

COVER STORY

BUILD THE SUPERTROL

For . . .

- Automatic start switching
- Interval timing
 - Voltage Sensing
 - Delayed Stop Action
 - Etc., etc., etc.

By **DON LANCASTER**

ASK NOT what the Supertrol can do, but rather, what it cannot do. For here is a circuit with an abundance of useful applications. The Supertrol is primarily a free-running master sequence generator, suitable for an exhibit or display, which provides a completely adjustable on/off ratio of from 50 milliseconds to 10 seconds. Husky 10-ampere relay contacts provide dual complementary—off/on, on/off—outputs.

Change around a connection or two and the Supertrol becomes a sensitive voltage level detector which opens or closes a relay with a positive snap action as the input voltage exceeds 2 volts, or drops below 1 volt.

Add a d.p.d.t. switch and once again change some connections around and you have a time-delay relay or an interval timer—depending upon your choice of output contacts. With this arrangement you can turn on a load once for a predetermined time interval, or get a con-

tinuous output at the end of an adjustable 0- to 20-second time interval.

How It Works. The Supertrol's actual circuit (Fig. 1) is nothing more than a jazzed-up version of a basic Schmitt trigger as described on page 44. Transistors *Q2* and *Q3* comprise the Schmitt trigger while *Q1* is an emitter follower used to keep charging capacitor *C1* from loading down the circuit. The capacitor charges through potentiometer *R11*, so that this control determines the relay's on time. Similarly, *R12*, which provides a discharge path for the capacitor, determines the relay's off time.

Most of the resistors added to the basic circuit are for stabilizing purposes, and to help eliminate current surges from the power supply and the unit's control circuitry. Capacitor *C2* helps to speed up the turn-off operation, while *D1* protects *Q3* from voltage spikes due to the inductance of the relay coil.

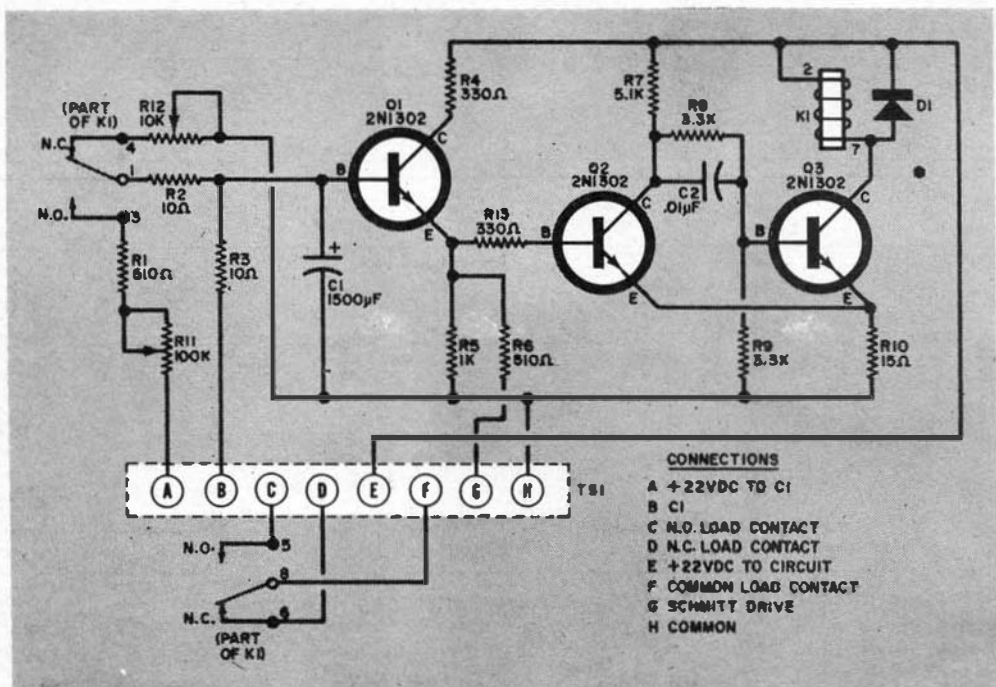


Fig. 1. The Supertrol is a practical application of the well-known Schmitt trigger circuit. A technical explanation of the triggering operation appears on page 44. Relay K1 is the workhorse of the Supertrol and the second set of contacts (octal pins 5, 6, and 8) are used to operate other circuits up to a drain of 10 amps. The author brought all control wiring functions out to a terminal strip, but this may be eliminated if the Supertrol is to be used for only one job.

