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by Rika Favoria Gusa

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Energy Needs in Dynamic Braking on Dahlander Motor

S A Saputro[1], Asmar[1], W Sunanda[1*]
[1]Department of Electrical Engineering, Universitas Bangka Belitung, Indonesia
E-mail: sunandawahri@gmail.com

Abstract. Dahlander motors are using with different speed regulation needs. In this article, dynamic braking is using by injecting a DC voltage to see energy usage at fast and slow rotation. Control of the fast and slow rotation at the control panel using Arduino. The DC voltage variations given are 15 volts, 20 volts, and 24 volts. At a 15 volt DC voltage injection, the energy needed at fast rotation is 0.0018 Wh and at slow rotation 0.00072 Wh. For injection of a 20 volt DC voltage, the energy required for fast rotation at 0.0025 Wh and at 0.00085 Wh for slow rotation. Whereas 24 volt DC voltage injection, the energy needed at 0.0036 Wh for fast rotation and 0.00077 Wh for slow rotation.

1. Introduction

The use of induction motors is increasingly massive in various sectors in supporting human life, including in the industrial sector, transportation sector, household sector, and other sectors increasingly massive [1] due to simple construction; and high levels of reliability but low maintenance [2]. One thing that needs attention is related to the speed regulation on the induction motor [3]. Induction motor speed regulation can be made by adjusting the frequency or number of poles [4]. Induction motor that uses a motor speed regulation uses the number of poles, the dahlander motor. Dahlander motor is an induction motor w two speeds in one motor without using tools other than contactors. There is a coil with two relationships, namely the relationship of stars and deltas , which will affect the formation of the number of polar pairs and motor speed regulation [5].

Research related to the use of induction motors, including 3 phase induction motor voltage 380 Volts to 80 Volts by re-rolling the motor with two speeds of 750 rpm and 1500 rpm [5]. Using dahlander type winding motor as a replacement for two separate sets of windings [6]. The operation of motor induction with regulated frequency and voltage [7] motor analysis and control, including PI Controller, improves the parameters [8]. Study of induction motors using self-tuning PI [9] and by using fuzzy logic [10] compared to conventional PI, induction motor drives using Indirect Field Oriented Control (IFOC) in PSIM environment [11], mathematical modeling [12] of induction motors with SIMULINK [13], mathematical modeling using MATLAB on a Dahlander motor that has a 2-speed setting [14] also electrical motor-driven systems to reduce output power [15]. This research will discuss dynamic braking will be done by injecting DC voltage with various voltage values in fast and slow rotation to see how much electrical energy is needed.

