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Application Note 005

Using a Brushless DC Motor Torque Amplifier for a Brushed DC Motor Application

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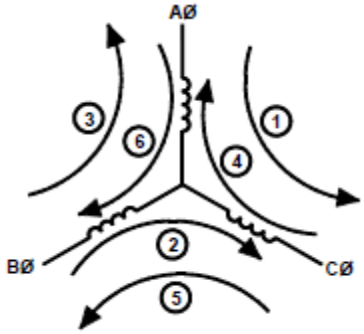
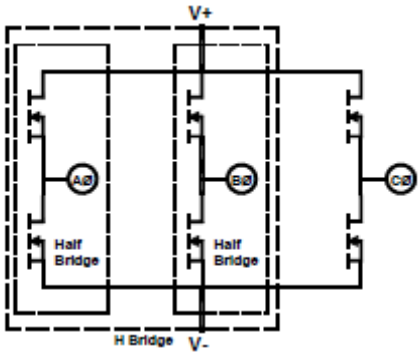
Using a brushless DC motor (BLDC) torque amplifier to drive a DC brushed motor is straight forward once a few things are realized about the characteristics of the amplifier. For a BLDC controller that uses hall devices in the motor for commutation, there are six steps in the commutation sequence for one electrical revolution of the motor. The motor needs to be "electronically commutated" by the controller for operation of the motor. There may be more than one electrical revolution per mechanical motor revolution depending on the number of poles in the particular BLDC motor. At any one point in the sequence, only two of the three phase connections to the motor are being activated. See Figure 1.



Six-step commutation sequence for energizing BLDC motor windings
Figure 1

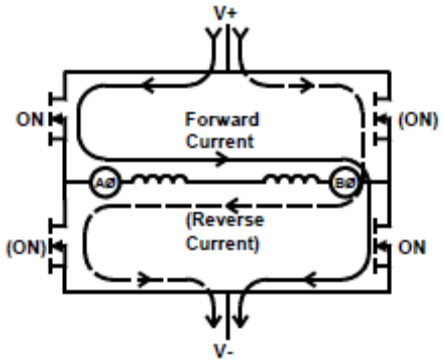
The hall devices tell the BLDC motor controller which windings to energize at any given time. Therefore, the BLDC controller is only activating one H bridge configuration at a time from the complete three-phase bridge. Looking at Figure 2, a complete three phase bridge consists of three half bridges connected together. It takes two half bridges to create the H bridge to energize that one winding at the correct time.



Three phase bridge consisting of three half bridges. Two half bridges working together will create one H bridge.

Figure 2

Energizing the top transistor in one half bridge connected to the A Phase motor winding terminal will connect the A Phase to V+. Energizing the bottom transistor in the second half bridge connected to the B Phase motor winding terminal will connect the B Phase to V-. This will complete the circuit for the A Phase winding and force current through it in one direction (forward). Turning off that pair of transistors and turning on the opposite pair will force current the opposite way (backward) through the winding. See Figure 3.



One H bridge configuration showing the circuit completed and current flowing in each direction through a motor winding.

Figure 3

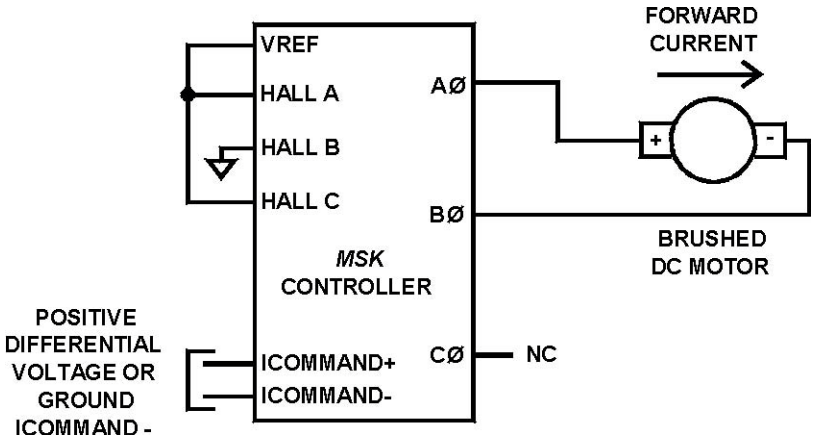
In a brushed DC motor, there are several windings as well contained within the motor with only one being energized at a time. The big difference is that the motor “self commutates” through the commutator on the armature and will control which winding is being turned on at any given time. Only two terminal connections to the two brushes in the commutator are brought out for connection to V+ and V-. Driving a brushed DC motor only requires one H bridge to make motor current go forwards or backwards. To take advantage of MSK’s unique BLDC torque amplifier characteristics while driving a brushed motor, the designer only has to lock the controller in one of the six sequences to utilize one H bridge out of the BLDC controller

HALL SENSOR PHASING						ICOMMAND=POS			ICOMMAND=NEG		
120°			60°								
HALL A	HALL B	HALL C	HALL A	HALL B	HALL C	AØ	BØ	CØ	AØ	BØ	CØ
1	0	0	1	0	0	H	-	L	L	-	H
1	1	0	1	1	0	-	H	L	-	L	H
0	1	0	1	1	1	L	H	-	H	L	-
0	1	1	0	1	1	L	-	H	H	-	L
0	0	1	0	0	1	-	L	H	-	H	L
1	0	1	0	0	0	H	L	-	L	H	-
1	1	1	1	0	1	-	-	-	-	-	-
0	0	0	0	1	0	-	-	-	-	-	-

MSK's BLDC Controller Commutation Sequence Truth Table with one step of the six-step sequence highlighted.

Figure 4

By tying the hall device inputs either "high" or "low", the controller can be locked into driving only one H bridge. In order to make the A Phase the source for current and the B Phase the return or the sink for the current, use the 120-degree configuration and tie Hall A "high", Hall B "low" and Hall C "high". This will force the three phase bridge to run only the H bridge desired. Connect one terminal of the brushed DC motor to the A Phase output and the other motor terminal to the B Phase output.



Block diagram circuit configuration of a MSK BLDC torque amplifier for driving a brushed DC motor.

Figure 5

By configuring MSK's BLDC torque amplifiers in such a way as to make the controller think that it's in a "locked rotor" condition, only one H bridge will be energized, allowing the controller to drive current in a current loop circuit with a brushed DC motor. The designer can then take advantage of the "true four quadrant" nature of MSK's BLDC torque amplifiers and apply them to a brushed DC motor for servo loop control.