The International Journal of Education Management and Sociology
E-ISSN 2963-0622
Vol 3, No 3, (May - June 2024) Pages: 172-180

Management Design and Construction of Electric Power Monitoring Electrical Design Laboratory Bandung State Polytechnic With Powertag

Toto Tohir
Electrical Engineering Study Program, Department of Electrical Engineering, Bandung State Polytechnic, Bandung, 40559, Indonesia
Email : toto.tohir@polban.ac.id

Linda Wijayanti
Professional Engineering Study Program, Indonesian Catholic University Atma Jaya, Jakarta 12930, Indonesia
Email : linda.wijayanti@atmajaya.ac.id

Melisa Mulyadi
Professional Engineering Study Program, Indonesian Catholic University Atma Jaya, Jakarta 12930, Indonesia
Email : melisa.mulyadi@atmajaya.ac.id

Hadrian Anwar
Electrical Engineering Study Program, Department of Electrical Engineering, Bandung State Polytechnic, Bandung, 40559, Indonesia
Email : hadrian.anwar.tlis22@polban.ac.id

Saurav Kumar
Senior Faculty, Corporate Secretaryship Department, K.B Womens College, Hazaribag, Jharkhand, India
Email : saurav1980kumar@gmail.com

Abstract

The Electrical Design Laboratory is a facility where lecturers and students carry out various experiments, research and developments related to electricity. Monitoring electrical power can be a very smart move to manage expenses and also help reduce environmental impact. Electrical power usage that is not directly monitored during peak loads will result in excessive power usage. Therefore, MCB trips often occur in electrical design laboratories on switchboards with high loads, so the ability to monitor electric current usage is required. The PowerTag system was introduced to meet this tracking need for controlling Air Conditioning, Incandescent Lamps, Heaters, Dispancers and Vacuum Cleaner loads. The system is connected to the load to determine the magnitude of electrical parameters such as power, voltage, current, power factor, and then these parameters will be sent via the Zigbee communication protocol to the Concentrator. The concentrator receives data from PowerTag and then forwards it to a local server using the Modbus TCP/IP communication protocol to then be processed to the HMI for presenting data resulting from monitoring the system. The aim of this research is to design a tool that can detect current, voltage, power, power factor and frequency in real time. The research results show that the current flowing in the neutral conductor is 4.46 A and 6.69 A.

Keywords: Management Design, Concentrator, Electric Power, Design Laboratory

1. Introduction

According to the Ministry of Energy and Mineral Resources (ESDM), electricity use continues to increase every year. Electricity is widely used in various industries, households, commercial buildings, transportation and other sectors. At the end of 2010, electricity consumption reached 90.35 billion barrels of oil equivalent (National Energy Council-Indonesia Energy Out Look Secretary General Team, 2019). Ideally, the distribution of electrical power in a three-phase system must have phase balance and the magnitude of the neutral current is zero, but in the industrial sector which has a variety of loads, the nature of the load (non-linear load) and the asymmetry of the load ignition timing will cause an imbalance in the three-phase system. (N. On L, T Distribution, Pt DI, J, Electro Luceat, 2018).

As a result of this, on the neutral current side it will cause the emergence of a neutral current that is three times the size of the phase current (Ruliyanto. -time. Based on this case, in order to realize the optimization of power imbalance monitoring for the emergence of neutral current, a system is needed that can determine the magnitude of this abnormal occurrence for the industrial sector. Therefore, the system for monitoring power imbalances and the emergence of neutral currents is a solution for carrying out real-time monitoring of every load in the sector (Setiana. H et al, J Electrical Automation and Renewable Energy, 2023) (Musthofa M, Energy & Electricity, 2020).

To overcome this problem, the aim of this research is to develop a simulator and implement it using the PowerTag device. to monitor the amount of power, voltage, current, frequency and power factor with various single-phase and three-phase loads where the data is monitored in real-time using the HMI display on a PC screen, testing is carried out at the Electrical Design Laboratory of the Department of Electrical Engineering, State Polytechnic Bandung.

