Edited by Bill Travis

Design makes handy audible circuit tracer

Jerry O'Keefe, Cupertino, CA

The circuit tracer in **Figure 1** is a handy tool for finding connectivity paths on a pc board. Because the sense voltage you use to measure the path is lower than a transistor's V_{BE} voltage, you can use the design in circuits containing semiconductor elements without affecting the measurement. The tracer's output takes the form of audio tones. An open circuit produces ticks at the rate of approximately one per second, and a short circuit results in a 2-kHz tone. An audible sensing device is ideal for a circuit tracer, because your eyes can focus on the circuit paths you're tracing and not on a meter movement. If you want to find the connections to a circuit point, a useful technique is to attach a lead to that point and just scan the other lead over the other sections of the circuit. When you hear a high-pitched tone, then you know that you have a pc-board connection.

With practice, you can quickly determine the quality of the circuit path by discerning the wide dynamic range of ticks to tones. You can also detect the presence of capacitors, which produce a sweeping tone as they charge. The circuit in **Figure 1** is sensitive enough to produce a noticeable audio change if you make contact with a circuit with wet fingertips. R_1 produces a 0.4-mA current to bias the current mirror comprising Q_1 and Q_2. Q_1, the resistance-sense transistor, is the heart of the circuit. The resistance between its emitter and V_{CC} determines C_2's charge current. Because C_2 receives current from a constant-current source, the waveform on the capacitor is a linear ramp. When C_2 charges and passes IC_1's threshold, IC_1 generates an output pulse. R_2 determines the discharge rate for C_2. IC_2, a 74C74, converts the NE555 pulses to symmetrical square waves to differentially drive the piezoelectric speaker. With normal, day-to-day use, the 9V battery should last approximately a year.

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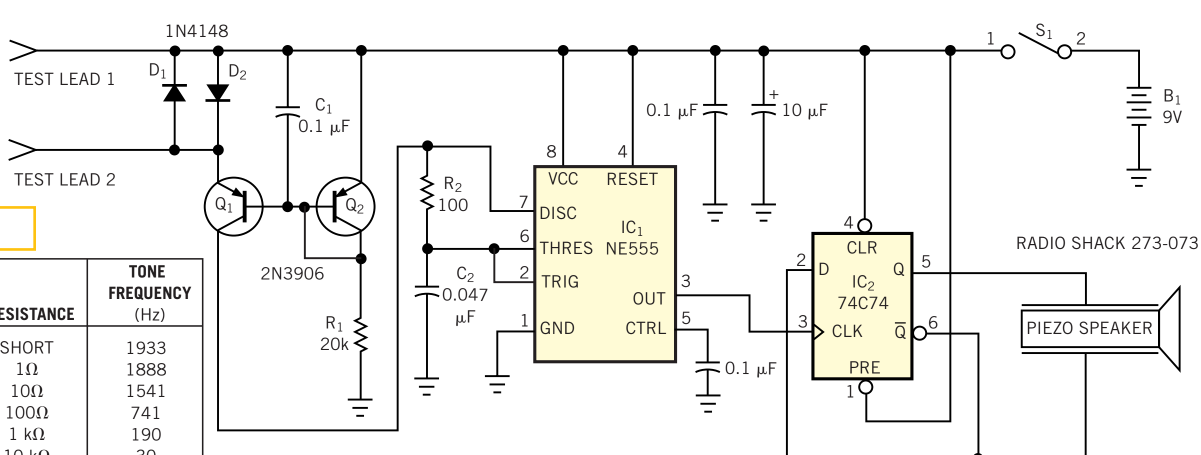
Figure 1



