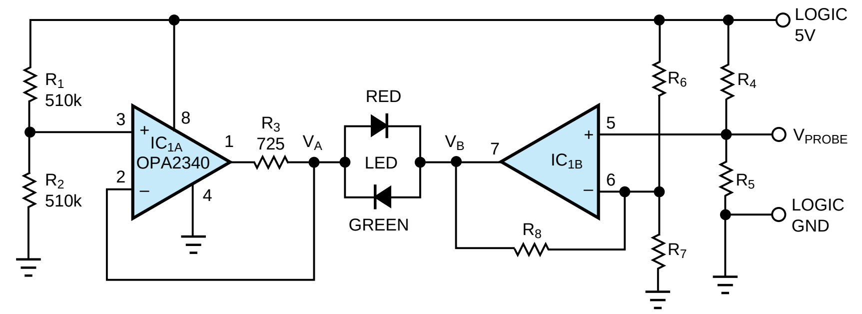
# Simple logic probe uses bicolor LED

*Mark Shill, Burr-Brown Corp, Tucson, AZ*

When probing digital logic levels on a circuit board, locating the indicator of the logic level near the probe tip is convenient, so that you can keep both the indicator and probe tip constantly in sight. When using a handheld DVM or oscilloscope probe, you must momentarily look away to read the logic level. In that instant, the probe can slip and cause a short circuit. The circuit in **Figure 1a** implements a simple handheld logic probe using just a few components. This

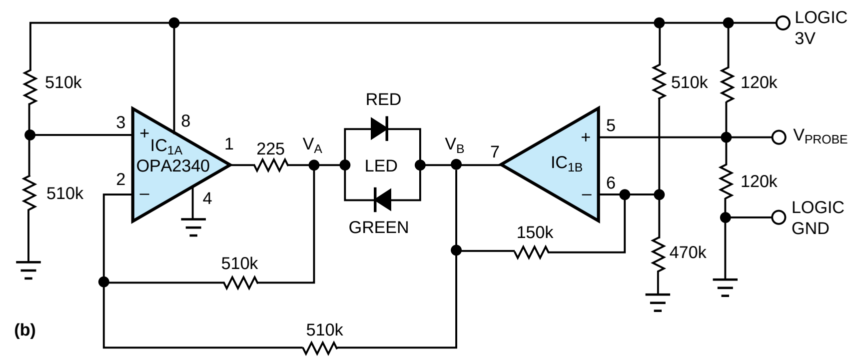
**FIGURE 1**




NOTE:
LED=RADIO SHACK 276-012.

| RESISTOR | 5V CMOS | TTL |
|---|---|---|
| $R_4$ | 160k | 250k |
| $R_5$ | 120k | 100k |
| $R_6$ | 510k | 820k |
| $R_7$ | 270k | 220k |
| $R_8$ | 180k | 470k |

(a)




(b)

**A simple handheld logic probe uses a rail-to-rail op amp and a bicolor LED (a). A modified probe circuit works with 3V CMOS logic (b).**

probe can measure high, low, and high-impedance logic states, in addition to indicating switching logic states. This probe is useful for quick measurements of dc logic levels. You can use a similar probe circuit (**Figure 1b**) for 3V CMOS logic.

The circuit centers around the OPA2340 dual rail-to-rail op amp and a Radio Shack 276-012 bicolor LED. The forward voltage for the red and green LEDs are 2 and 2.1V, respectively. Op amp $IC_{1A}$ derives a buffered 2.5V reference output from the 5V supply, and $R_3$ limits the current to the LED when it is on. $IC_{1B}$ buffers and amplifies the probed logic signal to a 0 to 5V output level. $R_4$ and $R_5$ set a reference level for the positive input of $IC_{1B}$ for the case of a high-impedance level. When a logic high is present, the green LED lights; a logic low lights the red LED. When a high-impedance state is present, the LED is off.

The output voltage transfer function of $IC_{1B}$ is

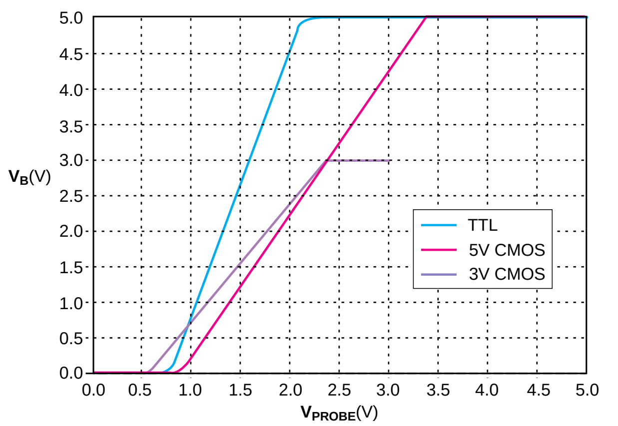
$$V_B = \left[1 + \frac{R_8(R_6 + R_7)}{R_6 \bullet R_7}\right] V_{PROBE} - \frac{R_8}{R_6} \bullet V_{CC},$$

which makes $V_{LED}=V_B-2.5V$. The values of $R_6$, $R_7$, and $R_8$ are such that $V_B$ limits at the positive or negative power-supply rail when $V_{PROBE}$ is at the logic family's minimum low or high level, respectively. **Figure 2** shows the voltage-transfer function for $V_B$. When $V_B$ limits at the rail voltage, the LED lights red or green, depending on the probed logic level. When $V_B$ is within 0.5V of the negative rail, the red LED turns on; when $V_2$ is within 0.4V of the positive rail, the green LED turns on. If the probe measures a high-impedance state, voltage-divider resistors $R_4$ and $R_5$ set the positive input of $IC_{1B}$, and the voltage across the LED is approximately 0V.

In **Figure 1b**, the output of $IC_{1B}$ feeds into $IC_{1A}$'s inverting input. For the resistor values in **Figure 1b**, the transfer function for $IC_{1A}$ is $V_A=-V_B+3V$, thus making $V_{LED}=2V_B-3V$.
(DI #2162)

**To Vote For This Design, Circle No. 409**

**FIGURE 2**




**The output of $IC_{1B}$, $V_B$, limits at either the positive or negative supply rail depending on the probe voltage.**