Solid State

By Lou Garner

EXPERIMENTING WITH LED'S

GENERALLY speaking, readers write to a magazine editor or contributor only when they (a) have a problem ("The circuit doesn't work!"); (b) need additional information ("Please send a pictorial diagram for converting my old Atwater Kent to television"); or (c) wish to contribute an idea or circuit ("Here's a terrific solid-state audio oscillator which can replace a doorbell for only $125.00!") But recently I had few surprises.

When I discussed LED applications in last October's column, I felt that readers might find the topic of passing interest. But the response has been overwhelming. Letters, phone calls and post cards have poured in from all over the world. Many readers offered circuit applications, such as Michael Lindsey's dual-LED flasher described last month. Some asked for additional circuit data. I even learned about an unusual multicolor LED offered by a small manufacturer/distributor in Maryland.

A letter from Mr. Scott Gilson (35225 Caryn Drive, Farmington, MI 48024) is typical. Scott wrote, in part...

Dear Mr. Garner:

Thanks so much for your October column on LED's. The circuits shown were very interesting, so I built a few from some scrap parts I had. I couldn't believe it when I snapped on the battery and it worked! Most circuits I build need a lot of troubleshooting just to get them to work...

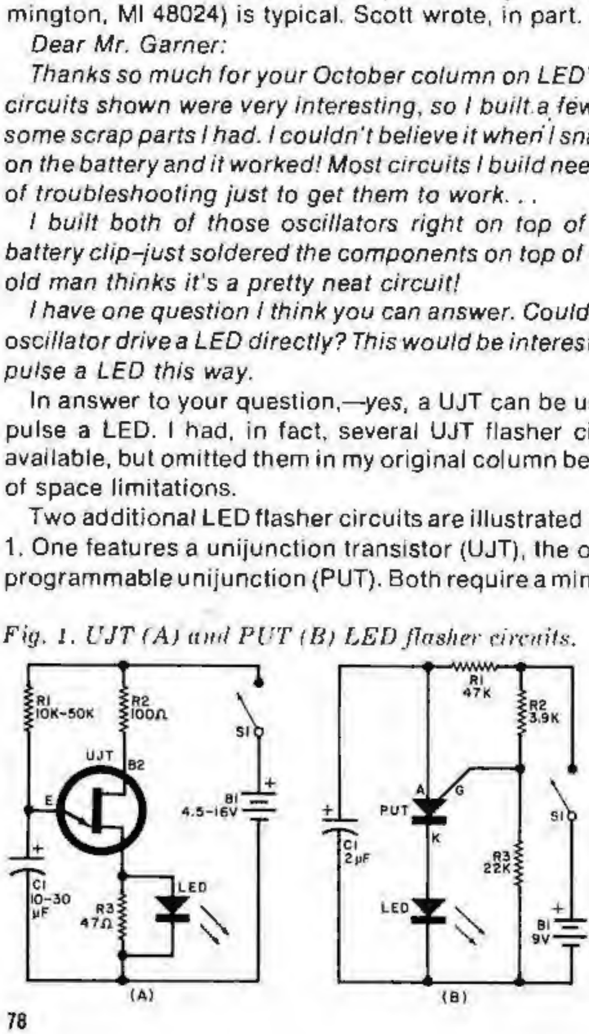
I built both of those oscillators right on top of a 9-V battery clip–just soldered the components on top of it. The old man thinks it's a pretty neat circuit!

I have one question I think you can answer. Could a UJT oscillator drive a LED directly? This would be interesting to pulse a LED this way.

In answer to your question,—*yes*, a UJT can be used to pulse a LED. I had, in fact, several UJT flasher circuits available, but omitted them in my original column because of space limitations.

Two additional LED flasher circuits are illustrated in Fig. 1. One features a unijunction transistor (UJT), the other a programmable unijunction (PUT). Both require a minimum

Fig. 1. UJT (A) and PUT (B) LED flasher circuits.



of components, are capable of working over a wide range of supply voltages, and can be duplicated quite easily in the home laboratory.

