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Design and Construction of A 3-Phase Motor Rotation Direction Control Module Based on PLC And VSD

Henry Hasian Lumban Toruan[1,*], Benrad Edwin Simanjuntak[2], Suprianto[3] & Siwan Edi A. Peranginangin[4]

[1, 2, 3] Department of Electrical Engineering, Politeknik Negeri Medan, Medan, Indonesia
[4] Department of Mechanical Engineering, Universitas Nommensen, Medan, Indonesia

Email address:

henrylumbantoruan@polmed.ac.id
[*]Corresponding author

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Abstract: This design consists of a practical module for controlling both forward and reverse rotational direction, utilizing a combination of a Variable Speed Drive (VSD) and a Programmable Logic Controller (PLC). The VSD regulates the frequency and voltage supplied to the motor, while the PLC serves as the logic control center, receiving input from the control buttons and sending instructions to the VSD. Testing was conducted on an unloaded motor to ensure optimal system operation. Rotational direction change testing was performed on an unloaded motor with speed variations of 10 Hz, 20 Hz, and 30 Hz and ACC/DEC values of 3.0, 5.0, and 7.0 seconds. The higher the motor speed frequency, the greater the time difference between the ACC and DEC values set on the inverter for 3, 5, and 7 seconds and the actual time for each setting. The higher the ACC value, the longer the stabilization time required for the motor to achieve stability at each frequency range.

Keywords: 3-Phase Induction Motor, PLC, VSD, rotational direction

1. Introduction

Three-phase induction motors are the most popular and widely used motors for industrial machinery, such as pumps, conveyors, compressors, blowers, and more. This is likely because induction motors offer several advantages over other types of motors, such as their simple construction, durability, easy maintenance, and high efficiency. In industrial applications, 3-phase induction motors are not only required to rotate in one direction but also need to be able to rotate in two directions, namely forward and reverse, depending on the needs of the system or process being run. Adjusting the direction of rotation of a 3-phase induction motor is usually done by swapping the position of two of the three electrical phases.

In Royhan's research, the Omron CPM1A-30CDR-AV1 PLC controls the right and left rotation direction of a 3-phase electric motor by controlling it using two 3-phase contactors, MCBs, and overload relays, and is programmed with a ladder diagram using CX-Programmer software version 9.7. The test results show that by pressing the right or left button, the PLC can change the direction of rotation of the motor rotor by changing the phase arrangement (R-S-T or R-T-S) [9].

In Ihsan's research, this motor speed control system was

applied to a 55 kW 3-phase induction motor used for water pumps at PERUMDAM Tirta Madani Serang. The test results showed that setting the input frequency on the VSD between 25 Hz and 40 Hz resulted in a motor speed of 1500 RPM to 2400 RPM. The higher the frequency set on the VSD, the faster the motor rotation, and the greater the water discharge sucked. Motor speed data was calculated based on the motor synchronization formula and the results were consistent with the given frequency value [3].

Based on the test results from Yusuf and Rohman's research, it was found that the Omron PLC can control the rotation of an induction motor from a minimum frequency of 10 Hz to a maximum of 50 Hz with a rotation speed equivalent to 1029 rpm to 2958 rpm. This test condition was carried out without a load on the 3-phase induction motor. If the test is carried out with a load, a decrease in speed is seen [10].

Previously, this was done manually or with a contactor circuit. However, with the development of technology, the direction and speed of the motor can be adjusted automatically using more modern and sophisticated tools, namely Variable Speed Drive (VSD) and Programmable Logic Controller (PLC). VSD functions to regulate the speed and direction of motor rotation by changing the frequency and voltage supplied to the motor. [4].

PLC acts as the brain of the system control, which receives signals from buttons or sensors, then adjusts the VSD so that the motor rotates according to the command (forward or reverse). By using a combination of VSD and PLC, the motor control process becomes more flexible, efficient, and safe.

