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STUDYING OF OPEN LOOP CONTROLLER ON DRIVE SYSTEM

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ABSTRACT

A control system is an interconnection of components shaping a system configuration that will give the required system response. The basis for analysis of a system is the foundation provided by a linear system, which assumes a cause-effect relationship between the components of a system. An open-loop control system uses a controller to gain the desired response. The open-loop control system is used to control the process by an input signal directly without taking benefits of feedback. The open-loop system does not use feedback to determine if the output has achieved the desired target of the input. Hence, the system will not observe the output of the processes that it is controlling. As a result, an open-loop system would not correct any errors that it would happen. The objective of this laboratory procedure was to measure and investigate certain parameters and characteristics about an open loop, alternating current (AC) motor drive system.

KEYWORDS: Open loop system, Power processing unit (PPU), and AC motor drive.

INTRODUCTION

A PPU is used to convert a fixed frequency and voltage to a variable frequency and voltage to apply to the AC induction motor used in this experiment. A power processing unit (PPU), electric machine, one to many sensors, electric loads and feedback controllers are the usual components that make up an electric drive system. These components are used to control the load at variable revolutions per minute [1]. In this experiment, an induction machine is employed. Since the voltage and the frequency that the machine operates at are proportional, the variable frequency supplied by the PPU lets the machine operate at variable speeds. The PPU is considered a volt per hertz converter when used as such in this application. The speed of the induction machine is proportional to the frequency, but an increased load torque will decrease the speed of the machine [2]. The motor was mechanically coupled to a dynamometer that allowed for variable load torque by modulating the field current. The PPU in this application is a three-phase AC motor control. The PPU will take in voltage at a fixed frequency and convert to a variable voltage and variable frequency using pulse width modulation (PWM) [3].

PROCEDURE

In the experiment, the V/Hz drive power-processing unit (PPU) was linked to a power source and the AC induction motor. Setting configuration mode to open loop, Setting motor control principle to U/f or volts per hertz, and Setting the DC controller to torque control were setting from (Danfoss) operation manual. Moreover, the LEM current sensor is used for this experiment instead of the typical current probe. The output of the AC induction motor was connected to a dynamometer armature with a DC controller. The DC controller used to modulate the field current and armature voltage in the dynamometer. Next, keeping the DC controller turned (Off) to operate the (V/Hz) drive at our specific group's frequency. After that, turning the DC control (On) and slowly increasing the torque to apply the rated current field to the DC machine is continued until rated torque is obtained. A Fast Fourier Transform performed by using an oscilloscope attached to the voltage and current output of the PPU. Voltage and current waveforms of the PWM drive were measured and captured using an oscilloscope. The RMS voltage and the

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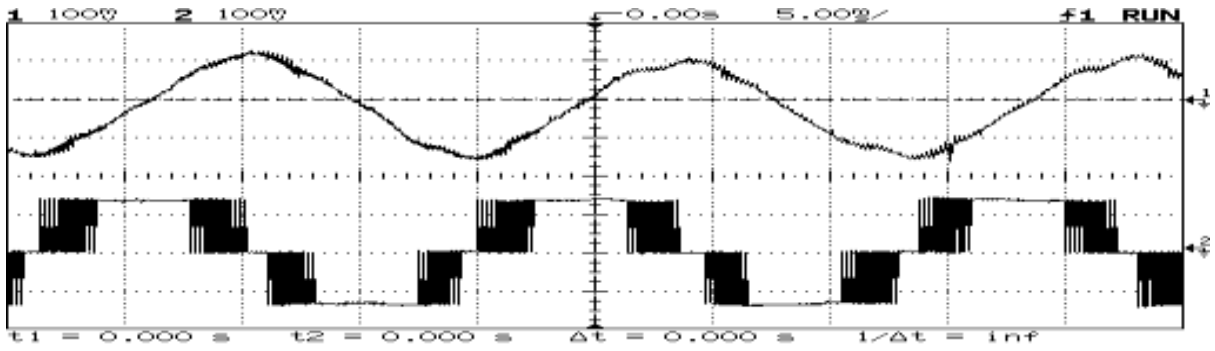
frequency spectra were captured as well. Lastly, the speed torque characteristics for the induction machine was measured from the minimum load to the rated load while the frequency operated at the group specific speed.

