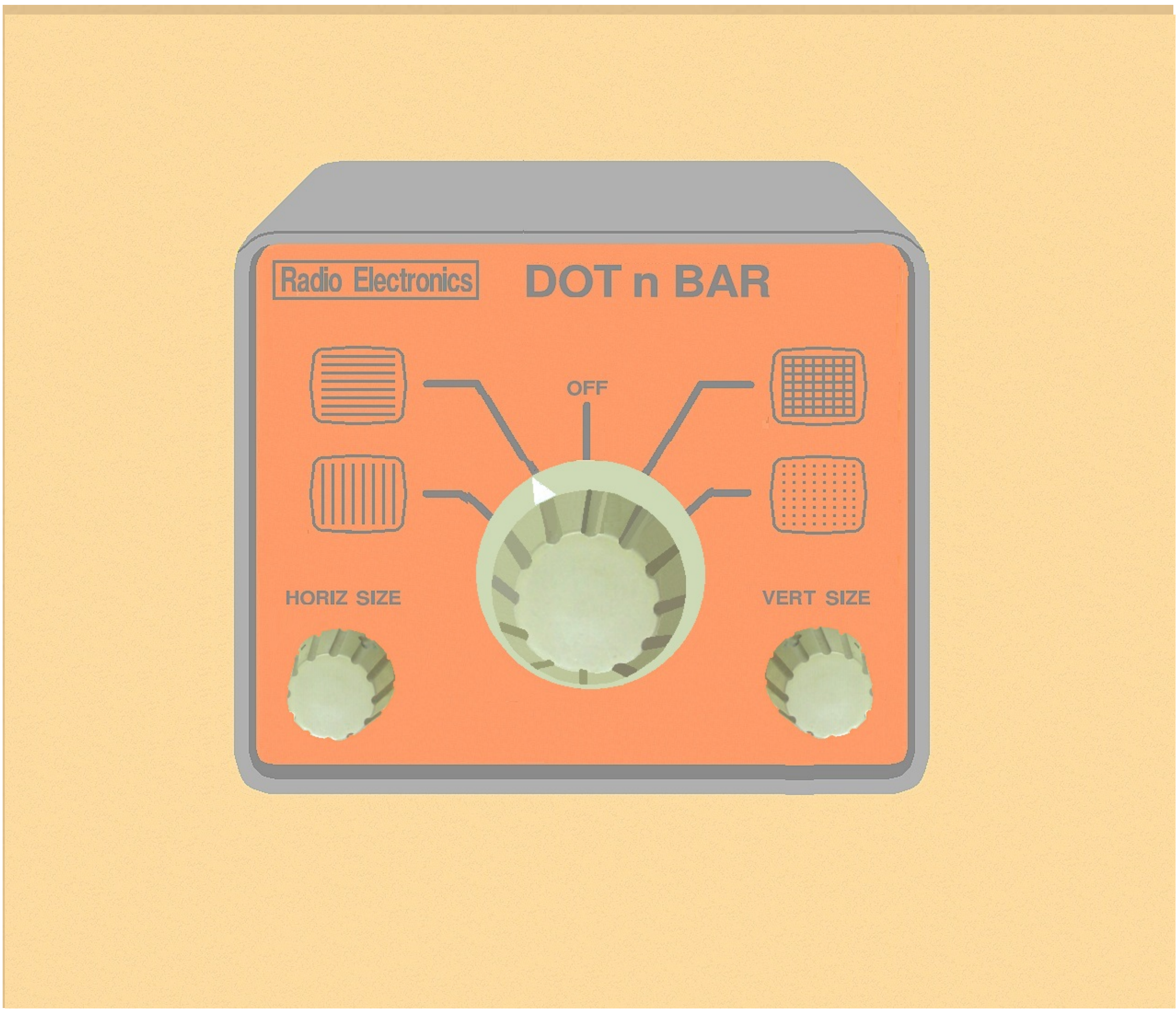
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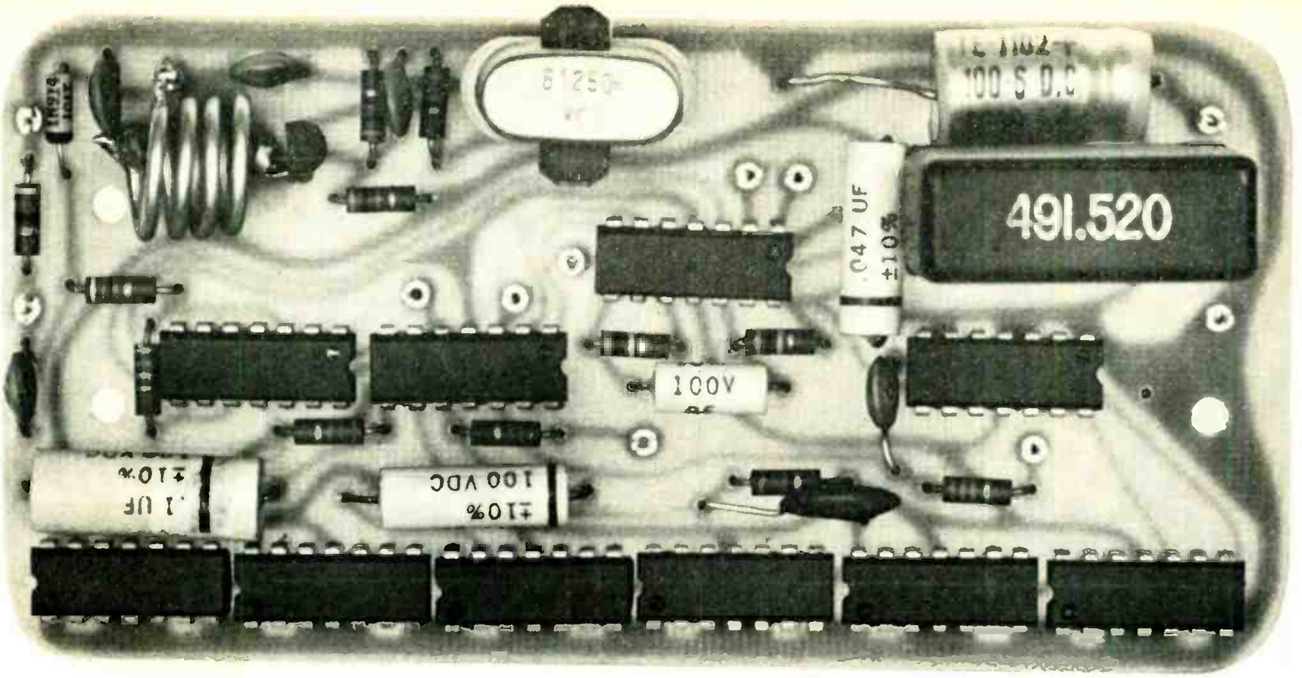


