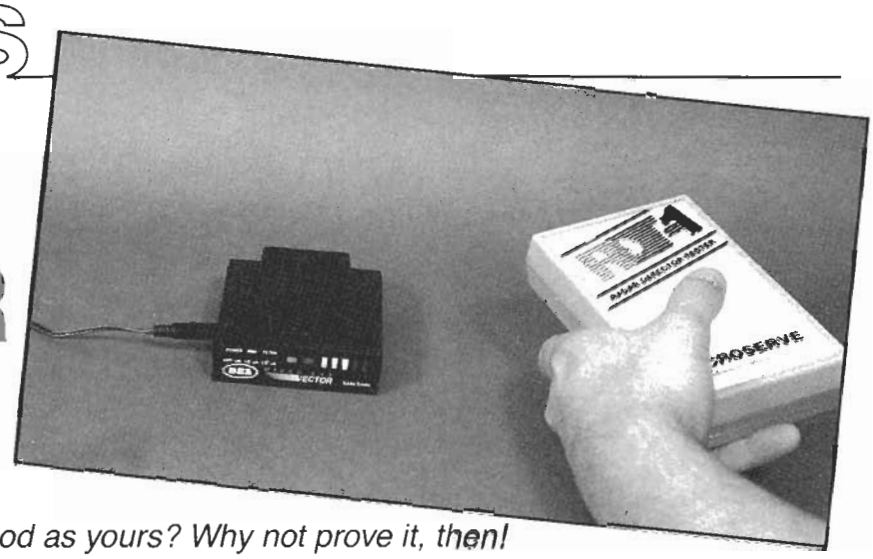
BUILD THIS

RADAR DETECTOR TESTER



Is your friend's radar detector as good as yours? Why not prove it, then!

JOHN B. AYER

HAVE YOU EVER WONDERED HOW SENsitive your radar detector is? Or have you ever had someone tell you that their detector was better than yours? Until now, the average radar-detector owner had no way to prove or disprove any claims made by the manufacturers concerning the performance of the various detectors on the market.

The radar-detector tester pictured in this article is an easy-to-build, low-power X- or K-band radar transmitter. With the device's low-level emissions, you do not need a license to use it. The average detection range is 12 feet, which is more than enough to determine the sensitivity of your radar detector. You can then do a side-by-side test with your friend who's been telling you his detector is better!

Operation

The heart of the circuit (see Fig. 1) is a one-transistor oscillator that operates at a fundamental frequency of 1169.44 MHz. The 9th harmonic of that frequency is 10.525 GHz, which happens to be the center of the X-band police radar assignment. The K-band unit operates at a fundamental of 1857.7 MHz with the 13th harmonic falling at 24.150 GHz. As you probably have guessed, 24.150 GHz is right in the center of the K-band police radar assignment.

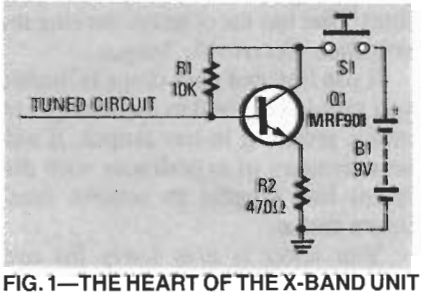


FIG. 1—THE HEART OF THE X-BAND UNIT is a one-transistor oscillator that operates at a fundamental frequency of 1169.44 MHz; the 9th harmonic of that frequency is 10.525 GHz, which happens to be the center of the X-band police radar assignment.

The oscillator uses a microwave transistor in order to maximize the X- or K-band output. The fundamental frequency is determined by the tuned circuit that is attached to the base of the transistor. The tuned circuit consists of a 50-ohm strip line that is etched onto a PC board, and then cut to the proper length during the tuning procedure.

The printed circuit board is made out of double-sided copper-clad teflon with fiberglass reinforcement. The teflon is necessary because of the high frequencies involved (standard G-10 epoxy printed circuit boards act like short circuits at frequencies above 3 GHz). Although teflon sounds exotic, it isn't, and it is readily available from the suppliers listed in the parts list.

