Cerdika: Indonesian Scientific Journal, 5 (9), 2025
p-ISSN: 2774-6291 e-ISSN: 2774-6534

Available online at http://cerdika.publikasiindonesia.id/index.php/cerdika/index

Working Principle of Contactor in Electrical System

Deitje S. Pongoh, Muhammad Arif Kurniawan Prajitno, Mutiara Gissyella Kalalo, Imanuel Rakwer Orlando Kraar, Eadvent Supit Jearty Mokalu
Politeknik Negeri Manado, Indonesia
Email: pongohdeitje@gmail.com, Prajitnoarif@gmail.com, imanuelrakwer@gmail.com, mutiarakalalo25@gmail.com, eadventm@gmail.com

Abstract
Contactors are crucial components in electrical systems that function as electromagnetic switches to control electric current in both industrial and residential settings. Although widely used, there remains a lack of understanding of the working principle, electromagnetic mechanisms, and their efficient application in electrical installations, resulting in a high risk of system failure and suboptimal energy use. This study aims to explain the working principle of contactors, electric current control mechanisms, and their role in enhancing the safety and efficiency of electrical installations. The methods used include literature studies and observational analytics, with data collected from electrical engineering learning modules, scientific journals, and articles related to contactors and electrical systems. The data are analyzed descriptively to assess how contactors operate, their applications, and benefits in various electrical systems. The results show that contactors can control high currents based on electromagnetic principles, protect electrical equipment, and facilitate system automation in electric motors, lighting, and industrial processes. A good understanding of contactors assists technicians and engineers in designing and maintaining safe, efficient, and durable electrical installations. This research provides practical guidance for the optimal implementation of contactors and serves as a foundation for further research on improving the efficiency and safety of electrical systems.

Keywords: Working Principle, Contactors, Electrical Systems

Article Info:
Submitted: 2025-09-09 ***Final Revised***: 2025-09-12 ***Accepted***: 2025-06-13 ***Published***: 2025-06-13
**Correspondence Author: Deitje S. Pongoh*
Email: pongohdeitje@gmail.com

INTRODUCTION

In the electrical system, controlling electric current is very important to maintain safety and efficiency in the world of work so that unwanted incidents do not occur. The use of contactors is essential for safety (El Dabaghi & Vucetic, 2021; Hughes, 2023; Jabir et al., 2018; Lai et al., 2021; Lemian & Bode, 2022; Mazza et al., 2018). One of the main components used is the contactor, which is an electromagnetic switch that can connect or disconnect the electric current automatically. This component is widely used in industrial, household, and protection systems, especially in circuits that require high current control, such as electric motor control systems in industry (De Klerk & Saha, 2021; Nguyen et al., 2020; Wang et al., 2022; Y. Zhang et al., 2021; Zhukovskiy et al., 2023).

Contactors are used to control large electric motors, such as 3-phase motors. By using a contactor, the motor can be turned on and off automatically through a control circuit, such as a dol stater or delta star, to reduce the amount of starting current on a 3-phase electric motor. The contactor works by utilizing the magnetic field generated by the coil when it is subjected to electric current, so that the main contacts can be opened or closed to regulate the flow of electricity. Thanks to its ability to handle large currents and operate automatically, contactors are an essential element in electric power systems (Kurniawan & Yandri, 2020; Siburian et al., 2021; Wang et al., 2021; H. Zhang et al., 2020).

Several previous studies have addressed the role of contactors in industrial electrical systems. For example, the study by Abdullah et al. (2021) emphasized the use of contactors for the control of electric motors in automation-based factories, but this study focuses more on the mechanical and performance aspects of the motor, emphasizing less the analysis of overall safety and energy efficiency. Meanwhile, Setiawan and Nugroho (2022) examined the effectiveness of electromagnetic switches in household installations, but their research was limited to the use of low current and did not examine the application of contactors on an industrial scale with high current.

This research is here to fill this gap by analyzing the working principle, electromagnetic mechanism, and the main role of contactors in various electrical applications. The purpose of this research is to provide a comprehensive understanding for technicians, electrical engineering students, and industry practitioners in order to design and maintain a safer, more efficient, and more durable electrical system. The benefits are expected to be practical guidance in the optimal application of contactors, as well as a basis for further research on improving energy efficiency and safety in modern electrical systems.