Research conducted by Fanny et al regarding monitoring and control systems used Labview to see the imbalance of three-phase systems in case studies in industry. Voltage, Current and MCB control can be controlled on the HMI Labview screen (International Journal of Computer Applications, 2019).

Research conducted by Hamdani et al regarding the design of an electrical measurement system using an augmented operator advisor on the switch panel for a control and monitoring system using a PLC using ecostructure software which can display imbalances on the HMI screen (Sentrinov, 2023).

Study on designing a boarding house electricity monitoring system based on the Internet of Things (IoT) by Ivan et al. Currently technology is developing rapidly in various fields of science (Magazine, Volume 08, Number 01, 2019). Society continues to develop and research technology to make people's lives easier, one of which is the field of Internet of Things technology.

According to Diah et al. Internet of Things (IoT) based study carried out by the Electrical Installation Laboratory of the Yogyakarta National Institute of Technology. His research monitors electrical loads in the form of voltage, current, power factor, frequency, power, and can also display real-time electricity usage graphs as long as the device is connected to an available Wi-Fi network, with average power measurements. error of 2.98% and maximum measurement error of 9.3% (National Proceedings of Industrial Engineering and Informatics XV, October 2020, ISSN: 1007-5995).

Research conducted by Tohir T et al on designing a tool that can read current, voltage and power data in real time for testing three-phase short circuit motors. This research provides an alarm if the measurement results exceed the specified value or a voltage drop occurs. The monitoring system uses the PowerTag A9MEM sensor as software to measure the electrical parameters Current, Voltage, Active Power, Active Energy and Power Factor. These parameters will be displayed in an HMI application. (Proceedings International: Innovation in Power and Advanced Computing Technologies (i-PACT), ieeexplore.ieee.org, 2023)

2. Research methods

The research method that will be applied is designing a system from a simulator by determining the specifications of the PowerTag type which is used as the object of implementing the monitoring system, then after carrying out the design process the next stage is testing on the simulator that has been designed. The following flow diagram describes the working system of the monitoring system that will be designed.

Figure 1 Designing a PowerTag Type Simulator System

3. Results

Figure 2 shows the problem solution framework in designing a monitoring system simulator which is carried out to ensure that all initial system requirements can be met before the system is operated. Then the PowerTag A9MEM will start connecting to the Concentrtor using the Zigbee communication protocol wirelessly. If the connection is not successful, it will continue to be repeated until the connection is successful.

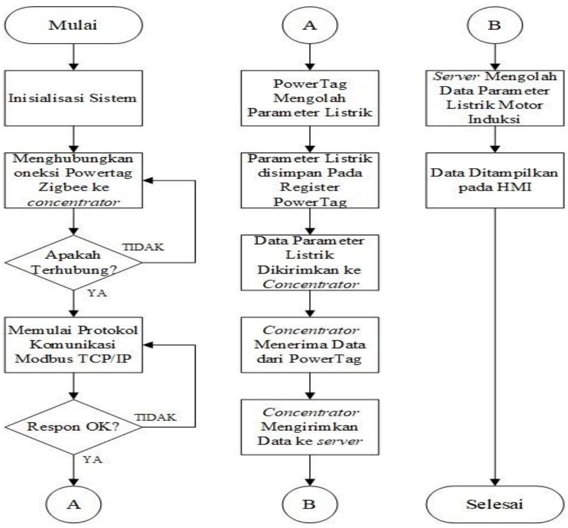

Figure 2. Monitoring System Flow Diagram

Then on the Concentrtor side it starts to open the ModbusTCP/IP path connected to the server. After the PowerTag and Concentrtor are connected to each other, the PowerTag will start sensing and processing the data and storing it in register memory. The parameter data that has been obtained will immediately be sent to the Concentrtor and the Concentrtor will receive the data and then forward it to the server. The data that has been received by the server will then be processed by the HMI software and the final process is displaying the data on the HMI

