

# SINGLE-LED ANALOG METER

Complete LED changes "color" with input voltage

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THERE are many ways that an electronic measuring circuit can display information. Numerical data can be displayed on LED or LCD readouts, analog meters, or similar devices, while on/off indications can be made via a low-cost discrete LED or lamp. Another possibility is to show a changing variable as a series of color variations, taking advantage of a new low-cost, multicolor LED.

This new device consists of a pair of LEDs, one emitting red light and the other green, oppositely polarized and enclosed in a common plastic housing with two electrical leads. Applying current in one direction causes only the forward-biased LED to glow, while the reverse-biased LED remains dark. If the current polarity is rapidly alternated, then the composite LED will glow yellow or greenish red, depending on the duty cycles of the currents in the two directions. This is the operating principle behind the Single

LED Analog Meter. The schematic diagram of the circuit for the meter is shown in Fig. 1.

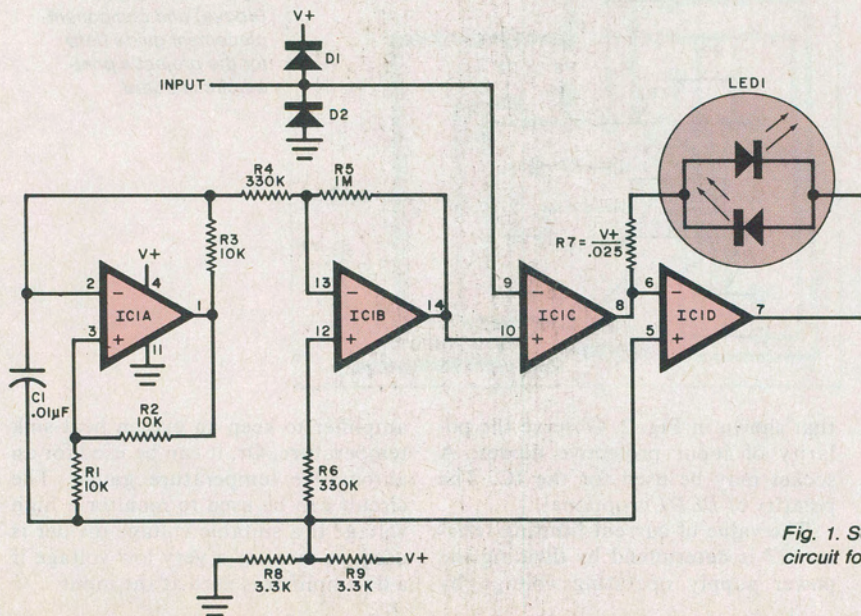
**Circuit Operation.** Op amp *IC1A* generates a ramp waveform at point A that drives amplifier *IC1B* via *R4* (*R5* acting as the gain-determining feedback resistor) with the amplified ramp voltage applied to the noninverting input (+) of comparator *IC1C*. The input voltage (referenced to ground) applied to the inverting (-) input is compared with the instantaneous ramp voltage applied to the noninverting input (also referenced to ground). If the input voltage is higher than the ramp voltage, the output of *IC1C* is near ground, and when the input voltage is lower than the instantaneous ramp voltage, the output of *IC1C* is near the positive supply voltage.

The output of *IC1C* is connected to the inverting input of *IC1D* with the

dual-color LED connected like a feedback element in conjunction with current-limiting resistor *R7*. When the output of *IC1D* is positive, the output of *IC1C* is at ground. Thus, current will flow from the output of *IC1C*, through *R7*, and the forward-biased LED to the virtual ground of *IC1D*. This causes that LED to glow. Since the other LED in the package is reverse-biased, it remains dark. When the output of *IC1C* goes to ground, the output of *IC1D* goes high, and current flows the opposite way, causing the now forward-biased LED to glow while the other goes dark.

Thus, contingent on the level of the input signal, the single LED can assume either of two distinct colors, or a combination of the two colors when the input voltage is centered on the ramp voltage.

The builder can decide which of the two colors within the LED can represent the high or low inputs, and ar-



## PARTS LIST

- C1—0.01- $\mu$ F disc ceramic capacitor
- D1, D2—PTC205, 1-V diode (see text)
- IC1—Quad op amp (Radio Shack 276-1714 or similar, see text)
- LED1—Two-color LED (Radio Shack 276-035)
- R1, R2, R3—10-k $\Omega$ , 1/2-W resistor
- R4, R6—330-k $\Omega$ , 1/2-W resistor
- R5—1-M $\Omega$ , 1/2-W resistor
- R7—See text
- R8, R9—3.3-k $\Omega$ , 1/2-W resistor

Note: A pc board (RW-205) is available for \$5.25, plus \$1.25 postage and handling from Danocinths Inc., Box 261, Westland, MI 48185. Michigan residents please add 4% sales tax.