Build DOTnBAR – A Professional Quality Pattern Generator

By **DON LANCASTER**

WHO SAYS A BAR GENERATOR HAS TO BE expensive, bulky, or hard to use? Behold the RADIO-ELECTRONICS DOTnBAR, a battery-operated, 2-pound instrument you can build for $35 to $50. By using computer techniques and low-cost integrated circuits, the DOTnBAR is more stable than nearly any other instrument available today. Patterns lock the minute power is applied. They are so stable that no internal sync adjustments are needed. Only three D cells are needed for the power supply.

The DOTnBAR (see photo on front cover) is easy to put together and the parts are readily available. Circuit boards and a professionally finished front panel are available.

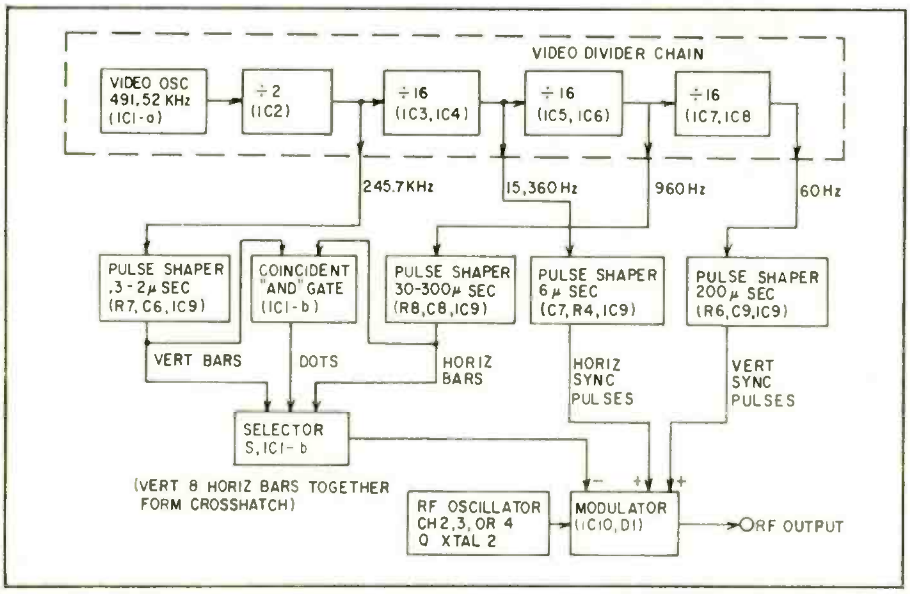


Fig. 1—Heart of the generator, as shown in this block diagram, is the divider chain.

For a stable television pattern, all picture elements must be locked to each other, and they should be derived from a single reference source. The DOTnBAR's exceptional stability is due to the use of *binary* flip-flops (which divide by 2). They sync the pattern. Unlike the familiar relaxation divider, a binary requires no adjustments and no regulated power supplies. Best of all, it cannot jump sync or divide by some different number.

To simplify the divider function, 512 horizontal lines are used (rather than the US standard of 525). With a vertical scanning rate of 60 Hz, the resulting horizontal line frequency is 15,360 Hz. Although a bit lower than the broadcast standards, this feature will cause only a small variation in horizontal hold and width settings on TV receivers.

Because flip-flop dividers work best when dividing by multiples of 2, the DOTnBAR uses two identical 256-line fields, no interlace, and no equalizing pulses.

