Product Review Column from *QST* Magazine

August 1986

Dick Smith Electronics K-6345 Radio Direction Finder

Heath Model ID-4801 EPROM Programmer

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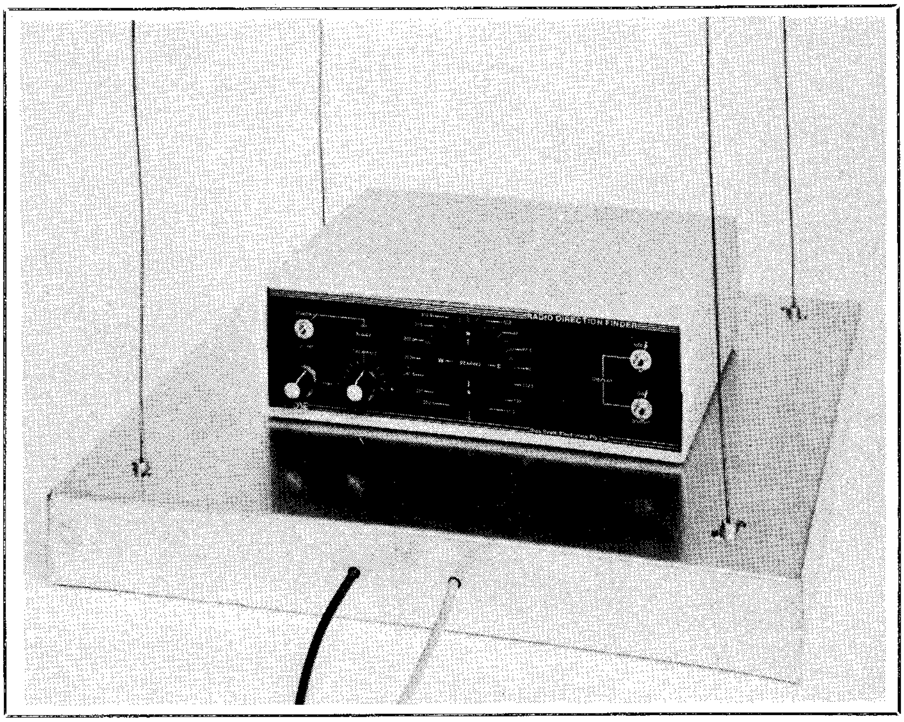


Designed to provide an easy method of tracking down illegal transmitters, RFI sources and antisocial radio operators, the Dick Smith Electronics Radio Direction Finder (RDF) operates on any frequency within the range of 50-500 MHz. It will work with just about any FM receiver, such as hand-held transceivers, pocket scanners or fixed stations. It is provided in kit form and requires a middle-level construction ability—that is, it is *not* a project for the first-time kit builder.

Who Is Dick Smith?

Dick Smith Electronics, Inc, is an American subsidiary of an Australian company. The Dick Smith product line is well known in "downunda" land (Australia and New Zealand), but perhaps not so well known in the US. They have, however, in a very short time established several outlets, primarily in the San Francisco Bay area and Southern California. They stock a very complete line of electronic items, ranging from components to major assemblies, and market much of their product line through mail orders. Because the company emphasizes kit projects for the Amateur Radio operator, as well as the electronics enthusiast, *QST* has looked at some of their projects in the past.[1] This is the first time that we have reviewed one of their more-advanced electronics projects.

RDF Description

Physically the RDF consists of two separate units. The major unit contains the control and display electronics, and will be located adjacent to an FM receiver or transceiver. The second unit, the antenna switching unit, is connected to the control unit through a 4-conductor cable and 2-conductor audio line, and to the receiver antenna terminal through a coaxial cable.

An electronic "compass" display consisting of 32 LED indicators in a circular pattern on the front panel indicates the relative bearing from the RDF to the transmitter being tracked. When a signal is received, its relative bearing to the RDF antenna system is indicated by whichever of the 32 LEDs illuminates. In fixed installations, this allows the compass bearing of the signal to be directly indicated to within ±5.6°. When installed in a vehicle, successive readings allow you to pinpoint the exact location of the transmitter.

How It Works

The theory of operation is relatively simple. Radio signals transmitted from a moving location and received on a stationary antenna, or transmitted from a stationary point and received on a rapidly moving antenna, undergo a frequency shift due to the Doppler effect. This effect is similar to that observed when a moving car blows its horn or a moving train whistles at a crossing.

