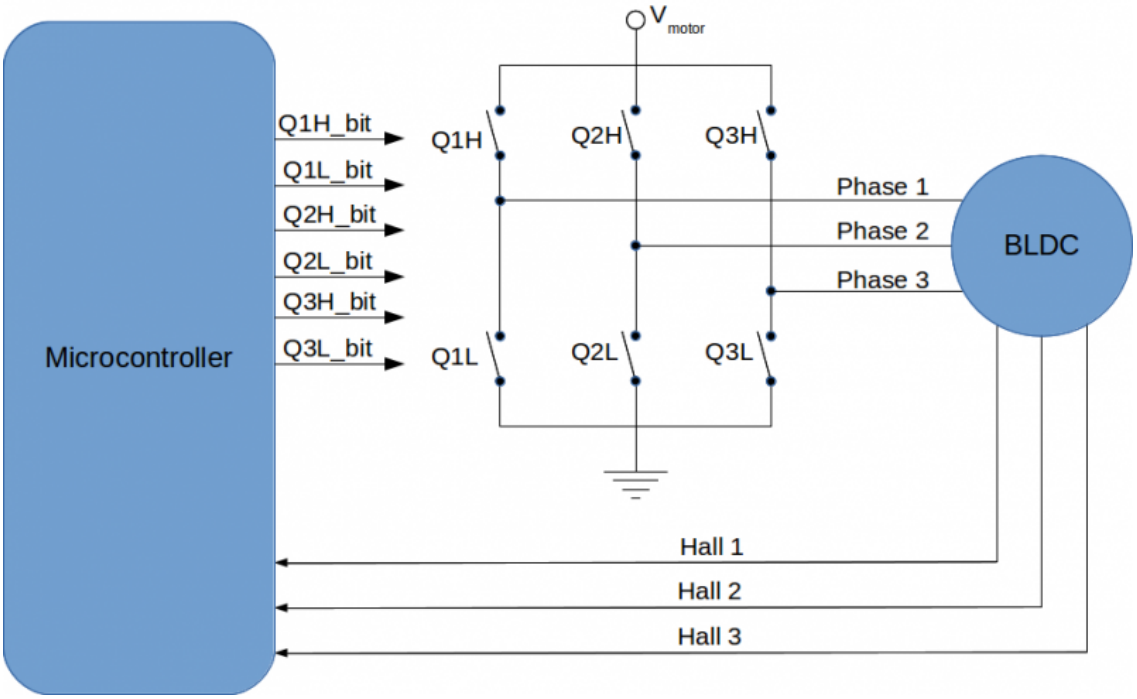
Robotics, Teaching & Learning

Philippe Lucidarme

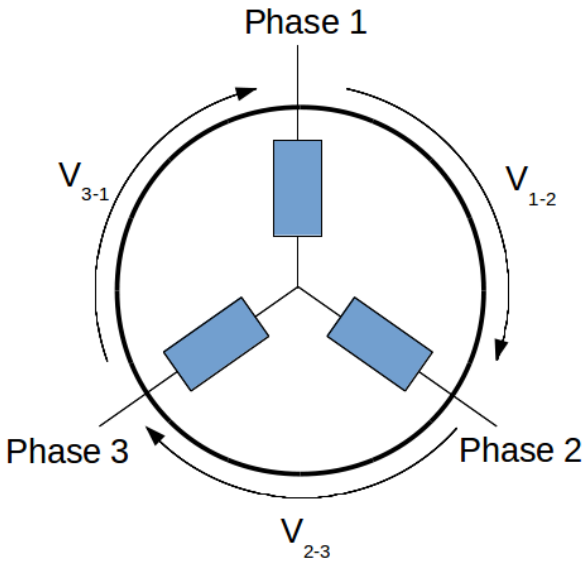
Commutation sequence for BLDC motors using Hall effect position sensors

May 30, 2014 Programming admin

The following diagram shows a simplify overview of the BLDC motor controller. The motor inputs are the three phase and the motor provides as output the binary data from three hall effect position sensors. The phases are driven by three H-Bridge (usualy made of transistors but simplified here as switches). Each switch is driven by the microcontroller outputs (Q1H, Q1L, Q2H, Q2L, Q3H and Q3L). In the following we will assume that the switches are closed (on) when the signal from the microcontroller is high (for exemple QL1_bit=1 => QL1 is closed => Phase 1 is connected to the ground). In the same way, we will assume that the hall effect sensors are active high.



