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# Enhance Control System and Monitoring Based on Star Delta Method

Eddy Sutejo
Faculty Science and Technology, Universitas Pembangunan Panca Budi, Medan, North Sumatera, Indonesia

***Abstract***— *The control system on a 3-phase motor is essential because a 3-phase induction motor requires maintenance in its use. This is related to maintaining the age of the 3 Phase motor so that it is longer and more economical. The purpose of the research conducted by the researcher is to monitor the work of the 3-phase engine using the star-to-delta method using the ATmega16 microcontroller as a reader for changes from the star-to-delta process, which is displayed on the LCD (Liquid crystal display). The shift from star to delta method uses auto mode, which can set the transfer time using TDR (Timer Delay Relay). The results of the tests showed that the monitoring and starting system that has been designed could run as expected.*

***Keywords***— *Monitoring, 3-Phase Motor, Microcontroller, Star and Delta Methods.*

## I. INTRODUCTION

The rapid development of human needs now is not only in terms of basic needs but also in terms of technology and machinery, especially in the industrial sector, to support the ease of managing a company's performance (Leevijit et al., 2017). In large and small industrial companies, many use induction motors, namely three-phase induction motors, because of the immense power available, the construction is solid and easy to operate, inexpensive maintenance, besides that the motor also provides good efficiency and constant rotation for each load change and speed stability compared to other types of motors (solly Aryza, 2017). Other motorcycles. For this motor to work correctly, it must be protected by a reliable safety system and operated by the manufacturer's provisions (Rossanty et al., 2018).

Three-phase electric motors have prominent initial current characteristics. Still, they can be overcome by a star (Y)-triangle (Δ) starting system, where this system is straightforward and can be applied to all types of three-phase electric motors. This means the application of daily needs. And induction motors are not only needed in the industrial world but in lectures, not only lectures in theory but also lectures in practical form. Especially in engineering faculties such as electrical engineering, there are lots of practicum courses, And this research can add tools for practical work in the electrical laboratory (Non et al., 2020).

Therefore, based on this, this research aims to create a valuable tool for controlling and monitoring the installation of a three-phase induction motor. This tool is straightforward to use as a practical tool for installing three-phase induction motors. In this research, the design is discussed and studied to make a valuable tool for controlling and monitoring three-phase motors for star delta connections and practical tools for controlling three-phase motors for other controller relationships (Wahjono, 2015). The practicum tools can be used for practicum courses in the electrical machinery laboratory. This valuable tool is helpful for students in learning practical methods on three-phase motor installations to find out how to control and monitor star delta in three-phase motor installations that are easier to detect faults quickly and secure more efficiently.

## II. LITERATURE REVIEW

### *2.1 Motor*

Electric Motor An electric motor is a device for converting electrical energy into mechanical energy. Likewise, the opposite, a tool to convert mechanical energy into electrical energy is usually called a generator or dynamo (A. H. Lubis, 2018). In an electric motor, electric power is converted into mechanical energy. This change is done by converting electric power into a magnet known as an electromagnet, as we know that the poles of like magnets repel and different poles attract each other (Dey et al., 2008). With this process, we can get motion if we place an appeal on a rotating axis and another interest in a fixed position. (I Nyoman Bagia & I Made Parsa Print 1, 2018) An electric motor is an electromagnetic device that converts electrical energy into mechanical energy.

This mechanical energy is used to, for example, rotate a pump impeller, fan, or blower, drive a compressor, lift materials, etc. Electric motors are also used in homes (mixers, electric drills, wind fans) and industry. Electric motors are sometimes called the "workhorse" of industry because it is estimated that they use about 70% of the industry's total electrical load (S. A. Lubis et al., 2015).

### *2.2. The Working Mechanism*

For all types of electric motors is generally the same as the picture above.

1.Electric current in a magnetic field will provide a force.
2.The wire that carries a current is bent into a circle or often called a loop, then both sides of the existing loop at right angles to the magnetic field, will get a force in the opposite direction
3. The pair of forces produces rotary power or commonly called torque, to rotate the existing coil
4. The motor has several loops on the dynamo to provide a more uniform rotating power
5. The magnetic field is generated by an electromagnetic array called the field coil.