Fig. 1, a block diagram, shows circuit function. The crystal-controlled 491.52-kHz video oscillator starts the action. Its output is divided by 2 to produce 245.76 kHz. This figure is then divided by 16 to produce the horizontal scanning frequency of 15,360 Hz. Following this, another division by 16

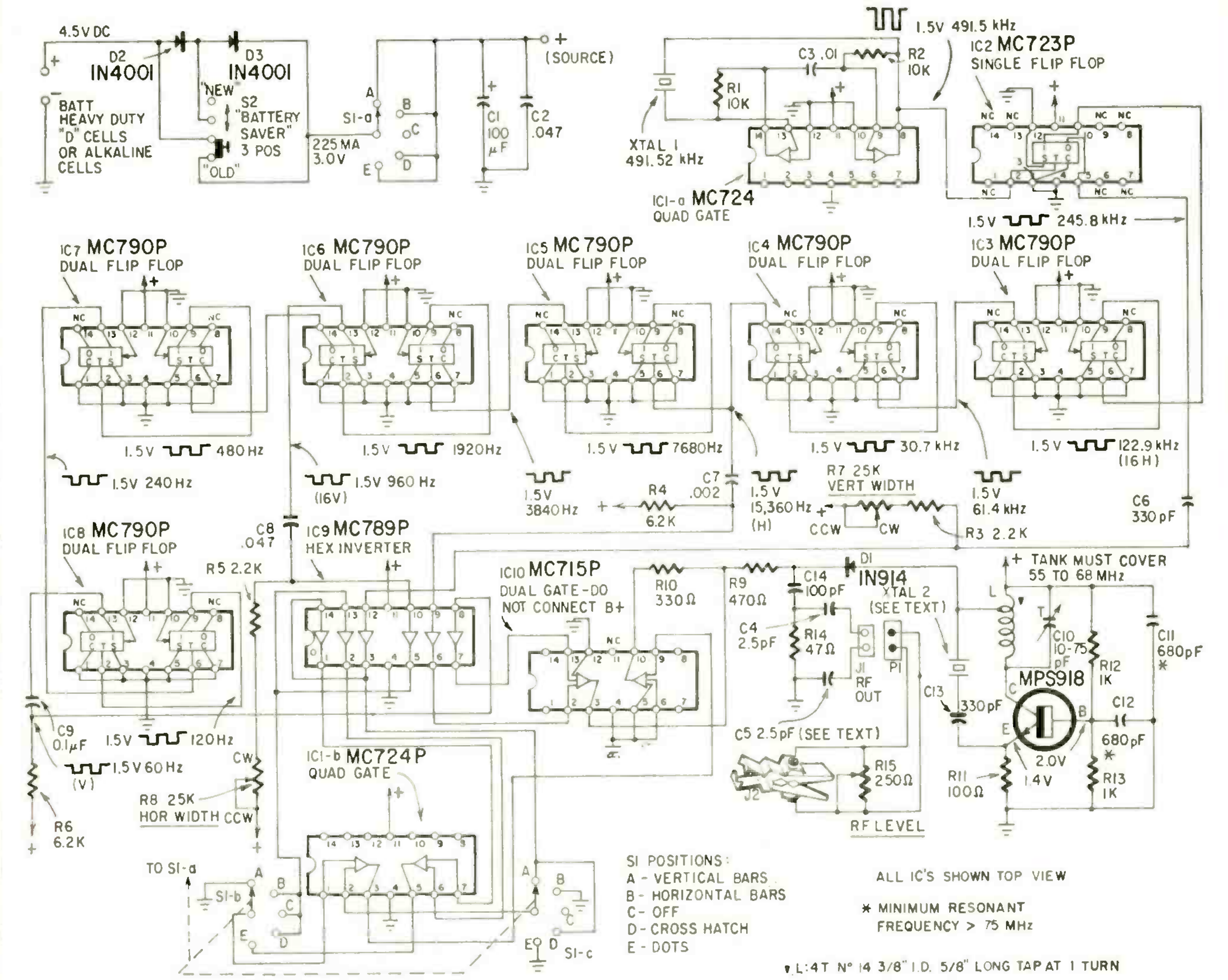


Fig. 2—Without the use of integrated circuits, the DOTnBAR would be two or three times as complex.

