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Build "Mixed 12" Hi-Fi Speaker System

POPULAR ELECTRONICS

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Build "Supertrol" your all-electronic RIGHT!
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 continuous 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.
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.

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 22½-volt battery which can be housed with the circuit board in the same enclosure. If, on the other hand,
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.

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**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"

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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 transmitting 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.

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.