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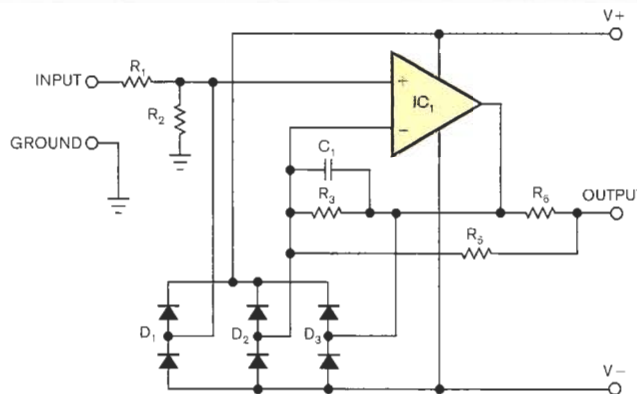
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## Circuits protect outputs against overvoltage

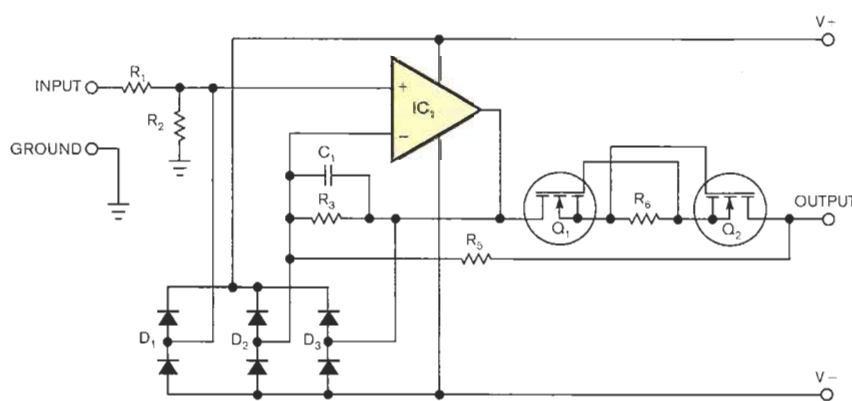
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**I**n test-and-measurement applications, you must provide overvoltage protection for the output terminals of amplifiers, power supplies, and similar components. The conventional way to accomplish this

task is to add series resistors with the output node along with the clamping diodes to power-supply rails or other threshold voltages (Reference 1 and Figure 1). This resistor significantly reduces current-output capability and



**Figure 1** The conventional way to provide overvoltage protection is to add series resistors with the output node along with the clamping diodes to power-supply rails or other threshold voltages.



**Figure 2** This circuit works as a bipolar-current source when the voltage drop across source resistor  $R_6$  becomes larger than the gate-threshold voltage of depletion-mode MOSFETs  $Q_1$  and  $Q_2$ , thus limiting the current through clamping diodes.

### DI Inside

**80 CPLD connects two instruments with half-duty-cycle generator**

**82 Achieve simple IR-data transmission from a PC's serial port**

**82 Circuit limits dV/dt and capacitor inrush at regulator turn-on**

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the output-voltage swing with low-resistance loads. The alternative approach is to use fuses or other current-limiting devices, which precede these clamps' high energy-absorption capability. The circuit in Figure 2 works as a bipolar current source when the voltage drop across source resistor  $R_6$  becomes larger than the gate-threshold voltage of depletion-mode MOSFETs  $Q_1$  and  $Q_2$ , thus limiting the current through the clamping diodes (Reference 2). The drawback of this approach is high power dissipation on series components during the overload condition.

A reasonable approach disconnects the amplifier-output node from the output terminals for the period when the overload voltage exists on output terminals. Engineers for decades have used such serial disconnection by means of electromechanical relays in audio power amplifiers but for a different reason: loudspeaker protection. SSRs (solid-state relays), including optoelectronic, photovoltaic, OptoMOS, and PhotoMOS devices, suit the task

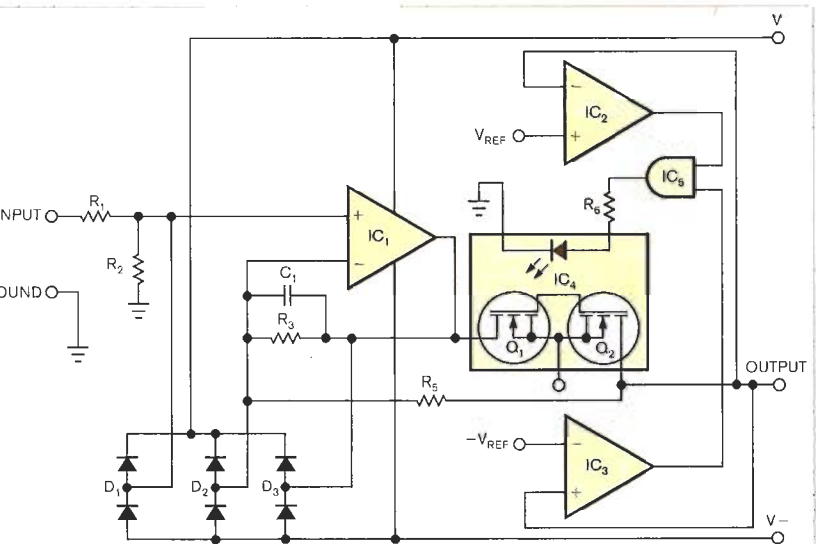
of load disconnection at moderate current levels because of galvanic isolation between the control and the load pins (Reference 3).