PARTS LIST

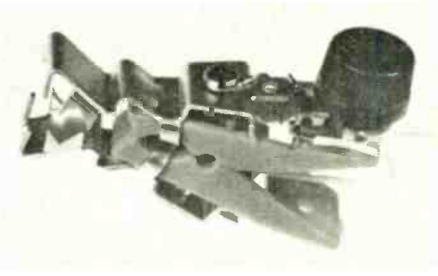
BATT—heavy-duty D-size flashlight cells (3): NEDA 13C (Burgess 210, Eveready 1150, Ray-O-Vac 3LP; also see text)
C1—100 µF, volts, electrolytic
C2, C8—.047 µF, 50 volts, mylar
C3—.01 µF, 50 volts, mylar
C4, C5—2.5-pF gimmicks (see text)
C6, C13—330 pF, ceramic disc
C7—.002 µF, ceramic disc
C9—0.1 µF, 50 volts, mylar
C10—10-75 pF, ceramic trimmer (Erie 557-000-COPO-109R equivalent, Newark Electronics catalog No. 19F2974 @ $1.06)
C11, C12—680 pF, ceramic disc (see text)
C14—100 pF, ceramic disc
D1—1N914
D2, D3—1N4001 or equivalent
IC1—MC724P MRTL quad two-input gate ($1.08)
IC2—MC723P MRTL J-K flip-flop (Motorola, $1.35)
IC3,4,5,6,7,8—MC790P MRTL dual J-K flip-flop ($2.00)
IC9—MC789P MRTL hex inverter ($1.08)
Q—MPS918 transistor (Motorola) ($1.30)
Note: Data sheets and distributor lists on all IC's and transistors available from Motorola Semiconductor, Box 955, Phoenix, Ariz. 85001
J1—chassis-type TV connector (Mosley 303 or similar)
J2—clothespin-type TV connector (GC KLIPPER or similar)
L—four turns No. 14 bare copper wire spaced out ⅝ in. on ⅜-in. form (see text)
P1—mating plug for J1
R1, R2—10K, ¼ watt
R3, R5—2,200 ohms, ¼ watt
R4, R6—6,200 ohms, ¼ watt
R7, R8—25K pot, linear taper
R9—470 ohms, ¼ watt
R10—330 ohms, ¼ watt
R11—100 ohms, ¼ watt
R12, R13—1,000 ohms, ¼ watt
R14—47 ohms, ¼ watt
R15—250 ohms, miniature potentiometer, linear taper, (CTS U201R251 or equivalent)
S1—3 poles, 5 positions, non-shortening selector switch
S2—dp3pos slide switch (Wirt G-128 or equivalent)
XTAL 1—491.520-kHz series-resonant crystal (Texas Crystals No. TC-21 @ $1.25, Texas Crystals, 100 Crystal Drive, Fort Meyers, Fla. 33901)
XTAL 2—55.25 (Ch. 2), 61.25 (Ch. 3), or 67.25 (Ch. 4) MHz crystal, fundamental or third-overtone type, similar to CTS (James Knights) No. H-173
Case—3 x 4 x 5-inch aluminum case (Bud CU2105A or Zero Z-64-80A-48 or equivalent)
Chassis—(optional) 13 x 8 x 1/32-inch aluminum sheet (see Fig. 5)
Front panel—(optional) Metal-photo hard anodized aluminum dial plate, available from Reill's Photo Finishing, 4627 N. 11 St., Phoenix, Ariz. 85014. In silver color, $2.75; red or copper, $3.25, postpaid in US
Circuit board—2 5/16 x 4¾ x 1/16-inch single-sided PC board (see below)
Spacer—(optional) 4¾ x 1½ x ⅛-inch (see text)
Misc.—Crystal sockets; ⅝-in. knob (2); 1¾-in. knob; 3-cell battery holder, size D; pop rivets (12); 4 × in. threaded spacers (4); No. 6 rivet-on spacers (4); No. 10 nylon cup washers for feet (4); 300-ohm twin lead
Wire—(3 feet); No. 14 BX or Romex house wire (etched and drilled PC board available from Demco, Box 16297, San Antonio, Texas 78216)

results in a frequency of 960 Hz, the same as sixteen times the vertical field frequency. One final division by 16 gives us the 60-Hz vertical-field scanning rate. Each divider output consists of a fast-rise square wave, and all are locked to the others.

The horizontal and vertical scanning signals are routed to separate pulse shapers to generate horizontal and vertical sync pulses. These are 6 μsec wide for the horizontal and 200 μsec for the vertical.

Frequencies of 245.76 kHz and 960 Hz are also sent to pulse shapers. They are adjustable, however, so you can control the overall line widths and dot size. Output of the 245.76-kHz pulse shaper consists of *vertical* lines, while output of the 960-Hz pulse shaper consists of *horizontal* lines. These horizontal and vertical lines are sent to a pattern-selector switch and a coincidence circuit which produces an output *only* where the lines cross. Consequently, a 256-dot pattern results. The pattern-selector switch chooses between horizontal lines, vertical lines, both for crosshatch, or the coincidence-circuit output for a screenful of dots.

For rf output, a crystal oscillator working on TV channel 2, 3 or 4 is used. This carrier is then modulated by both sync and pattern pulses produced by the pulse formers.



A pot on the rf output feedline maintains best signal-to-noise ratio to TV receiver.

The circuit

Fig. 2—the schematic—looks a lot more complicated than it really is. Outside of the transistor and ten IC's ($16.50 worth), there's really very little to it. XTAL 1 and the 2 gates in IC1-a form the video oscillator. IC2 then performs the first binary division, producing an output square wave at 245.76 kHz. The rest of the video divider chain—IC2 through IC8—consists of flip-flops, two per package. Each flip-flop divides by 2; each $2 package by 4. The desired frequencies are picked off as they occur during three consecutive divisions by 16.

