Speed Drive Variable Three-Phase Motor

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Abstract: *The present document is an approach to build a speed regulator. Generally, the regulators are used in high power applications as induction motors of industrial base. The objective of the project is to reduce the speed of the motor so that the transportation of the material is the one that the operator of the machine needs, thus by providing a model of efficient regulator. Here the three-phase regulator is formed by three lines and a neutral line, which are interconnected with a microcontroller. This project will be based on the existing electronic design technology, to build an electrical circuit that is capable of increasing or decreasing the speed of a 5-hp three-phase motor, depending on how the operator requires it. For the success of this project we will rely on diagrams that were extracted from articles that were used in our research. This circuit will be controlled by the Arduino board, which will have a digital programming according to the engine, we will also use a screen to the speed controller in which it will show to what power our motor is turning.*

Keywords: three-phase, regulator, diameter, variable

1. Introduction

Electric motors have become an important part of human life. [1] The simple fact of converting electrical energy into mechanical energy brings with it loads of applications and facilities [2].

From everyday things, from opening the electric gate, to movement the bands in an industrial level production plant. The management and control of the various types of engines have allowed industries to improve and optimize their processes [3]. For this reason and more, this project intended to perform the design and implementation of a control system that allows the management of the speed of an AC motor [5]. This control will be carried out by programming electronic power. To do this, we will investigate the characteristics of the operation of a DC motor. Motors are widely used in modern industry, especially in electric motors, this due to their good performance characteristics and low pollution (an aspect that is taken into account in our days). In addition, these engines usually work at variable speeds to obtain maximum productivity all the time, as well as significant energy saving. Therefore, it is necessary a rigorous control of the speed for this type of machines, among which include conveyor belts, pumps, fans, elevators [4].

Electric motors are manufactured in various powers from fractional low voltage to high power at high voltages in alternating current and direct current.

These motors can be classified in different ways, but the one that must be applied for practical purposes considers the following characteristics (power) type of application, electrical characteristics, starting, speed control and torque characteristics. Other elements are the type of mechanical protection and the cooling method.

2. Objective

To build a programmable electrical circuit to control the power of a three-phase motor by means of a microcontroller interconnected with a potentiometer and a screen to observe the total power of the motor.

2.1 Specific objectives

- To build a circuit based on relays that controls the speed of the induction motor.
- To design the structure and the arrangement of the control circuit of the project to put it next to the required machine.
- To program the controller to modify the speed with a potentiometer.
- To build a 220v - 12v power supply.
- To display the motor power through an LCD screen

3. Description of the problem

Generally, the problem of the market speed regulators is that they are not programmed with Arduino, these regulators have some printed plates and these can't be programmed to our need, they simply do their operation according to the motor, that is to say for each motor or centrifugal pump each one needs to have its own regulator device.

These speed regulators for three-phase motors come very robust and they are very expensive, both for purchase and spare parts if needed.
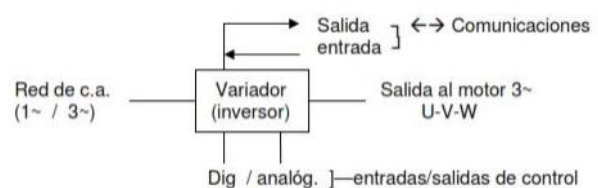

Figure 1: Speed variator

4. What is an induction motor?

It is a type of AC motor. All induction motors are formed by a rotor and a stator. The rotor can be of two types, squirrel cage or winding, and in the stator are the inductor coils [6]. Its operating principle is based on electromagnetic induction and was designed by engineer Nikola Tesla.

Figure 2: Induction motor

4.1 Connections box

In most cases, electric motors have a junction box. The connection box is an element that protects the drivers that feed the engine, protecting themselves from its mechanical operation, and against any element that could damage them [7].
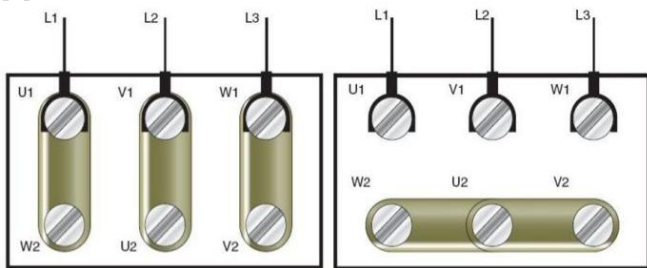

Figure 3: Connections box

4.2 Speed regulation

Synchronous three-phase there are two ways to vary the speed, one is varying the frequency by a special electronic equipment and the other is varying the polarity thanks to the design of the motor. The latter is possible in the separate winding motors, or the Dahlander connection motors but it is only possible to have a limited polarity change eg: 2 poles and 4 [8]. The industrial machinery is generally driven through electric motors, at constant speeds or variables, but with precise values. However, electric motors generally operate at a constant or almost constant speed, and with values that depend on the power supply and on the characteristics of the motor, which cannot be easily modified [9].

In order to regulate the speed of the motors, a special controller called the variable speed drive is used [10]. Variable speed drives are used in a wide range of industrial applications, A speed variator can consist of the combination of an electric motor and the controller that is used to regulate the speed of the same [11]. The combination of a constant speed motor and a mechanical device that allows to change the speed continuously (without being a stepper motor) can also be designated as a speed variator.

5. Types of Drives

5.1 Mechanical variators

- Adjustable pitch variator: this device uses pulleys and belts in which the diameter of one or more pulleys can be modified [12].
- Drive variator: transmits power through metal rollers. The ratio of input / output speeds is adjusted by moving the rollers to change the contact areas between them and thus the transmission ratio [13].

5.2 Electric-electronic variators

- Variators for DC motors.
- Speed drives by Eddy currents.
- Sliding drives.
- Variators for AC motors (also known as frequency inverters) [14].

5.3 Frequency inverters

The frequency variator devices operate on the principle that the synchronous speed of an alternating current (AC) [15], motor is determined by the supplied AC frequency and the number of poles in the stator, according to the relationship: [16].

$$RPM = 120 \times f/p$$

Where
RPM = Revolutions per minute
f = frequency of AC supply
p = Number of poles
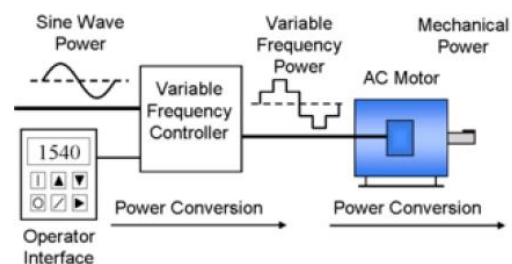
Mechanical Power: Power = Force x Speed

6. Gratefulness

7. Conclusions

The project was successfully achieved despite the fact that there was no information about the operation or programming, with the help of the books and articles consulted it was possible to obtain information about the connection of the engine, this project is also of great impact for the market for being more economical and can be used in any other engine that does not exceed 5 hp.

8. Results

The following project was obtained as a result to vary the speed of the three-phase motor 220v to increase and decrease the speed in an appropriate manner as the operator requires.

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