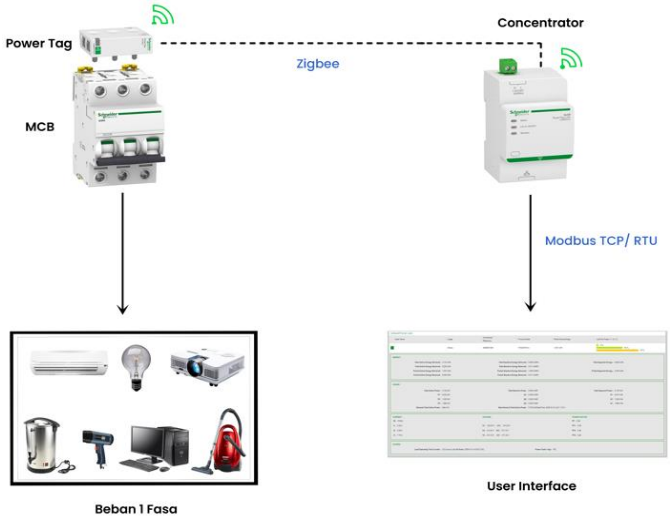

Figure 3. Monitoring System Architecture Design

Figure 3 shows the overall system design of the energy use monitoring simulator for single phase load testing. The grid source comes from a three-phase AC system network, which is then divided into two supplies, namely, one phase for the PowerTag concentrator voltage source and a 3-phase source for testing the load for each of the R, S and T phases. The simulator is equipped with an MCB functions as protection if disturbances occur due to short circuits and overloads.

The power flow will pass through the current and voltage sensors which are an integral part of the PowerTag device, where the load voltage and current will be sensed and then the data will be sent via wireless communication to the PowerTag concentrator where the data will then be processed and sent to the PC/laptop using a cable. UTP. Electrical parameters such as inter-phase voltage, per-phase current, active power, reactive power, apparent power, power factor, energy will be read on the PC screen using ecostructure commission software.

Figure 4. Electric Power Monitoring Simulator

Figure 3 is the layout of the electrical energy monitoring simulator for both single phase and 4 phase loads. Where the components used will be placed according to the design that has been made. The simulator designed for this suitcase is equipped with indicator lights for the voltage per phase and network frequency.

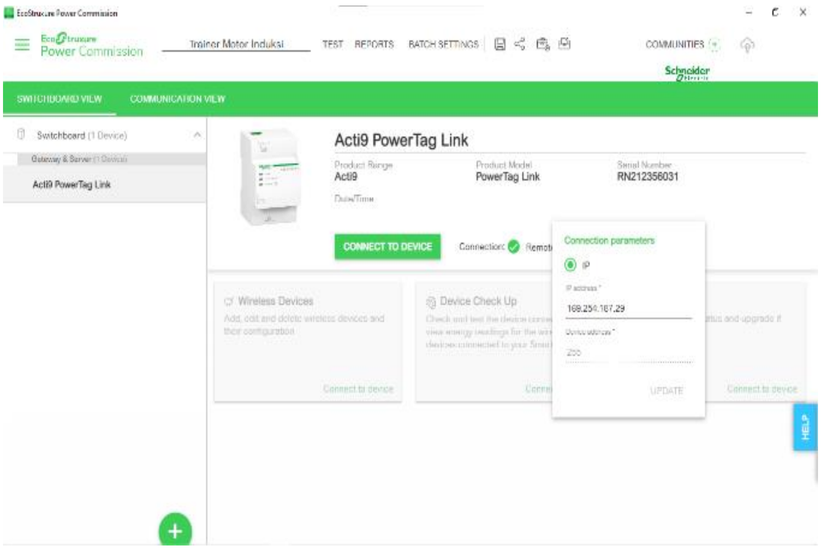

Figure 5. Initial view of the HMI Ecostruxture Commission

Figure 5 is the main display of the energy monitoring software, with the initial step being to determine the type of communication that will be used,

Electrical power is the ability of an electrical device to do work within a certain time. Electrical power is measured in watts (W), which is the product of voltage (in volts) and electric current (in amperes).