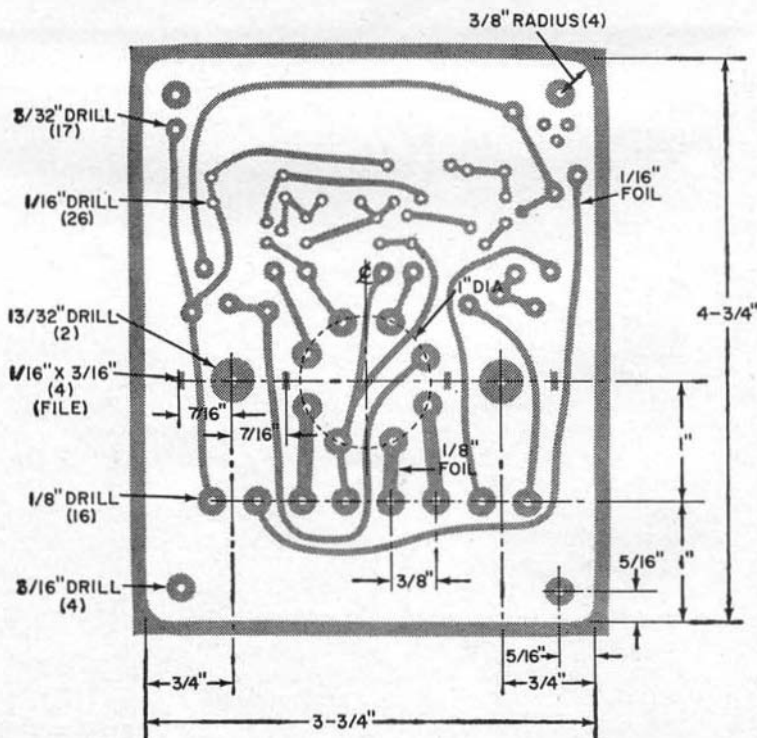


Fig. 2. A printed circuit board can be etched following the outlines shown in this drawing. Use of this outline should be predicated on the physical size of capacitor C1, location of the terminals for the octal socket to hold K1, and whether or not the builder uses twist-tab potentiometers for R11 and R12. Point-to-point wiring can be used in place of a printed circuit without encountering any problems.

PARTS LIST

C1—1500- μ F, 6-volt d.c. electrolytic capacitor
 C2—0.01- μ F disc capacitor
 D1—750-mA, 200-PIV silicon diode
 K1—24-volt d.p.d.t. relay, 400-ohm coil, with 10-ampere contacts (similar to Potter & Brumfield KRP11DG)
 Q1, Q2, Q3—2N1302 transistor or similar unit
 R1, R6—510-ohm, 1-watt resistor
 R2, R3—10-ohm, $\frac{1}{2}$ -watt resistor
 R4—330-ohm, $\frac{1}{2}$ -watt resistor
 R5—1000-ohm, $\frac{1}{2}$ -watt resistor
 R7—5100-ohm, $\frac{1}{2}$ -watt resistor
 R8, R9—3300-ohm, $\frac{1}{2}$ -watt resistor
 R10—15-ohm, $\frac{1}{2}$ -watt resistor
 R11—100,000-ohm twist-tab potentiometer (similar to Centralab TT-40)

R12—10,000-ohm twist-tab potentiometer (similar to Centralab TT-14)
 1—3" x 4" x 5" box, or printed circuit board*, or both
 I—8-terminal barrier strip (similar to Cinch Jones 140-V)
 Misc.—Octal P/C tube socket, knobs (2), threaded rivet-type standoffs (4), solder, 22 $\frac{1}{2}$ -volt battery or a.c.-operated d.c. supply—see below.

*An etched and drilled circuit board, complete with all mounting hardware, is available for \$2.50 postpaid in the U.S.A. from DEMCO, Box 16297, San Antonio, Texas 78216

Construction. The Supertrol can be built on a printed circuit board or on a punched phenolic circuit board, and can be housed in a small plastic container or in a metal box. If a printed circuit board is preferred, one can be purchased from the source indicated in the Parts List. If you want to etch your own board, you can do so following the layout given in Fig. 2, and the parts can be mounted as shown in Fig. 3.