Referring first to Fig. 1A, a simple UJT relaxation oscillator is used to flash a LED in the device's lower base circuit. In operation, *C1* is charged slowly through *R1* by the power source, then discharged periodically through *R3* and the LED by the UJT. The flashing rate is determined by the supply voltage and by *R1-C1*'s time constant. The larger the value of the resistor or capacitor, the slower the flashing rate.

In bench tests, I used a type 2N4891 UJT, values of from 10 to 50μF for *R1* and values of from 10 to 30 μF for *C1*. The resistors may be ¼ to 1 watt types (non-critical). With a 15-volt dc source, the flashing rate was about once a second. The circuit would flash with supply voltages of from 4.5 to 16 volts, although the light output is less with the lower voltages. Resistor R3 is optional and is used to insure capacitor discharge when low-current LED's are used. If a high-current LED is used, *R3* may be omitted.

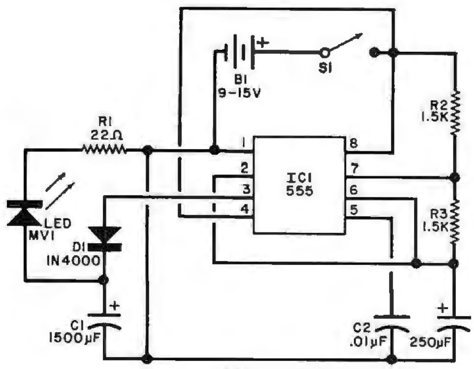
The PUT flasher circuit illustrated in Fig. 1B operates in much the same fashion as the basic UJT circuit, with *C1* discharged periodically through the LED as the PUT switches on. In bench tests, I used a D13T2 PUT and an MV50 LED together with a 9-volt transistor battery. The flashing rate was about 100/minute with the component values listed.

This circuit is slightly more critical than the basic UJT flasher, in that the ratio of *R2* to *R3* must be adjusted for optimum performance. The proper resistance ratio depends on the PUT's characteristics and the supply voltage.

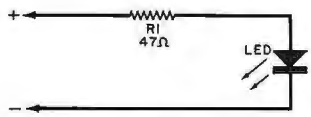
About the unusual multicolor LED. Available exclusively from the manufacturer/distributor, *Electronics Unlimited, Inc.*, this special device is designated type MV1. Unlike the more familiar bipolar multicolor LED, which is essentially two LED's connected back-to-back in the same case, the MV1 is a single diode which can supply red, orange, yellow or green light, depending on the applied voltage (current). With low voltages (and currents), the output is red, gradually changing through orange to yellow and green at higher voltages and at currents approaching 200mA (the device's maximum rated current).

With its unique color-changing feature, the MV1 can be used in a variety of both practical and experimental display applications.

One useful practical application is illustrated in Fig. 2A—an extremely simple battery tester. In operation, *R1* serves to limit the LED's maximum current. As higher voltages are applied, the LED's current increases and its light color output changes. Unlike a basic voltmeter, this instrument checks the battery under load (to over 100 mA for a 9-12-volt battery). In tests with a typical MV1 and a



(B)



(A)

Fig. 2. (A) is a simple multicolor LED battery tester; (B) a multicolor LED flasher circuit.

47-ohm, ½-watt resistor, the tester's "calibration" was approximately as follows:

1.6 - 4.0 volts: RED
4.0 - 5.5 volts: ORANGE
5.5 - 9.0 volts: YELLOW
9.0 - 12 volts: CHARTREUSE
12 - 15 volts: GREEN

Of course, the exact voltages at which color changes occur vary somewhat from one MV1 to another and the delineation is not sharp. Each instrument should be "calibrated" by the individual user.

The battery tester can be assembled conveniently in a pocket-size probe using an old ball-point pen. In practice, it may be necessary to experiment with *R1*'s value to achieve optimum color variation at different voltages due to tolerance in the MV's characteristics. Although a 47-ohm, ½-watt unit is nominal, you may have to use values as low as 22 ohms to as high as 56 ohms. In a series of bench tests with several MV1's, I found 39 ohms optimum for some units, 47 ohms for others.

