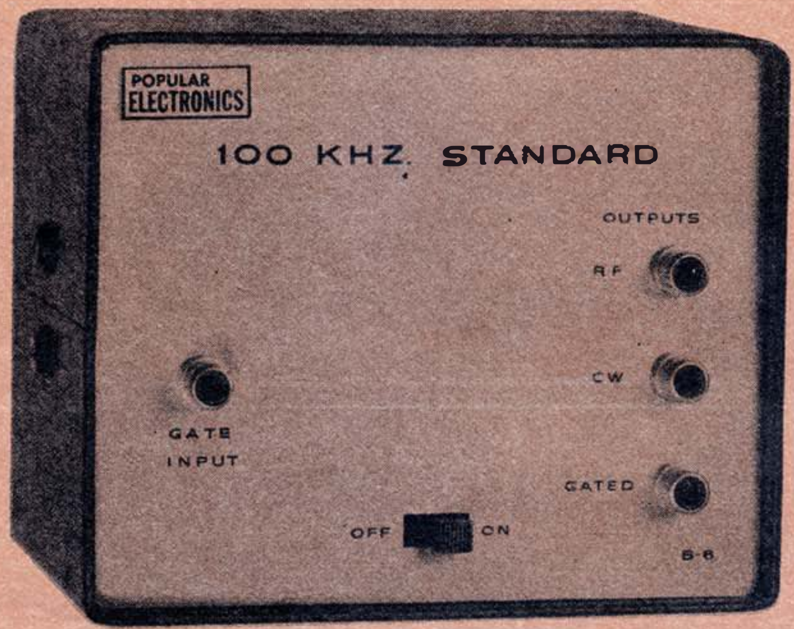

Build The 100-kHz Standard

STABLE, ACCURATE SOURCE OF REFERENCE SQUARE WAVES

BY DON LANCASTER

A STABLE, accurate source of 100-kHz reference square waves has many applications—most of which are adequately filled by the "100-kHz Standard" described here. For the ham or SWL, it is a must for receiver calibration, providing a "birdie" every 100 kHz and, if desired, it can be adjusted to zero beat against WWV for optimum accuracy.

For general experimental and laboratory work, the Standard can be used as a top-notch calibrator for oscilloscopes and r.f. generators, since it has a very accurate frequency and excellent rise time (about 12 nanoseconds) for probe compensation.

In work involving digital IC's, the unit is a handy high-frequency clock source. For example the frequency can be divided to obtain ultra-precise time gates for an electronic counter. Or, the gate input can be used to start and stop the gate output making available a train of 10-μsec pulses that can be fed to the counter to measure the velocity of a bullet and perform other experiments in the laboratory.

IC EXPERIMENTER'S CORNER

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About the Circuit. The 100-kHz standard employs a crystal and a single integrated circuit (*XTAL* and *IC1* in Fig. 1) in a very simple circuit. Three outputs are provided: CW (*J3*) for 100-kHz square waves all of the time; RF (*J2*) for wide-spectrum narrow (10-μsec) period spikes for receiver calibration; and GATED (*J4*) for the 100-kHz square waves only when a separate GATE INPUT (*J1*) is grounded. Application of +1-4 volts d.c. to the GATE INPUT removes the output signal.

In addition, an internal trimmer capacitor, *C5*, is provided to allow shifting the frequency approximately 100 Hz on either side of the crystal frequency to provide compensation for crystal tolerance, variations in supply voltage and temperature, and zero beating with WWV. A buffer stage between the oscillator and the outputs insures minimum constant loading.

Integrated circuit *IC1* consists of four two-input gates, two of which are biased into the class A region to act as linear amplifiers with resistors *R1* and *R2*. These amplifiers are cross-connected to each other through capacitors *C3* and *C4* and the crystal to form a feedback loop.

A third gate and *R3* provide an isolating buffer stage. The output of this gate goes to *J3* directly, and to *J2* through capacitor *C6* to provide only the sharp leading and trailing edges for the calibrator output.