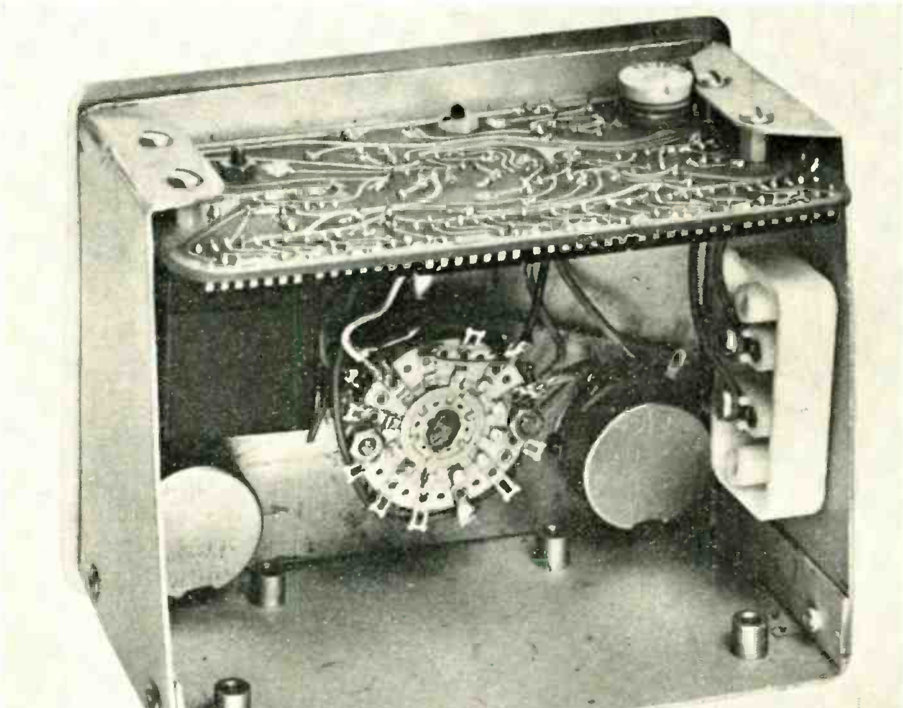
Sync-pulse shaping is accomplished by R4, C7, R6, C9 and IC9. The output sync pulses are then routed to modulator stage IC10.

VERT WIDTH control R7 and HOR WIDTH control R8 shape the 960-Hz and 245.76-kHz signals, together with R5, C8, R3, C6 and IC9. The dot coincidence is performed by the lower right gate of IC1-b. Selector switch S1, together with the remaining gate in IC1-b, chooses the desired pattern. A fifth switch position turns the DOTnBAR off.

Q and XTAL 2 are an rf oscillator, operating at channel 2 (55.25 MHz), 3(61.25 MHz) or 4(67.25 MHz) depending on your choice. Usually, you'll want to pick an unused channel in your area. Resonant tank L1-C10 tunes the oscillator to suit the selected crystal.

Diode D1 is the rf modulator. The amount of current through D1 is determined by IC10 and resistors R9 and R10. In the absence of sync or pattern pulses, the *series* combination of R9 and R10 determines the diode current, and hence the black output level. A sync pulse grounds R9, increases the diode dc current, decreases the impedance of D1, and *increases* the rf output. A pattern pulse *opens* R10, which turns D1 *off*, producing very little output rf and a resultant white line or dot.

Composite rf appears across R14 and is delivered to the receiver antenna via a piece of 300-ohm twin lead and a clothespin connector. Coupling from R14 is with two 2.5-pF capacitors—C4 and C5—used to reduce rf level. These capacitors are "gimmicks"—made by simply leaving insulation *on* the hookup wire that contacts the screwheads on chassis connector J1 (see photo below). They're as near to a zero-cost, zero-effort pair of capacitors as you'll probably ever come across.



Parts placement in the cabinet isn't crowded, but be sure to allow room for batteries.

Batteries

Ordinary D-size flashlight cells do not have quite enough capacity for any reasonable battery life in this application, so *heavy-duty* D cells are recommended. The NEDA type 13C (Burgess 210, Eveready 1150, Ray-O-Vac 318) costs about $0.16 each. With such batteries you'll get about 8 hours of continuous operation.

If you prefer, you can go to fancier cells to reduce your per-hour cost. For instance, alkaline D cells such as the NEDA 13A (Burgess AL-2, Mallory MN-1300) will give you 40–50 hours of operation per set. Professional service people might also consider rechargeable nicad batteries. The 2,000 mA-hr rated D-size (Burgess CD-7 or Eveready C2) is ideal.

A battery-saver switch, consisting of S2 and two silicon diodes, is included in the generator. When the cells are fresh, you can run the DOTnBAR with *both* diodes in series with the battery, giving you a supply voltage around 3.2. As the batteries age, you cut out first D2 and later D3, thus maintaining about 3 volts for the circuit. If you always use the saver position with the *maximum* number of diodes in series that still gives you output patterns, you'll more than double battery life.

Construction

A circuit board is a must for this project as the IC's alone require nearly 140 tightly packed connections. You can buy this board predrilled and ready for assembly, but if you prefer you can lay out and etch your own board, using the full-size layouts shown in Figs. 3 and 4. Use a small iron and fine solder while soldering the IC's in place. Note that the second row of IC's has its identifying notches pointing in the opposite direction from the first row. IC10 receives no B+. The IC's are not interchangeable.

