Switching-mode controller boosts dc motor efficiency

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On-site monitoring equipment that makes use of a variable-speed dc motor places a special premium on the efficient use of the instrument's battery supply, because current drain is often high. This motor-speed controller circuit, which works on the principle of the highly efficient switching-mode power supply, saves energy and thus reduces circuit losses associated with the motor.

In this circuit, large, low-duty cycle pulses of supply current set up continuous currents in a small (0.01-horsepower) motor that are almost equal in magnitude to the peak current drawn by the supply, thereby contributing to circuit efficiency. As a typical example, almost 200 milliamperes of continuous motor current can flow when the average battery current drain is 100 mA, for an output voltage of 3.5 volts.

A_1, a voltage comparator, serves as both an oscillator and a duty cycle element in the controller, as shown in the figure. C_1 and R_1 provide positive feedback to A_1, enabling it to oscillate at about 20 kilohertz. The duty cycle, which can be from 10% to 70% of one 20-kHz period, is controlled by the negative feedback loop formed by Q_1, R_1, C_3, and R_3.

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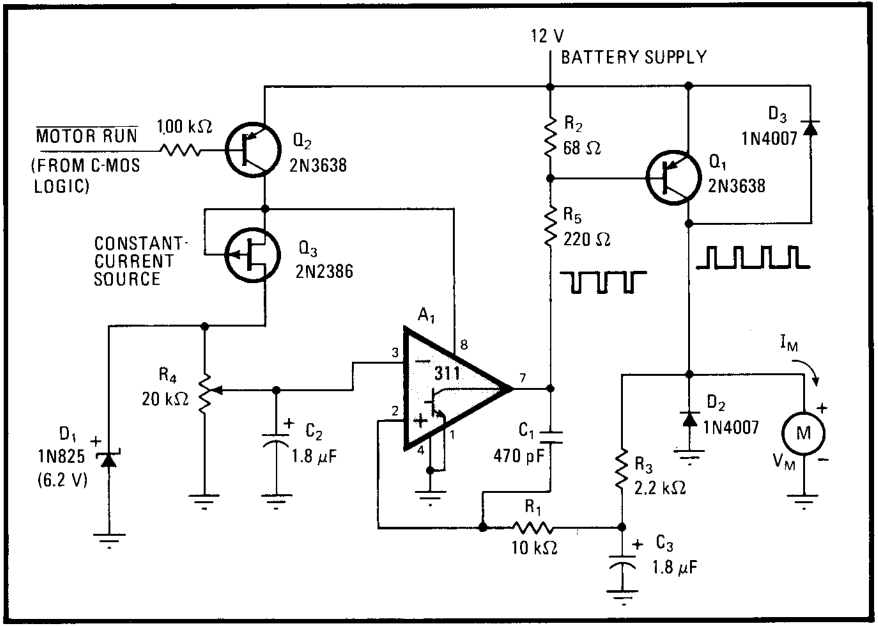
the circuit's operating principle and purpose. We'll pay $50 for each item published.

Less drain. Dc motor-speed control, which works on principle of switching-mode power supply, ensures minimum circuit losses. Duty cycle of pulsed output, 10% to 70% of one cycle at 20 kHz, drives motor, keeping battery current to minimum. Motor's inductance stores and filters pulses, essentially replacing filter capacitor normally used.



When the system's control signal, $\overline{\text{MOTOR RUN}}$, is asserted low, Q_2 turns on and applies power to the entire circuit. Pulses emanating from A, are amplified and inverted through Q_1 and pass through the motor, M. R_4 and D_1 set the average voltage supplied to the motor and thus largely determine the motor speed.

Note the absence of a capacitor at the output, which would normally be required to filter the pulsed signals and enable the motor to run smoothly. If a capacitor were used, it would have to be large in value and therefore large in size and costly as well. Instead, diode D_2 is placed in the circuit for filtering, enabling the pulsed energy to be stored by the motor's inductance in the field surrounding the windings. Between pulses, when Q_1 is off, little battery current is drawn, but the motor current is relatively large, since the amplitude of the current decays slowly through D_2.

Note also that although D_1 provides a stable, accurate reference, the average voltage fed back from the motor's terminals is affected by the forward-voltage drop of D_2. The drop varies with temperature and the current drawn through it and so reduces the absolute accuracy with which the output voltage can be set. However, resettability and stability are both very good with respect to battery voltage variations, and in applications where the temperature variations are minimal, the drawback will be unimportant. For example, the current variations due to even a 4-v supply-voltage change will be less than 2%.□