For printed circuit construction, be sure to use the specified twist-tab potentiometers since the PC board has been laid out with holes drilled for these units.

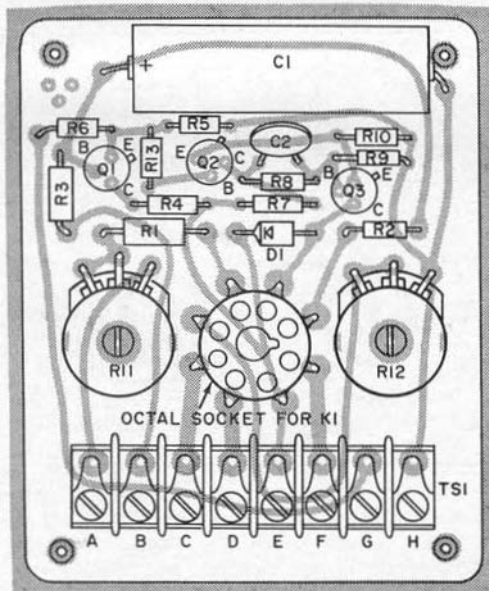


Fig. 3. If you make or buy a printed circuit board the components should be positioned as shown. The 3 spare holes in the corner mount a socket to hold Q1 when this transistor is not in the circuit.

POWER SUPPLY PARTS LIST

C1—500- μ F, 25-volt electrolytic capacitor
 D1—750-mA, 100-P.I.V. silicon power diode (similar to Motorola 1N4002)
 R1—4700-ohm, $\frac{1}{2}$ -watt resistor
 T1—Power transformer: primary, 117 volts; secondary, 18 volts, 100mA, or higher (similar to Stancor TP-1 or Knight (Allied Radio) 54 A 3987)

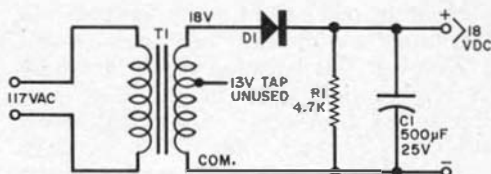


Fig. 4. For continuous duty operation, this power supply can be substituted for the 22 $\frac{1}{2}$ -volt battery. The circuit will work on 17 to 24 volts d.c.

Suitable standoffs can be used to mount the circuit board in its enclosure, if one is used, or else support it on a table or other surface.

While transistors Q2 and Q3 can be wired directly to the circuit board, Q1 should be installed in a socket since it has to be removed from the circuit during certain applications. After completion, the circuit can be tested by hooking it up as shown in Fig. 5. With power applied, it should start oscillating at about 1 hertz. If it does not, adjust R11 and R12 as necessary.

If the Supertrol is to be used only on occasion, and if you do not want to go through the expense of building an a.c.-operated power supply, you can operate the unit with a 22 $\frac{1}{2}$ -volt battery which can be housed with the circuit board in the same enclosure. If, on the other hand,

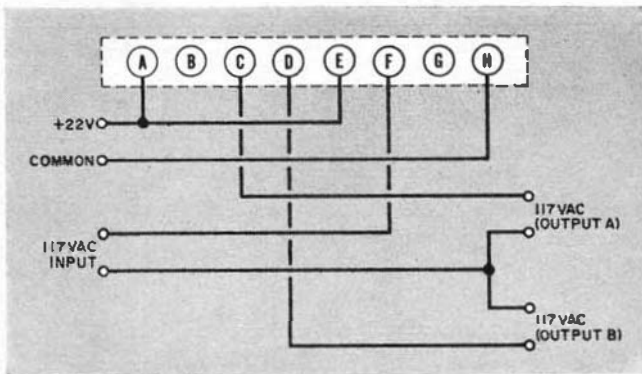


Fig. 5. To test the Supertrol, connect a 22½-volt battery with the plus side going to terminal strip points A and E, and the negative side of the battery to point H. The circuit should start oscillating at about 1 hertz. If the relay does not start clicking, juggle R11 and R12 until the relay has a rhythmic beat. As explained below this circuit is also used to make the Supertrol a display sequence generator.

you plan to use the Supertrol on a fairly continuous basis, you may want to build the power supply shown in Fig. 4 using the parts shown on the accompanying Parts List. The output voltage from this supply will be up to 24 volts depending on the load.