In this design, control is carried out on a motor without load to make it easier to analyze and understand. Even without load, this system can be an important basis for application in more complex industrial systems [10]. Therefore, it is important to learn how to control the direction of rotation of a 3-phase motor using a PLC-based VSD, so that the motor work system becomes more efficient, automatic, and can be controlled easily and safely. This design will be a learning module related to the use of VSD to control the direction of rotation of a PLC-based 3-phase induction motor.

2. Method

This design uses an experimental method, by carrying out system design activities which are created while simultaneously observing the direction of motor rotation and measuring the time when the direction changes from the program in the PLC setting on the VSD. The design of induction motor direction control using PLC-based VSD is explained in the process block diagram in Figure 1. Installation and wiring of PLC and VSD can be seen in Figure 2 and 3.

The 220V AC source is the main source of electrical voltage used to power the entire system. This voltage comes from the PLN electricity network with a standard voltage of 220V AC. The Miniature Circuit Breaker (MCB) functions as a system protector from overcurrent or short circuits. If the current exceeds the threshold, the MCB will automatically cut off the power to prevent damage to the system. A 24V power supply is required to activate the push button input. The Omron CP1E-E40SDR-A PLC acts as the brain of the control system. The PLC receives input from the buttons (such as push buttons for forward/reverse direction), then processes the control logic, and sends an output signal to the VSD to determine the direction of motor rotation. The VSD (Variable Speed Drive) receives signals from the PLC and regulates the output voltage and frequency for the induction motor. The VSD allows flexible control of the motor's direction and speed. In this project, the VSD is used to control the direction, both forward and reverse, and the motor rotation. A three-phase induction motor is the main actuator controlled by the system. This motor receives signals from the VSD in the form of 3-phase voltage, and will rotate according to the direction command sent from the system

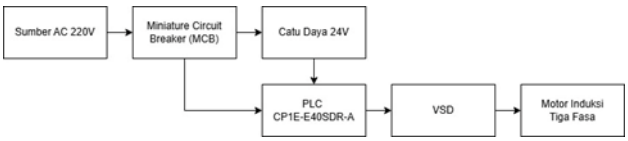

Figure 1. *System Block Diagram.*

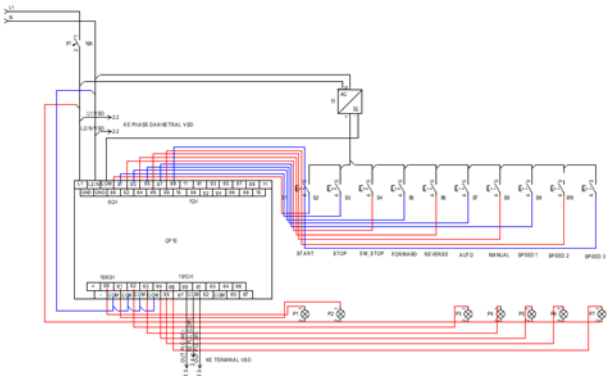

Figure 2. *Wiring PLC.*

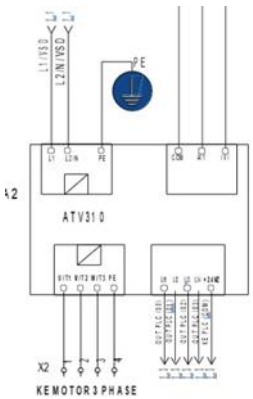

Figure 3. *Wiring VSD.*

Design of a tool holder layout measuring 88.5 cm x 100 cm to arrange all components of a three-phase induction motor control system based on PLC and inverter (VSD) systematically, ergonomically, and safely. The tool holder layout can be seen in Figure 4.

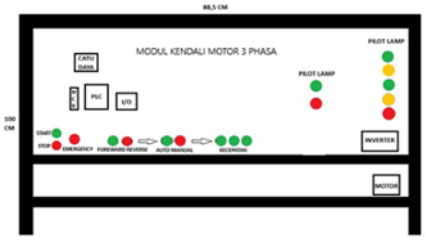

***Figure 4**. Tool holder layout.*

The flowchart for controlling the direction of rotation of a 3-phase induction motor using a PLC-based VSD can be seen in Figure 5.