The rf oscillator requires a bit of care in assembly. Bypass capacitors C11 and C12 must be high-quality disc units that do not resonate below 70 MHz. *Do not substitute Q*. The coil is made of No. 14 solid copper wire. Wind four turns on a 3/8-inch form and space the turns out to 5/8-inch. You can strip a piece of BX or Romex electric cable to get this size. The coil is self-supporting and mounts directly on C10. The oscillator tank consists of these two components; they must cover a 55- to 68-MHz range. C10 mounts on the *foil* side of the circuit board. A solder terminal and wire jumper form the tap for L1.

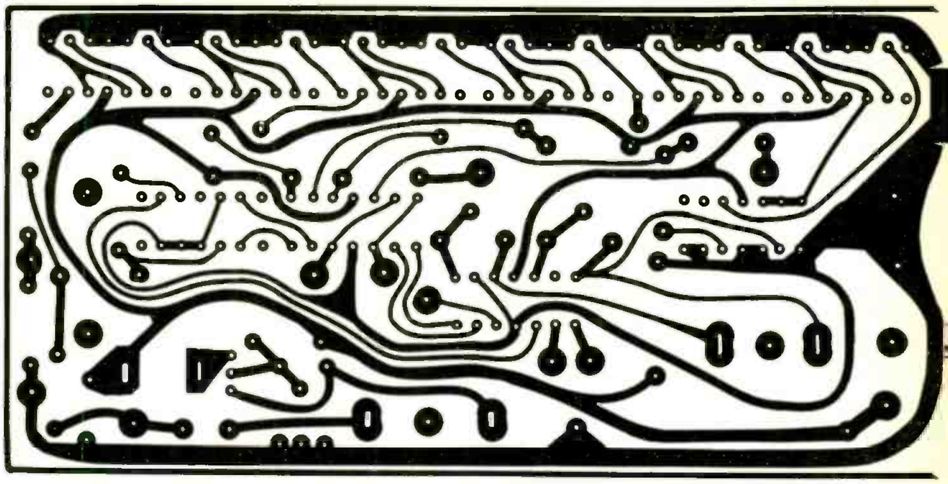
You can use a 3 x 4 x 5-inch metal box or similar deep-drawn aluminum case for your unit. If your plans call for the deep-drawn case, the photos show the chassis and the circuit-board mounting. Use the front panel and circuit board as drilling templates. If your S1 is multideck, you'll have to shorten the spacers to avoid mechanical interference with the batteries.

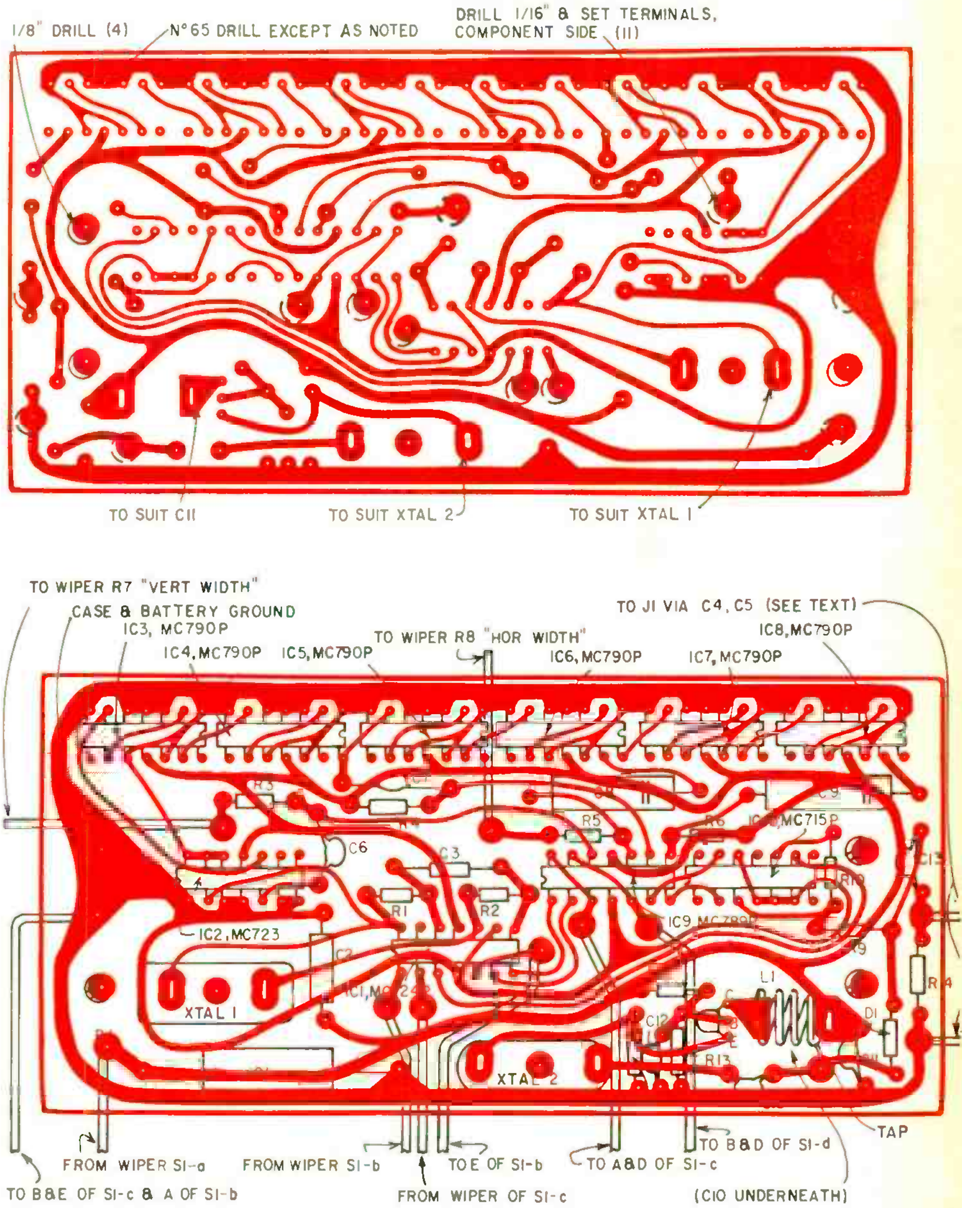
The chassis supports the circuit board upside down with four threaded spacers and No. 4 hardware. A 1/8-inch thick piece of aluminum is mounted behind the chassis to pull back the bushings of S1 and the pots. This lets the knobs hug the front panel, but still allows you to make use of the antirotation tabs on the controls.