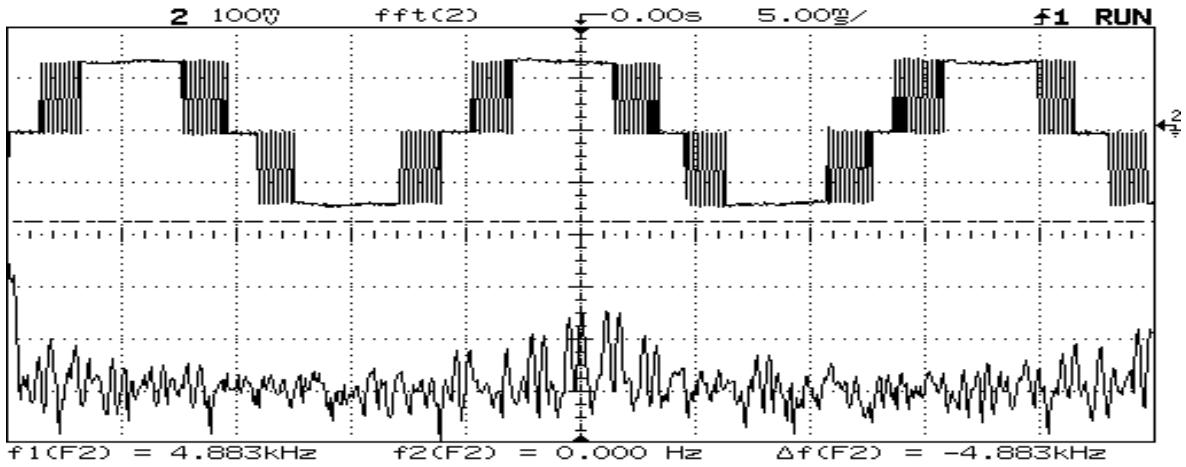
DISCUSION



Voltage and current waveforms.

As it can be noticed that the voltage and the current waveforms were obtained on the oscilloscope, and the current waveform was more sinusoidal in shape than the voltage waveform, which was nearly pulsed waveform with some distortions. It was because of the three-phase flux induced in the rotor winding which induces the voltage.