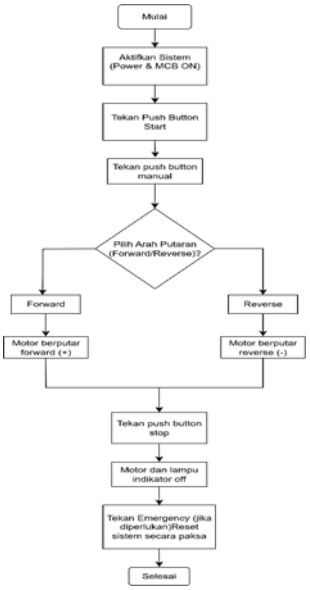

***Figure 5.** Flowchart system.*

The flowchart for controlling the rotation direction illustrates the logical flow of the 3-phase induction motor rotation direction control system using a PLC-based VSD, namely activating the main power source and turning on the MCB so that current enters the system. The system is controlled via the start button. When pressed, the indicator light will light up indicating the system is active. The user selects the manual mode of the system. After the mode is selected, the user selects the direction of rotation of the motor: Forward: The motor rotates clockwise (FWD). Reverse: The motor rotates counterclockwise (REV). The motor rotates in the selected direction. The frequency and direction are controlled by the VSD based on the logic of the PLC. To stop the motor, the user presses the stop button. All outputs are off, including the VSD and indicator lights. In the event of an emergency, the emergency button is pressed to forcibly disconnect all control circuits. The system is declared complete or inactive until the next cycle is restarted.

3. Result and Discussion

The module design results represent the final component layout, designed to meet the system's needs and function. This module includes a power supply, push buttons, indicator lights, PLC, VSD, and a single-phase induction motor, all arranged systematically for ease of operation and maintenance. The resulting module design and ladder diagram can be seen in Figures 6 and 7.

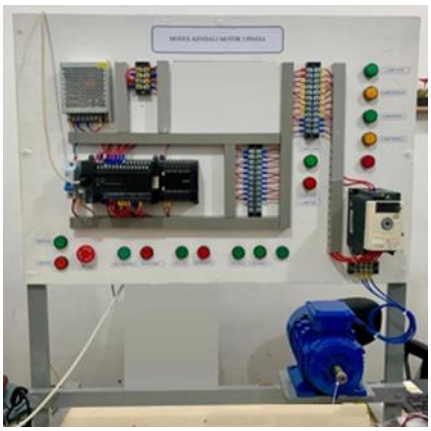

***Figure 6.** Module realization.*

***Figures 7.** Ladder Diagram rotation direction (Forward) and (Reverse).*

Figure 7 shows that the PB_FORWARD button is pressed. This causes the current path at the top to be active, which is indicated by a lit green line, and activates coil W0.06. This coil is responsible for activating the auxiliary contact KONTAK_BANTU_FORWARD_MANUAL, so that even if the PB_FORWARD button is released, the path remains active due to the self-hold of the auxiliary contact. In this condition, the motor will rotate in the forward direction, and the reverse direction is locked because the downward path (Reverse) is inactive. The PB_REVERSE button is pressed, so that the lower path becomes active. Coil W0.07 lights up and activates KONTAK_BANTU_REVERSE_MANUAL. This auxiliary contact also functions as a lock so that the motor continues to rotate in reverse after the button is released. Meanwhile, the upper path (Forward) becomes inactive because there is a logic lock when Reverse is active, so Forward will not be able to turn on, and vice versa.

The test results for the motor's rotational change time at 10 Hz are shown in Table 1. Results of Data Collection for the direction of rotation (Forward and Reverse) at a speed of 20 Hz. The results of the Motor Rotation Direction Change Time Test at a Speed of 20 Hz can be seen in Table 2. The results of the motor rotation direction change time test at a speed of 30 Hz can be seen in Table 3.

