Jurnal E-Komtek
Vol. 8 No. 2 (2024) pp. 267-274
https://jurnal.politeknik-kebumen.ac.id/index.php/E-KOMTEK
p-ISSN : 2580-3719 e-ISSN : 2622-3066

Prototype Design of Delta Wye Starting System for Laboratory-based 3-Phase Induction Motor

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https://doi.org/10.37339/e-komtek.v8i2.1946

Published by Politeknik Piksi Ganesha Indonesia

Artikel Info
Submitted:
21-08-2024
Revised:
23-12-2024
Accepted:
23-12-2024
Online first :
23-12-2024

Abstract

Electric motors with electromagnetic devices that convert electrical energy into mechanical energy, so it can be that electric motors are included in the category of dynamic electric machines. The research aims to find out the design of the circuit form prototype from wye-delta, how to replace the system control circuit starting wye-delta, and obtain a significant result measuring the flowing current of the 3-phase induction motor when the motor starts the motor running. The method used in another study of literature is to design and test tools and data retrieval. The system test results are compelling, obtained, digging, initial current, electric motor with value, with the acquisition of measurement results when using the wye system on R, S, and T phase each 0,6 ampere, 0,8 ampere, and 0,6 ampere. When using the delta system on the R phase of 7,5 ampere, S phase of 8,5 ampere, and T phase of 8,3 ampere. Prototypes from these tools operate with a controller system, using a tool called a semiautomatic control system, with an electromagnetic working principle where the primary function of the contactor is a magnetic switch.

Keywords: *Electric Motors, Starting Wye Delta, Electric Current.*

Abstrak

Motor listrik dengan perangkat elektromagnetiknya bekerja mengubah energi listrik menjadi energi mekanik, sehingga dapat dikatakan bahwa motor listrik termasuk mesin listrik dinamis. Penelitian ini dimaksudkan dapat mengetahui desain prototype dari rangkaian, cara mengoperasikan sistem pengendali pada rangkaian starting wye delta untuk motor induksi tiga phasa, dan mengetahui jumlah total dari pengukuran hasil pengasutan motor induksi tiga phasa motor mulai start sampai pada motor bekerja. Menggunakan metode studi literatur dan kemudian melakukan perancangan dan pengujian alat, serta pengambilan data hasil pengukuran. Diperoleh kesimpulan bahwa dengan menggunakan rangkaian sistem *wye delta* dapat mengendalikan tingginya pengasutan arus *starting* awal, dengan perolehan hasil pengukuran saat menggunakan hubung *wye* pada phasa R, S, dan T masing - masing 0,6 ampere, 0,8 ampere, dan 0,6 ampere. Sedangkan saat menggunakan hubung *delta* pada phasa R sebesar 7,5 ampere, phasa S sebesar 8,5 ampere dan phasa T sebesar 8,3 ampere. *Prototype* dari alat ini beroperasi dengan sistem pengendali, menggunakan alat yang disebut sistem kontrol semiotomatis, dengan prinsip kerja elektromagnetik dimana fungsi utama kontaktor sebagai saklar magnetis.

Kata-kata kunci: Motor Listrik, *Starting Delta Wye*, Arus Listrik.

1. Introduction

The classification of induction motors is divided into two (2) parts: single-phase induction motors and three-phase induction motors. The three-phase electric motor is the superior type in every company and industry due to its high-power capacity, both from technical and economic perspectives.

Electric motors are categorized into direct current (DC) motors and alternating current (AC) motors. AC electric motors can be synchronous or induction motors [1]. The previous research [10] explained a simple and accessible star (Y)-delta multi-system (Δ) drive system. The results and discussion of this research indicate the design of a control system with several buttons, such as start, delta, and off. The realization of this system showed that when the delta button is pressed, the motor's rotation speed increases. In conclusion, these buttons can control the speed of the induction motor from minimum to maximum. However, [11] suggests that the system should be able to gradually control the voltage and current entering the motor according to the desired settings.

Therefore, we have designed a delta-wye starting system prototype for a three-phase induction motor at the Electrical Engineering Laboratory of Muhammadiyah University of Makassar. This system is expected to help students conduct practical exercises and reduce the inrush current when the motor starts operating. This research also develops a control and protection system for the three-phase induction motor delta-wye starting. This system is helpful in case of a surge during the initial starting of the delta-wye induction motor, which could cause a disturbance or an abnormal condition, ensuring that this does not affect the system [2].