Another interesting application for the MV1 is illustrated in Fig. 2B—a multicolor flasher featuring a standard 555 timer IC. In operation, *C1* is charged by *IC1* and the battery through *D1*. As the voltage across the capacitor rises, the current through the LED increases and its color output changes from red through orange, yellow and green. When *C1* is discharged, the cycle is repeated.

The MV1 multicolor LED is offered as part of a special *LED Designer's Kit.* Two of these devices are included in the kit, together with 8 miniature and 12 large assorted LED's in red, yellow and green, a red/green bipolar LED, a 555 timer IC, a 558 dual 741 IC, 10 assorted diodes and zeners, 20 assorted capacitors, 20 assorted resistors, a 4" x 6" perfboard, and a folder featuring 15 project circuits. The complete kit is priced at $8.95, postpaid (plus sales tax, where applicable), and may be ordered directly from: Electronics Unlimited, Inc. P.O. Box 91, Olney, MD 20832.

Readers' Circuits. Frustrated by a relatively poor null indication when measuring low resistance values on his impedance bridge, reader Mike McNatt (7707 E. 118 Ter-

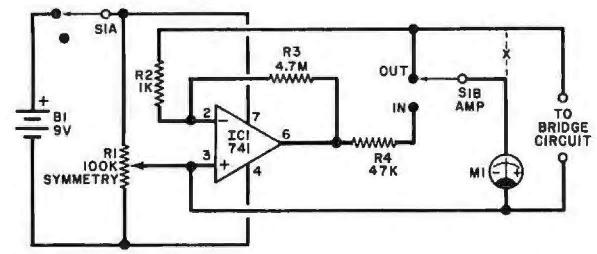


Fig. 3. A null meter amplifier circuit.

race, Kansas City, MO 64134) put on his thinking cap and devised a solution. He designed and built a meter amplifier. Mike reports that he can obtain sharp nulls even on the bridge's lowest resistance range (0.1 ohms full-scale) when he uses the amplifier in conjunction with the instrument's standard null meter.

Featuring an op amp IC, Mike's circuit is illustrated in Fig. 3. In operation, the amplifier and null meter can be switched in and out of the circuit alternately by means of switch S1, which also serves as a power switch for the amplifier. *Symmetry* control *R1* serves to "split" the supply voltage, permitting operation on a single-ended power source.

Series load resistor *R4* was chosen to provide a full-scale deflection on the 100-0-100-µA meter used in his bridge and a different value may be required for other instruments. The original meter connection, shown dotted, is opened for amplifier installation.

With neither layout nor lead dress critical, the bridge amplifier circuit may be assembled on perfboard, on a pc board, or even on a small chassis.

Suitable for troubleshooting PA systems, intercoms, phonographs, tape recorders, and the audio sections of radio and TV sets, the audio signal tracer circuit in Fig. 4 was submitted by reader Bill Roberts (Roberts Electronic Service, Highway 81, Route 3, Winder, GA 30680). Bill, you may recall, contributed the stereo preamp circuit discussed in last December's column. Featuring readily available components, the signal tracer can be assembled in one or two evenings and makes a dandy addition to the home lab's complement of test instruments.

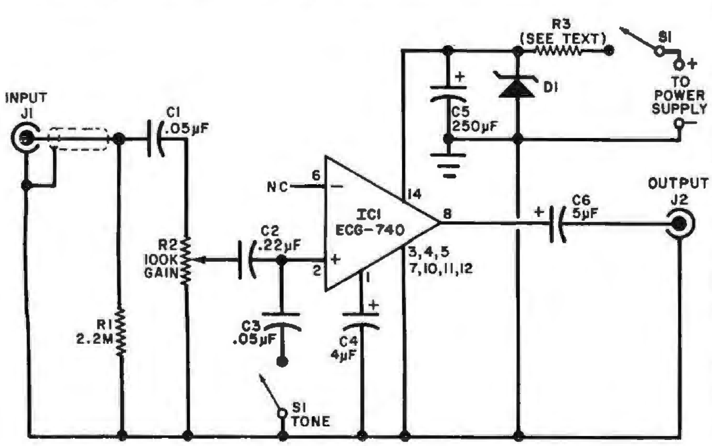


Fig. 4. Audio-signal tracer circuit.