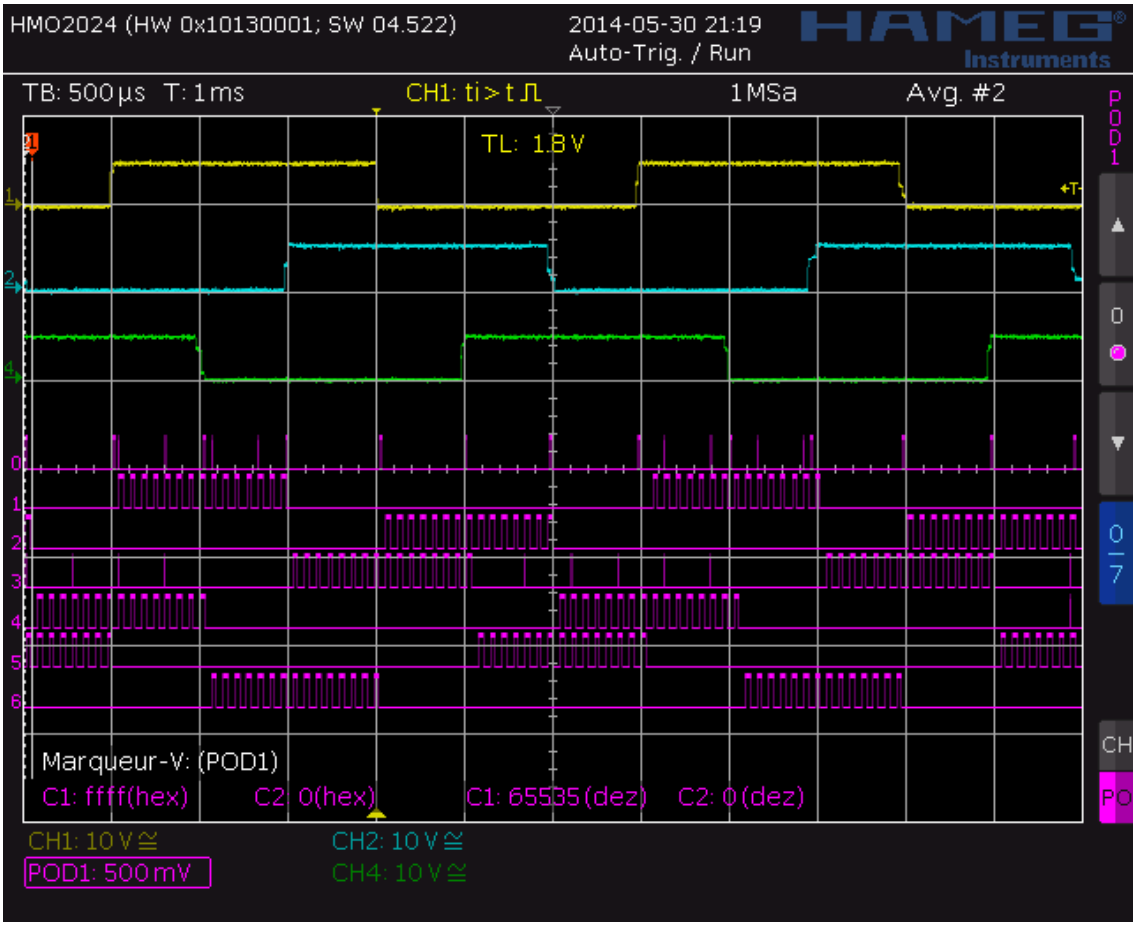
The following notation will be used for the windings voltage:



Clockwise commutation table

	Hall sensors			Switchs						Phases			Windings		
Phase	H3	H2	H1	Q1L	Q1H	Q2L	Q2H	Q3L	Q3H	P1	P2	P3	V_{1-2}	V_{2-3}	V_{3-1}
I	1	0	1	0	1	1	0	0	0	$+V_m$	Gnd	NC	$-V_m$	-	-
II	0	0	1	0	1	0	0	1	0	$+V_m$	NC	Gnd	-	-	$+V_m$
III	0	1	1	0	0	0	1	1	0	NC	$+V_m$	Gnd	-	$-V_m$	-
IV	0	1	0	1	0	0	1	0	0	Gnd	$+V_m$	NC	$+V_m$	-	-
V	1	1	0	1	0	0	0	0	1	Gnd	NC	$+V_m$	-	-	$-V_m$
VI	1	0	0	0	0	1	0	0	1	NC	Gnd	$+V_m$	-	$+V_m$	-