The fourth gate is the only one in which the second input is used. This stage is used for gating the CW output

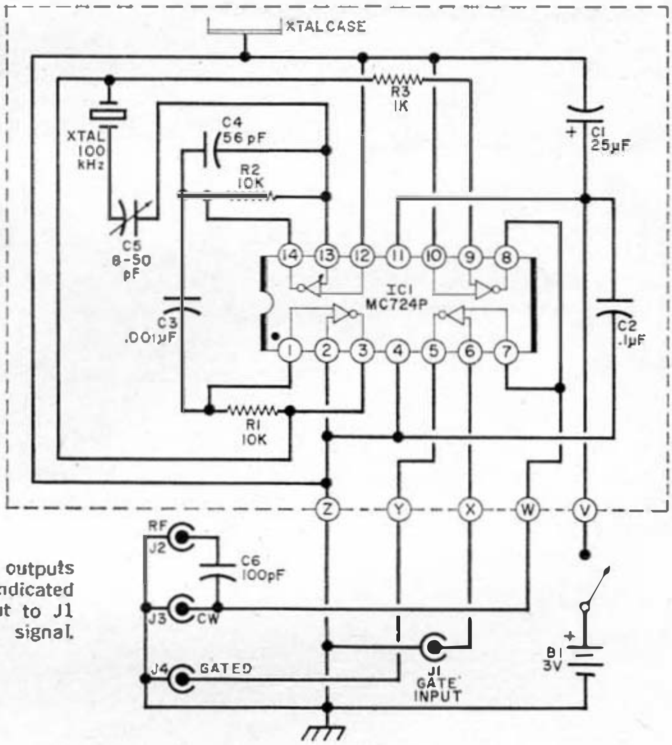

Fig. 1. Separate outputs are available, indicated near J2-J4. Input to J1 removes output signal.

PARTS LIST

B1—1.5-volt D cell (2)
C1—25-µF, 6-volt electrolytic capacitor
C2—0.1-µF disc capacitor
C3—0.001-µF, 50-volt Mylar capacitor
C4—56-pF mica capacitor
C5—8-50-pF screwdriver-adjustable trimmer capacitor
IC1—Quad two-input-gate integrated circuit (Motorola MC724P)
J1-J4—Phono jack
S1—S.p.s.t. switch
XTAL—100-kHz parallel resonant crystal, specified into 32-pF load
Mis.—Printed circuit board (see text); crystal holder and rivets; hardware for C5 if needed; 5" x 4" x 2½" vinyl-clad case; Keystone No. 176 battery holder; #6 hardware; hookup wire; solder; etc.
The following items are available from Southwest Technical Products Corp., 219 W. Rhapsody, San Antonio, TX 78216: etched and drilled printed circuit board No. 173C for $9.85; complete kit of parts, including pre-punched case, but less batteries, No. 173b $2.15; postpaid in U.S.

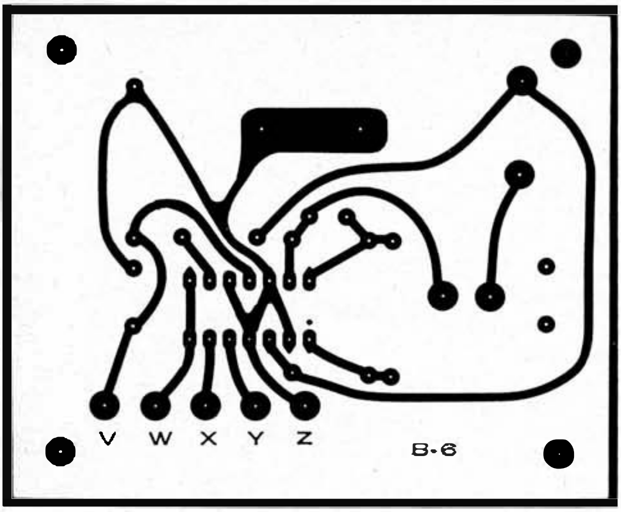

Fig. 2. Full-size printed circuit etching guide at left should be copied exactly as shown. Exercise caution to avoid short circuits between close proximity IC pin solder pads.

and, in turn, provide a gated output signal.