Bill has used a 2.5-watt IC as the heart of his instrument. A shielded test probe connects to input jack *J1*, while the output, available at jack *J2*, may be used to drive any standard PM loudspeaker.

Gain control *R2* is a 100k potentiometer, preferably with an "audio" taper, and *R3*, if used, is a 1-to-5-watt unit, depending on the power source. The input capacitor, *C1*, should be a 600-volt ceramic or paper type, with *C2* and *C3* 100-volt units. Electrolytic capacitors *C4*, *C5* and *C6* are all 25-volt types.

Any of several construction techniques can be used for assembling the signal tracer. Although neither parts placement nor wiring arrangement are overly critical, good audio wiring practice should be observed when duplicating the design, with signal carrying leads kept short and direct. Bill writes that he designed his original model around a 2" x 2" pc board, provided a socket for the 14-pin DIP IC, and used a dual RCA-type phono jack for *J1* and *J2*, mounting the unit in a 2" x 4" *Minibox*. Standard red and black binding posts were installed for the power connections. The shielded input lead shown in the diagram may not be needed if the input and output jacks are well separated.

Bill suggests that an 18-20-volt dc external supply be used as a power source. If a higher voltage supply is employed, a 20-volt zener diode, *D1*, and appropriate series resistor, *R3*, should be used in a standard shunt regulator configuration to limit the applied voltage to 20 volts. The circuit's current requirement ranges from 8 mA at zero output to 110 mA at maximum output.

Device/Product News. GE's Semiconductor Products Department (Building 7, MD 49, Electronics Park, Syracuse, NY 13201) has introduced a new line of axial lead GE-MOV™ varistors to complement their standard line of radial devices. The new line, designated the "MA" series, is capable of both ac and dc operation, and offers voltage ratings of 121 to 365 volts dc, 88 to 264 volts rms. Designed primarily for use in transient suppression and circuit protection applications, GE-MOV™ varistors are voltage dependent, symmetrical metal oxide resistors which operate much like back-to-back zener diodes.

A version of the popular 2N3055 power transistor has been announced by RSM Sensitron Semiconductor (221 West Industry Court, Deer Park, NY 11729). Designated the 2N3055C, the new device offers a maximum I_C of 30 A as compared to the conventional 2N3055's maximum rating of 15 A, a power dissipation of 150 W compared to 115 W, a BV_{CEO} of 120 volts, and a h_{FE} of 10 at 8 A.

From the RCA, Electronic Components Group (Harrison, NJ 07029), comes news of a line of GaAs single-diode injection lasers suitable for use in such applications as intrusion alarms and control systems. Identified as the SG2000 series, the new units offer minimum power outputs ranging from 1 to 20 watts at peak drive currents of 10 to 100 amperes. The peak wavelength of spectral radiant intensity at 27°C is 904 nanometers. Ranging in price from $10.00 to $39.00 each in unit quantities, the new devices are supplied in RCA coaxial OP-3 and OP-12 packages.

In addition to announcing substantial price cuts in its CMOS product line, the National Semiconductor Corporation (2900 Semiconductor Drive, Santa Clara, CA 95051) has introduced a new hybrid instrumentation amplifier suitable for use in thermocouple amplifiers, active filters, isolation amplifiers, control interfaces and similar applications. Designated the LH0036G, the new IC features a high input impedance of 300 megohms and a common-mode rejection ratio of 100 dB. Its gain can be adjusted from X1 to X1000 with a single resistor, while its output bandwidth is also adjustable from 350 kHz (small signal) to 5 kHz (full power) at unity gain. ◈