- Voltage spectra



Voltage wide

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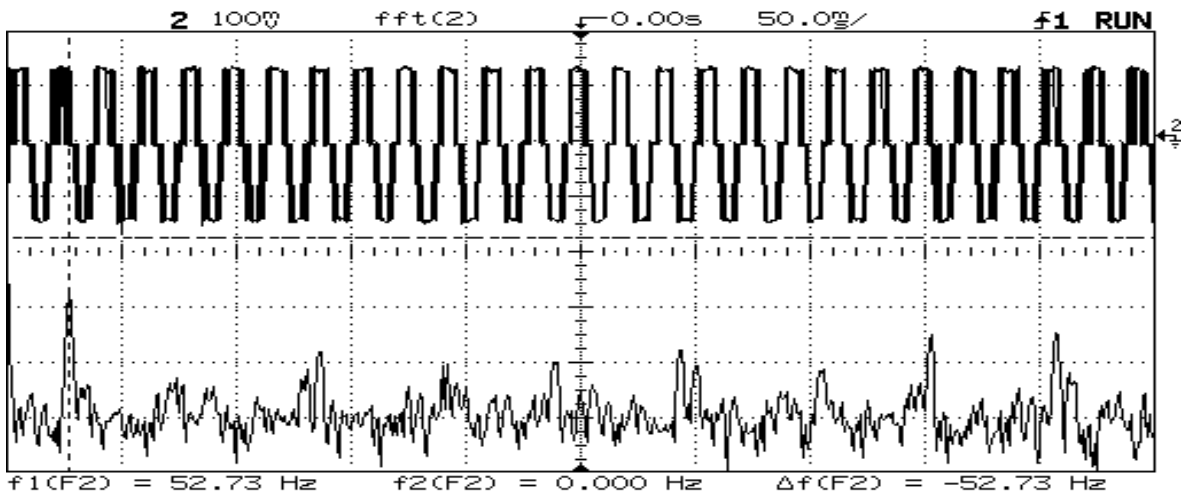
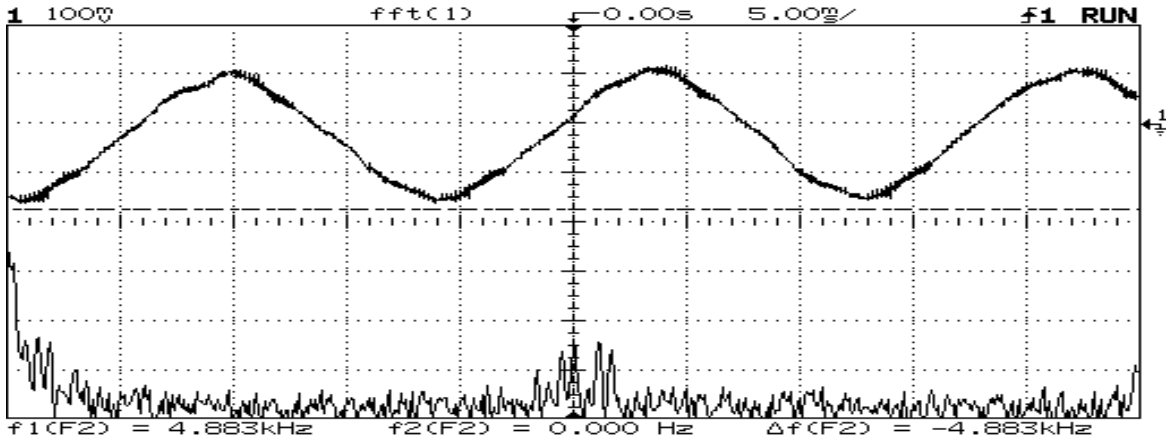


Voltage details

As it can be seen above from the voltage spectra pictures that the voltage waveforms were captured in terms of (FFT) analysis. The voltage waveform contained the most switching frequency harmonic compare to the current waveforms that had less harmonic distortions. The harmonic of the voltage waveform was about 5KHz. The 5 KHz was harmonious with the switching frequency of the power-processing unit.

- Current spectra



Current wide band

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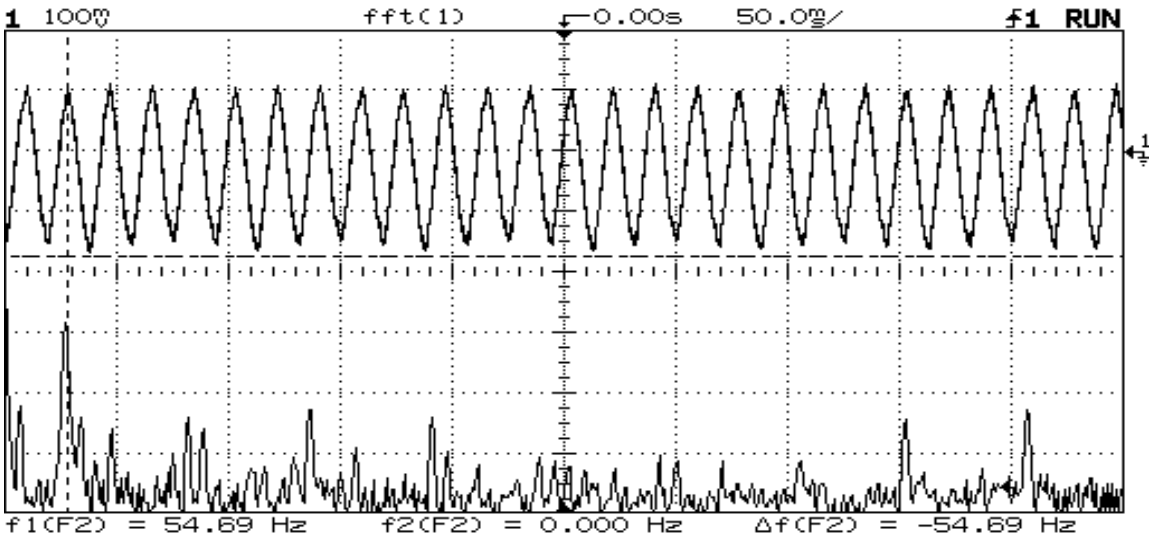