The crystal specified is a 100-kHz parallel-resonant type into a 32-pF load. When *C5* is set to 32 pF, the operating frequency will be the same as the characteristic frequency of the crystal. Increasing the capacity of *C5* decreases the crystal's operating frequency, and vice versa. This feature allows the user to "pull" the oscillator frequency to exactly 100 kHz.

Construction. A printed circuit board is recommended for this project. You can buy one already etched and drilled (see Parts List), or you can make your own by carefully following the etching guide provided in Fig. 2.

The first step in assembling the circuit is to rivet the crystal clip to the component side of the PC board in the appropriate location. Then mount the components on the board as shown in Fig. 3. Use a low-power, small tip soldering iron to solder the leads of *IC1* to the foil pattern, and apply heat just long enough to get the solder to flow.

Next, mount the circuit board to the front panel with #6 hardware and four ½"-long spacers. Interconnect the jacks, switch, and circuit board.

For a housing, you can use either the pre-punched vinyl-clad one specified in the Parts List or a 5″ × 4″ × 3″ metal utility box. In either case, the batteries should be mounted to the rear of the case, and an access hole to *C5* should be drilled. (Note that both sides of *C5* must be "floating," precluding the use of a conventional panel-mounting variable capacitor; so do not attempt to substitute this component.)

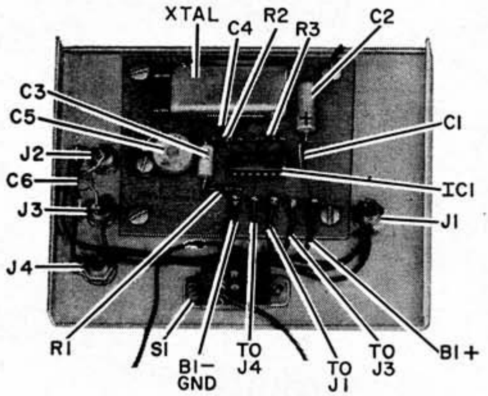

Fig. 3. Photo shows component locations on circuit board and front panel. Notch on IC1 is to left.

How To Use. Calibration of the 100-kHz Standard is needed only for very exacting applications since the normal operating frequency of the standard will usually be well within a 99.9-100.1-kHz range. To calibrate, use either an electronic counter or a communications receiver tuned to a high-frequency WWV transmission. Adjust *C5* with an insulat-

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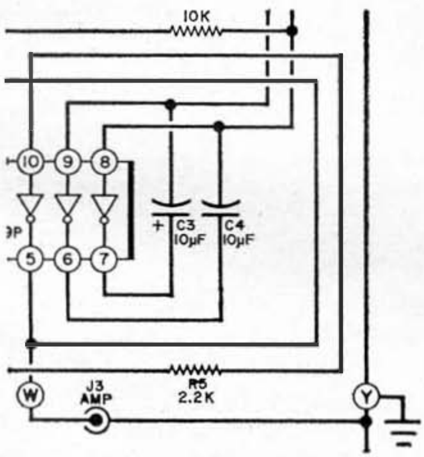
ed alignment tool to obtain either a 100 kHz reading on the counter or a quiet "chuffing" zero-beat note from the receiver speaker.

The circuit should operate properly with all good-quality 100-kHz parallel-resonant crystals. However, older surplus or odd cut crystals might require a shift in the values of capacitor *C4* and, rarely, *C3* for proper starting and clean operation. If you are using non-standard crystals, you might have to experiment to get the best results. Also, crystals with other frequencies can be used for special applications, up to 8 MHz or so.

For powering the standard, you can use batteries or any power supply capable of delivering 1.5-6 volts of relatively clean d.c. Supply voltage has a slight effect on the operating temperature; so, be sure to calibrate your 100-kHz Standard at the voltage you will be using. –30–

OUT OF TUNE



"Build the Two-Tone 'Waverly' Alarm" (February 1970). The schematic diagram, Fig. 1 on page 30, shows *R6* and *R7* connected to the incorrect pins on *IC1*. In the partial diagram above the correct connections are shown.