Table 1. *Results Data for Rotation Direction Change Time at a Speed of 10 Hz.*

Pengujian	Nilai ACC dan DEC					
	3,0 Detik		5,0 Detik		7,0 detik	
	F→R	R→F	F→R	R→F	F→R	R→F
1	1,91	1,79	2,63	2,52	3,33	3,30
2	1,90	1,78	2,64	2,53	3,35	3,28
3	1,91	1,78	2,65	2,53	3,35	3,28
4	1,91	1,77	2,63	2,55	3,35	3,28
5	1,92	1,78	2,63	2,53	3,34	3,27
Rata-rata	1,91	1,78	2,63	2,53	3,53	3,28

Table 2. *Results Data for Rotation Direction Change Time at a Speed of 20 Hz.*

Pengujian	Nilai ACC dan DEC					
	3,0 Detik		5,0 Detik		7,0 detik	
	F→R	R→F	F→R	R→F	F→R	R→F
1	3.2	3.9	4.65	4.62	6.23	6.24
2	3.0	3.9	4.67	4.64	6.23	6.23
3	3.0	3.7	4.66	4.62	6.25	6.23
4	3.0	3.9	4.65	4.63	6.23	6.24
5	3.1	3.9	4.65	4.62	6.21	6.23
Rata-rata	3,0	3,9	4,65	4,62	6,23	6,23

Table 3. *Results Data for Rotation Direction Change Time at a Speed of 30 Hz.*

Pengujian	Nilai ACC dan DEC					
	3,0 Detik		5,0 Detik		7,0 detik	
	F →R	R→F	F →R	R→F	F→R	R→F
1	4.31	4.14	6.63	6.64	8.91	8.98
2	4.33	4.14	6.65	6.63	8.94	8.97
3	4.32	4.12	6.63	6.64	8.90	8.97
4	4.33	4.14	6.62	6.63	8.91	8.97
5	4.33	4.13	6.63	6.63	8.91	8.98
Rata-rata	4,33	4,14	6,63	6,63	8,91	8,97

The data collection of acceleration (ACC) and deceleration (DEC) time tests in the process of changing direction from forward to reverse (F→R) and reverse to forward (R→F) was carried out at three frequency levels, namely 10 Hz, 20 Hz, and 30 Hz, with each tested at ACC/DEC values of 3, 5, and 7 seconds. At a frequency of 10 Hz, the average change time was recorded at 1.91 seconds (F→R) and 1.78 seconds (R→F) with an ACC/DEC setting of 3 seconds. When the parameter was increased to 5 seconds, the transition time became 2.63 seconds (F→R) and 2.53 seconds (R→F). At an ACC/DEC setting of 7 seconds, the time increased to 3.53 seconds (F→R) and 3.28 seconds (R→F). At 20 Hz, the change-of-direction time increases proportionally. With ACC/DEC of 3 seconds, the average transition time is 3.0 seconds (F→R) and 3.9 seconds (R→F). At 5 seconds, the values change to 4.65 seconds (F→R) and 4.62 seconds (R→F). When ACC/DEC is set to 7 seconds, the change-of-direction time for both is recorded at an average of 6.23 seconds. Meanwhile, at 30 Hz, the change-of-direction time is the longest compared to other frequencies. With ACC/DEC of 3 seconds, the transition time reaches an average of 4.33 seconds (F→R) and 4.14 seconds (R→F). When the setting is increased to 5 seconds, the time increases to 6.63 seconds for both directions. At the maximum setting of 7 seconds, it took up to 8.91 seconds (F→R) and 8.97 seconds (R→F).