2. Method

The mechanism and procedure of this research are as follows.

a. Create a list of tools and materials, then prepare them.

b. Study the design of the delta-wye starting prototype for a three-phase induction motor, including the data that will be obtained.

c. Design the circuit that will be used.

d. Design (assembly) the delta-wye starting system.

e. Test the designed equipment's control circuit with a single-phase power source.

f. Test the system using a three-phase electric motor and measure the current flowing through each phase (R, S, and T).

g. Finishing stage: tidy up the equipment.

h. Perform calculations and data analysis.

i. Data processing.

j. Make revisions if there are errors in the data processing.

Research flow diagram can be seen on **Figure 1.**

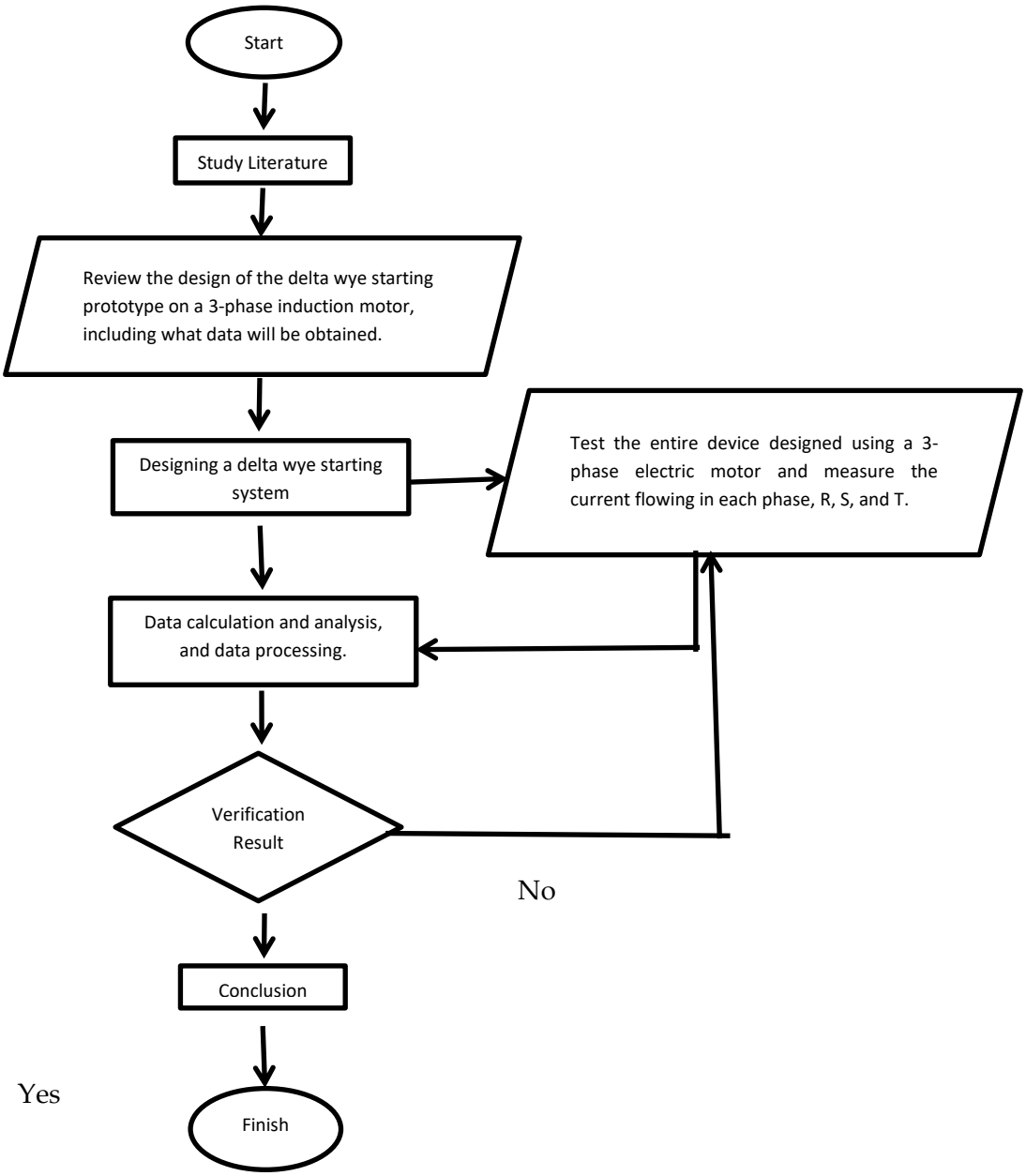

Figure 1. Research Flow Diagram

3. Results and Discussion

3.1 Wiring Diagram of the Research.

a. Power Circuit

Power circuit design results can be seen in **Figure 2**.

