Brushless Motor Drives

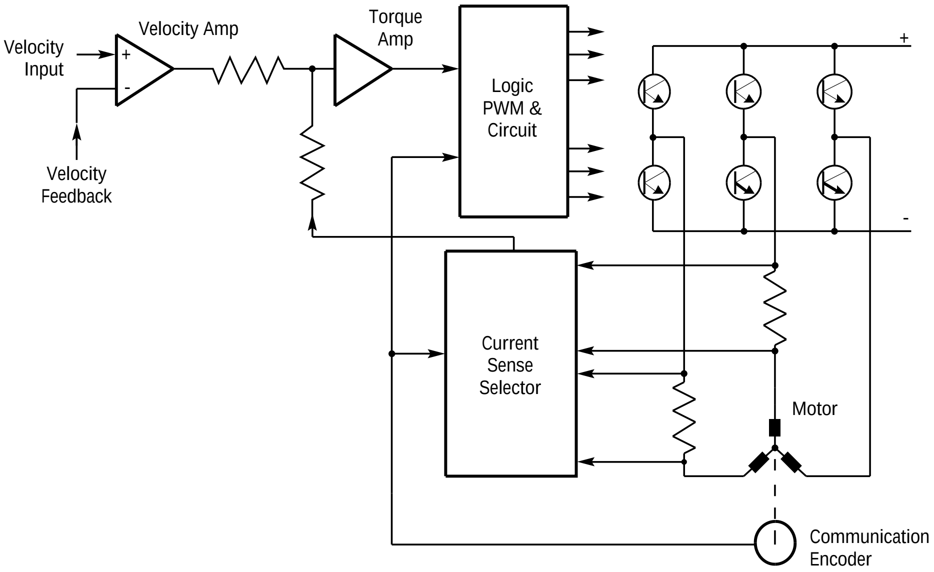
The trapezoidal drive

Fig. 2.20 shows a simplified layout of the drive for a three-phase trapezoidal motor. The switch set is based on the familiar H-bridge, but uses three bridge legs instead of two.The motor windings are connected between the three bridge legs as shown, with no connection to the star point at the junction of the windings. By turning on the appropriate two transistors in the bridge, current can be made to flow in either direction through any two motor windings. At any particular time, the required current path depends on rotor position and direction of rotation, so the bridge transistors are selected by logic driven from the commutation encoder.

A PWM recirculating chopper system controls the current in the same way as in the DC brush drive described previously. The required current feedback information is provided by sense resistors connected in series with two of the motor leads. The voltage signals derived from these resistors must be decoded and combined to provide a useful current reference, and the circuit that does this also uses the commutation encoder to determine how to interpret the information. In fact, this is not a simple process because the relatively small feedback voltage (about 1V) must be separated from the large voltage excursions generated by the chopping system (240V in the case of a typical high-power drive).

The input stages of the brushless drive follow the same pattern as a conventional analog brush drive (using a high-gain velocity amplifier that generates the torque demand signal). Velocity feedback can be derived in a number of ways, but it is clearly desirable to use a brushless method in conjunction with a brushless motor. Some motors incorporate a brushless tach generator that produces multi-phase AC outputs. These signals have to be processed in a similar way to the current feedback information using additional data from a tach encoder. Again, this is not a particularly straightforward process and it is difficult to obtain a smooth, glitch-free feedback signal. A more satisfactory alternative is to use a high-resolution optical encoder and convert the encoder pulse frequency to an analog voltage. The encoder can also be used as the feedback device for a position controller.

Fig. 2.20 Simplified trapezoidal brushless servo drive



The Sine Wave Drive

Sine wave brushless motors can be two- or three-phase, and the drive we'll look at is for the two-phase version (see Fig. 2.21). This uses two H-bridges to control current in the two motor windings, and the power section of this drive closely resembles a pair of DC brush drives. By contrast with the previous example, this drive uses a digital processor-based control section that takes its input in the form of step and direction signals. We need to generate currents in the two motor windings that follow a sine and cosine pattern as the shaft rotates. The drive shown in Fig. 2.21 uses a brushless resolver and a resolver-to-digital converter (RDC) to detect the shaft position. From this, we will get a number that can be fed to a reference table to determine the instantaneous current values for that particular shaft position. Bear in mind that the reference table will only indicate *relative* currents in the two windings—the absolute values will depend on the torque demand at the time. So the processor must multiply the sine and cosine values by the torque demand to get the final value of current in each phase. The resulting numbers are fed to D-to-A converters that produce an analog voltage proportional to demanded current. This is fed to the two PWM chopper amplifiers.

Commutation information for a sine wave drive may also be derived from an absolute or incremental optical encoder. An incremental encoder will be less expensive for the same resolution, but requires some form of initialization at power-up to establish the required 90° torque angle.

A “pseudo-sine wave” drive using feedback from a low-resolution absolute encoder can offer a cost-effective alternative. The pseudo sine wave drive gives superior performance to the trapezoidal drive at lower cost than the standard high-resolution sine wave system.

Fig. 2.21 Two-phase sine wave brushless drive