CIRCUIT CIRCUS

By Charles D. Rakes

Indicators for All Occasions

This month the Circus is going to spotlight the LED, offering as many circuit applications as space will allow. Probably the most common task performed by the LED is to indicate a circuit condition or function. In battery-powered equipment, using LED's as indicators requires little more than placing a current-limiting resistor in series with the LED and connecting that combination across the power source. However, in non-battery-operated equipment, such an arrangement may not be practical.

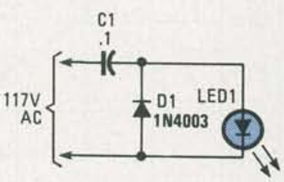

Fig. 1. This simple pilot light can be used to indicate the presence of 117 volts in AC-operated equipment.

AC PILOT LIGHT

Figure 1 shows a simple pilot light that can be used with AC operated equipment. In that circuit, capacitor C1, which can have a value of from 0.1 μF to 0.4 μF, sets the current level for the LED. The greater the capacitor's value, the brighter the LED will glow. But don't go overboard, increasing the value of the capacitor also increases the LED's current, which could result in LED burnout.

With a 0.1-μF capacitor, the LED's current is limited to about 2 mA; with a 0.4-μF unit, the current is limited to about 10 mA. Diode D1 (a 1N4003 1-amp, 200-PIV rectifier) half-wave rectifies the AC, providing a DC voltage for the LED.

DC PILOT LIGHT

Figure 2 shows another AC pilot light circuit; this one differs from the previous one in that current is full-wave rectified before it is applied to the LED. Since the full-wave rectifier supplies current pulses twice as often, the value of the capacitor can be cut to about half, and yet deliver the same amount of current as the half-wave circuit shown in Fig. 1.

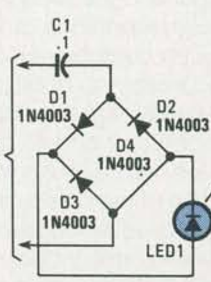

Fig. 2. This AC pilot-light circuit differs from the previous one in that current is delivered to the LED through a full-wave rectifier.

TRANSISTOR-DRIVEN PILOT LIGHT

Our next circuit, see Fig. 3, can be used in circuits where DC voltage levels can vary between 6 and 20 volts, and yet keep the LED lit with little change in output brilliance. In that circuit, a 2N3906 general-purpose PNP transistor is connected in a constant-current circuit, while R1 is used to limit the current through the LED to about 6 mA. Decreasing R1's value would cause the current through the LED to increase, causing the LED's glow to intensify; the opposite would be true if the value of R1 is increased.

POLARITY INDICATOR

In our next circuit, see Fig. 4, two LED's are wired in parallel but are polarized oppositely to produce a circuit that is capable of indicating whether the applied voltage is positive or negative DC, or if it is AC. That circuit can be used to check battery or power-supply polarity, or any other source that's capable of supplying 3 to 15 volts at least 15 mA. Although the circuit may seem too simple to be of any value, it is sure to prove its worth when you have to troubleshoot circuits that operate from

PARTS LIST FOR THE AC PILOT LIGHT

D1—1N4003, 1-amp 200-PIV silicon rectifier diode
LED1—Light-emitting diode
C1—0.1–0.4-μF, 600-WVDC, ceramic-disc capacitor
Perfboard materials, wire, solder, hardware, etc.

PARTS LIST FOR THE DC PILOT LIGHT

D1–D4—1N4003 1-amp, 200-PIV silicon rectifier diode
LED1—Light-emitting diode
C1—0.1–0.2-μF, 600-WVDC, ceramic-disc capacitor
Perfboard materials, wire, solder, hardware, etc.

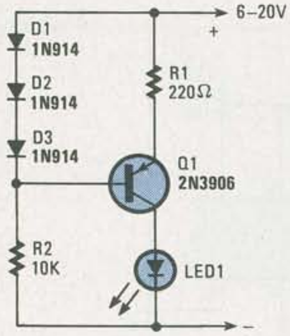

Fig. 3. With only a slight change in output brilliance, this pilot circuit can be used as an indicator for DC sources that vary in voltage from 6 to 20-volts.

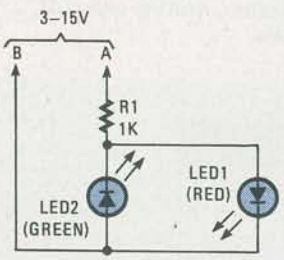

Fig. 4. This circuit, which contains two oppositely-polarized LED's wired in parallel, is capable of indicating whether positive or negative DC, or AC voltage is present.

dual-polarity power supplies.

When probe A is connected to a positive source and probe B is connected to a negative source (or ground), the LED1 will light. Reversing the polarity will cause the green LED2 to light. But, if the probes are connected to an AC source, the two LED's will light alternately.

EXPANDED-RANGE POLARITY INDICATOR

An expanded-range polarity indicator is shown in Fig. 5. That version of the polarity indicator can be used to indicate the polarity of voltages of over 100 volts.