2. Methodology

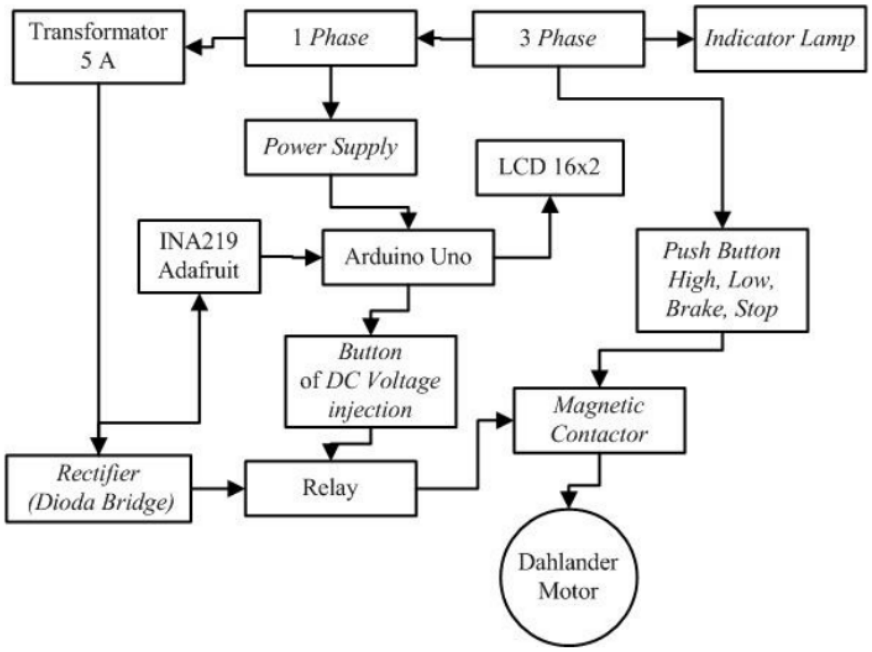


Figure 1. Block diagram of monitoring dynamic braking in Dahlander motor

Figure 1 shows that the 3 phase source used connecting to the indicator light on the box panel, which is an indicator of R, S, and T sources. The 3 phase source is also connected directly to the push button used as a control on the dahlander motor that is *High* for fast rotation, *Low* for slow turns, *Brake* for braking, and *Stop* for turning off the control dahlander motor. Whereas the source used for Arduino from a single-phase source, it is regulated with a power supply to match the voltage required for Arduino Uno to work.

Arduino will be programmed to control the relay with several buttons, used as DC voltage injection options for the braking process. The DC voltage source used in the braking process from a single-phase voltage was reducing with a voltage transformer. For its output rectified with a bridge diode-connected by a relay. This relay will function to provide the DC voltage for the selected braking to the contactor for the braking process. In contrast, the INA219 sensor serves to detect voltage and current in the braking process, which will be read by Arduino, and displayed via a 16x2 LCD.

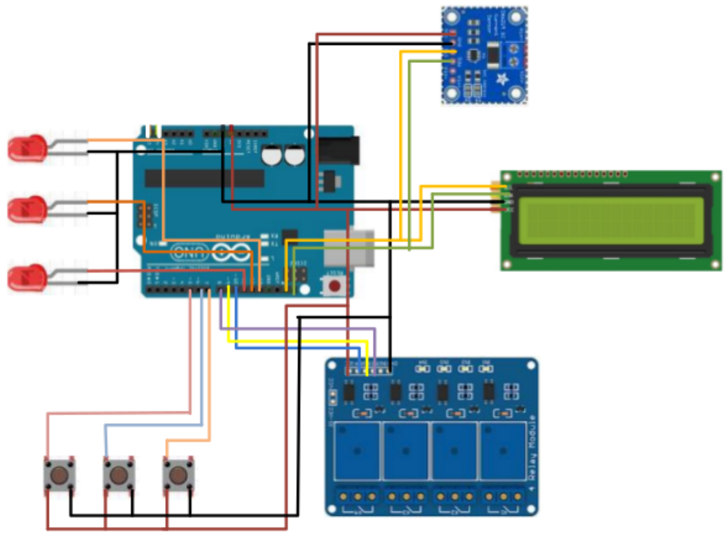
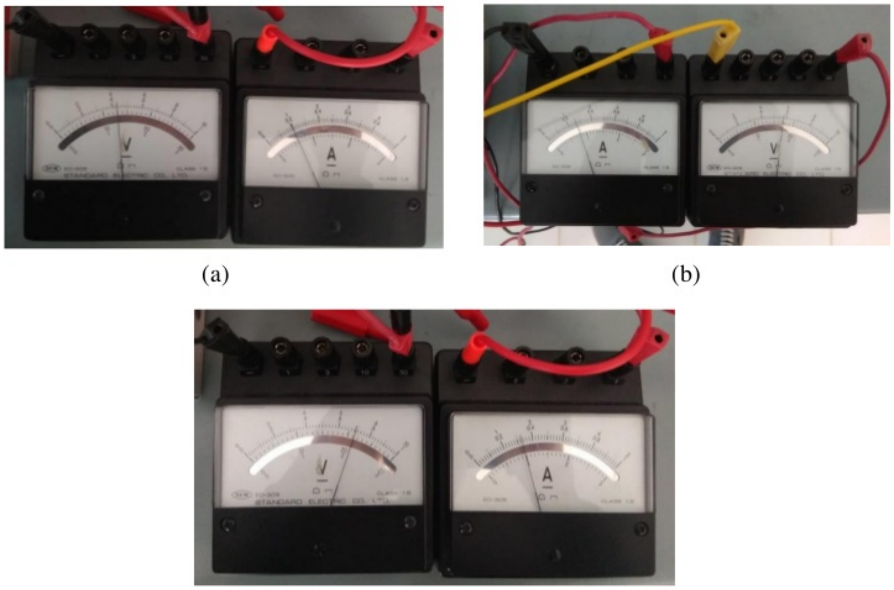