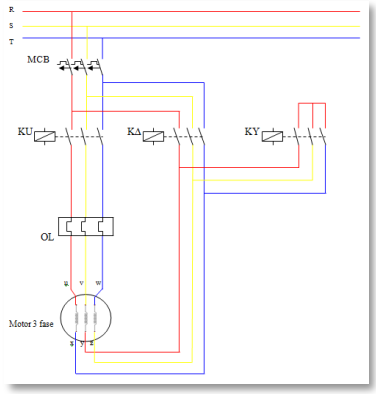

Figure 2. Power Circuit Design Results

Control circuit design results can be seen in **Figure 3**.

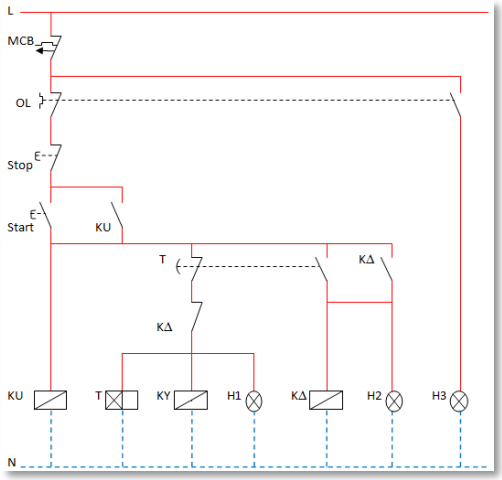

Figure 3. Control Circuit Design Results

3.2. Results

We can see the results of designing and operating the wye-delta starting system circuit for a three-phase induction motor.

1.1 Results of Line-to-Neutral Voltage Measurements

Preparing the tools and materials needed to measure voltage, such as an ammeter or clamp meter, is essential. Set the selector switch to the 600 V AC measurement range, then connect the probes to the voltage terminals of phases R, S, and T to be measured in parallel with the negative terminal. The red probe should be connected to the positive terminal of phase

R, S, or T, and the black probe to the negative terminal. Results of line-to-neutral voltage measurements are **Table 1.**

Table 1. Results of Line-to-Neutral Voltage Measurements

Tegangan Line - neutral	Jumlah Tegangan (Volt)
R – 0	227
S – 0	226
T - 0	228

Table 1 is the results of the measurements from phase R to neutral, phase S to neutral, and phase T to neutral are 227 V, 226 V, and 228 V, respectively. Please refer to the following diagram presented on **Figure 4**.

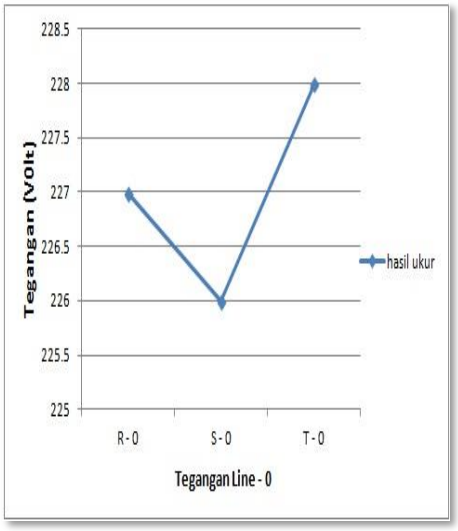

Figure 4. Line-to-Neutral Voltage Measurement Graph

The graph in Figure 4 above illustrates the fluctuating measurement results, showing an unpredictable rise and fall in voltage from high to low and then back to high for the voltages of phases R, S, and T.

1.2 Results of Line-to-Line Voltage Measurements

First, prepare the ammeter or clamp meter to measure the line-to-line voltage. Set the selector switch to the 600V AC measurement range. Then, the probes are connected to the voltage terminals of phases R-S, R-T, and S-T to be measured in parallel. The red probe should be connected to the positive terminal of phases R, S, or T, and the black probe should be measured to one of the phase terminals. Results of line-to-line voltage measurements are **Table 2.**

Table 2. Results of Line-to-Line Voltage Measurements

Tegangan Line - Line	Jumlah Tegangan (Volt)
R – S	400
R – T	396
S - T	397

Table 2 above shows that the line-to-line voltage measurement between phase R and phase S is 400 V, between phase R and phase T is 396 V, and between phase S and phase T is 397 V. Please refer to the following graph.

