PWM for small motors

Peter Hale presents two simple but efficient pwm schemes for driving and controlling small motors.

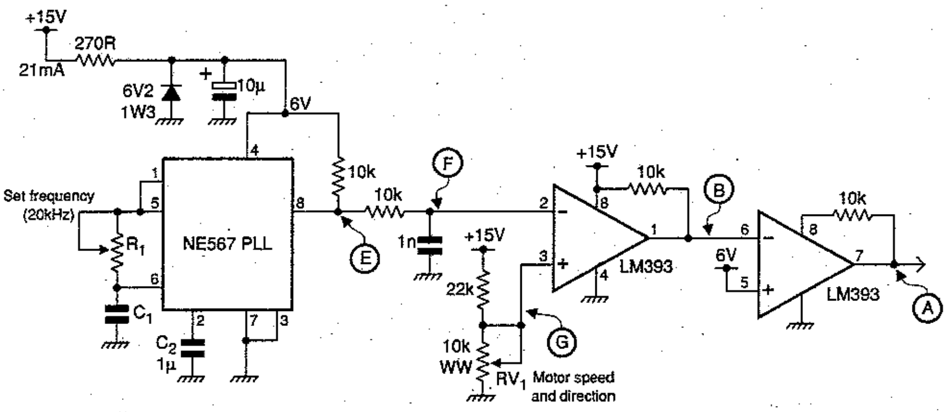
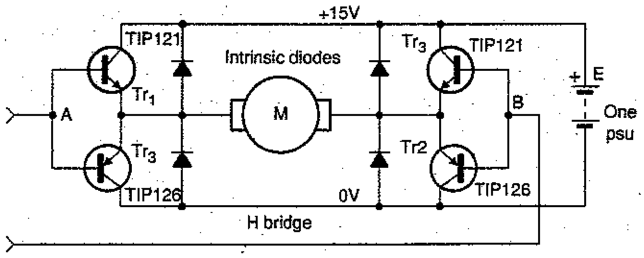


Fig. 1. Where only a single supply is available, four transistors in a bridge formation provide a means of driving the motor in either direction.



There are two pulse-width modulated drives described here. Each controls the speed and direction of a low voltage dc motor via a single potentiometer.

Pulse width modulation, or pwm, is a method by which a rectangular pulse has its mark to space ratio varied thus ntrolling the average value of voltage seen' by the motor. These pwm drives reverse the polarity of the average value of voltage from zero volts thus enabling a smooth change of direction of the rotor.

Pulse-width modulated drives have

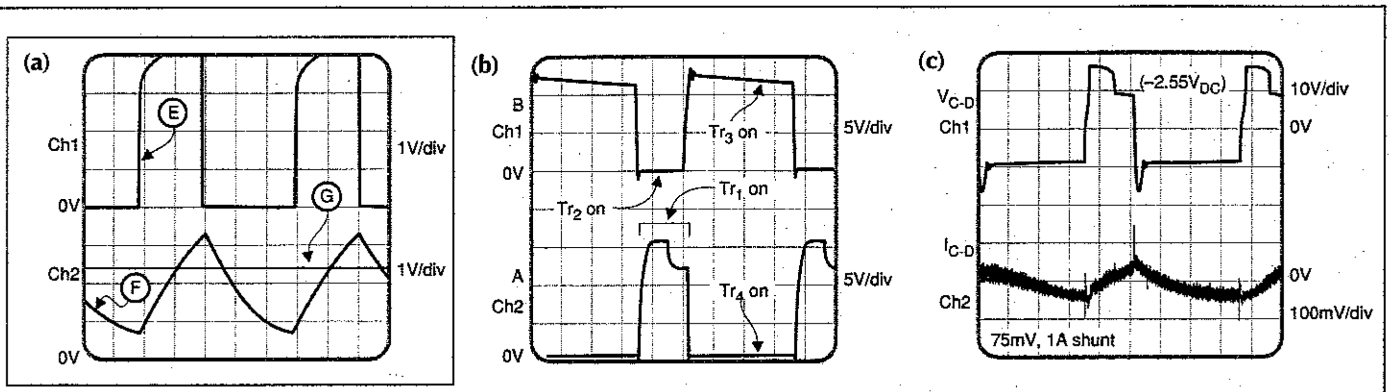


Fig. 2. Waveforms associated with the circuit of Fig. 1. Triangle wave F causes switching as it rises above and below reference G, resulting in pulses at B. Varying the reference causes variations in pulse width. Degradation of waveform A, which is B inverted, is due to using the second comparator in the dual package. Motor speed is 1000rev/min, supply is 15V and horizontal deflection is 10µs/div.

an advantage over linear alternatives in that the heat loss in the transistors is greatly reduced. This is because they are conducting only in the saturation region when V_{ce} will be about 1V or even less.

Both of the drives are bipolar. This means that the instantaneous voltage across the motor reverses polarity – at a rate of 20kHz in this case. But the average voltage appearing across the motor is the net sum of the positive and negative blocks of voltage. Hence the direction and speed of the motor can be precisely controlled.

