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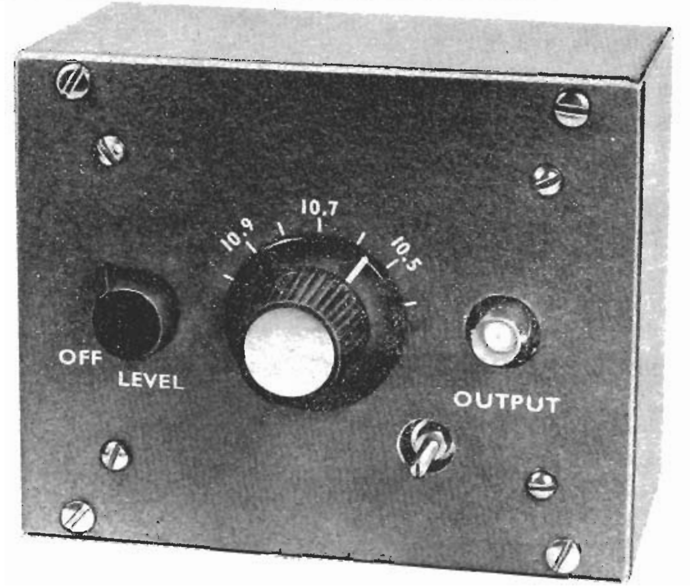

Low-Cost 10.7-MHz Signal Generator

FOUR HUNDRED kHz BANDSPREAD TUNING TO VERIFY FREQUENCY RESPONSE

IF YOU'VE EVER had occasion to check the frequency response of 10.7-MHz i-f stages, ratio detectors, and discriminators, you're aware of the inherent shortcomings of conventional signal generators employed for this kind of work. Most standard FM i-f transformers are designed to have a 3-dB bandwidth of about 200 kHz, while ratio detector and discriminator transformers usually have a peak-to-peak response of 300-600 kHz.

Since conventional signal generators are designed to cover a wide frequency range, the band required for FM i-f testing and alignment occupies a rather narrow segment of the generator's tuning dial. Consequently, frequency readings, in terms of 10 kHz or so, are next to impossible to obtain unless you can continually monitor the generator's output with a frequency meter. Even then, it is a tedious and touchy procedure.

However, for about $12 you can build a simple 10.7-MHz signal generator that will spread out the 600 kHz of interest to cover a 180° segment of the tuning dial. Calibration is accurate enough to do the job for which the instrument was designed, and the tuning can be continuously reset to within 1 or 2 kHz at the marked points on the dial or within 10 or 20 kHz in between the markings if your interpolation is good.

Theory of Circuit Design. The 10.7-MHz generator employs two field effect transistors; *Q1* is in a Colpitts oscillator configuration, while *Q2* operates as a source-follower output circuit (see Fig. 1). The frequency of oscillations is determined by the values of *L1* and the combination of *C1* through *C5*, with *C1* serving as the main tuning element in the circuit. The capacitive value specified in the Parts List for *C1* provides a frequency spread of slightly in excess of 600 kHz. This could easily be expanded or narrowed by changing the value of the tuning capacitor.

The drain of *Q1* is operated at +6 volts and is grounded for r-f through *C6*. Similarly, the drain of *Q2* is operated at +6 volts, with *C8* providing the r-f ground return. The output from *Q1* is coupled through *C7* to the gate of *Q2*. Capacitor *C9* provides signal