In that circuit, the two transistors act as switches. When a positive DC source of one volt or more is connected to the input, transistor Q1 turns on, lighting LED1. However, when the input of the circuit is connected to a negative voltage, Q2 turns on, causing LED2 to light. Applying an AC voltage to the input of the circuit causes Q1 and Q2 to turn on and off alternately. That, in turn, causes LED1 and LED2 to alternately light; however, the switching speed is so fast that both LED's will appear to be lit at the same time.

Resistor R1 limits the input current to about 1 mA at 100 volts, and to less than 100 µA at 10 volts. Two 9-volt transistor-radio batteries are used to power the circuit. A power switch is not needed because the circuit draws current only when either transistor turns on.

VOLTAGE-LEVEL INDICATOR

Our next circuit uses three LED's to form a simple voltage-level indicator. The circuit, shown in Fig. 6, can be used to monitor a 5-volt power source for over- or under-voltage conditions. In that circuit, the transistor (Q1) is configured as an emitter follower through which current is supplied to the anodes of the three LED's (LED1–LED3). The cathode terminal of each LED is tied to a different voltage level, which is set by the diode string that is formed by D1–D3.

In that circuit, LED1 lights when the input voltage (which is applied to the base of transistor Q1) is about 3.5 volts; LED2 lights at about 4.5 volts, and LED3 glows when the voltage reaches about 5.5 volts. The voltage range of the circuit can be increased above 5.5 volts by adding more diodes in series with D1–D3.

PARTS LIST FOR THE TRANSISTOR-DRIVEN PILOT LIGHT

SEMICONDUCTORS

Q1—2N3906 general-purpose PNP silicon transistor
D1–D3—1N914 small-signal silicon diode
LED1—Light-emitting diode

ADDITIONAL PARTS AND MATERIALS

R1—220-ohm ¼-watt, 5% resistor
R2—10,000-ohm, ¼-watt, 5% resistor
Perfboard materials, wire, solder, hardware, etc.

PARTS LIST FOR THE POLARITY INDICATOR

LED1—Light-emitting diode (red)
LED2—Light-emitting diode (green)
R1—1000-ohm, ¼-watt, 5% resistor
Perfboard materials, wire, solder, hardware, etc.

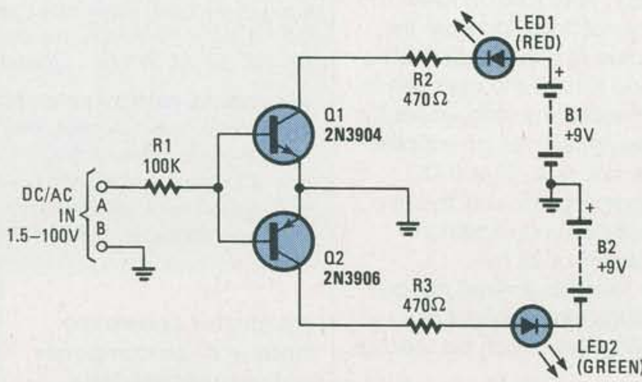

Fig. 5. The expanded-range polarity indicator can be used with voltages of over 100 volts.

PARTS LIST FOR THE EXPANDED-RANGE POLARITY INDICATOR

SEMICONDUCTORS

Q1—2N3904 general-purpose NPN silicon transistor
Q2—2N3906 general-purpose PNP silicon transistor
LED1—Light-emitting diode (red)
LED2—Light-emitting diode (green)

ADDITIONAL PARTS AND MATERIALS

R1—100,000-ohm, ¼-watt, 5% resistor
R2, R3—470-ohm, ¼-watt, 5% resistor
B1, B2—9-volt transistor radio battery
Perfboard materials, wire, solder, hardware, etc.

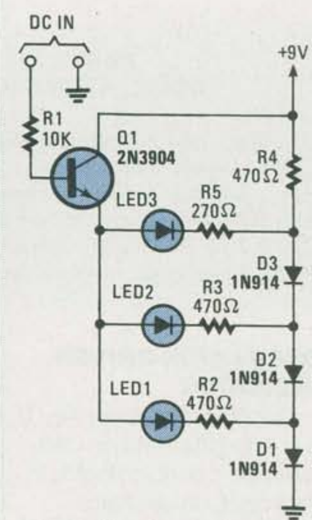

Fig. 6. The circuit shown here can be used to monitor a 5-volt power source for over- or under-voltage conditions.

PARTS LIST FOR THE VOLTAGE-LEVEL INDICATOR

SEMICONDUCTORS

Q1—2N3904 general-purpose NPN silicon transistor
D1–D3—1N914 general-purpose small-signal silicon diode
LED1—LED3—Light-emitting diode

RESISTORS

(All resistors are ¼-watt, 5% units.)
R1—10,000-ohm
R2–R4—470-ohm
R5—270-ohm

ADDITIONAL PARTS AND MATERIALS

Perfboard materials, wire, solder, hardware, etc.