Consider a single antenna mounted on the edge of a rapidly spinning disk. As the antenna moves toward the source of the RF signal, the apparent frequency will increase due to the Doppler effect. Conversely, as the antenna moves away from the RF source, the apparent frequency decreases. Thus, the rotating antenna causes frequency modulation of the received carrier. When the antenna is connected to an FM receiver, a tone will be heard corresponding to the modulation induced by the rotation. By analyzing the phase of this tone, the direction to the transmitter can be determined.

To avoid the obvious drawbacks associated with a mechanically rotated antenna system, the Dick Smith RDF simulates a rotating antenna electronically. Four vertical whip antennas are arranged around a circle with a diameter of 0.07-0.4 wavelength. The antennas are electronically switched on and off in a clockwise direction such that all four antennas are scanned once every 1/1250th of a second. Only one antenna is active at any point in time. This situation is equivalent to one vertical antenna mounted on the perimeter of a disk spinning at 1250 revolutions per second. For a diameter of 800 mm (31½ inches), which is 0.4 wavelength at 144 MHz, this results in a tangential velocity of 10,300 feet per second, or 3140 meters per second (m/s).

The deviation of the received carrier is determined as follows. For $V \ll C$, we will neglect relativistic effects and use

$$Fr/Ft = 1 - V/C \qquad \text{(Eq 1)}$$

also,

$$dF = |Fr - Ft| \qquad \text{(Eq 2)}$$

therefore,

$$dF = Ft \times V/C \qquad \text{(Eq 3)}$$

where
- Fr is the received frequency
- Ft is the transmitted frequency
- dF is the frequency shift
- C is the velocity of light (3×10^8 m/s)
- V is the antenna velocity

For V = 3140 m/s and Ft = 144 MHz, the carrier will deviate 1.5 kHz at a rate of 1250-Hz. For lower carrier frequencies, the deviation will be proportionately lower. Note, however, that the 1250-Hz modulating tone remains constant as it is a function of the antenna switching rate only.

The audio output from the FM receiver is fed to the signal input of the RDF and compared with an internal reference phase. The resultant phase angle appears as a 5-bit binary code that is decoded to a 1-of-32 output to drive the appropriate indicator LED. In addition, the detected audio tone is fed to an internal speaker to allow monitoring of receiver tuning.

Construction

The RDF control unit includes two PC boards, a main circuit board and a display-

[1] Bruce O. Williams, "Build a UHF Wattmeter," *QST*, Oct 1985, pp 35-37.

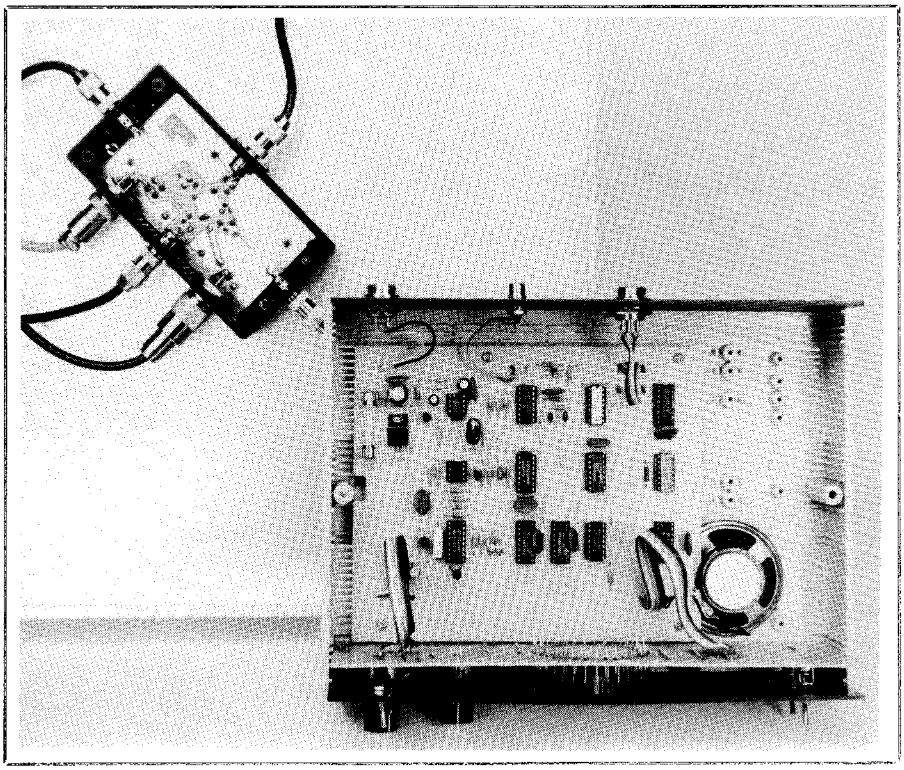


Fig 1—View of the Dick Smith RDF with the top cover removed. The homebuilt antenna system, at top left, includes the Antenna Switching Unit. Note the clean and uncluttered circuit boards in both units. At the bottom right, the 32-LED compass display can be seen. The LEDs must be soldered in to match the spacing between the front panel and the display panel PC board.