Applications. To have the Supertrol function as a display sequence generator, make the connections shown in Fig. 5, enabling one set of relay contacts to alternately switch the "hot" side of the 117-volt a.c. line between Outputs A and B. The common side of the line goes directly to the load, and there is no connection between this set of contacts

and the rest of the Supertrol circuit. The switching time required to go from A to B is determined by the adjustment of R11 and R12. This circuit is ideally suited for running exhibits and displays.

The connections required for a voltage level detector function are shown in Fig. 6. Here, emitter follower Q1 must be removed from its socket. This enables the circuit to turn on whenever the input signal exceeds 2 volts or turn off when the signal drops below 1 volt. Input impedance is approximately 1000 ohms. Relay contacts C and D are used as required to provide power for an alarm bell, signal light, etc.

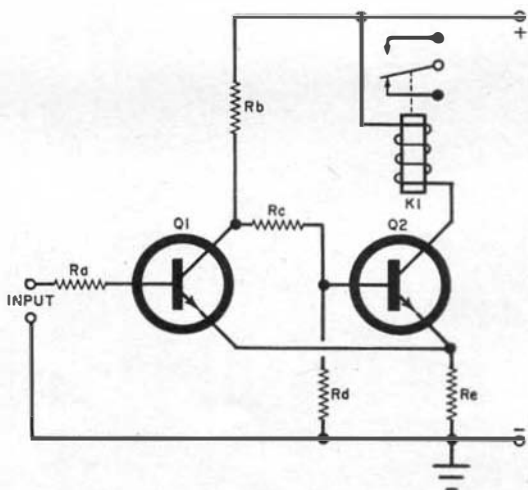
(Continued on page 94)

CIRCUIT THEORY

To understand the secret behind the Supertrol's success, consider the Schmitt trigger circuit shown at right. The circuit and biasing arrangement is such that Q1 is normally OFF while Q2, which controls relay K1's current, is normally on.

If a positive voltage—say about 2 volts—is applied to base resistor Ra, Q1 turns on, causing Q2 to turn off due to reverse biasing applied across Rc and the increase in the voltage across emitter resistor Re. This causes the relay, which acts as Q2's collector load, to drop out as the current falls to zero or to any value below its pickup point. The circuit will revert to its original quiescent state whenever the voltage at the input falls below the tripping level, and the relay will pull in again.

By placing a relatively large capacitor in Q1's base circuit (see Fig. 1), and a charging path from a battery through the relay contacts and a couple of current-limiting resistors, the circuit can be made to free-run by the charge and discharge of the capacitor, enabling Q1 and Q2 to change state at a predetermined interval. The rate at which the transistors change state is established by the charge and



discharge rate of the capacitor; and this, in turn, is a function of the resistor values chosen. It can be seen that if a potentiometer is substituted for at least one of the resistors, the charging time can be varied at will.

THE "SUPERTROL"

(Continued from page 44)

In this application, the connection from the battery to terminal *A* is broken to prevent *C1*, which is rated at 6 volts, from charging up and shorting out. If you want to replace *C1* with a capacitor of higher voltage rating, say 25 volts, then the connection at point *A* need not be broken. It is important that you put *Q1* back in its socket before applying power to the circuit.

The connections for an interval timer or a time delay relay are the same as required for the voltage level detector (Fig. 6), except that the relay contact selection must be as shown in Fig. 7. This circuit also includes a d.p.d.t. switch, used to control the load power while charging capacitor *C1* is being shorted out. In position 2, power is applied to one set of contacts to enable the capacitor to charge sufficiently to trigger the Schmitt trigger circuit. The charging

time is, of course, determined by the setting of *R11*. When *C1* charges to its upper trip point, *Q1* conducts and the relay switches power from the interval output to the delay output. When the switch is flipped to position 1, the capacitor is shorted through a resistor, and the circuit is reset.