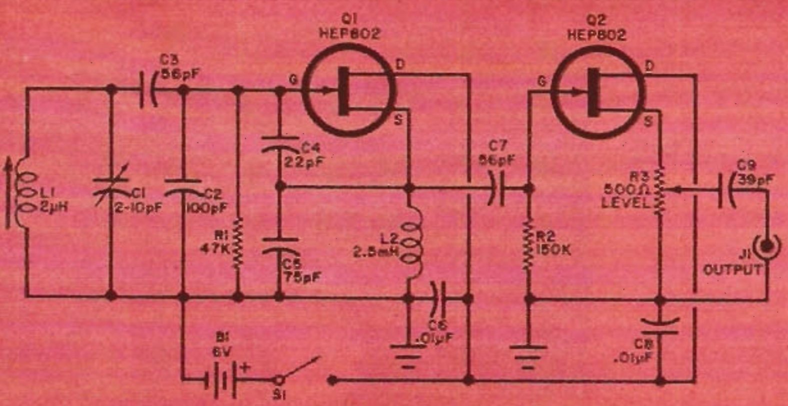

Fig. 1. Stage Q1 is wired up as a Colpitts oscillator, while source-follower stage Q2 serves as a buffer to prevent erratic oscillator operation under load.

PARTS LIST

B1—Four 1.5-volt AA cells in series
C1—2-10-pF variable capacitor (Johnson No. 160-109A, or similar)
C2—100-pF silver mica capacitor
C3,C7—56-pF silver mica capacitor
C4—22-pF silver mica capacitor
C5—75-pF silver mica capacitor
C6,C8—0.01-μF disc capacitor
C9—39-pF disc capacitor
J1—UG-290A/U BNC-type coaxial connector
L1—2-μH inductor (15 turns #24 enameled wire close-wound on ¼" slug-tuned coil form; use Miller No. 21A000 or similar form)
L2—2.5-mH r-f choke (Miller No. 70F253A1, or similar)
Q1,Q2—HEP802 or MPF102 field-effect transistor (Motorola)
R1—47,000-ohm, ½-watt resistor
R2—150,000-ohm, ½-watt resistor
R3—500-ohm potentiometer
S1—Spst switch (part of R3)
Misc.—5" × 4" × 3" metal utility box; battery holders; circuit board material; hardware; spacers; control knob; hookup wire; solder; etc.

coupling to the external circuit connected to *J1* and dc isolation between the signal generator and the external circuit.

Construction. With the exception of *C2*, all of the components that make up the 10.7-MHz signal generator mount on a printed circuit board, the actual-size etching guide for which is shown in Fig. 2. When mounting the components on the board, orient *C1* so that its capacitance increases with clockwise rotation of the shaft and so that the flat on the shaft is parallel to the bottom edge of the front panel with *C1* set for half capacitance. Then connect and solder *C2* between the rotor and stator terminals of *C1*. Referring to Fig. 3, finish mounting all the remaining parts as shown.

Mount the circuit board to the front panel of a 5″ × 4″ × 3″ aluminum utility box with 6-32 hardware and ¼″-long spacers. Then fasten the battery holders to the rear panel of the utility box with 6-32 machine hardware.

Panel lettering must be done during the calibration process. Although there are several methods you can choose from to mark the panel with the proper legends, the dry-transfer technique is by far the neatest and most professional looking. Also, if you wish to make the panel markings more permanent, wait several days after applying the lettering; then spray two or three light coats of clear acrylic finish on the front panel. Make these coats light, and wait until each is completely dry before applying the next coat or the lettering will lift off.

Calibration and Use. To accurately use the signal generator, it must first be calibrated. To do this, you need at least temporary access to an accurate frequency meter, such as a surplus BC-221. The calibration procedure is as follows:

First, turn on the signal generator and the frequency meter and allow both to warm up and stabilize. After a sufficient length of warm-up time has elapsed, set the tuning dial on the signal generator so that the index on

