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BLDC Motor Control Using Simulink Matlab and PCI

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Abstract – *This paper presents the control of BLDC motor using Simulink Matlab and PCI as interfacing to hardware. The control based on six step method that have certain relations among rotor positions and winding currents. These relations convert to digital functions and simplify using K-Map. The result then implemented by basic digital elements on Simulink Matlab and used to trigger the inverter through PCI interfacing to produce six step waveform. Before feed to inverter, a PWM added to these signal as speed control of BLDC motor. Test experiment results show that the control can produce variable speed, voltage and current.* ***Copyright © 2013 Praise Worthy Prize S.r.l. - All rights reserved.***

Keywords*: BLDC, Control, Karnaugh, Simulink, PCI, Six Step, PWM*

Nomenclature

B	Friction coefficient
B_x	Fux density vector
D	Duty cycle (Ton/T)
E,E_a, E_b,E_c	Back-EMF in winding, in winding A, in winding B, in winding C
H_A, H_B, H_C	Hall A, Hall B, Hall C
I, I_a,I_b, I_c	Motor Current in winding, in winding A, in winding B, in winding C
J	Moment of inertia
L,L_a, L_b,L_c	Self inductance in winding, in winding A, in winding B, in winding C
L_x	Length of the core
N_p	Number of active phases
N_{spp}	Number of slots per pole per phase
N_t	Number of turns per slot per phase
N_t	Number of turns per slot per phase
P	Number of magnet poles
$Q_n,Q_1,Q_2,$ Q_3,D_4, Q_5, Q_6	Inverter switch in n-th, in switch 1, switch 2, switch 3, switch 4, switch 5, switch 6
R,R_a,R_b,R_c	Resistance in winding, in winding A, in winding B, in winding C
R_x	Outer radius of rotor (moment arm)
T_e	Electric Torque
T_F	Friction Torque
T_J	Inertia Tourque
T_L	Load torque
V_s	Voltage supply

Abbreviation

BLDC	Brushless Direct Current
CCW	Counter Clockwise
CW	Clockwise
EMF	Electric Motion Force
K-Map	Karnaugh Map
PCI	Peripheral Component Interconnect
PWM	Pulse Width Modulation

I. Introduction

BLDC motors have many advantages over other types of motors. These advantages are high torque, low maintenance, high efficiency, long life operating, low noise, high density power and high reliability [1].

Due to their properties and the evolution of low-cost power semiconductor switches and permanent magnet materials, BLDC motors are widely used in automotive, robotics, industrial automation equipment, machine tools, medical, instrumentation and so on [1], [2].

In order to produce good performance, BLDC motor require particular control for specific system. Many designs and methods have been created for this purpose. Some of the controls use the Field Programmable Gate Array, Digital Signal Processor, Application Specific Integrated Circuit, and the most is using a microcontroller [3]-[7].

But these controls is not flexible, because it is not possible to change easily, such as exchange PWM frequency, current limitation, type of closed-loop control and others. To solve this problem, this research will be build BLDC motors control using computer, which based on Simulink Matlab and PCI 1711 L interfacing.

This control is expected to gain control system that easily modeled and modified, so that it can be used to obtain the optimal control system, only by changing the software.

This research is a continuation of previous research, which has resulted in digital circuits represent logic functions among the sensor signals to triggers of the inverter [8].

II. BLDC Control Fundamental

II.1. Basic Structure

A BLDC motor is a synchronous electric motor powered by DC power and is electronically

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