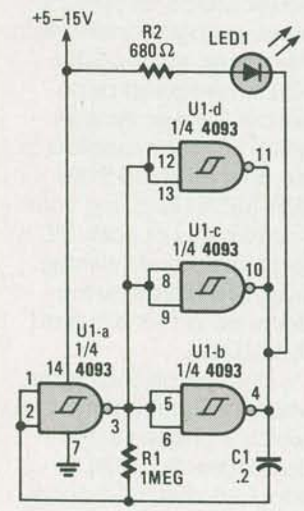

Fig. 7. This circuit, built around a 4093 quad 2-input quad NAND Schmitt trigger that is configured as an oscillator/driver, switches the LED on and off at a rate of 1 Hz.

PARTS LIST FOR THE OSCILLATOR-DRIVEN INDICATOR

U1—4093 quad 2-input NAND Schmitt trigger, integrated circuit
LED1—Light-emitting diode
R1—1-megohm, ¼-watt, 5% resistor
R2—680-ohm, ¼-watt, 5% resistor
C1—0.2-µF, 50-WVDC, ceramic-disc capacitor
Perfboard materials, wire, solder, hardware, etc.

OSCILLATOR-DRIVEN INDICATOR

Our next circuit, see Fig. 7, is a little different from the average panel indicator. In that ciruit, an oscillator—built around a 4093 quad 2-input NAND Schmitt trigger—is used to switch the LED on and off at a rate of 1 Hz. The oscillator portion of the circuit is formed by two gates, U1-a and U1-b. The two remaining gates (U1-c and U1-d) are connected in parallel with U1-b (the output gate) to share the LED's drive current.

The values of R1 and C1 set the oscillator's operating frequency, which, by extension, also determines the LED's flash rate. To lower the rate of flash, increase the value of either or both R1 and C1; do the opposite to increase the rate. Power for the circuit can be supplied by any 5- to 15-volt DC source; at 15 volts, the circuit draws a maximum current of 22 mA.

The circuit need not be limited to pilot-light applications; it can be used as an indicator for a critical or urgent circuit condition. Just like any other indicator, all that's required is for power to be applied to the flasher circuit for activation.

VISUAL CW DECODER

The majority of the radio amateurs who are into CW communications do so by ear (the exceptions are those who use computers or computerized code readers). But for hams who are hearing impaired or for those in the process of losing their hearing, CW is no longer a viable option. But with the aid of the circuit shown in Fig. 8, it's possible to receive and decode CW by sight rather than sound, providing a means by which the hearing impaired can continue a fun hobby. Even if your hearing is not gone or fading, using the circuit can be fun and challenging...and no one will need to yell "turn down that dit-dah racket."

In the visual CW decoder, U1 is configured as a tunable audio-tone decoder. The output of U1 at pin 8 supplies current to "fire" the LED. The input to the circuit is designed to be connected to the headphone jack of a general-coverage communications receiver. Then, with receiver peaked for a CW output tone centered around 750 Hz and adjusting R2 (a 10k potentiometer) to the CW output tone, the LED will flash the CW message.

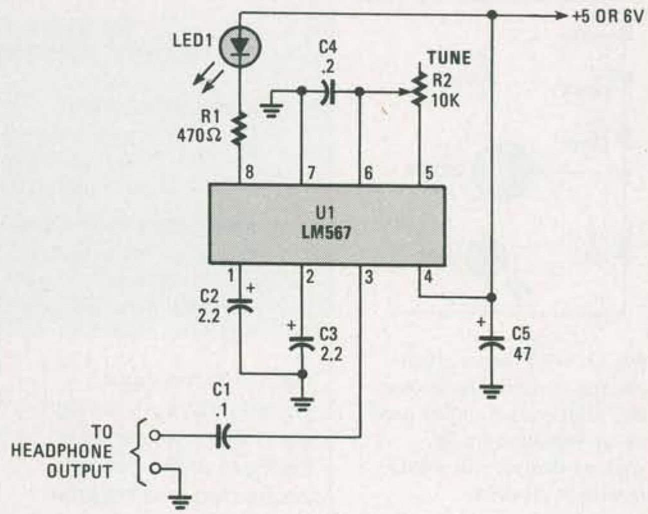

Fig. 8. By connecting this circuit to the headphone jack of a general-coverage communications receiver, hearing-impaired hams can continue to enjoy their hobby.

PARTS LIST FOR THE VISUAL CW DECODER

CAPACITORS

C1—0.1-µF, 50-WVDC, ceramic-disc capacitor
C2, C3—2.2-µF, 25-WVDC, electrolytic capacitor
C4—0.2-µF, 50-WVDC, ceramic-disc capacitor
C5—47-µF, 16-WVDC, electrolytic capacitor

ADDITIONAL PARTS AND MATERIALS

U1—LM567 tone decoder, integrated circuit
LED1—Light-emitting diode
R1—470-ohm, ¼-watt, 5% resistor
R2—10,000-ohm potentiometer
Perfboard materials, wire, solder, hardware, etc.

'TIL NEXT WE MEET

Well it looks like we have reached the end of the space allotted to us for this month. But be sure to join us on the next go-round, when we'll present another batch of circuits to entertain and educate you in the ways of electronics. Until then, may the flow be with you. ■