RESISTANCE	TONE FREQUENCY (Hz)
SHORT	1933
1Ω	1888
10Ω	1541
100Ω	741
1 kΩ	190
10 kΩ	30
100 kΩ	5.6
OPEN	~1

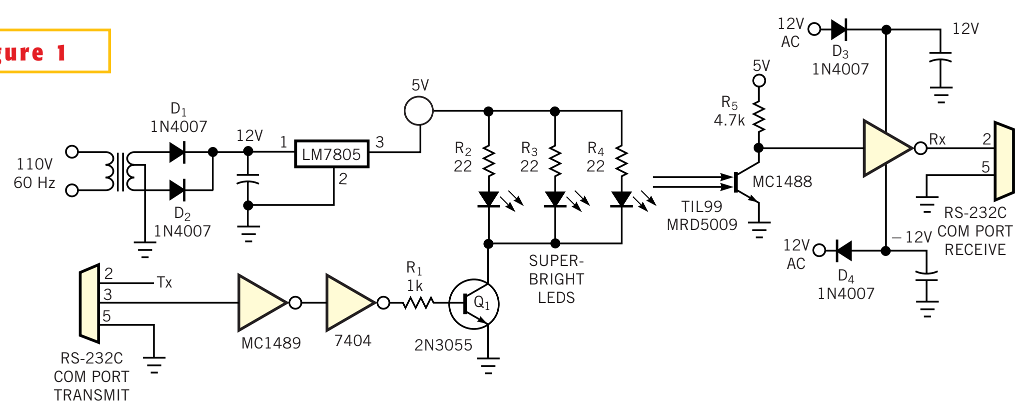
Use your ears to test continuity with this audible-tone circuit tracer.

Design a visible optical link for RS-232C communications

Shyam Tiwari, Sensors Technology Ltd, Gwalior, India

THE DESIGN in **Figure 1** is a visible optical link for those who need to see the transmitted data. An isolation figure of more than 5000V is a bonus. Tests of the system used the COM input of a data-acquisition system, as well as a standard PC's COM port. The MC1489 converts the RS-232C data to TTL signals. A 7404 gate then inverts the signal. The output of the 7404 drives Q_1, a 2N3055 power transistor. The transistor drives the set of three LEDs to form a light source. When no data exists on the RS-232C port, the LEDs remain off. When data transmission takes place, the LEDs glow at the rate of the data transmission. Keep the optical receiver 50 cm away from the LEDs to obtain maximum isolation. The MRD5009 phototransistor directly converts the light to a TTL output. (A TIL99 phototransistor also works well.) You should also isolate the power supply to the MRD5009/TIL99 and the MC1488 from the power supply of the receiver circuit. The MC1488 is a TTL-to-RS-232C converter.

Figure 1



This circuit provides a visible indication of RS-232C data transmission.

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Hot-swap structure offers improved redundancy

Samuel Kerem, Corvus Corp, Columbia, MD

FOR REDUNDANCY PURPOSES, a number of power supplies, using ORing diodes, can work into the same load. During maintenance, when you can remove any power supply, the minimum possible power perturbation at the load is desirable. To compensate for the voltage drop across the ORing diodes, you must connect the power-supply feedback lines after the diodes, at the load. Thus, the feedback connection is common for all participating power supplies (**Figure 1**). Because of natural variations in each power supply, only the one with the highest V_{OUT} is active. The others, sensing the "higher" output voltage, try to reduce their own outputs, effectively turning off their regulation. If you remove the "active" module from the setup similar to **Figure 1**, it causes V_{OUT} to dip (**Figure 2**). **Figure 2a** applies to a linear module that comprises two regulators that have independent 3.339 and 3.298V output voltages. Both have loads of approximately 10Ω in parallel with 100 µF. **Figure 2b** applies to a boost configuration that comprises two regulators with 5.08 and 4.99V outputs, each loaded with approximately 2.5Ω in parallel with 100 µF. The sags and glitches in the voltages arise from the inevitable delay for another power supply to step in and to start the regulation. Costly power-supply bricks deal with this problem by using current-sharing techniques. The techniques provide roughly equal output-current distribution among all power modules, thus keeping all modules ac-