The hookup shown in Fig. 7 can be used for a darkroom photo timer, as a delay relay to allow the filaments of a transmitter to warm up before plate voltage is applied, or as a starting relay for a generator or a fluorescent lighting system. You can also use it in a driveway or hallway lighting circuit to extinguish the lighting by delay action. By varying *R11*, the circuit can be made to introduce a time delay varying from 50 milliseconds to 10 seconds.

To keep the load from oscillating, an additional relay can be added to the output connections to lock up on its own contacts and thereby provide a continuous stable output. Another approach to this problem is to reset the switch to position 1 approximately 8 seconds or so before the oscillation starts. —~~50~~—

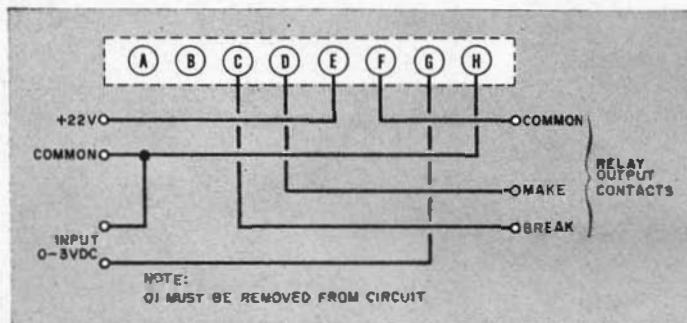
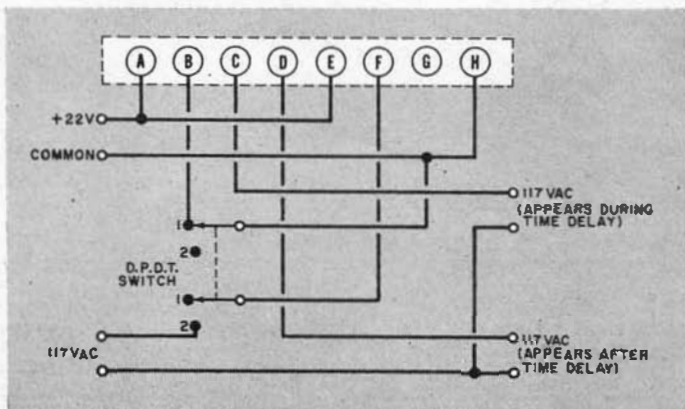


Fig. 6. Remove transistor *Q1* and make the external connections in this diagram and your Supertrol becomes a low voltage sensor. An input of 2 volts turns the circuit on and a drop below 1 volt turns the circuit off. This circuit could be used as an alarm.

Fig. 7. The most practical application of the Supertrol is as an interval timer. However, this requires an external d.p.d.t. toggle switch wired into the circuit as shown here. Timing begins with the switch in position 2. Circuit reset is position 1.



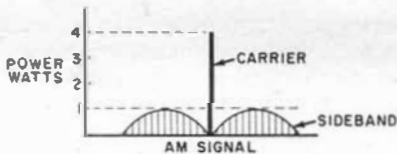
THE "MULE BOX"

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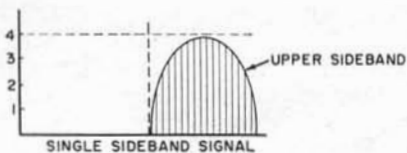
A few words of warning concerning the adjustments described above are in order at this time. First, running the carrier output at a higher level than indicated will only result in illegal operation and short tube life. Output power will not be increased, since the tube cannot produce any more power with the power supply specified.

Why DSBRC?

According to FCC Regulations (Part 95.43), the ideal unmodulated CB transmitter would have an average power input of 5 watts and an average power output of 4 watts. When the carrier wave is 100% amplitude-modulated, two sidebands appear, also containing r.f. power, but particularly carrying all of the useful voice intelligence, as in (A) below. To increase the "talk power" of a CB rig, a possible method would be to eliminate the useless carrier and concentrate all of the available r.f. energy in one or both sidebands, as in (B). Although advanced forms of voice communications (SSB) do just this, the absence of a carrier introduces a new set of complex receiving problems. The "Mule Box" effects a compromise by reducing the r.f. power in the carrier and simultaneously increasing the power in the intelligence-carrying sidebands, as in (C). Thus, the DSBRC signal sounds "louder." This idea has been used commercially for several years in the Regency "Range Gain" CB transceiver.



(A)



(B)



(C)

March, 1967

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