Both drivers have similar performance. A major consideration in selecting which one is preferable for a given application may be the availability of single or dual power supply rails.

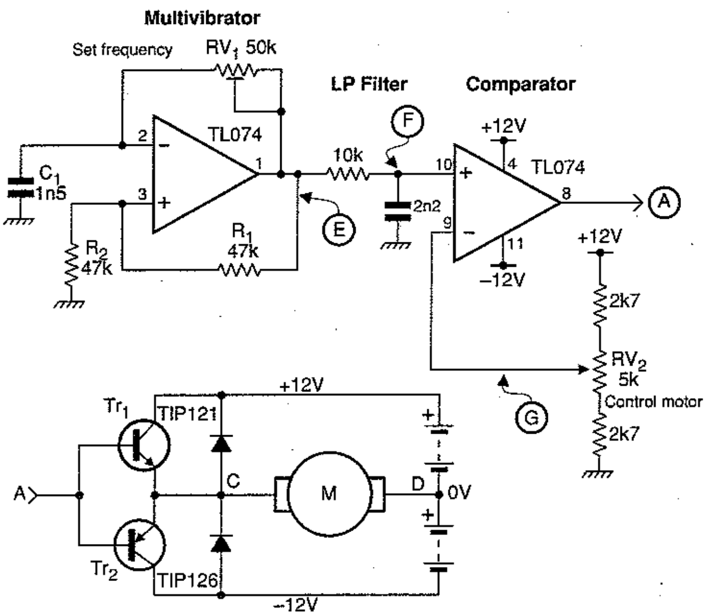


Fig. 3. With a dual supply rail, only two drive transistors are needed to provide forward and reverse motor control.

H-bridge using a single rail

This method involves turning switches Tr_1 and Tr_2 on and Tr_3 and Tr_4 off simultaneously, then Tr_1 and Tr_2 off and Tr_3 and Tr_4 on simultaneously, at a rate of 20kHz.

The oscillator generates a rectangular pulse at E, then a low-pass filter integrates to produce waveform F. Mark to space ratio of the driving pulses for the transistor bases at points A and B is set via potentiometer RV_1. Waveform B is an inverted version of waveform A.

Figure 1 shows the circuit diagram and the H-bridge, and **Fig. 2** the associated waveforms.

Using two supply rails

This alternative method has only two switches, Tr_1 and Tr_2, switching at a rate of 20kHz and varying pulse width set by the potentiometer RV_2. Hence the polarity of the voltage across the motor changes at a rate of 20kHz and the motor sees the net sum, i.e. average value, of these two voltage blocks.

Figure 3 shows the circuit diagram and the two-transistor driver while **Fig. 4** shows the associated waveforms. ■

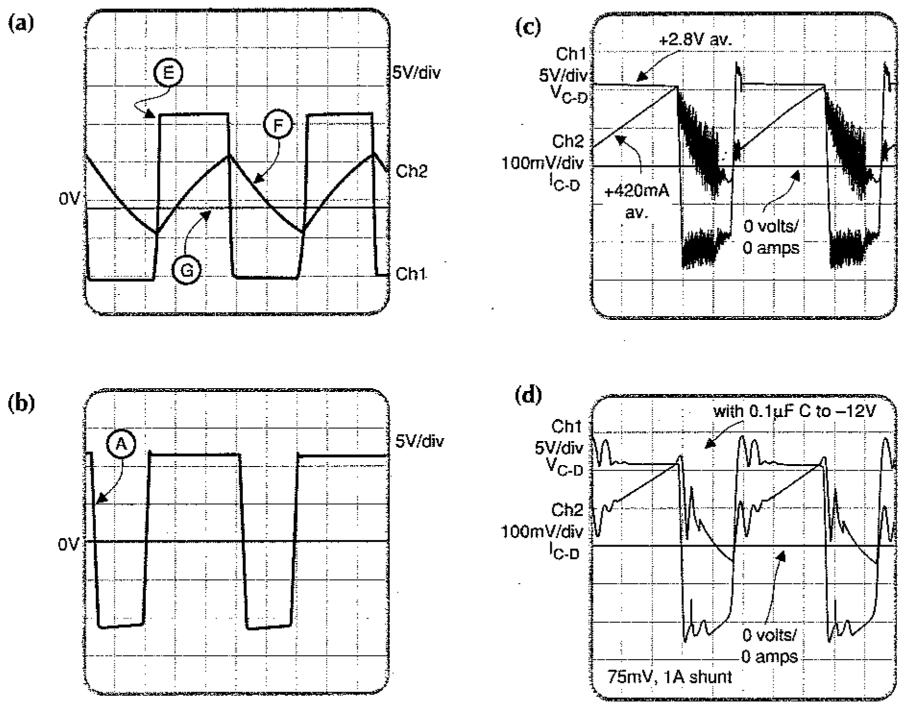


Fig. 4. Waveforms for Fig. 3. Screens a) and b) are control waveforms while those in c) and d) show drive output under load. In d), you can see that adding the 0.1μF capacitor between the negative rail and output significantly reduces the high-frequency noise. Again, motor speed is 1000rev/min and horizontal deflection is 10μs/div.