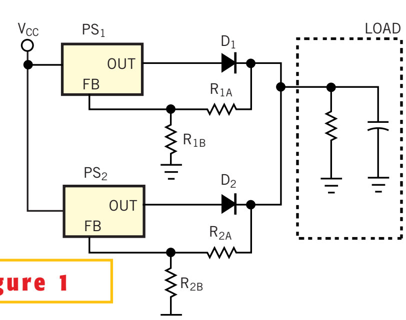
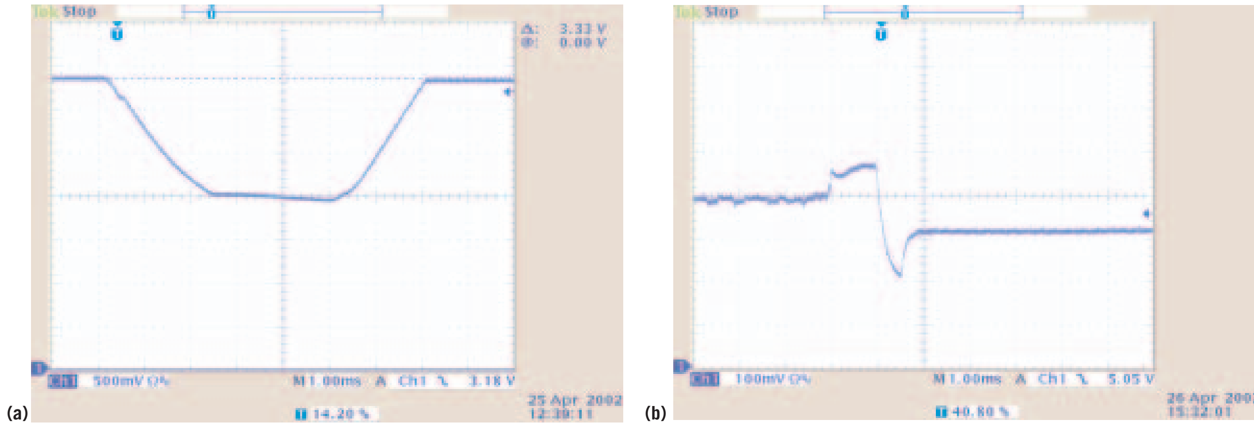


Figure 1

A standard redundant configuration of power-supply modules uses ORing diodes at the outputs.

Figure 2

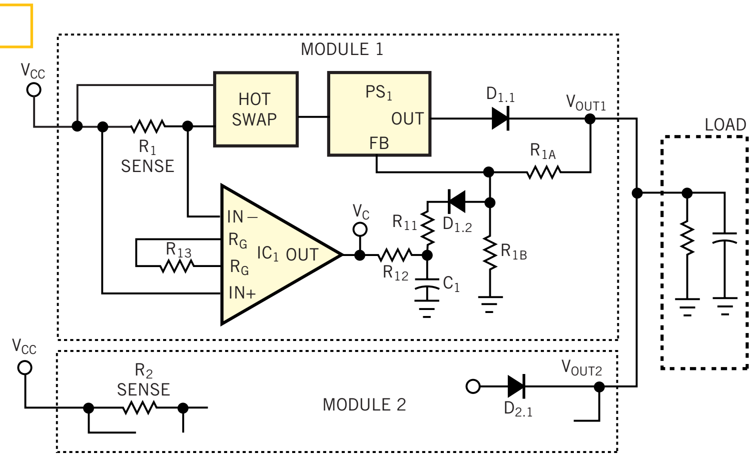


When you remove one supply from the redundant configuration, you incur sags (a) and glitches (b) in the output voltage.

tive. The configuration in **Figure 3** adds little cost to a power system. The improvements in performance are evident in **Figures 4a** and **4b**, representing the two types of redundant power-supply modules.