Some people may not be familiar with strip-line circuitry. Any line that is etched on one side of a double-sided PC board will have inductance along its length and capacitance through the dielectric (the fiberglass, teflon, etc.) to the ground plane (the copper plating on the other side of the board). In a properly designed strip line, the inductance and capacitance cancel each other leaving the designer with just a resistive impedance to worry about. As it turns out, the width of the line and the thickness of the dielectric determine the resistive impedance.

In this particular case, it was determined that 50 ohms was the optimum impedance. After deciding which PC-board material would be best suited for this project, the following equation was used to determine the width of the strip line needed:

$$Z_o = (87/\sqrt{E_r + 1.41}) \times L_n[5.98H/(T + .8W)],$$

Z_o = characteristic impedance (50 ohms)
E_r = dielectric constant (2.48)
L_n = natural logarithm
H = thickness of dielectric (0.0156 inches)
W = width of line (0.038 inches)
T = thickness of copper cladding (0.0004 inches)

Once the width of the line is determined, all that's needed to finish the job is to determine the length of the line for the target frequency. (The oscillator is similar to a pipe organ where the length and diameter of a pipe determines the tone that is produced; the length of the strip line determines the resonant frequency.)

Construction

Etch the circuit board using the pattern provided in PC Service; a ready-made board is also available. The transistor has four leads; two are connected to the emitter, and you must determine which they are. Use an ohmmeter if you are not sure. (The

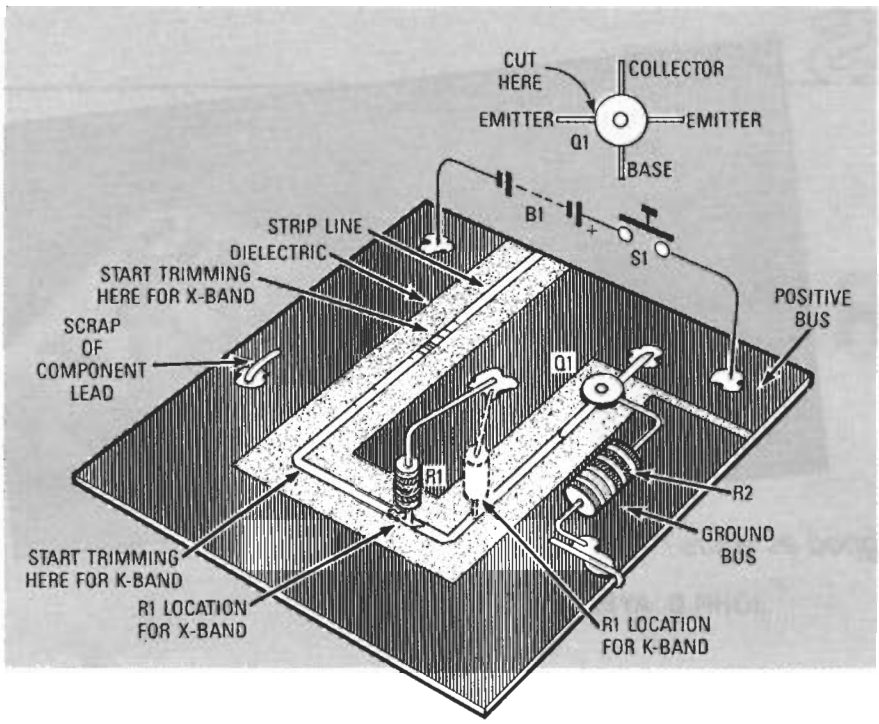


FIG. 2—PARTS-PLACEMENT DIAGRAM. Resistor R1 must be in a different location, depending on whether you're building an X- or K-band unit. Also, when aligning the unit, the strip line must be cut in a different location depending on the type of unit.

emitter leads are the only two that will exhibit a dead short from one to the other.) Cut off the left-hand emitter lead, as shown in Fig. 2.

