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APPLICATION NOTE 4555

Circuit Guards Amplifier Outputs Against Overvoltage

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Abstract: To protect audio amplifiers and other automotive electronic circuits in the event of an accidental direct connection to the car battery voltage, add the circuitry shown (a shunt regulator, diodes, and an n-channel MOSFET in series with each audio path).

A similar version of this article appeared in the July 7, 2007 issue of *EDN* magazine.

A universal requirement for automotive electronics is that any device with direct connections to the wiring harness must be able to withstand shorts to the battery voltage. Though brutal, this requirement is necessary for reliability and for safety. One example of the need for this protection is the audio amplifier that produces indicator noises in the automotive interior. Though operating from a lower voltage (3.3V or 5V), it must be able to stand off the full battery voltage. A protection network appropriate for these amplifiers (**Figure 1**) can be used for other automotive circuits as well.



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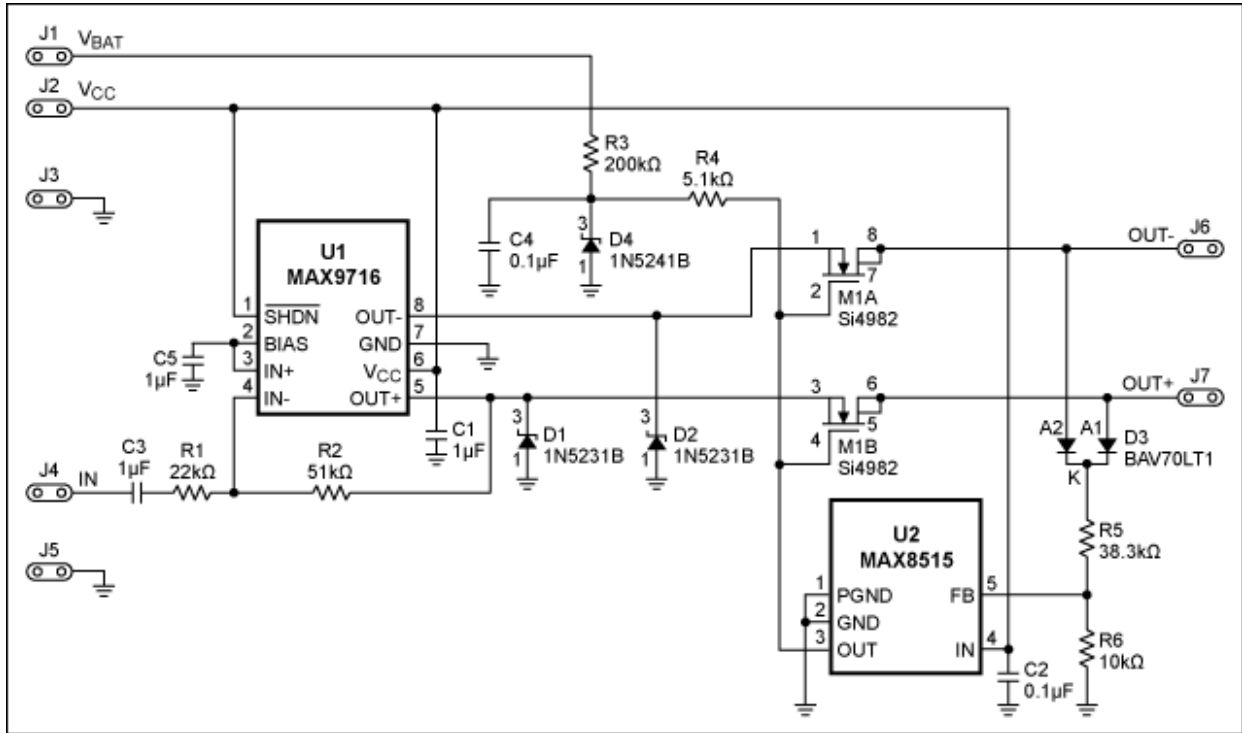


Figure 1. This output-protection circuit provides continuous protection against overvoltage faults.