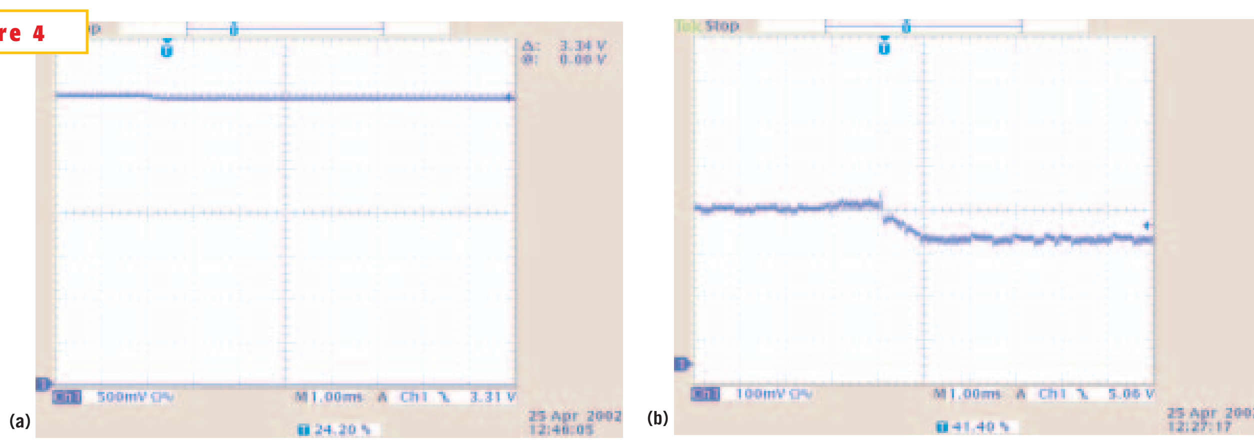
An instrumentation amplifier, IC_1, measures and produces a voltage, V_C, proportional to the current going into the regulator. V_C in turn controls V_{OUT}, pushing the regulator into active mode. For most adjustable controllers, $V_{OUT}=V_{REF}(1+R_A/R_B)$, where R_A is R_{1A}, and R_B is R_{1B} for module 1. If no current flows through R_{SENSE}, IC_1's output is close to ground, paralleling R_{1B} with the resistances of $D_{1.2}$, R_{11}, and R_{12}, thereby making R_B smaller and V_{OUT1} consequently higher. The increase needs only to compensate the V_{OUT} variation be-

Figure 3



The addition of an instrumentation amplifier and a few passive components provides sag- and glitch-free redundant performance.

Figure 4



Linear (a) and boost (b) regulators use the scheme in Figure 3 to eliminate sags and glitches in the output voltage.

tween same-configuration power supplies. This variation is only a few percentage points. If the current into the load rises, V_C also rises, reducing the current through $D_{1,2}$ and consequently reducing V_{OUT1}. When IC_1's output rises and differs from V_{FB} by less than the direct voltage drop across $D_{1,2}$, no current flows through $D_{1,2}$. Thus, V_{OUT1}, for any higher current, stays at the value the above equation defines. With the proper selection of R_3 (the instrumentation amplifier's gain-setting resistor), R_2 and R_1 from other modules provide the required current into the load from all power supplies, guaranteeing that they stay in active condition.