The series-protection circuit of **Figure 3** disconnects the amplifier-output terminal using a series-connected, high-voltage SSR. Raising the output voltage above the positive-reference-voltage or below the negative-reference-voltage threshold causes either the IC<sub>2</sub> or the IC<sub>3</sub> comparator to change its output state and turn off SSR IC<sub>4</sub> through AND logic element IC<sub>5</sub>. **Figure 4** shows the simple circuit realization of this approach.

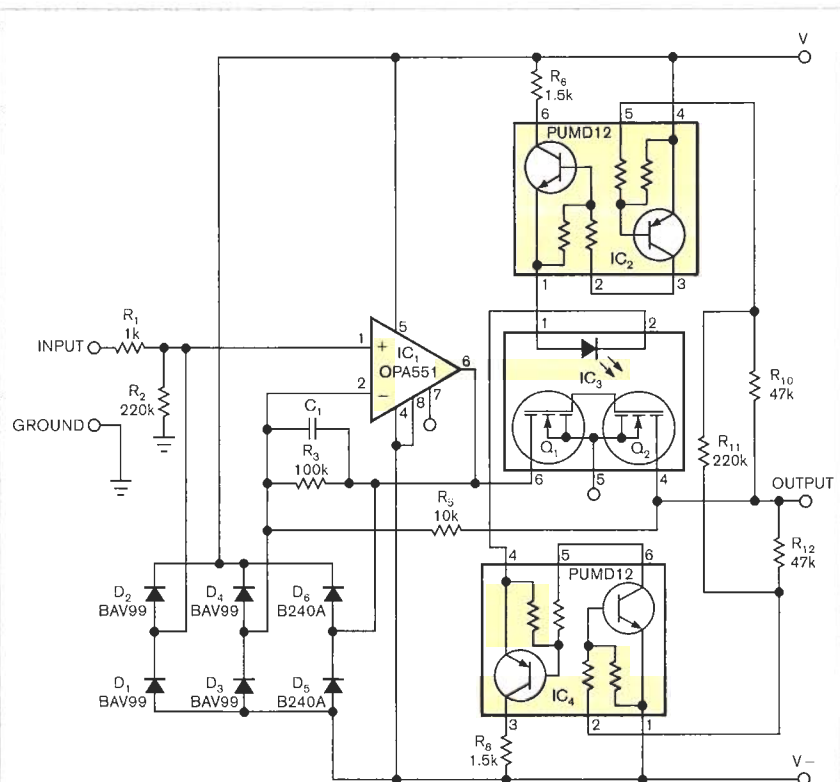
The circuit in **Figure 4** requires only a couple of external components to use an SSR for output-overvoltage protection. Rising overvoltage turns off both transistors in IC<sub>2</sub>, interrupting current flow through the control LED of IC<sub>3</sub>. Relay IC<sub>3</sub> opens, protecting the amplifier and clamping diodes. The circuit was tested with a handful of Clare, Matsushita Electronic Works, and Panasonic ([www.clare.com](http://www.clare.com), [www.naisis.co.jp/english](http://www.naisis.co.jp/english), [www.panasonic.com](http://www.panasonic.com)) SSRs with and without internal current protection. The power-supply rails are  $\pm 15V$ ; R<sub>10</sub>, R<sub>11</sub>, and R<sub>12</sub> set the triggering levels and are equal to  $\pm 16V$ . Omitting R<sub>11</sub> shifts the triggering levels to  $\pm 14.5V$ . The SSR turn-off delay in protection-circuit operation is 100 to 200  $\mu\text{sec}$  for relays with 0.5V overvoltage protection and becomes slightly shorter with higher overvoltage. Note that the peak current through clamping diodes can be rather high with low-on-resistance SSRs. **EDN**

## REFERENCES

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**Figure 3** This series-protection circuit disconnects the amplifier-output terminal using a series-connected, high-voltage SSR.



**Figure 4** This circuit requires only a couple of external components to use an SSR for output-overvoltage protection.

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