P-channel power-MOSFET driver uses unity-gain op amp

Suded Emmanuel - January 21, 2010

PDF Version

P-channel MOSFETs can simplify designs when you use them as high-side switches on circuits with voltages exceeding 100V dc. When driving a MOSFET, you must rapidly charge and discharge the input capacitance between its gate and its source to reduce heat losses. The circuit in **Figure 1** can accomplish that task. Q_7, an International Rectifier IRF5305 power P-channel MOSFET, switches 50V to a load. A series of pulses from a pulse generator or PWM (pulse-with-modulation) source drives the load at frequencies as high as 60 kHz with a variable duty cycle. The circuit comprises Q_4, R_5, D_2, R_4, D_3, and R_3; provides a means of level-shifting; and ensures that the voltage drop between the gate-to-source voltage of Q_7 never exceeds 10V. When Q_4 is on, 10V develops across D_3. This voltage drop turns on Q_7 through op amp IC_{1A}, one-half of an MC33072 from On Semiconductor. IC_{1A} has a 13V/µsec slew rate and can drive capacitances as high as 10 nF.

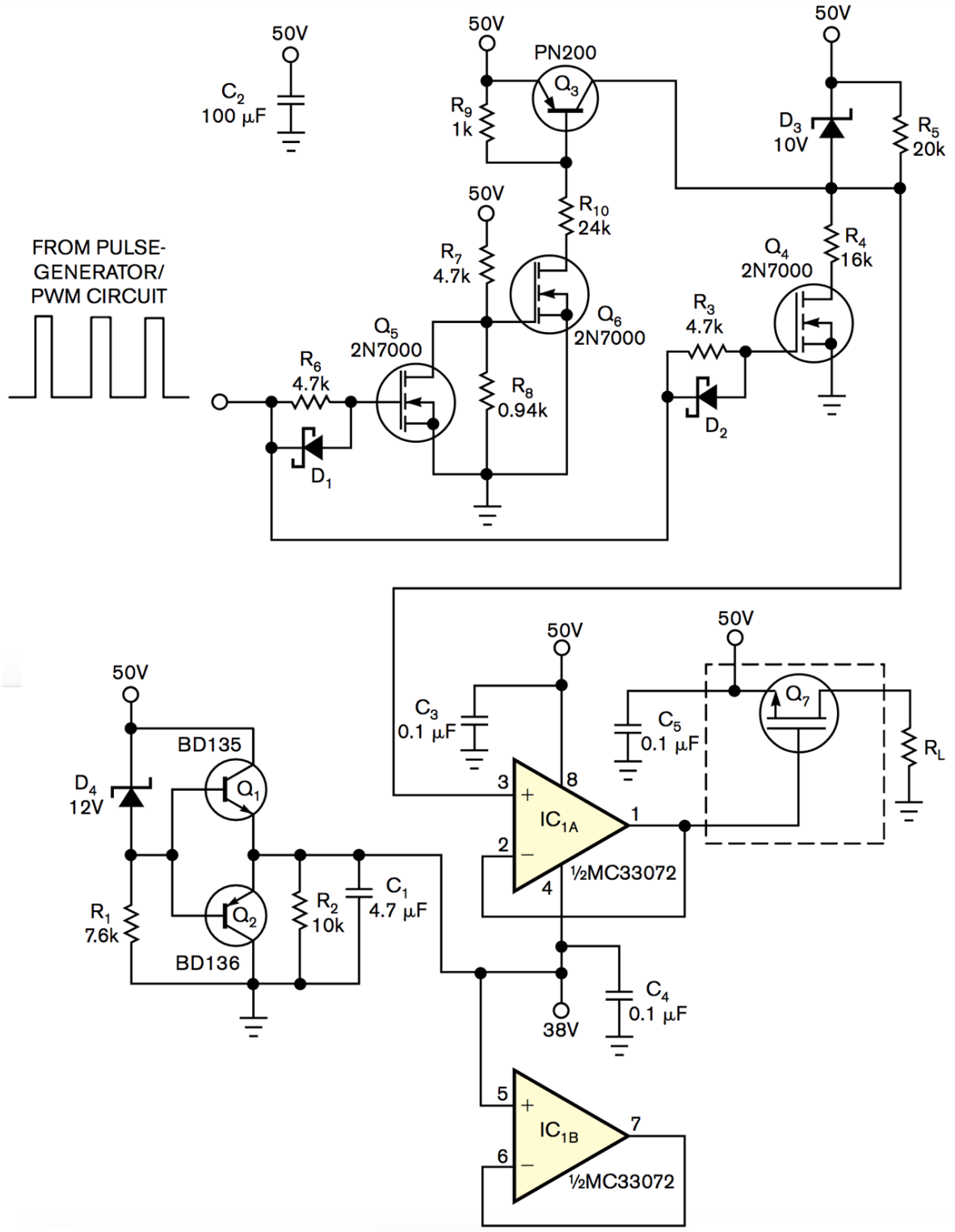

Figure 1 An op amp operating at 38 to 50V provides power to a load through power-MOSFET Q_7.

The combination of D_4, R_1, Q_1, Q_2, R_2, and C_1 provides "ground" for the op amp, which is at 38V—that is, 12V below the 50V rail voltage. The positive voltage is 50V, and ground is 38V. The anode of D_3 connects to the noninverting input of IC_{1A}, whose output drives Q_7's gate at 40V, which is 10V below the rail voltage of 50V. The circuit comprising R_6, Q_5, D_1, R_7, R_8, Q_6, R_9, R_{10}, and Q_3 rapidly switches D_3's anode to 50V, which turns off Q_7. Transistor Q_5 functions as an inverter that turns on Q_6, which subsequently drives Q_3 to rapidly switch D_3's anode to 50V and thus drives Q_7's gate. Schottky diodes D_1 and D_2 alternately enhance the switching speed of Q_5 and Q_4.

Unity-gain op amp IC_{1A}, with its high slew rate, fast settling, capacitive-driving capability, and feedback of the gate voltage, enhances Q_7's switching speed. Using this circuit, you can achieve a rise time and fall time of approximately 500 nsec at Q_7's output.

Related articles:

- Comparator directly controls power-MOSFET gate
- Design Ideas Submission Guide