, if you are getting rid of any old Heathkit Manuals or Catalogs, please pass them along to me for my research.

Thanks - AF6C

This article originally appeared in the July 2013 issue of RF, the newsletter of the Orange County Amateur Radio Club - W6ZE.