panel board. Fig 1 shows the control unit with the cover removed and a bottom view of the antenna system that I built in accordance with the assembly instructions. On the main circuit board, there are 13 ICs, a 5-V regulator and miscellaneous discrete components—resistors, capacitors, transistors and the like. The display-panel circuit board includes the 32 LEDs mounted in a circle, the two control potentiometers, two decoder ICs, the POWER ON LED and two switches, HOLD and DIM. This circuit board is mounted directly behind the silk-screened clear-plastic front panel. The controls mounted on the PC board must align with the holes and markings on the front panel, so it is important to follow the assembly instructions explicitly. The hardest job in the whole assembly process is the mounting and soldering of the 32 LEDs that make up the directional display. The LEDs must be soldered in so that they protrude just the right amount to fit snugly against the front panel and match the clear spots in the panel screening. One thing that bugged me was the mounting of the ON-OFF switch—it is mounted so that you activate the switch *down* for ON. This is just opposite to the US convention where up is on, down is off. Well, the RDF was designed and built downunda and I guess that's the way they do things. Because the switch is mounted on the display-panel circuit board, there is no way to change the arrangement. There is a POWER-ON LED in the front panel, so you don't have to remember which way is ON, however.

The Antenna Switching Unit (ASU) consists of a small PC board mounted in a small plastic box. This unit incorporates the antenna control diodes and connections to the transceiver, control unit and the four antennas. I made an antenna system by mounting four 18-inch vertical antennas on a square box and mounting the ASU on the inside bottom of the box. Although this is a very rough-looking unit, it serves its purpose. It gives some protection to the ASU and allows use of short coaxial cables from the ASU to the antennas.

The assembly instructions for the ASU are complete—the only problem I had was with the four coaxial connectors used to connect from the ASU to the antennas. A coaxial connector is provided for each cable—the problem is that I had never seen a connector like this. It took me a while to figure out how to connect the coaxial cable using it, but eventually it worked out. The four antennas are mounted in the corners of the box, with a spacing of about 20 inches on the diagonal. This meets the specified 0.07 to 0.4 wavelength spacing for 2 m and above, and allowed me to use the RDF for the FM broadcast band.

The assembly instructions are adequate for the experienced builder. There were a few problems during the process, mostly occasioned by a few strange components that I encountered and the different level of capability that Dick Smith expects in Australia. I contacted the manufacturer, and they agreed to do several things to make the kit easier for US constructors. There were no IC sockets provided in my kit. I feel that any IC should be socket-mounted, particularly in a kit. Trying to replace a soldered-in IC is not an easy task. I had a problem with both the VOLUME control potentiometer and the CALIBRATION potentiometer. Both were intermittent and caused some performance problems. It was difficult to find suitable replacements at the specified values (25 ohms and 500 kilohms). In addition to the problem with the unfamiliar coaxial-cable connector, there were no instructions for connecting the shield provided with the 4-conductor cable used for interconnections between the ASU and the main unit. I discussed all of these problems with the manufacturer, and they agreed to furnish IC sockets with all future kits, as well as replace the potentiometers with higher reliability types. The assembly manual will be changed to add the instructions for use of the coaxial connectors and shield. They are also providing silk-screened PC boards to make assembly easier.

I spent about 10 hours assembling the kit and constructing the antenna system. I had no insurmountable problems, just annoying little things. I'm sure that the changes promised by the manufacturer will do much to make construction easier.

Operation

I operated the RDF in several different ways. First, I used it with my Alinco handheld transceiver to locate the various 2-m repeaters around the Newington, Connecticut area. Because of the severe reflections in the ARRL Lab, I was able to get only general directions on these transmitters, and maybe these weren't too accurate. I then tried operating from a 12-V battery in my truck. I was a few miles away from the Lab environment, and I was able to pinpoint fairly well the locations of the various repeaters. Attempts to locate FM broadcast stations from my QTH were apparently successful—I got directions for them, and they coincided with where I think the transmitters are. Remember, the resolution of this RDF is only about 11.5°. Repetitive readings will be necessary to locate the transmitters exactly. I was also able to locate an FM paging system transmitter operating on about 155 MHz, near my home.