### *2.3. Functions and Uses of Electric Motors*

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Electric motors can be found in household appliances such as fans, washing machines, blenders, water pumps, mixers, and vacuum cleaners. For electric motors used for work (industry) or in the field, such as electric drills, grinders, blowers, moving compressors, lifting materials, etc. In understanding a motor, it is essential to understand what the motor load means. Load refers to the output torque/torque according to the required speed. Bags can generally be categorized into three groups (BEE India, 2004):

1. A constant torque load is a load where the demand for energy output varies with the operating speed, but the torque does not change. Examples of gears with constant torque are conveyors, rotary kilns, and continuous displacement pumps.
2. A load with variable torque is a load with a torque that varies with the operating speed. Examples of gears with variable torque are centrifugal pumps and fans (torque varies as the speed square).
3. A constant energy load is a load with a torque demand that changes and is inversely proportional to speed. Examples of loads with continuous power are machine tools.

### *2.4. Three-Phase Induction Motor*

A three-phase induction motor is an alternating current electric motor with two main parts: the stator, the stationary part, and the rotor, the rotating part. In the rotation of the rotor with the stator field, there is a difference in a slipped cycle. The stator and the rotor are separated by a narrow air gap, with a distance ranging from 0.4 mm to 4 mm.

The type of three-phase induction motor based on the windings in the rotor is divided into two types, namely the wound rotor (wound rotor) is a type of induction motor that has a rotor made of the same winding as the stator winding and a squirrel-cage rotor, which is a type of induction motor where the rotor construction is composed of several metal bars that are inserted through the slots in the induction motor rotor. Each part is united by a ring to make the metal bar short-circuited with another metal bar. If a 3-phase voltage source is attached to the stator coil, a rotating field will arise with speed like the following formula

$$Ns = 120\ f/P$$

Ns = Speed Rotate
f = Frequency
P = Pole Motor

The rotating field of the stator will cut the conductor rods on the rotor. As a result, on the conductor rod of the rotor, there will be an induced emf. Because the conductor rod is a closed circuit, the emf will produce a current (I). The presence of current (I) in the magnetic field will cause a force (F) on the rotor. If the initial coupling generated by force (F) on the rotor is large enough to support the load coupling, the rotor will rotate in the direction of the stator rotating field. The induced emf arises because the stator's rotating field cuts the conductor rod (rotor).

This means that for the induced emf to occur, it is necessary to have a relative difference between the speed of the stator rotating field (ns) and the rotational speed of the rotor (nr). Starting is a method of connecting coils in a 3-phase motor

## III. METHOD

In the research procedure, several testing steps will be carried out to find out how the circuit of the Electric Motor monitoring and control system using the Star Delta method will be carried out. A more detailed explanation of the research methodology The design of the Electric Motor monitoring and control system with the Star Delta method is divided into two parts, namely hardware design and design. software. Hardware design is divided into control system design, input unit design, and output unit design. While the software design consists of designing the display program on the LCD.

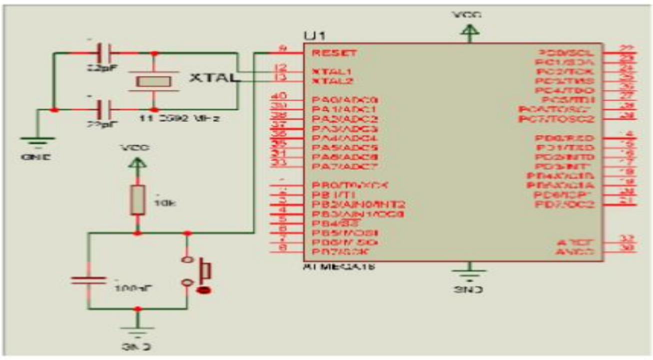


Figure 1. wiring System

The minimum system circuit is the minimum circuit where the microcontroller chip can work (running). The Atmega AVR chip is equipped with an internal oscillator, so to save costs, there is no need to use an external crystal/resonator for the CPU clock source. Several components are needed to make a minimum system circuit: 1. ATMega162.3 microcontroller IC, paper capacitor, which is 22 pF (C2). And C3) and 100 nF(C4)3.1 electrolytic capacitor 4.7 uF (cl2) 2 resistors, namely 100 ohms (R1) and 10 Kohm (R3)4.1 pushbutton reset button (PB1) Program memory is PEROM Flash memory which is in charge of storing programs (software) which we make in the form of program codes (containing the address along with the program code in the address memory space) which we compile in the form of hex or binary numbers.