A 300-ohm chassis-type TV connector is mounted on the left side of the chassis and can be reached through a rectangular access hole in the case. Remember *not* to strip the leads going under the terminal screws.

A three-cell battery holder is pop-riveted to the rear panel. So is the battery-saver switch, mounted vertically so that the maximum *upward* switch travel corresponds to both diodes being in the circuit. Watch the clearance between battery, chassis and case. You can use the case as a ground return as the PC board automatically picks up this connection.

You might like to use several wire colors to keep track of the leads to S1. Your output cable can consist of 3 feet





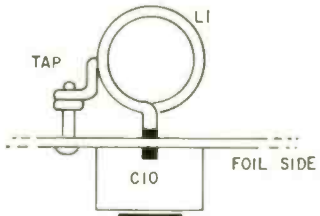


Fig. 3 (top)—Here is the life-size pattern for the PC board that's used in the generator.

Fig. 4—Board holes and foil patterns (middle) and component-mounting locations (bottom).

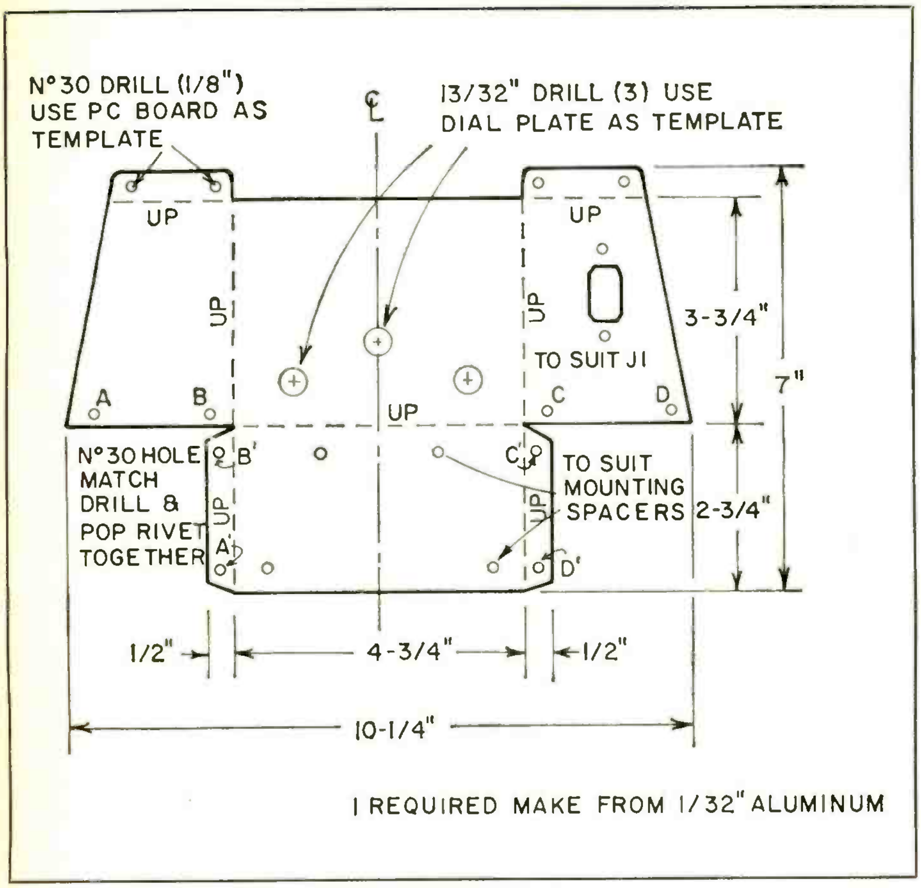


Fig. 5—If you use a deep-drawn case, you'll need a chassis like this, made of aluminum.