$$Daya\ Aktif\ (P) = V\ x\ I\ x\ Cos\ \emptyset \quad (1)$$

This management concept is important in many applications, including energy consumption calculations, electrical network planning, and electronic device design. Several important things related to electrical power include: (1) Active Power (P), namely the power actually used to do work, measured in watts, (2) Reactive Power (Q), namely the power stored in the electric and magnetic fields in the AC system. , measured in reactive volt-amperes and (3) Apparent Power (S), which is a combination of active power and reactive power, measured in volt-amperes.

$$Reactive\ Power\ (Q) = V\ x\ I\ x\ Sin\ \emptyset \quad (2)$$

$$Apparent\ Power(S) = V\ x\ I \quad (3) \text{ or } Apparent\ Power\ (S) = \sqrt{P^2 + Q^2} \quad (4)$$

4. Discussion

The results of electrical power monitoring tests for various loads consisting of incandescent lamps, AC, computers, blowers, projectors, vacuum cleaners, electric thermoses are shown in Table (1). Results of electrical power monitoring tests with PowerTag, Table (2) and Table (3).) Electric power monitoring test results with PowerTag unbalanced load

Table 1. Electrical Power Monitoring Test Results with Powertag

PowerTag testing with 1 phase load

		Voltage (V)	Current (A)	Power Factor	Active Power (Kw)	Reactive Power (Kvar)	Apparent Power (Kva)
Load Type	Incandescent lamps 240W	221.30	1.17	0.99	0.999	0.000	1.017
	Incandescent lamps 120W	217.80	0.58	0.99	0.112	0.000	0.113
	Incandescent lamps 100W	214.70	0.50	0.99	0.092	0.000	0.093
	Incandescent lamps 40W	220.10	0.34	0.98	0.040	0.000	0.040
	Electric thermos 1000W	215.40	7.75	0.99	1.670	0.000	1.671
	Air Condisioner	213.60	4.95	0.98	1.042	0.000	1.059
	Vacuum cleaner 850W	217.10	4.16	0.95	0.859	0.181	0.903
	Heater blower	213.40	5.35	0.81	0.942	0.000	1.142
	Projector	220.80	1.25	0.97	0.259	-0.044	0.265
	Computer	214.40	2.18	0.96	0.45	0.000	0.046

The test results show that the voltage magnitude is relatively balanced, the power factor shows a value above 0.8 and from each load the active power, reactive power and apparent power obtained from calculations using measurements are almost the same.

Table 2. Test results 1 Powertag with unbalanced load

PowerTag testing with unbalanced load

		Phase	Voltage (V)				Current (A)		Power Factor	Active Power (Kw)	Reactive Power (Kvar)	Apparent Power (Kva)
			V-N	R-S	S-T	T-R	Phase	Neutral				
Load Type	Laptop Charger	R	220.50	374.20	373.10	377.20	0.38	6.69	0.86	0.032	0.000	0.037
	Air Condisioner	S	213.60				4.86		0.98	1.026	0.000	1.039
	Electric thermos 1000W	T	215.10				7.75		0.99	1.688	0.000	1.669
									Total	2.185	0.000	2.745

Based on the test results, it shows that there is a current flowing in the neutral of 6.69A.

Table 3. Test results 2 Powertag with unbalanced load

PowerTag testing with unbalanced load

		Phase	Voltage (V)				Current (A)		Power Factor	Active Power (Kw)	Reactive Power (Kvar)	Apparent Power (Kva)
			V-N	R-S	S-T	T-R	Phase	Neutral				
Load Type	Air Condisioner	R	212.5				4,78		0.98	0.999	0.000	1.017
	Heater blower	S	213.4	370.30	374.50	376.10	5,35	4,46	0.81	0.932	0.000	1.142
	Incandescent lamps 240W	T	221.3				1,17		0.99	0.252	0.000	0.253
									Total	2.185	0.000	2.413

The test results show that there is a current flowing in the neutral of 4.46 A.

Conclusion

Monitoring of energy usage, power, voltage, current, power and power factor has been successfully designed and implemented. The test results show that all electrical parameters on all single-phase loads can be monitored by displaying real-time values with the HMI. Apart from using PowerTag as energy data processing and HMI as a facility for monitoring electrical parameters, the test is also equipped with a Volt meter measuring instrument, Ampere Tang. Cos phi meter.