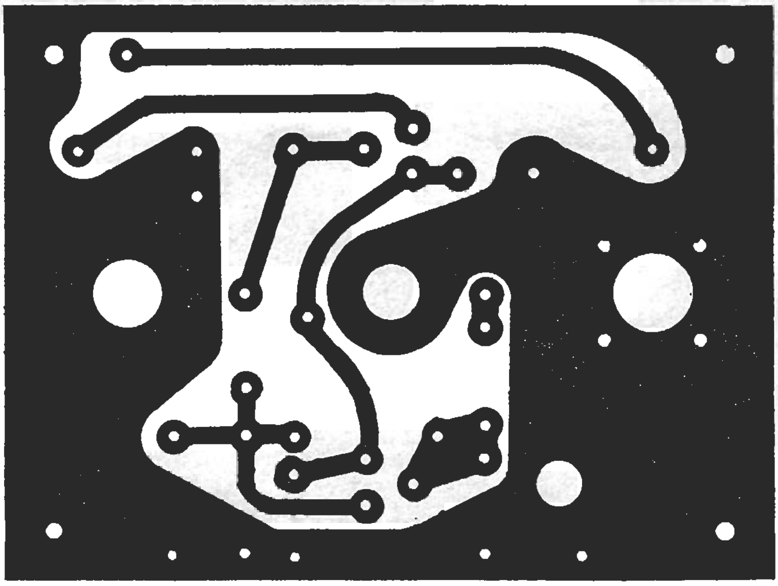

Fig. 2. To obtain proper operation from circuit, actual size etching guide must be carefully copied as resist pattern on copper foil side of circuit board.

the control knob is pointing straight up. Be sure that *C1* is at half capacitance at this point. Then connect the generator to the input of the frequency meter through a suitable length of coaxial cable. Set *R3* to its midpoint.

Adjust the setting on the frequency meter to exactly 10.7 MHz. Now, tune the slug in *L1* to produce a zero beat between the output signals of both instruments. Tighten *L1*'s locknut, and mark the 10.7-MHz calibration point on the front panel in line with the control knob's index or pointer. Repeat the process for the other calibration points desired.

You can roughly calibrate the level control (*R3*) with the aid of a low-voltage r-f voltmeter or other instrument capable of measuring low-level r-f voltages. An oscilloscope, properly calibrated, will do nicely.

When using the 10.7-MHz oscillator, here are some suggestions to enable you to obtain the maximum benefit from your instrument. Always use coaxial cable between the generator and the equipment under test to prevent stray coupling and false readings. When aligning FM i-f stages, or when running bandwidth measurements, keep the output level of the signal generator as low as possible so that limiting in the i-f strip will not give false indications. If a vacuum-tube receiver is involved, you can take dc readings at a limiter grid with a VTVM. In solid-state circuits, one way is to use a VTVM with a rectifier-type r-f probe and take readings at the base or collector of an i-f stage.

When checking peak-to-peak responses of discriminators, keep the generator's output level *high* so that heavy limiting occurs ahead of the discriminator. This maintains the discriminator's input level relatively constant

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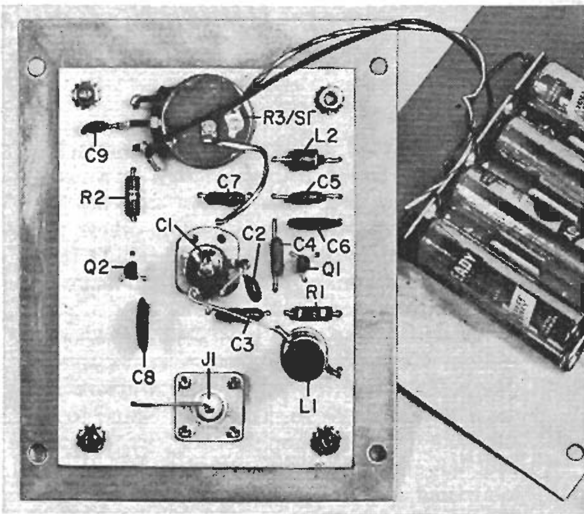

Fig. 3. Note that only one hole in board is used for C9; other lead of C9 goes to center lug of R3. A length of bare wire connects C1 directly to L1.

GENERATOR

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throughout its frequency range. Discriminator output readings should be taken at the dc output point, but prior to any audio coupling capacitor. A zero-center VTVM is handy for these measurements, although any VTVM or TVM can be used simply by switching the meter polarity as the pointer deflection passes through zero. —30—