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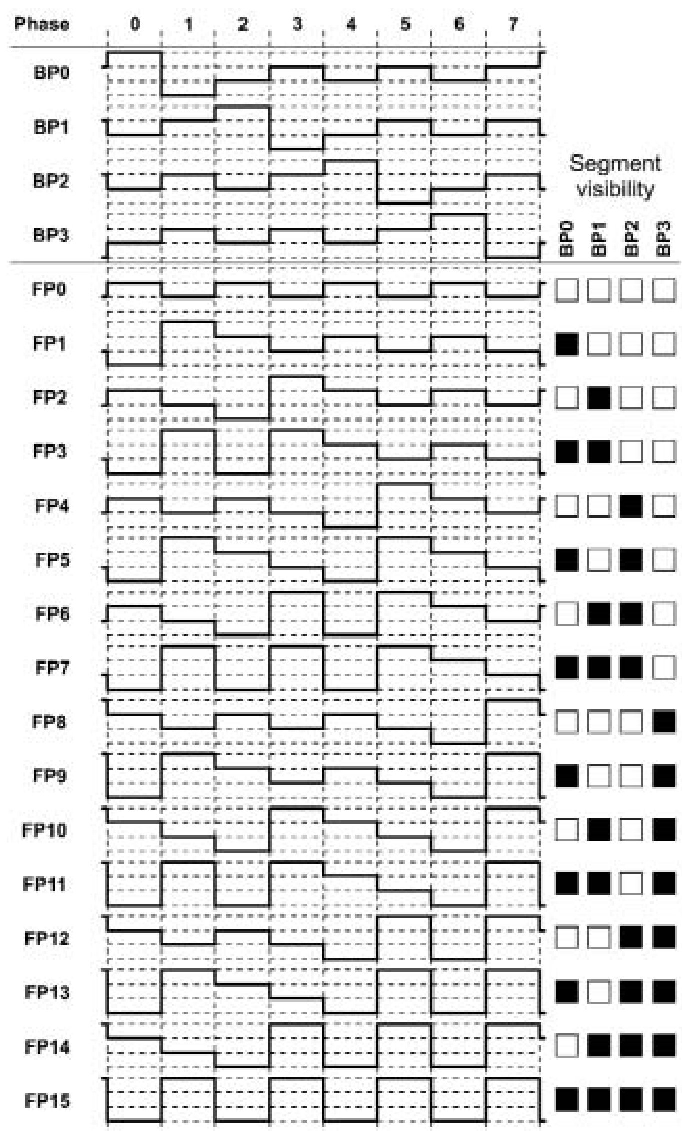
Embedded processor directly drives LCD

Daniel Malik, Motorola, Czech Republic

Driving a bare LCD does not necessarily require specialized interface circuitry or peripherals. This Design Idea describes an alternative drive scheme, which you can easily implement using the general-purpose outputs of a microcontroller. Many embedded-system applications need to interact with a user by displaying simple numeric or alphanumeric characters. Seven- or 14-segment LED displays are readily available at low cost and in many sizes. However, their relatively high power requirements and limited readability in direct sunlight restrict their use in battery-powered, portable devices. LCD modules driven by HD44780-compatible controllers offer simple interface characteristics, low power consumption, and good readability. However, their cost is relatively high, and their large dimensions sometimes preclude their use in small enclosures. Bare LCDs overcome these disadvantages. However, their drive requirements are usually nontrivial. **Figure 1** shows the usual waveforms you use to drive an LCD with four backplanes. The algorithm uses four discrete voltage levels for all LCD signals. Synthesis of such signals without dedicated peripherals or an external controller is difficult and requires many components. Fortunately for users of general-purpose microcontrollers without specialized on-chip peripherals, an alternative exists. **Figure 2** shows the alternative waveforms.

The algorithm uses only three voltage levels on the backplane pins and only two voltage levels on the front-plane pins of the LCD. Such waveforms are easy to synthesize using the general-purpose pins of

Figure 1



In the standard waveforms for driving LCDs, the algorithm uses four discrete voltage levels for all LCD signals.

a microcontroller. **Figure 3** shows a typical application of the alternative algorithm, using a general-purpose microcontroller. You implement the BPx (backplane) connections using general-purpose, tristatable outputs of the microcontroller. The FPx (frontplane) connections require only ordinary, general-purpose outputs. You obtain the $V_{DD}/2$ voltage on the BPx pins by tristating the microcontroller's pins. (You can usually obtain this result by configuring the pins as inputs.) Modern microcontrollers operate from a wide range of power-supply voltages. Altering the microcontroller's power-supply voltage is an effective way of adjusting the LCD's contrast. **Figure 4** shows examples of LCDs driven by general-purpose microcontrollers from Motorola (www.motorola.com). **Figure 4a** shows a display with two×11-segment organization; for **Figure 4b,** the organization is four×16 segments. **Figure 5** shows the modification of the waveforms for the smaller display of **Figure 4a**, using only two backplanes.

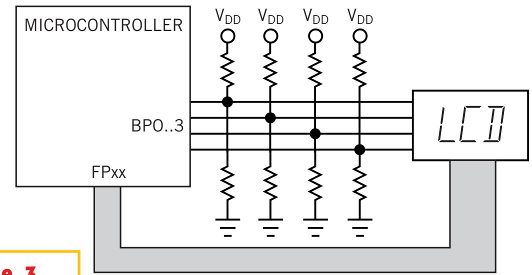


Figure 3

You can use a general-purpose microcontroller to drive any size LCD.