Acknowledgment

Thank you to: (1). Department of Electrical Engineering, Bandung State Polytechnic which has provided Electrical Design Laboratory room facilities as a place for research. (2). Professional Engineering Study Program, Indonesian Catholic University Atma Jaya Jakarta which has given assignments in the form of writing scientific articles.

Reference

Amin, M. A., & Emidiana. (2020). Efficiency of a Shaded Pole Type Induction Motor as a Blower Driver. Ampere Journal, 5(2), 85-91.

Anjarsari, L. A., Surtono, A., & Supriyanto, A. (2015). Design and Realization of a Liquid Density Measuring Instrument Based on Archimedes' Law Using a Photodiode Sensor. Journal of Theory and Applications of Physics, 3(2), 123-130.

Buyung, S. (2018). Comparative Analysis of Power and Torque in Electric Lawn Mowers (APRE). Voering Journal, 3(1), 1-4.

Dan N, On L, T Distribution. Pt DI, Sorong PA. (2018). Analysis of the Effect of Load Imbalance on Neutral Current and Losses in Distribution Transformers at PT. PLN (Persero) Sorong Area. J Electro Luceat, 4(1): 1-10.

Daeng, I. T., Mewengkang, N., & Kalesaran, R. E. (2017). Use of Smartphones to Support Lecture Activities by Fispol Unsrat Mando Students. Acta Diurna Journal, 4(1), 1-15.

Dewi, N. L., Rohmah, M., & Zahara, S. (2017). Smart Home Prototype with NodeMCU ESP8266 Module Based on Internet of Things (IoT). Journal of Informatics Engineering, 5(2), 1-9.

Doringin, F., James, M., Waluku, S. (2019). 3 Phase Monitoring and control Control System Based on Labview. In:International Journal of Computer Applications, p:21-4.

Efendi, Y. (2018). Internet Of Things (IOT) Light Control System Using Mobile Based Raspberry PI. Scientific Journal of Computer Science, 4(1), 19-26.

Fahmianto, E. N. (2017). Design for Starting a 1 Phase Capacitor Motor. Journal of Electrical Engineering Education, 2(1), 21-25. Fathulrohman, Y. N., & Saepuloh, A. (2018). Temperature and Humidity Monitoring Tool Using Arduino Uno. Journal of Management and Information Engineering, 2(1), 161-170.

Fauzi, R., Massarang, M., Pirade, Y., & Rahman, Y. A. (2020). Design of a Three Phase Induction Motor Speed Monitoring System Based on a Microcontroller with Display in MATLAB. Foristek Scientific Journal, 10(39-44).

Ferdiansyah, M., Ardianto, F., & Yuniarti, E. (2021). Utilization of Universal Motors as Driving Force for Oil Draining Machines with Speed Control. Journal of Solar Energy, 5(2), 41-49.

Haryanto, H. (2011). Making an Inverter Module to Control the Rotation Speed of an Induction Motor. Journal of Electrical Engineering, 4(1), 11-20.

Ibrahim, R. R., & Yulianti, B. (2022). Design and Construction of IoT-Based PLN Electric Current Usage Monitoring. Journal of Industrial Engineering, 11(2), 43-51.

Jezny, J., & Curilla, M. (2013). Measuring Position With a Hall Effect Sensor. American Journal of Mechanical Engineering, 1(7), 231-235.

Jokanan, J. W., Widodo, A., Kholis, N., & Rakhmawati, L. (2022). Design and Build an IoT-Based Electrical Power Monitoring Tool Using Firebase and Android Applications. Journal of Electrical Engineering, 11(1), 47-55.

Julius, S.S., Trabani, M.YI. (2017). Load Imbalance Against Neutral Current and Power Losses in Distribution Transformers. J Symmetric,7(2): 68-73. Things on the Motor Control Panel. J Electrical Automation and Renewable Energy.5(2):88-97.