After removing the extra lead, place the transistor in the hole on the board so that the base lead is on the strip line and the collector lead is on the positive bus, and solder them in place (see Fig. 2). Place R2 on the board and, keeping both leads as short as possible, solder one of its leads to the remaining emitter lead of Q1. The other resistor lead should go through the hole in the PC board, and soldered on both sides (a through hole, if you will). A scrap piece of component lead must go through the other hole on the left side of the board, and also soldered on both sides (another through hole).

Cut one lead of R1 so that it's ⅛-inch long. Refer to Fig. 2 for proper placement of R1 for either the X or K band. Then solder the shortened lead of R1 to the strip line so that the resistor is standing on end. The longer lead of the resistor should then be soldered to the positive bus of the PC board (see Fig. 2).

Using a silicone adhesive, glue the PC board into the enclosure that you have selected. DO NOT use a metal enclosure. The microwaves need to escape from the box, and you will defeat the entire project by using a metal box. Be sure to orient R1 so that it's closest to the front of the box, because most of the radiation is emitted from that point.

Attatch the battery and switch as shown in Fig. 2, being careful not to reverse the polarity. Route wires away from the strip line and components, because stray wires can de-tune the oscillator. Construction is now complete and you are ready to tune the transmitter (see Fig. 3).

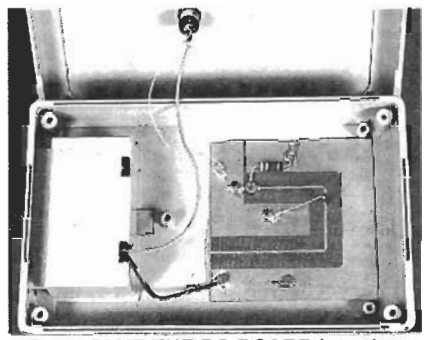


FIG. 3—GLUE THE PC BOARD into the *plastic* enclosure using a silicone-type adhesive.

PARTS LIST

R1—10,000 ohms, ¼-watt resistor
R2—470 ohms, ½-watt resistor
Q1—MRF-901 Motorola transistor for X band, *or* NE68137 California Eastern Laboratories transistor for K band.
B1—9-volt battery
S1—push-button switch
PC-board material—6 × 6-inch piece of 0.0158-inch thick teflon-fiberglass (Taconic Plastics, part number TLT-9-0150-C1/C1)
Plastic project case

Note: A complete parts kit is available from MICROSERVE, 60 Thompson Street, Maynard, MA 01754. Besides the parts, the kit also includes a custom plastic enclosure with an integrated battery holder and decorative face plate. X-band kits are $55, and K-band kits are $65. Shipping and tax extra. Spare parts list available on request.

Motorola Semiconductor Products
3102 N 56th St.
Phoenix, AZ 85018
602-952-3000 or 800-521-6274

California Eastern Laboratories
3260 Jay St.
Santa Clara, CA 95054
408-988-3500

Taconic Plastics LTD.
Petersburg, NY 12138
518-658-3202

Alignment

To align the unit, you will need a radar detector and an X-acto knife with a fine blade. Turn on the radar detector and the tester. Now make an initial cut in the strip line starting at the point specified in Fig. 2 for either the X- or K-band unit. Be sure to cut all the way across and through the copper trace. If your detector does not sound an alarm, make another cut about 1/16-inch closer to the transistor. At some point your detector will sound an alarm, and the tester will be properly tuned. Be careful not to cut too much at one time, because if you go too far you will have to carefully solder the line back together.

However, if you go just a *little* too far, you can save some work by cutting nicks in the remaining strip line (cuts that go part way across the strip line). That has the effect of making the strip line electrically longer.

If you find that your range is limited you may have tuned to the wrong harmonic resulting in low output. It will be necessary to experiment with different line lengths to achieve maximum range.

Your tester is now ready for use. Simply hold the unit near a detector and turn it on. The range of the X-band transmitter is about 12 feet, while the range for the K-band unit is about 5 to 10 feet. **R-E**