Figure 2. Block diagram of Arduino uno circuit

In the circuit in figure 2, it consists of several components, namely 3 push buttons, 3 LEDs, an INA219 adafruit sensor, 16x2 LCD, 4 channel relay module, and Arduino Uno. The voltage used in this circuit is the source voltage from Arduino 5 V, as the input voltage. There is an adafruit in INA 219 sensor. Adafruit is consisting four pins: namely, Vcc connected to the 5 V voltage source on Arduino, the GND pin is connecting to the Arduino ground source, SCL is connecting to the SCL pin on Arduino, SDA connected to the SDA pin on Arduino. For LCDs used I2C as an additional module to save the use of pins on Arduino. So that only four pins are used: namely, Vcc connected to the 5V source from Arduino, then GND is connected to the ground source from Arduino, SCL pin is connecting to the Arduino SCL pin, and SDA to the SDA pin on Arduino. For the relay module, fou channels will only use three relays to test the variation of input DC voltage on braking used only 3. There are six pins in the relay module, namely Vcc, as input for the 5 V source, then the GND pin, for connecting to the ground from Arduino. Pins In1 are connected to pin 8, In2 on pin 9, and In3 on pin 10 on Arduino. The push-button will use as an input command on Arduino connecting to pins 5, 6, and 7 on Arduino. The Last LEDs will connect to pins 11, 12, and 13 on Arduino.

3. Results and discussion

Braking is testing on a dahlander motor in a no-load condition. The nominal current on the Dahlander motor nameplate used is 0.89 / 1.2 A. The test will be giving 3 different DC voltage inputs; 15 Volts, 20 Volts, and 24 Volts. It is intended that from the test can be known the length of braking time and electrical energy needs on the motor when given a large voltage injection and when the motor is given a smaller voltage injection.



(a) (b)

(c)

Figure 3. Measurement of braking voltage and current at DC voltage
(a) 15 Volt (b) 20 Volt (c) 24 Volt

Figure 3 (a), (b), and (c) shows the current and voltage measured with the injection voltage of 15 Volt, 20 Volt, and 24 Volt, at the input voltage of 15 volts, the voltage drop of 2 volts during the braking process, so that the voltage used during braking is 13 volts and the braking current is 0.2 amperes. In braking with a voltage input of 20 Volt, the measured voltage has a voltage drop of 3 Volts so that the voltage injected in the braking process is 17 Volts, with a braking current of 0.26 Amperes. Whereas for braking with a voltage of 24 Volt, the measured braking voltage also decreases by 3 Volts, so that the voltage injected in the braking process is 21 Volts, and the braking current is 0.33 Ampere.

Table 1. Parameters of Dynamic Braking on Dahlander Motor

DC Voltage (Volt)	**Measured Voltage (Volt)**	**Braking Current (Ampere)**	**Braking Time (Seconds)**		**Energy Needs (Wh)**	
			Fast Rotation	Slow Rotation	Fast Rotation	Slow Rotation
15	13	0,2	2,6	1	0,0018	0,00072
20	17	0,26	2,1	0,7	0,0025	0,00085
24	21	0,33	1,9	0,4	0,0036	0,00077

Table 1 shows that when given a voltage of 15 volts, the energy needed for the motor to stop spinning is 0.0018 Wh when it is spinning fast and 0.00072 Wh when the motor is turning slowly.

When given a 20 volts voltage, the amount of energy needed by the motor is 0.0025 Wh at fast rotation speed and 0,00085 Wh at a slow rotation speed. Whereas when the motor is given a voltage of 24 volts, the energy needed by the motor when it is spinning fast is 0.0036 Wh, and when it is spinning slowly at 0.00077 Wh

4. Conclusion

The greater the DC voltage applied to the braking process, the faster the motor rotation process stops, and electrical energy is needed. On dynamic braking, it also needs to be considered the specifications of the motor used, adjust the DC input voltage and current for braking to match the motor used to avoid damage to the motor.

1

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