# DT0002
# Design tip

## Reducing torque variation in half step drive

By Thomas Hopkins

| Main components | |
|---|---|
| L6506 | Current Controller For Stepping Motors |
| L6207, L6227 | Dual DMOS Full Bridge Driver with PWM Current Controller |

## Purpose and benefits

This note describes a technique to reduce torque variation when driving two phase bipolar stepper motors in half step. Reducing the torque variation can reduce the chance of the motor stalling and give more reliable operation.

## Description

The stepping sequence for a half step drive of a two phase bipolar stepper motor alternates between states driving current in both phases and driving current in only one phase. In many implementations, the current level is set to be the same whether one or both phases of the motor are being driven, as shown in Figure 1a.

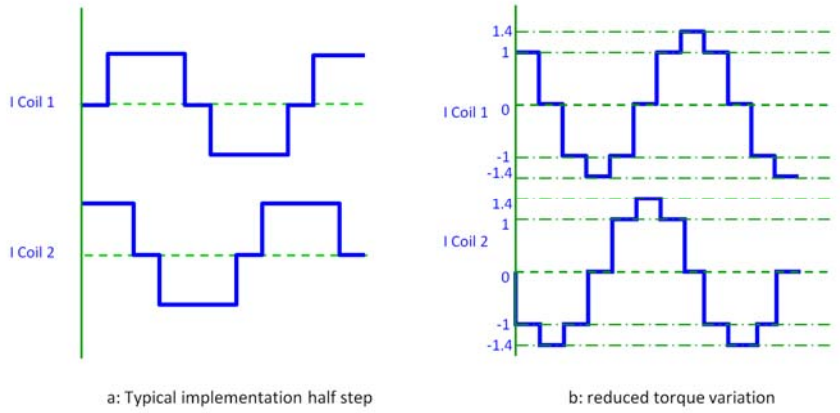


**Figure 1. Current waveforms in half step operation**

For the motor, torque is proportional to the magnitude of the stator and rotor magnetic vectors times the sine of the angle between the stator vector and the rotor vector. When driving a motor with two coils, the magnitude of the resulting magnetic vector is the vector sum of the vectors produced by each coil. If the two coils are oriented 90 degrees apart

and are driven with equal currents, the magnitude of the resulting magnetic vector is √2, or approximately 1.4, times the magnitude of the individual vectors. Since torque is proportional to the amplitude of this vector, one can easily see that as the magnitude of the vector changes from 1.4, with both coils energized, to 1, with only one coil energized, the torque also is changing and has a variation of about 40%.

This variation can be reduced by increasing the current in the coil during the half steps when only one coil is being driven. If the magnitude of the current is increased by √2, as shown in Figure 1b, the magnitude of the magnetic vector will also be increased by √2 and will be equal to the magnitude of the vector when both coils were driven by the original current.

Figure 2 shows an easy way to implement a circuit to drive the stepper as shown in Figure 1b. In this example, the microcontroller provides the phase and enable information for the stepper to a driver like the L6207 or L6227 or a current controller like the L6506 used with a driver IC like the L6201, L6202, L6203 or L298. The resistor values are calculated so that the reference voltage is reduced by a ratio of 1.4:1 when the open drain output is turned on. For a typical implementation, the values may be set at 0.7V and 0.5V. When the microcontroller turns both coils on, it also turns on the open drain device and reduces the reference voltage. When only one coil is energized, the open drain device is turned off and the reference voltage is raised to the higher value so that the current in the single coil is increased to 1.4 times the current when both coils are on.

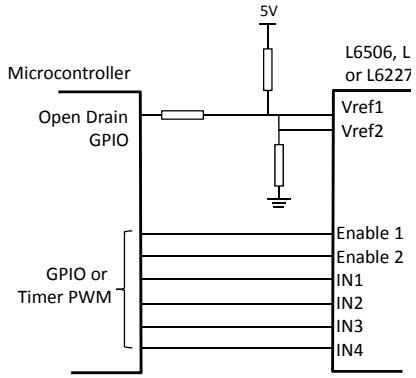


**Figure 2. Connection Diagram**

With this technique, the variation in torque caused by the one on - two on drive pattern can be reduced or eliminated.

## Support material

| Documentation |
|---|
| Datasheet L6506, Current Controller For Stepping Motors |
| Datasheet L6207, Dual DMOS Full Bridge Driver with PWM Current Controller |
| Datasheet L6227, Dual DMOS Full Bridge Driver with PWM Current Controller |

## Revision history

| Date | Version | Changes |
|---|---|---|
| 19-Apr-2012 | 1 | Initial release |

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