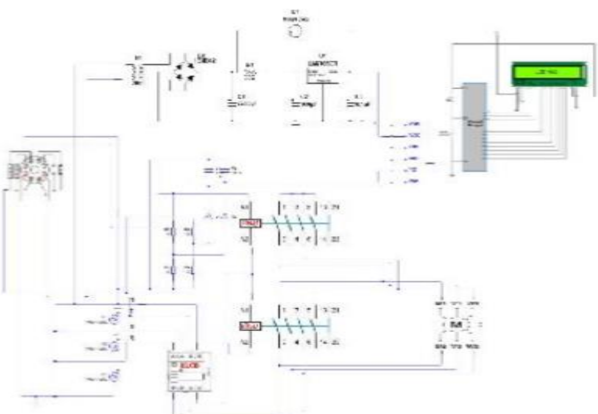

Figure 2. Wiring Schematic Full System

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## IV. Result

In this stage the author uses the formula for calculating engine power without a load and measuring current on a machine without a load when using the start delta method and not using the start delta method. As a comparison material, the author calculates using the following formula

P = V x I x Cos θ x √3

Where:

P = Power On Motor

V = Voltage On Motor

√3 = The number of phases on the motor

P = V x I x Cos θ x √3

11000 = 380 x I x 0,8 x √3

I = P / V x Cos θ x √3

I = 11000 / 380 x 0,8 x 1,73

I = 11000 / 526

I = 20,91 A

Then the engine speed without load if it does not use the start delta method, the current is 20.91 A. Then the author takes measurements using a measuring instrument on a no-load machine.

Figure 3. Three Phase Motor Measurement No Load

TABLE 1. Measurement Results of 3 Phase Motor Without Load

| Motor | Counting Using Formulas | Counting Using Measuring Tools | Error |
|---|---|---|---|
| 380 / 50 Hz | 20,91 A | 38,8 A | 17,89 A |

Star = In / 3

= 20,91 / 3

= 6,97 A

Delta = In / √3

= 20,91 / 1,73

= 12,08 A

So if the engine without a load uses the start delta method, the initial current that can be obtained on the motor is 6.97 A and then moves to the delta method of 12.08 A. Then the author uses a measuring instrument on a machine without a load.

Figure 4. When the Star of the program language results

```
$regfile = ""m16.def.dat"
Config Portb = Input
Config Portc = Output
Config Portd = Output
Config Lcd = 16 * 2
Config Lcdpin = Pin , Db4 = Portd.4 , Db5 = Portd.5 , Db6 =
Portd.6 , Db7 = Portd.7
, E = Portd.3 , Rs = Portd.2
Cursor Off
Starting Alias Pind.6
Delta Alias Pind.7
Rangkaian
Star
Rangkaian
Delta
LCD
Motor Listrik
Kontaktor 1
Kontactor 2
Relay Timer
65
Portb = &B11111111
Portc = &B11111111
Do
If Starting = 0 Then
Cls
Lcd "STAR"
Waitms 500
Else
Cls
End If
If Delta = 0 Then
Cls
Lcd "DELTA"
Waitms 500
Else
Cls
End If
Loop
```

## V. Conclusion

So after the tests carried out by the author, the following conclusions were obtained: 1. With the presence of a 3-phase motor using the star and delta method, it will extend the life of the motor because the motor does not immediately rotate at a high current at the beginning of the motor running 2. LCD on the electric motor circuit 3 phase using the star delta method is handy for knowing the transfer of star to delta 3. Timer relay is helpful as a pause in transferring the star to the delta method. 4. The current of a 3-phase electric motor using the start delta method is lower in current than not using the star delta method 5. The calculation results using the formula to find the current of a 3-phase electric motor without a load is 20.91 A6. The measurement results using a tool to find the current of a 3-phase electric motor without a bag is 38.8 A7. Errors or losses that occur using formula calculations and measuring instruments equal to 17.89 A8. From the results of analyses using the formula for the current at the star, it is 6.97A

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