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Low-Cost DC Motor Speed Control with CMOS ICs

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INTRODUCTION

Two low-cost CMOS ICs manage a 12 VDC, current-limited speed control circuit for DC brush motors. The circuit design (see Figure 1) uses PWM (pulse width modulation) to chop the effective input voltage to the motor. Use of CMOS devices gives the benefits of low power, minimal heat and improved longevity. The overall design is simple, inexpensive and reliable, and is useful in applications such as embedded DC motor control where efficiency, economy and performance are essential.

CIRCUIT CONCEPT

A CMOS update of the popular bipolar-555 timer device is used because it draws much lower operating currents and thus runs cooler and lasts longer in typical operating environments. By adjusting the wiper of the speed-control potentiometer, output-signal duty cycle, or pulse width, can be varied from 2% to 98%. Operating frequency is fixed at 20kHz, to remain in the inaudible range.

Two signals are generated: the PWM signal, and a direction signal (high = forward, low = reverse). These signals become inputs to the TC4469, a CMOS Quad MOSFET driver. Its logic inputs allow proper output chopping and commutation.

OUTPUTS

Four outputs drive a MOSFET H-bridge, to provide rapid motor-speed changes and motor-direction reversal. The lower rail power MOSFETs are N-channel devices, the upper MOSFETs are P-channel. All four are driven directly by the TC4469.

In the lower rail devices, a small series resistor helps prevent gate oscillation and slows transition time, helping the upper device to stay "OFF." For motor voltages over 12VDC, a resistor divider and low-cost level shift transistor can be added easily and economically to maintain a 15VDC gate drive for the upper rail MOSFETs. Since the ICM7555 and TC4469 need negligible current, a simple linear regulator can power them from the positive motor supply when it is above 15VDC. Zener diodes can be used to help protect the gates from supply transients. Gate-to-source capacitors help keep the upper MOSFETs "OFF" when the lower MOSFET in the same leg turns "ON," causing a high dV/dT. Keeping the upper MOSFET gate drive impedance low in the "OFF" state will also help.

A sense resistor in the ground leg of the H-bridge provides an easy way to sense motor current, pulse by pulse, regardless of forward or reverse motor rotation. This signal is filtered and applied to the ICM7555 to inhibit PWM generation if motor current exceeds the allowed value.

CONCLUSIONS

This flexible, inexpensive circuit eliminates costly PWM devices and complex floating upper rail drives, while still delivering efficient motor control and protection.

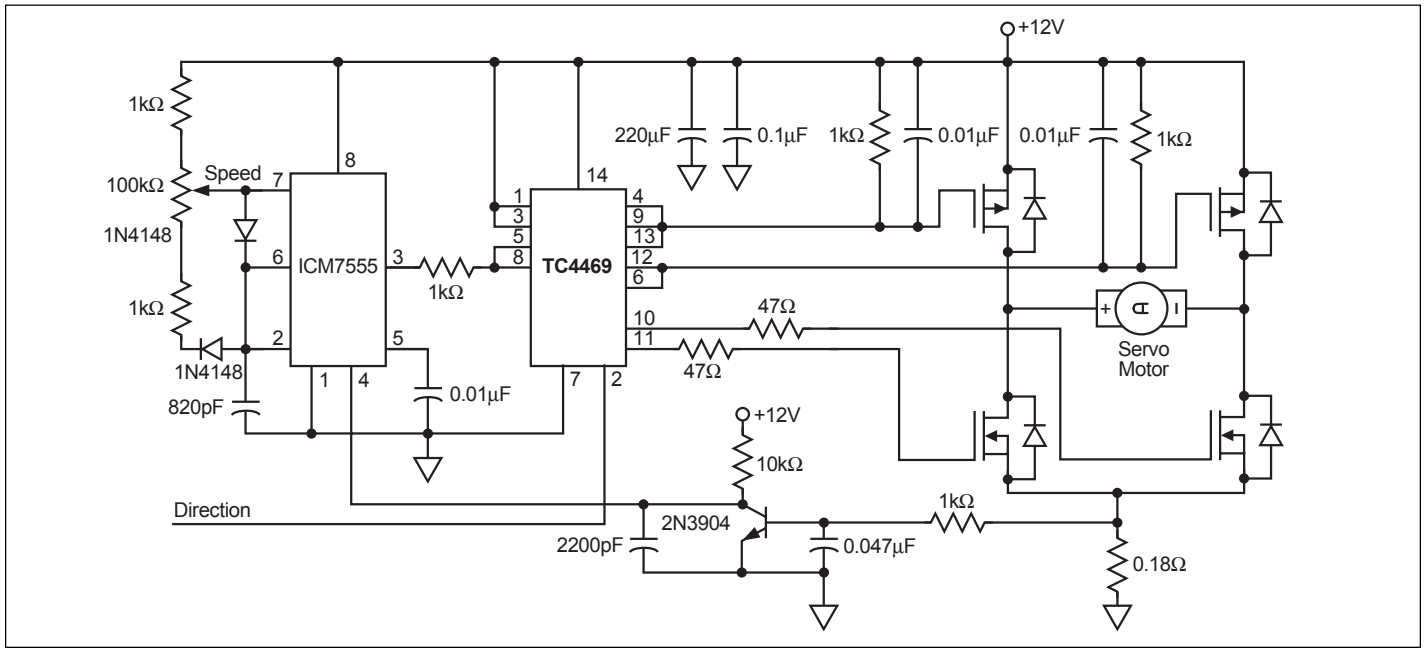

FIGURE 1: *12VDC speed control and current limit.*

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