PROJECT OF THE MONTH

A Multifunction VMOS Oscillator

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IN THIS era of increasingly complex integrated circuits, it's easy to overlook the versatility offered by some very simple transistor circuits. Figure 1, for example, shows a multivibrator made with a pair of VMOS MOSFETs. This circuit has many useful applications.

To understand how the multivibrator operates, assume that initially *C1* is discharged and *C2* is charging to V_{DD}. Therefore, *Q2* is off and *Q1* is on. Components *C2* and *R3* form a differentiator that delivers to the gate of *Q1* a voltage that decreases in time. Eventually, the voltage falls to a point at which *Q1* is switched off. Then *C1* in the differentiator formed by *C1* and *R4* immediately begins charging and turns on *Q2*. The charge-discharge cycle then repeats, and the two transistors are alternately switched on and off.

The basic circuit has an oscillation frequency of approximately the reciprocal of 3.6 multiplied by R times C where $R = R3 = R4$ and $C = C1 = C2$. Under these conditions, the on and off times for *Q1* and *Q2* are equal. It's easy to produce nonsymmetrical operation where one transistor is on or off longer than the other simply by altering the RC time constant of one or both halves of the circuit.

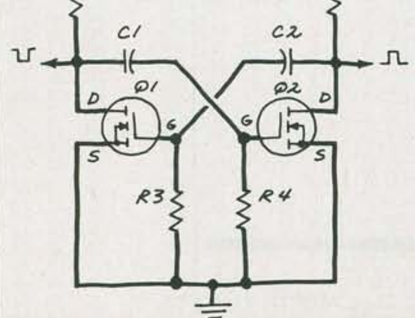

Fig. 1. Multivibrator made with a pair of VMOS MOSFETs.

Practical Applications. The circuit in Fig.1 has two important advantages over similar types that use bipolar transistors. First, the VMOS power MOSFET transistors are capable of driving directly such current-demanding loads as incandescent lamps. Second, the almost infinite gate resistance of VMOS MOSFETs makes it possible to have cycle times much longer than those obtained when bipolar transistors are used.

Figure 2 shows the most obvious application for a VMOS multivibrator, a dual LED flasher. Here *R1* and *R2* limit current through the LEDs to a safe level. Note the inclusion of *Q3* to provide an enable input that can be controlled by a TTL or CMOS signal. When *Q3*'s gate is high, the oscillator operates. Otherwise the oscillator is disabled. If an enable input is not needed, *Q3* can be omitted or replaced by an spst on-off switch.

Another interesting addition to the circuit is potentiometer *R5*. Reducing its resistance *increases* the circuit's flash rate. If the resistance of *R5* is reduced below about 1 kilohm, the circuit will cease oscillation. Therefore you may wish to insert a 1.5-kilohm fixed resistor in series with *R5*. Should the circuit cease to oscillate and then fail to restart when power is interrupted, it can be restarted by momentarily shorting one or both timing capacitors.

The circuit in Fig. 2 can be easily modified for different flash rates and nonsymmetrical operation by changing the values of the RC components. A particularly interesting application is to replace *R3* and *R4* with thermistors or cadmium-sulfide photocells. The circuit can then be used to visually monitor temperature or light level differences in two locations.

For example, say you wish to match the temperatures of two solutions of darkroom chemicals but you have misplaced your thermometer. First immerse the thermistors in each of the two solutions. If the temperatures are identical, the LEDs will flash on and off at equal time intervals. If, however, the temperatures are different, the flash rate will be uneven. Simply add ice to the warmer solution until the flash rate is even.

For this application to be successful, you should use glass-bead thermistors. They are fragile, but they can be immersed. You will also have to devise some flexible leads to connect the thermistors to the circuit. Be sure to completely insulate the connection between the thermistors and the leads as moisture may cause erroneous results.

The circuit in Fig. 2 can also be used as a tone generator. Piezoelectric speakers can be connected directly across the LEDs, or standard 8-ohm miniature speakers can be substituted for the LEDs. You will need to reduce the resistances of *R1* and *R2* to about 100 ohms. One or two speakers can be used, depending upon your application.

If the device(s) you wish to drive adversely affects the operation of the circuit, you can always use additional VMOS transistors as buffers. Simply connect their gate leads to the drain connection of *Q1* or both *Q1* and *Q2*.

Finally, to provide one cycle of operation, insert a capacitor between *R4* and ground. Add a normally open pushbutton switch and 1.5-kilohm resistor in series across the capacitor. When the switch is closed, the circuit will operate. Release the switch, and it will cease operation after one cycle. Use any capacitance from 0.01 to 0.1 μF for the capacitor. ◇

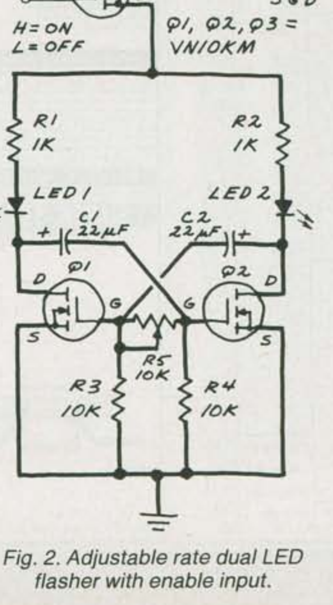

Fig. 2. Adjustable rate dual LED flasher with enable input.