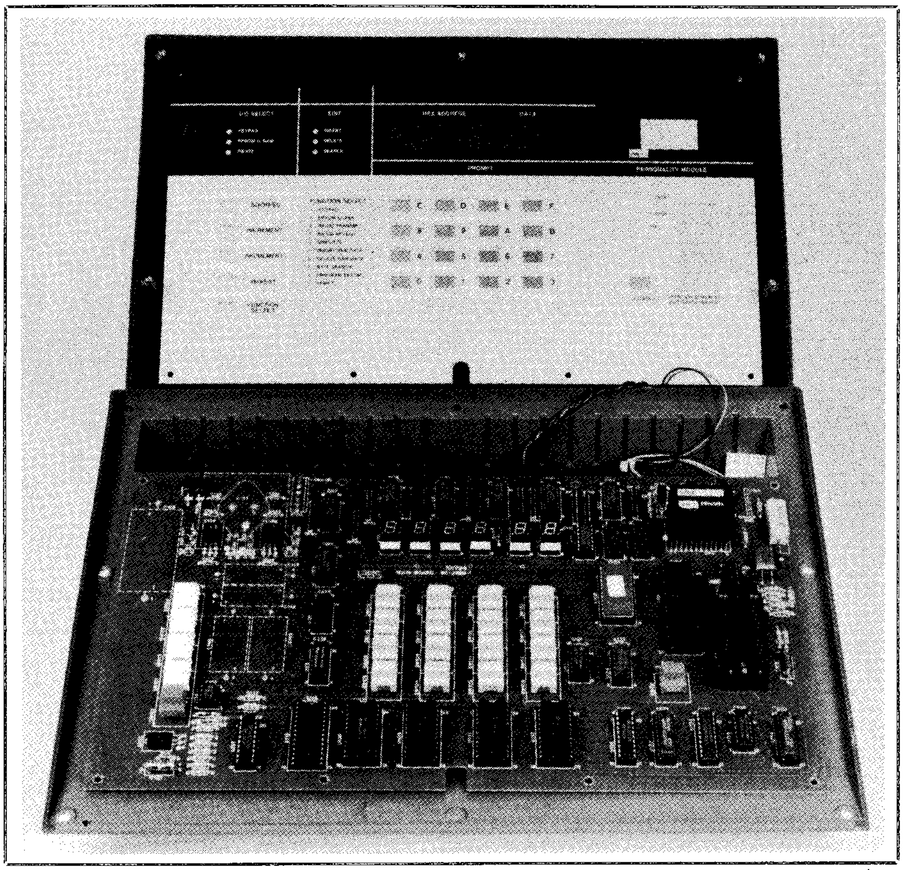
Conclusion

After spending considerable time playing with the RDF, I have a lot of confidence in it. It is a useful piece of equipment for the ham operating in the FM bands, particularly if there are malicious interference problems in the area. It is ideal for transmitter hunts, but I'm sure the local rule makers will outlaw it for competitive use in T hunting. I intend to make a new antenna system, mounted in a large, round pie pan with some sort of magnetic mount, to satisfy the esthetic demands of the XYL and my wishes for a semipermanent mobile installation.

If you are considering an FM DFing application, the Dick Smith RDF is certainly worth looking at. When you consider that similar commercial items may cost as much as \$500-600, it seems to be a good value at \$100. It is available from Dick Smith Electronics, Inc, PO Box 8021, Redwood City, CA 94063, tel 415-368-8844.—*Bruce O. Williams, WA6IVC*

HEATH MODEL ID-4801 EPROM PROGRAMMER

The Heath Model ID-4801 EPROM (*E*rasable *P*rogrammable *R*ead *O*nly *M*emory) programmer allows you to program the con-



tents of 5-V, 2500- and 2700-series devices. The microcomputer-based design of this unit allows a great deal of flexibility in entering data into, and retrieving data from, an EPROM.

The programmer is housed in a sloping-front cabinet that provides easy tabletop access to the controls. Push-button switches are used to select functions and for data entry, and seven-segment LED displays and status indicators provide visual indication of all operations of the unit. All data entry and display is done in hexadecimal values. Two IC sockets are located on the front panel. One socket is a zero-insertion-force (ZIF) type for the EPROM to be programmed; the other is for a "personality module" that configures the programmer for the particular type of EPROM being used. A separate personality module is required for each type of EPROM used.

