Simple continuity tester fits into shirt pocket

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This Design Idea describes a handy continuity tester with two modes of operation: It may sound if it detects continuity between its two probes, or it may sound when it detects no continuity. The second option permits testing for intermittent cable breaks. Response must be sufficiently fast to permit swiping a probe across perhaps 100 pins to instantly find a connected pin. The tester may also identify microfarad or larger capacitance between two conductors.

To properly test for continuity, the tester's voltage and current are limited so that low-power semiconductors do not suffer overstress or appear as a connection between two conductors. The tester must protect itself if you accidentally connect it across an energized circuit or a charged capacitor. Power consumption must be low so that if you accidentally leave the tester on overnight, it will not discharge the battery. The tester must operate even with low battery voltage.

Continuity requires a threshold of less.than 200Ω. Depending on battery voltage, that threshold may even be 80Ω. The tester's open-circuit voltage is less than 0.5V. Its short-circuit current is approximately 1 mA. Values are low so that the tester doesn't mistake a Schottky-barrier rectifier for continuity. When the tester is silent, it draws slightly more than 1 mA of current from a 9V battery. You can connect the probes for a few seconds across any voltage from −50 to +200V without damage.

A feedback circuit comprising Q_1 PNP and Q_2 NPN transistors maintains voltage on the gate of IGFET (insulated-gate field-effect transistor) Q_3 at less than 1.4V despite a 680-kΩ pullup resistor, R_4, and current from D_2 (**Figure 1**). When you short the probes, you divert more Q_1 base current to the probes, and less current flows through D_2. Eventually, Q_2 can no longer maintain a low Q_3 gate voltage. As the gate voltage exceeds 1.8V, Q_3's drain-to-source current causes Q_4 to become nonconductive. A 1-MΩ pullup resistor, R_6, then applies 9V to Q_5's gate, causing the tester to sound, announcing continuity.

Without a conducting Q_2 collector, Q_3's gate voltage approaches 9V. Current would then leak through Q_1's collector-to-base path. Diode D_2 blocks Q_3's gate voltage from leaking to the shorted probes.

The tester detects instantaneous continuity even when you quickly swipe a probe across 100 pins. Capacitor C_1 and pullup resistor R_5 extend Q_5's low gate-voltage response by 20 msec. Thus, the tester sounds slightly longer to indicate that it has established connectivity and does not miss a conductive pin during a fast swipe.

Probe current charging a capacitor may also create a short beep. The 20-msec extended beep means that the tester detects even 10-µF or smaller capacitors. With practice, you can estimate capacitance within decades from the beep's period.

Diodes D_3 through D_5 block destructive currents if probes touch an energized circuit. Resistor R_3 must be at least ½W to withstand current from an energized circuit for a few seconds without damage.

To test for cable continuity, the tester sounds only during a broken connection. In this case, firmly connect the probes to both ends of the cable. Switching S_2 changes the tester's function so that Q_4 drives the buzzer during a cable break.

You can modify the circuit to be a better cable tester by reducing the value of resistor R_1 to 4.7 kΩ and omitting capacitor C_1. With these modifications, detecting loss of continuity occurs at a threshold resistance of less than 100Ω.

Unfortunately, a continuity tester may create noise currents that feed back into the sensitive Q_1/Q_2 detector. Three circuit features minimize that noise. First, capacitor C_2 connects across the buzzer. Second, IGFET Q_3 acts as a buffer. Last, diode D_5 grounds Q_4 and Q_5 separately from ground for Q_2 and Q_3.

The circuit performs even when a battery voltage is less than 6.5V. However, lower battery voltage means that the tester detects continuity at a higher threshold resistance. You may install the entire tester in a plastic case smaller than a pack of cigarettes. EDN

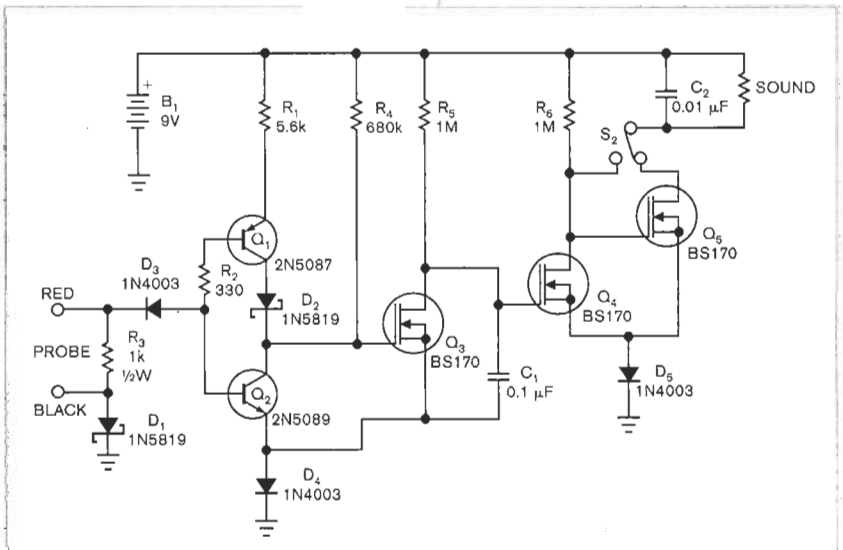

Figure 1 This simple continuity tester is switch-selectable to sound on either shorts or opens. It prevents a user from accidentally connecting it across live circuits.