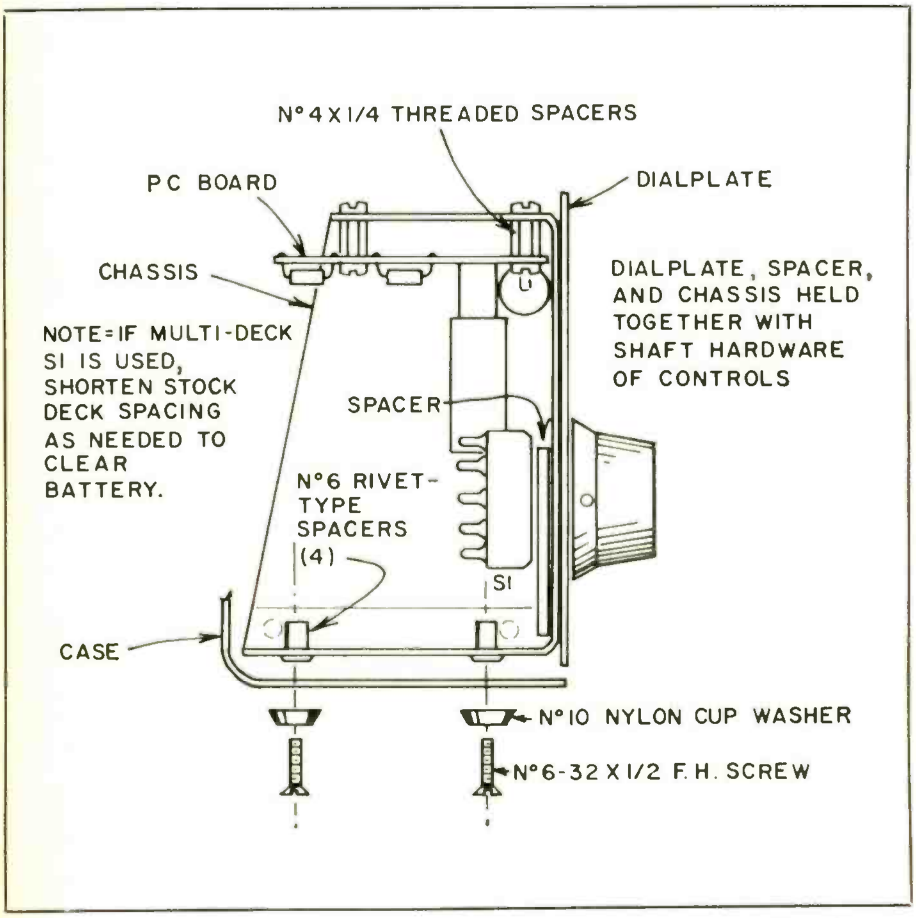


Fig. 6—Assemble case, chassis and PC board like this. Be sure switch clears battery.

of twin lead with a connector that fits J1 on one end and, on the other, a clothespin connector. Mount a small 250-ohm pot (R15) on the clothespin to give you a point-of-use rf attenuator.

Preliminary checkout

Monitor power-supply current with a dc vom and *briefly* switch the DOTnBAR to the crosshatch position with the battery-saver switch up (both diodes in the circuit). If the current is not approximately 225 mA, *stop immediately*, and carefully check out the circuit to find the short, the open, or the IC that's in backward.

Once you have the proper meter current, clip the DOTnBAR to a working TV tuned to the proper channel, and switch to the crosshatch position. Adjust trimmer C10 till the oscillator starts. Set C10 halfway between the start and dropout points. Then adjust the TV fine tuning for the brightest vertical line and, if you have to, touch up the horizontal stability control. Finally, adjust the DOTnBAR width controls to get a typical crosshatch pattern.

Operating hints

Always use minimum rf output to the receiver, to prevent possible overloading. Once adjusted, C10 should not need readjustment unless you change crystals. The width controls may occasionally need touching up, or you might like to purposely vary them for special effects and multiple dot patterns.

You'll find the picture a bit larger than broadcast programs in both directions—horizontally because of the 15,360-Hz sweep frequency, and vertically because of a narrower blanking bar. It amounts to ¼ inch each way on a 20- or 21-inch set. Remember that the horizontal stability may need retouching on a few sets, particularly low-cost portables, so always run a final stability check on an actual station.

You can add a gated rainbow by building an adjustable, crystal-controlled, 3.5641-MHz oscillator and injecting this signal as a subcarrier into the junction of R9–R10 with a small capacitor. I've purposely left off this feature as it adds significantly to the DOTnBAR's cost and is normally not needed for the majority of color setup and convergence work, particularly for in-home service.

Always use the battery-saver switch as far up as possible. If the pattern ever becomes skitterish or drops out, switch down to the next position. Remember that the DOTnBAR needs no warmup time, and you're only wasting battery life if the instrument is on and not being used. END