Fig. 1. Schematic diagram of the complete circuit for the LED Analog Meter.



## analog meter

range the LED polarity accordingly. (It is suggested that red be used for higher values.) Protection diodes *D1* and *D2* are included to ensure that the input voltage level does not go above the power supply positive voltage or below  $-1V$  with respect to ground. If desired, one or more conventional 1N914 or similar silicon diodes can be used in place of the 1-volt diodes specified. Each silicon diode drop is about 0.6 volt, so two in series can provide a limit of about 1.2 volts. Since a single-ended power supply is used, the network of *R8* and *R9* is used to bias the noninverting inputs of the three operational amplifiers

**Construction.** The circuit can be assembled on a small pc board such as

0.025. For example, with a 9-volt supply, *R7* is  $9/0.025$  or 360 ohms (the nearest standard value can be used). Operating power can be any value between 5 and 35 volts dc. If desired, discrete op amps may be used for the four stages.

**Applications.** The Single LED Analog Meter can be used any place an approximate measurement is to be made. For example, a thermistor can be used to convert temperature to a voltage level that is applied to the input. The LED is then arranged so that a rise in temperature causes the red portion to glow, while lower temperatures keep the green LED lit. The thermistor can be thermally coupled to the output stages of an audio power

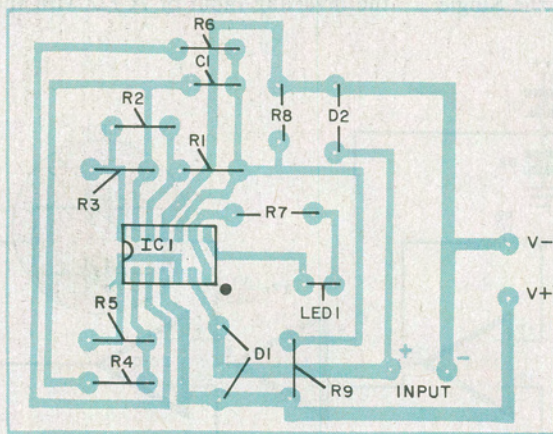
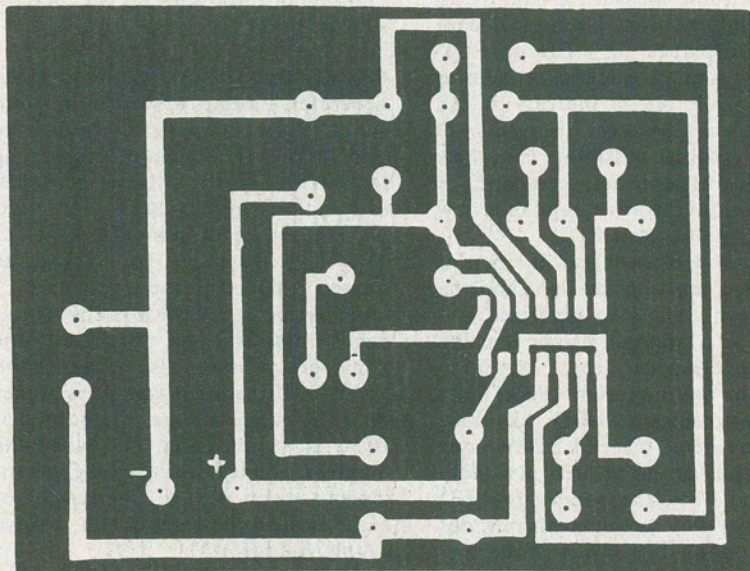


Fig. 2. Full-size etching and drilling guide (above) and component placement guide (left) for the project's printed-circuit board.

that shown in Fig. 2. Observe the polarity of input protective diodes. A socket may be used for the IC. The polarity of *LED1* is optional.

The value of current-limiting resistor *R7* is determined by dividing the power supply operating voltage by

amplifier to keep an eye on heat-sink temperature. Or, it can be used for an automotive temperature gauge. The circuit can be used to monitor a high voltage if a suitable voltage divider is used, or monitor a very low voltage if a dc amplifier is used at the input. ◇