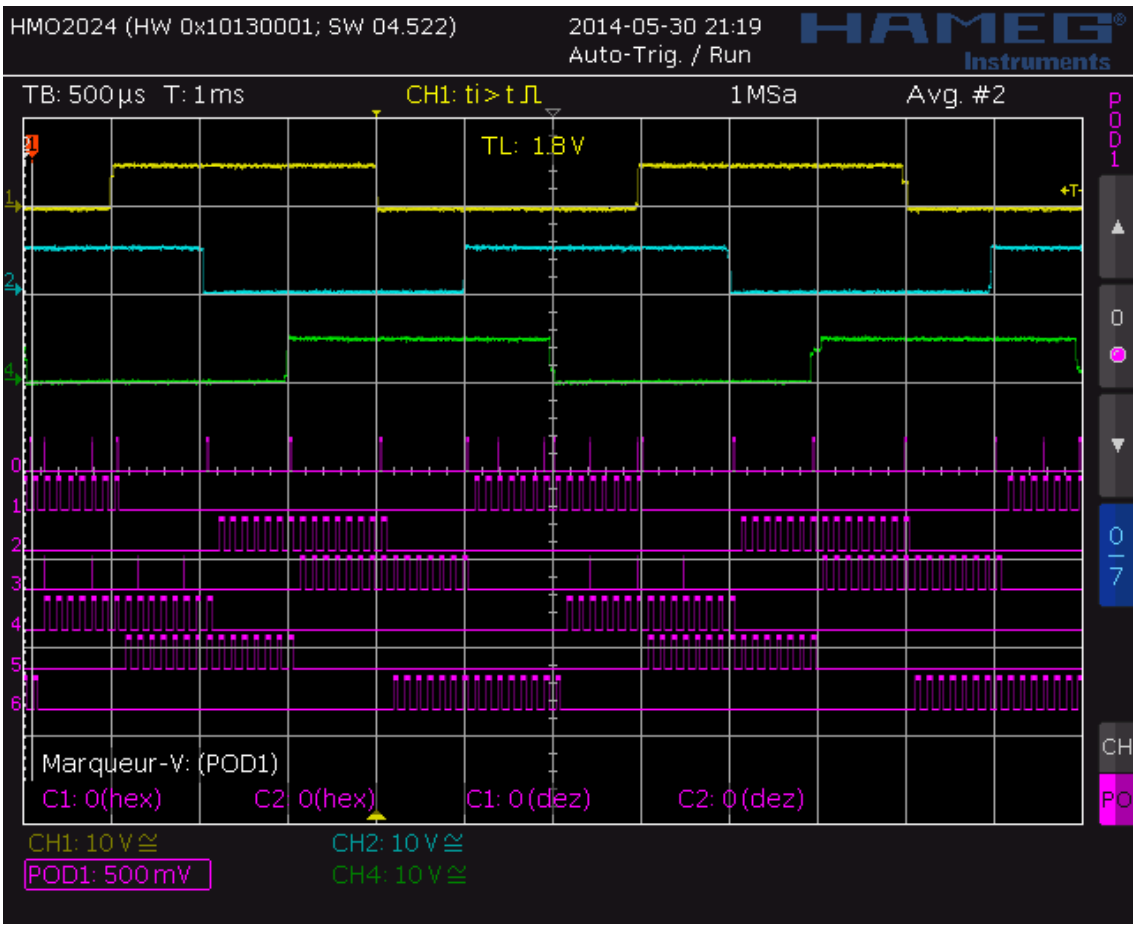
1=Q1H 2=Q1L
3=Q2H 4=Q2L
5=Q3H 6=Q3L



Counter clockwise commutation table

	Hall sensors			Switchs						Phases			Windings		
Phase	H3	H2	H1	Q1L	Q1H	Q2L	Q2H	Q3L	Q3H	P1	P2	P3	V_{1-2}	V_{2-3}	V_{3-1}
VI	1	0	0	0	0	0	1	1	0	NC	$+V_m$	Gnd	-	$-V_m$	-
V	1	1	0	0	1	0	0	1	0	$+V_m$	NC	Gnd	-	-	$+V_m$
IV	0	1	0	0	1	1	0	0	0	$+V_m$	Gnd	NC	$-V_m$	-	-
III	0	1	1	0	0	1	0	0	1	NC	Gnd	$+V_m$	-	$+V_m$	-
II	0	0	1	1	0	0	0	0	1	Gnd	NC	$+V_m$	-	-	$-V_m$
I	1	0	1	1	0	0	1	0	0	Gnd	$+V_m$	NC	$+V_m$	-	-

Same capture as previously for counter clockwise:



5 thoughts on "Commutation sequence for BLDC motors using Hall effect position sensors"

June 2, 2016 at 3:23 pm

sir i want the code of this program. for microcontroller atmega32

ahsan

June 3, 2016 at 8:55 am

It has been developed for ATmega32M1. Have a look at this board :

Philippe
Lucidarme

June 15, 2017 at 4:53 am

Can you tell me when should i use complementary PWMs for high and low legs. Currently you have used one pwm and the permanently LOW.

Learner

June 15, 2017 at 4:55 am

Also what is the frequency of PWM. On what factors should we select this frequency? Please suggest.

Learner

June 15, 2017 at 6:22 am

The frequency selection is dependent of several parameters. If the PWM is under 20KHz, it becomes audible, so F>20KHz. Sometime, increasing the frequency ~100KHz create cross conduction in the transistors. Increase the frequency, but check the power consumption.

Philippe
Lucidarme