Musthofa M. (2020) . Real Time Online Monitoring System for Unbalanced Loads and Overloads of Distribution Transformers at PT. PLN (Persero), Energy & Electricity, 12(2): 56-64. https://doi.org/10.33322/energi.v12i2.1163

Crookedness, T. S. (2018). Design of a Noise Detection Tool Based on Arduino Uno. Journal of Electrical and Computer Engineering, 7(2), 183-188.

Natsir, M., Rendra, D. B., & Anggara, A. D. (2019). Implementation of IoT for Automatic AC Control Systems in Classrooms at Serang Raya University. Prosisko Journal, 6(1), 69-72.

Nurdiansyah, E. D., & Haryudo, S. I. (2018). Backpropagation Based Single Phase Induction Motor Speed Control. Journal of Electrical Engineering, 07(1), 69-76.

Noor, H.N.A. (2023). Design of an Electrical Quantity Monitoring Device on a Switching Panel Based on Augmented Operator Advisor. In: National Seminar on Applied Innovative Research (Sentrinov), p: 599-607.

Prasetya, W., Sukmadi, T., & Facta, M. (2015). Analysis of the Placement of a Run-Capacitor Single Phase Induction Motor Speed Controller Using a TRIAC as a Voltage Converter. Scientific Journal of Electrical Engineering, 4(1), 185-191.

Putra, A. R., Novianta, M. A., & Priyambodo, S. (2015). Speed Control of Single Phase AC Induction Motor Based on Atmega8535 Microcontroller with LCD016L Display. Electrical Journal, 2(2), 19-26.

Sander, A., Rusidi, & Pujianto, D. (2022). Building an Automatic Mask Booth Device to Prevent Covid-19. Mahakarya Information Engineering Journal (JTIM), 5(1), 1-8.

Sholihin, M., Wibowo, S. A., & Prasetya, P. R. (2021). Application of the Internet of Things (IoT) to the Design and Development of a Boundary Warning System and Accident

Location Detection for Arduino-Based Motorcycle Riders. Informatics Engineering Student Journal, 5(2), 597-604.

Soedjarwanto, N., Budiarto, & Nama, G. F. (2020). Induction Motor Speed Control Using IoT (Internet Of Things) Technology. ELTEK Journal, 18(2), 9-17.

Supardi, A., Umar, Setiyoko, I., & Saifurrohman, M. (2022). Design and Development of an Induction Motor Speed Monitoring and Control System Based on a Programable Logic Controller (PLC) Equipped with a Touch Screen. Journal of Electrical Engineering, 22(01), 65.

Ruliyanto, R. (2020). Effect of Load Imbalance on Neutral Current and Ground Current in Transformer 1 and Transformer 2 at Momentary Peak Load. J Ilm Giga, 23(1):27.

Safril Hudan, I & Rijanto, T. (2019). Design and Development of an Electric Power Monitoring System in Boarding Rooms Based on the Internet of Things. Journal, Vol 8, No. 1, p: 91-99.

Setiana, H., Zein, MH., Yuspita, OI. (2023). Internet Based Electrical Power Quality Monitoring of

Suwarti Widyastuti, D., Basuki, A & Nugroho Sulistyo, E. (2020). Electrical Power Monitoring of the Yogyakarta National Institute of Technology's Electrical Installation Laboratory Based on the Internet of Things. Proceedings homepage: https://journal.itny.ac.id/index.php/ReTII. ISSN:1907-5995, p:046-053.

Taufiqi, M. I., Endryansyah, Rusimamto, P. W., & Achmad, F. (2021). Analysis of the Use of Single Phase AC Motor Speed Control Devices Using Bdirectional Triode Thytistor (TRIAC). Journal of Electrical Engineering, 10(2), 315-323.

Tohir. T., Habinuddin, E., Muhammad Iman, S., Ariefka Septian Putra, F., Anwar, H & Fadilah, R. (2023). A Comparative Study of Inrush Current On Star, Delta, and Star-Delta Staters for a 1.5 kW Three Phase Induction Motor with Power Quality Analyzer and Powertag. Innovation in Power and Advanced Computing Technologies (i-PACT), ieeexplore.ieee.org

Team of the Secretary General of the National Energy Council. Indonesia Energy Out Look. (2019):p.1689-99.