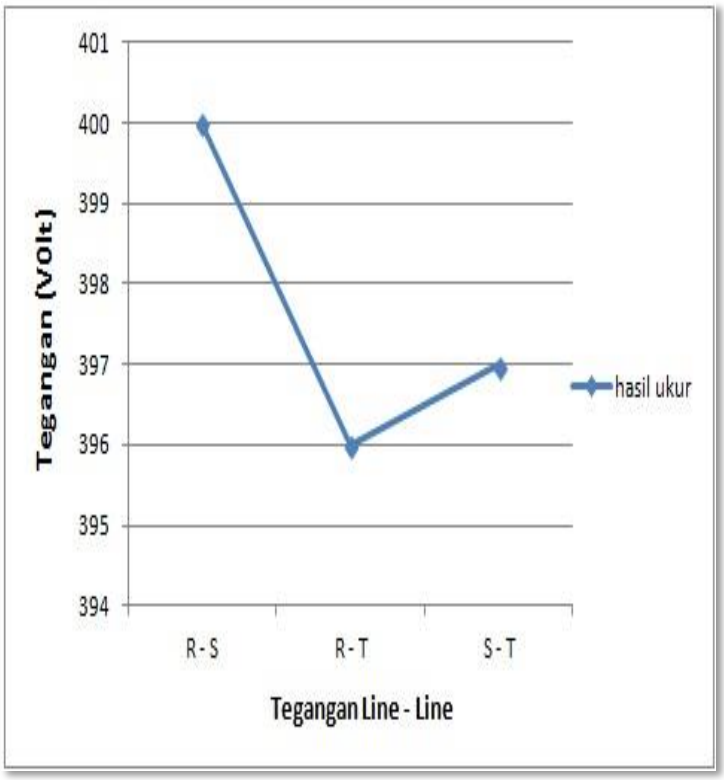

Figure 5. Line-to-Line Voltage Measurement Graph

The graph in Figure 5 above illustrates the measurement results that fluctuate unpredictably, rising and falling from high to low and then rising again to high, for the line-to-line voltages between phases R-S, R-T, and S-T.

1.3 Relationship Between Wye-Delta and the Measurement Results of Each Phase

Set the selector switch to the 200-amp measurement range using an ammeter or clamp meter. Then, press the trigger to open the clamp meter's jaws and clip them around the conductor cable through which the electric current is flowing. Observe the result displayed on the digital screen; this will be the measurement value.

Table 3. Results of Current Measurements for Phases R, S, and T.

Relationship Y - Δ	Sum of Flows (Amper)		
	R	S	T
Y	0,6	0,8	0,6
Δ	7,5	8,5	8,3

The electric current flowing through phase R in the wye (Y) connection is 0.6 Ampere, while in the delta connection, it is 7.5 Ampere. Meanwhile, in phase S and phase T, the current in the wye connection is 0.8 Ampere and 0.6 Ampere, respectively. In the delta connection, the measurements show 8.5 Ampere for phase S and 8.3 Ampere for phase T. Measurement of phases R, S, and T in wye and delta connections are presented on **Figure 6.**

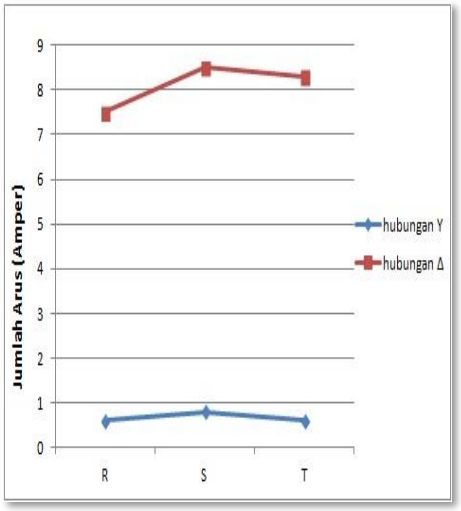

Figure 6. Measurement of Phases R, S, and T in Wye and Delta Connections

The graph above (Figure 6) shows the differences in the current measurement results for each phase (R, S, and T) about the wye and delta connections.

4. Conclusion

This prototype is assembled with a power and control system, where the power circuit functions as the central system in the circuit, while the control system acts as the controller. This prototype operates using a semi-automatic control system, with the primary function of the contactor acting as a magnetic switch that operates based on the electromagnetic principle.

By applying the wye-delta connection to each phase (R, S, and T), it can be concluded that the current values fluctuate. In the wye connection, the measured currents are 0.6 Ampere, 0.8 Ampere, and back to 0.6 Ampere for phases R, S, and T, respectively. In the delta

connection, a similar fluctuation occurs with current values of 7.5 Ampere, 8.5 Ampere, and 8.3 Ampere for phases R, S, and T, respectively.

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