A dual n-channel MOSFET disconnects the amplifier outputs from the wire harness in response to a high-voltage condition on either output. The MOSFETs (M1A and M1B) are normally on, with their gates driven to approximately 11V by the 11V zener diode (D4) and its bias components. The dual diode D3 provides a diode-OR connection to the dc voltage on each output, thereby producing a voltage that controls the output of shunt regulator U2 (MAX8515). The circuitry shown protects U1, a 1.4W Class AB amplifier (MAX9716) suitable for the application mentioned above (audible warnings and indications for the automobile's driver).

During normal operation, the amplifier outputs' dc components are at one half of the V_{CC} supply (2.5V in this case, for which V_{CC} = 5V). The MOSFETs are fully enhanced by the 11V gate drive, and the shunt-regulator output is OFF because its feedback input (pin 5) is below the internal 0.6V threshold. If either output exceeds 5V, current flows through D3 into the R5/R6 divider, pulling the feedback terminal above its threshold. The shunt regulator output then pulls the MOSFET gate voltage from 11V almost to ground, which blocks high voltage from the amplifier by turning off the MOSFETs. The MOSFETs easily withstand the continuous output voltage, and the circuit returns to normal operation when the short is removed. Because the circuit does not respond instantaneously, two zener diodes are included (D1 and D2) to provide protection at the beginning of a fault condition.

The waveforms of **Figure 2** represent an operating circuit. One of the amplifier outputs (top trace, dark blue) is a 1kHz sine wave biased at 2.5V DC. The second trace (cyan) is the signal seen on the wire harness. It also starts as a 1kHz sinewave biased at 2.5V DC, but at 200μs it is shorted to an 18V supply. The third trace (magenta) is the shunt regulator output, initially biased at 11V, but pulled to ground in response to the overvoltage condition. The fourth trace (green) is current in the wire harness. Initially a sine wave, this current drops to zero in response to the overvoltage condition.

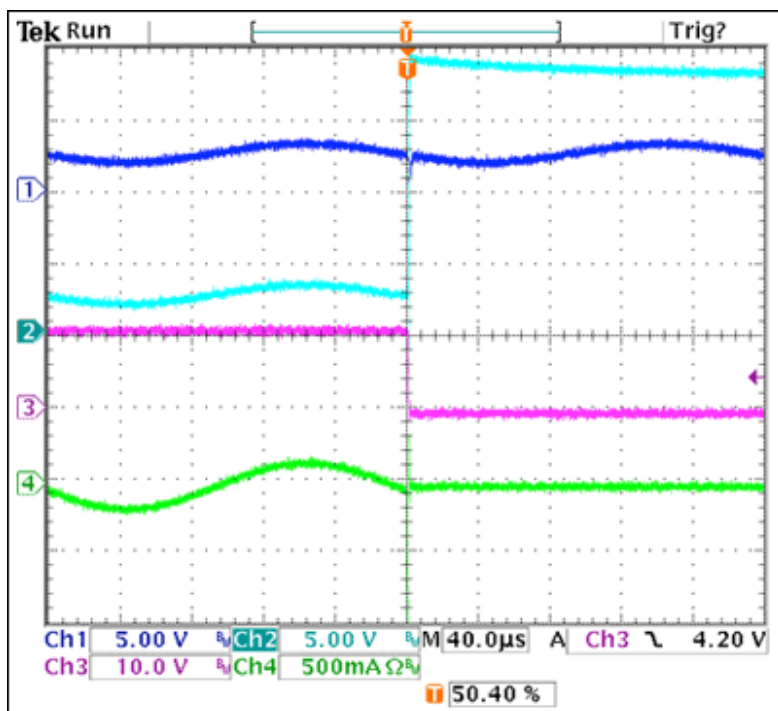


Figure 2. In Figure 1, one of U1's two audio outputs (top trace) is protected when its external terminal accidentally contacts an 18V supply voltage (2nd trace).

The components shown optimize this circuit for 5V operation. For other voltages, you can adjust the R5/R6 resistor values. The shunt regulator must be able to function in saturation, and therefore requires a separate supply pin in addition to the shunt output pin. The circuit withstands 28V shorts repeatedly without damage.

Related Parts

MAX8515	Wide-Input 0.6V Shunt Regulators for Isolated DC-DC Converters	Free Samples
MAX9716	Low-Cost, Mono, 1.4W BTL Audio Power Amplifiers	Free Samples

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