Current details

RESULTS

The RMS values of voltage and current are found to be as 0.108608 and 0.08982 respectively. The RMS voltage=0.108608 *200*10=217.216 V_{rms}

Rated power of the machine =1/3 Hp

= (1/3)*746=248.66 Watts

The desired motor speed was observed after applying the PPU settings without load on the AC motor. The set motor speed was 1650 RPM, and the speed measured from the equation

(F =1800-50*4) was 1600 RPM. Now, w = (2*3.14*1600)/60=167.55 rad/sec . The rated motor torque was determined to be 1.48 Nm. (T = P/w =248.66/167.55= 1.48 Nm).

Rated field current is applied to the DC machine and set it to the rated torque.

The below table represents the speed values for different torque values

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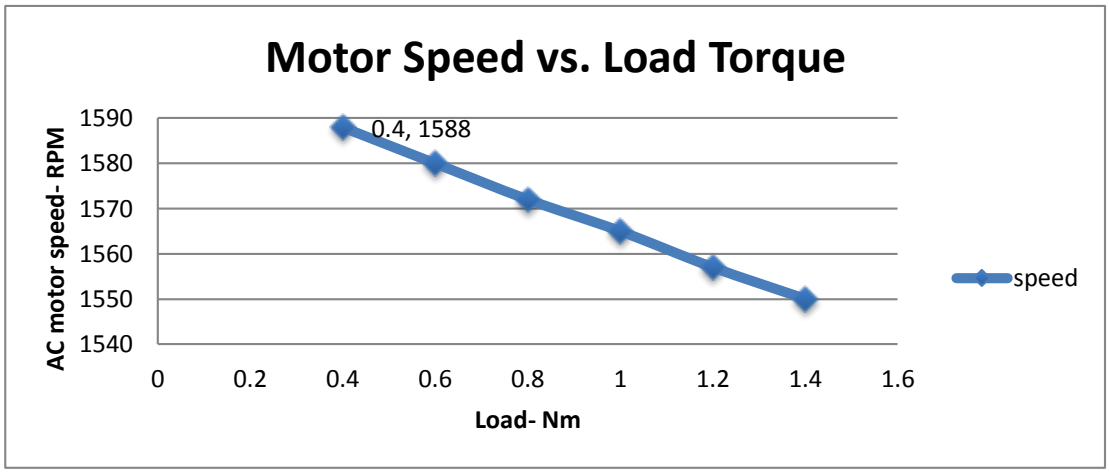
Torque(T)	Speed(N)
1.4	1550
1.2	1557
1.0	1565
0.8	1572
0.6	1580
0.4	1588

Percentage speed drop= ((1588-1550)/1550)*100 =2.45 %

We can observe from the above calculations that speed does not change much with the torque.



Plot of AC motor speed with respect to load torque applied.

CONCLUSIONS

A PPU was able to convert a fixed frequency and voltage to a variable frequency and voltage to apply to the AC induction motor. Moreover, the velocity of the AC motor with V/Hz relationship was modulated by the power-processing unit. The drop in the motor speed obtained at less than 3% of the synchronous speed. The voltage output waveform from the PPU was found to contain the switching frequency harmonic over the output waveform, while the current waveform contained significantly less harmonics.

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