

One oscillator drives multiple solid-state relays

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Thanks to a combination of low initial cost and low on-resistance, a conventional electromechanical relay often makes sense for switching large amounts of load current on and off and when proportional control of the load's current or voltage is unnecessary. Low cost and low on-resistance represent the main reasons that relays still enjoy widespread use in the industry. In addition, a relay remains useful for switching high-voltage ac under the control of low-voltage electronics, due to the high degree of isolation between the control and the load circuits.

However, although relay technology has matured and offers proven performance, the relay remains a mechanical device that suffers from wearing out and other failure modes. Electrical endurance of the relay's contacts imposes a limit on the number of switching cycles. When a relay's contact opens, interruption of the current in an inductive load causes a spark that deteriorates the contact's performance. When switching high currents, a relay may reach the end of its operating lifetime in as few as 100,000 actuation cycles.

As an alternative to a conventional relay, a series-connected pair of MOSFETs can replace a contact in an ac circuit (**Figure 1**). A pair of IRF530 devices switches loads in circuits with peak maximum voltages as high as $\pm 100\text{V}$. Based on the well-known 555 timer, an astable oscillator, IC₁, provides a source of square-wave voltage to drive the MOSFET pairs' gate. Resistors R₁ and R₂ provide charge and discharge paths for timing capacitor C₁. The 555's output stage can sink and source several tens of milliamperes and provide enough current to drive as many as 10 stages' simultaneously operating switch gates, each consuming 5 mA of peak current; the 555's output sinks a maximum of 50 mA at an on-state maximum voltage of 0.75V. The 555's output drives a distribution bus that provides power to an array of pulse transformers, T₁ and T₂. Capacitor C₃ in series with the transformers' primary removes the dc offset voltage that would otherwise appear across the winding.

Selection of the transformer is not critical, and any ferrite-core pulse transformer that can provide gate voltage to the MOSFETs and maintain a

safe level of voltage isolation can function in the circuit. For example, you can use C&D Technologies' (www.cdtech.com) 76601/3, which provides a 1-to-1 turns ratio at a primary inductance of 219 μH with 500V-dc interwinding isolation.

Applying a control signal to the base of general-purpose NPN switching transistor Q₃ allows collector current to flow through the primary of its associated transformer. Diode D₂ provides a reverse-current path through the winding. On the secondary side, diode D₁ rectifies the secondary voltage and charges capacitor C₄, which filters the rectified voltage to improve noise immunity and reduce voltage ripple at the MOSFETs' gates. Removing the control signal switches off Q₁ and Q₂. Resistor R₃ provides a discharge path for C₄, allowing the MOSFETs to switch off in approximately 3 msec. For faster turn-off, you can reduce the value of either C₄ or R₃ at the expense of increased ripple on the rectified gate voltage.

Using two series-connected MOSFETs allows bidirectional ac conduction through the pair. When the MOSFETs are off, their parasitic diodes connect in series opposition and thus block conduction. You can select from among a range of MOSFETs to match your application's requirements, but make sure that the voltage you apply to the gates of Q₁ and Q₂ is sufficient to fully switch

both devices into full conduction. The IRF530 has a gate threshold voltage of 3V, but applying a gate-source voltage of 10V ensures low on-resistance. You can adjust the gate-source voltage by altering the transformer's turns ratio or IC₁'s power-supply volt-

age within its 4.5 to 16V rating (references 1 and 2).**EDN**

REFERENCES

1 "Transformer-isolated gate driver provides very large duty cycle ratios," Application Note 950, International

Rectifier Co, www.irf.com/technical-info/appnotes/an-950.pdf.

2 Balogh, Laszlo, "Design and application guide for high speed MOSFET gate drive circuits," Texas Instruments, 2002, focus.ti.com/lit/ml/slup169/slup169.pdf.

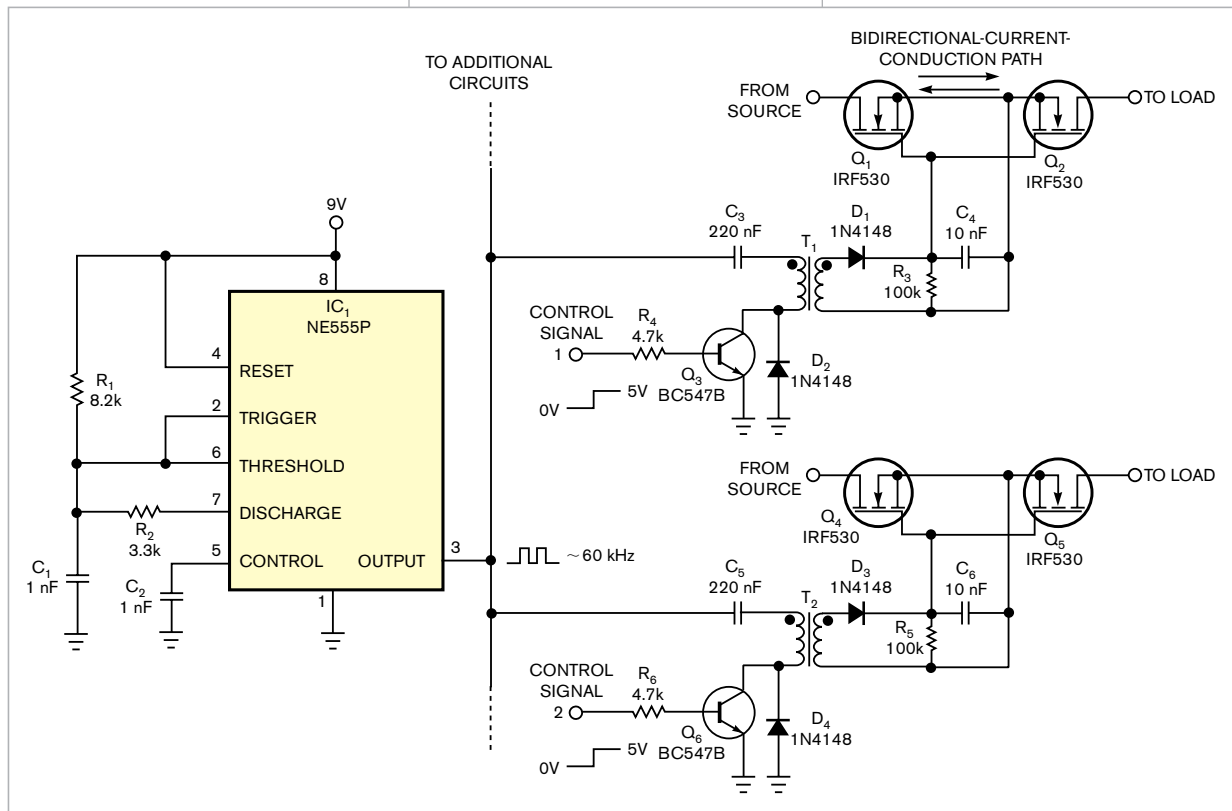


Figure 1 A single 555 oscillator provides square-wave ac gate drive to an array of as many as 15 MOSFET-based solid-state relays.