Functions

Internally, the programmer has read/write memory (RAM) into which data is placed. These data can come from any of several sources, depending on the operation being performed. The RAM can be loaded using the control-panel keypad to enter memory addresses and data; data can be read from an EPROM in the ZIF socket; and data in the form of Intel hex object records can be loaded into RAM through a rear-panel RS-232-C serial port. Once data is in RAM, it can be (1) displayed—location by location—on the control panel display, (2) programmed into an EPROM, (3) altered from the keypad or (4) sent as Intel hex object records through the serial port to a computer.

Entering data into RAM from the keypad is easy. You simply punch in the first memory address you want to enter data into, then key in the two hex data bytes. The programmer then automatically increments the address to the next memory location. The address can be incremented or decremented without entering data, as well.

The editing functions provided from the front panel are flexible and easy to use. In addition to changing the data in any memory location, you can insert and delete data. Inserting a byte into memory at a particular address causes the data in all of the higher-address locations to move up one location in memory. Deleting a byte causes all higher-address bytes to move down one location. This feature is particularly useful if you have keyed in data and left out a byte, or entered a byte twice.

Operation

Before reading or programming an EPROM, you must first configure the programmer for the type of EPROM in use by plugging in a personality module. These are constructed on 24-pin plugs and Heathkit supplies two with the unit. Additional personality modules can be purchased as an accessory. A personality module for a particular EPROM is configured by soldering jumper wires between pins of the plug. Some modules require an internal resistor and/or a diode as well. Instructions for configuring modules for several presently available EPROMs are included in the operating manual. The programmer can only handle EPROMs—the programming voltages and currents required for fusible-link PROMs are not available in the ID-4801.

The ID-4801 comes with 2 kbytes of internal RAM. If you intend to program EPROMs larger than 2 kbytes, it is best to have more memory. Heath sells 8-kbyte and 16-kbyte memory expansion kits.

Once you have loaded the programmer's RAM with data, programming that data into an EPROM is simple. You merely place an erased EPROM into the ZIF socket and enter the starting and ending addresses using the control-panel keypad. The programmer then applies the address and data bits and the control signals to the EPROM to store the data. One minor annoyance is that the programmer requires that all of the EPROM locations to be programmed are *fully* erased (all bits are set to 1). This is annoying because there are occasions when you may want to change a single bit in a programmed EPROM. Although an EPROM cannot change a bit that is programmed to a 0 back to a 1 short of complete erasure, a 1 can be changed to a 0. It's good that the programmer checks to make sure the EPROM is erased, but it would be better if the check function could be overridden to allow an EPROM location to be reprogrammed. Of course, you *can* read the EPROM contents into RAM, alter the data in RAM, remove and erase the EPROM, and reprogram the entire EPROM.

The ID-4801 does a good job of handling 2500- and 2700-series EPROMs; nearly every operation you might need to perform on the data in an EPROM is possible. If you want to work with microprocessor-based equipment, an EPROM programmer is a practical necessity, and the Heath ID-4801 is a good candidate.

Manufacturer: Heath/Zenith, PO Box 167, St Joseph, MI 49085. Price class: ID-4801 kit, $370; SD-4801 wired and tested, $525; IDA-4801-1 Personality Module kit, $20, IDA-4801-2 8K RAM expansion kit, $20; IDA-4801-3 16K RAM expansion kit, $40.
—Jon Bloom, KE3Z

Strays

CALL FOR ARTICLES

☐ With the miniaturization of circuit boards and components, standard soldering techniques are no longer sufficient. Many manufacturers have turned to a process called surface mounting.

If you work in a field related to surface-mounting techniques, why not share the technology with other readers through the pages of *QST?* Prepare an article of the methods involved, and what the advantages or disadvantages of the system are. Submit your material to Paul K. Pagel, N1FB, Senior Assistant Technical Editor, 225 Main St, Newington, CT 06111.

I would like to get in touch with...

☐ anyone having tube charts for a Superior Tube Tester, Model TW-11, made after 1956. Ronald Blocker, K9JON, 40 N Pine La, Glenwood, IL 60425.

☐ anyone with a manual for a Hy-Gain linear, Model 640. Art Southard, WB2CUQ, Rte 2, Box 668, Yaphank Rd, Middle Island, NY 11953.