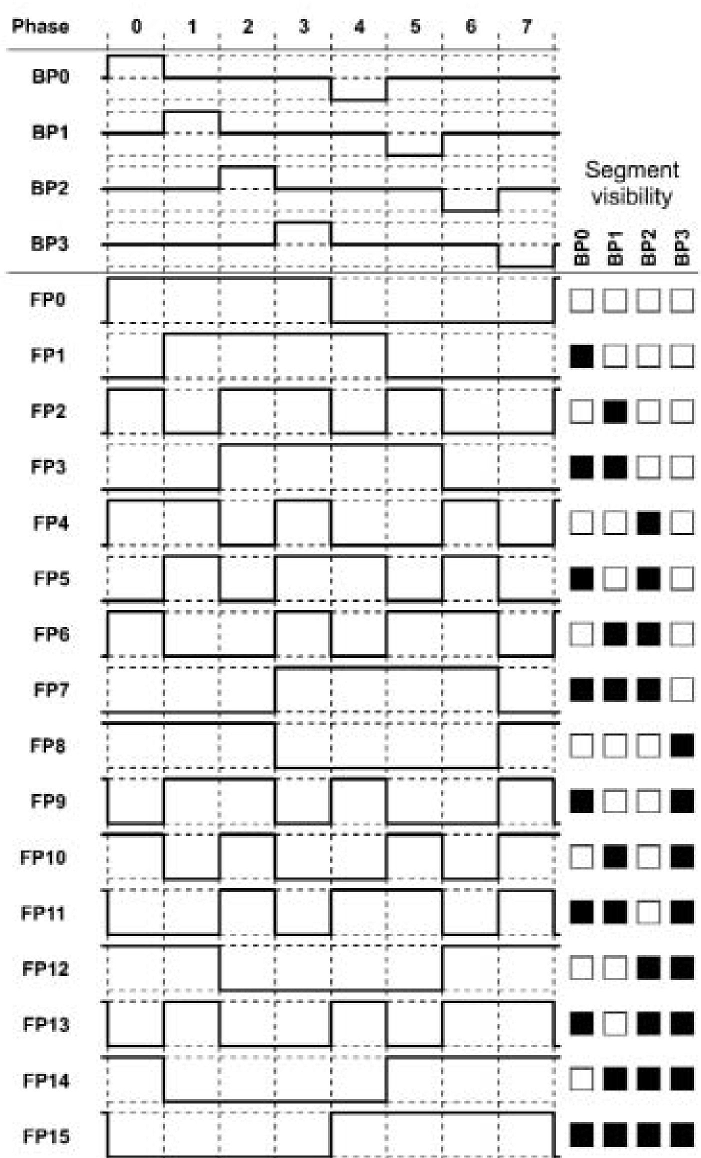


Figure 2

Alternative LCD-drive waveforms use only three voltage levels on the backplane pins.

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(a)

(b)

Figure 4

A general-purpose MC68HC908GP32 drives a two×11-segment LCD (a) and a four×16-segment LCD (b).

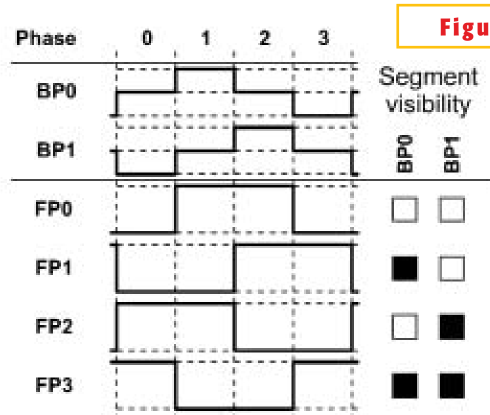

Figure 5

This modification of an LCD has only two backplanes.