4. Conclusion

The conclusion of this study is that when the rotation direction changes, the higher the motor speed frequency from 10, 20 and 30 Hz, the greater the time difference between the ACC and DEC value settings for 3, 5 and 7 seconds on the inverter and the actual time for each setting. The higher the ACC value, the longer the stabilization time required for the motor to reach stability at each frequency increase range. This indicates that while increasing the ACC provides smoother and safer speed transitions, it also makes the motor take longer to reach stability.

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References

[1] Evalina, N., Azis, A. H., & Zulfikar. (2018). Pengaturan Kecepatan Putaran Motor Induksi 3 Fasa Menggunakan Programmable logic controller. Journal of Electrical Technology, 3(2), 73–80. https://jurnal.uisu.ac.id/index.php/jet/article/view/545.

[2] Gilang Arrachman, Rusdi, R., & Bustani. (2023). Evaluasi Pengendalian Kecepatan Putaran Motor Induksi Tiga Fasa Menggunakan Variable Speed Drive ATV61 Terhadap Penghematan Energi Pada PLTGU Tanjung Batu. PoliGrid, 4(2), 68–74. https://doi.org/10.46964/poligrid.v4i2.31.

[3] Ihsan Faturrohman, & Mohammad Fatkhurrokhman. (2023). Pengaturan Kecepatan Motor Induksi 3fasa Dengan Mengatur Frekuensi Menggunakan VSD di PERUMDAM Tirta Madani Serang. Jurnal Sains Dan Teknologi, 2(1), 46–56. https://doi.org/10.58169/saintek.v2i1.135.

[4] Janaki Priya, V., Joshiba, S., Hemalatha, N., & Kavya Shree, R. (2021). Speed control of induction motor using PLC and VFD. 12th International Conference on Advances in Computing, Control, and Telecommunication Technologies, ACT 2021, 2021-Augus(05), 873–878.

[5] Luthfi, M. A. (2022). Pengaturan Kecepatan Motor Tiga Fasa Dengan Arah Putar Reverse Menggunakan Variabel Speed Drive (VSD). Indonesian Journal of Electrical Engineering and Renewable Energy (IJEERE), 2(2), 64–69. https://doi.org/10.57152/ijeere.v2i2.394.

[6] Nasution, E. S., & Hasibuan, A. (2018). Pengaturan Kecepatan Motor Induksi 3 Phasa Dengan Merubah Frekuensi Menggunakan Inverter ALTIVAR 12P. Sisfo: Jurnal Ilmiah Sistem Informasi, 2(1), 25–34. https://doi.org/10.29103/sisfo.v2i1.1001.

[7] Pambudi P.E., Suyanto M., Firman Beny, Saifilla O.D. (2024). Variable Speed Drive (VSD) sebagai Pengendalian Kecepatan Motor Induksi. Prosiding Seminar Nasional Aplikasi Sains & Teknonoli (SNAST) 2024, Yogyakarta. DOI:10.34151/prosidingsnast.v1i1.5037.

[8] Rahmania, B., Abdillah, H., & Misri, M. (2022). Analisa Perbandingan Rangkaian Forward Reverse pada Motor Listrik 3 Fasa Manual dengan Berbasis PLC Schneider

[9] M221CE24R. RESISTOR (Elektronika Kendali Telekomunikasi Tenaga Listrik Komputer),5(2), 157.

https://doi.org/10.24853/resistor.5.2.157-162.

[10] Royhan, M. (2021). M Mengatur Putaran Kanan-Kiri Motor Listrik 3 Fasa dengan Programmable Logic Controller (PLC). Journal of Informatics and Communication Technology (JICT), 3(1),1–9. https://doi.org/10.52661/j_ict.v3i1.67.

[11] Yusuf, M., & Rohman, A. (2020). Pengendalian Kecepatan Motor Induksi 3 Fasa menggunakan PLC Omron CP1E dengan Kontrol Proposional. Jurnal Ecotipe (Electronic, Control, Telecommunication, Information, and Power Engineering),7(2), 92–98. https://doi.org/10.33019/jurnalecotipe.v7i2.1465.