RESEARCH METHOD

This research was conducted using a literature study method by collecting information from various sources such as books, journals, and articles related to contactors in electrical systems. The collected sources were used to explain the working principle of contactors, their application in industrial settings, and their role in safety and protection systems within the industry. This study focused on the use of contactors not only for efficiency but also for improving workplace safety, particularly in occupational health and safety (K3).

The research highlighted how contactors are often combined with other protective components, such as MCBs and Thermal Overload Relays (TOR), to prevent damage to electrical equipment caused by overloads or electrical interference. Through this literature review, the study provided a deeper understanding of the working principle of contactors in electrical systems, serving as a useful reference for academics and students interested in this topic.

RESULTS AND DISCUSSION

Based on the results obtained, it can be concluded that the working principle of the contactor in the electrical system is based on the electromagnetic field that regulates the flow of electricity in a control circuit, namely an electromagnetic switch that can connect or disconnect the electric current automatically. This component is widely used in industrial, household, and protection systems, especially in circuits that require high current regulation, such as electric motor regulation systems in industry. Contactors act as automatic switches used to control large-capacity electrical equipment, such as electric motors, in both industrial and home applications. So when the electric current flows through the electromagnetic coil, then the resulting magnetic field will attract the contactor child to move so that the main contact of the contactor will be attracted, so as to connect or break the electric flow. So the way the contactor works is that when the electromagnetic coil in the contactor is given an electric current and a magnetic field is formed, this magnetic field will attract the main contact contacts so that the contacts that are initially open will turn into closed when given an electric current for coils A1 and A2, as well as the contacts that are initially closed when given an electric current. Then the contacts that were initially closed when the electric current was flowing will open. In the contactor component there are 2 contacts, namely Normal Open (NO) and Normal Close (NC) So these two contacts will be used in various uses such as electric motor circuits, dol stater circuits and delta star circuits for 3-phase motors and lighting systems for houses, and in industrial environments the contactors are most widely used as motor safety in buildings that use protection so that the contactor can be used.

along with Thermal Overload Relay (TOR). That is its function as overload protection so that the security system in buildings can run properly in accordance with occupational health and safety (K3) standards.

Discussion

Contactor is one of the components in electrical installations that is usually used in industry, usually used in 3-phase electric motors or lighting, the working principle of the contactor is that when an electric current is flowed there will be an electromagnetic field on the contactor which will attract a coil that will close and open the contactor child, Contactor or often called contact relay is an electrical component that functions as a connector and alternating electric current disconnect automatically, on the contactor there are switches with NO (Normally Open) and NC (Normally Close) types as well as coils. Reporting from the book Basic Electrical Power Installation (2020) by Lauhil Mahfudz Hayusman, in general, this contactor is divided into three types, namely coils, main contacts, and auxiliary contacts. The coils, coils A1 and A2 contained in the contactor function to change the condition of the contact child which was previously NO (Normally Open) will be NC (Normally Close) and vice versa is connected to a 220 volt voltage source which is controlled through the start or stop press button, the main contact, the main contact on the top side is used as input from a 3-phase source whose code number is 1, 3 and 5 are for input, while at the bottom it is used for output or you can say that it is input to the load (Load) with code 2, the auxiliary contact on the contactor has two conditions, namely the auxiliary contact Normally Open (NO) with codes 13 and 14 which functions as a locking contact whose purpose is to lock the contactor so that it can continue to work. The Normally close (NC) auxiliary contacts with codes 21 and 22 can be connected with the indicator light or (pilot lamp) as a sign that the system is active (MCB ON) but not yet running (Push Button Start). Contactors have several types, including, directional reversal contactors, non-directional reversing contactors, mechanical locking contactors, open delay type contactors, 1-phase contactors, 3-phase contactors, dc contactors.

For the former, a reversal contactor whose purpose is to reverse the direction of rotation, for a 3-phase motor that works in both forward and backward directions. This is usually done by swapping two alternately acting contactors, the voltage entering the load of a 3-phase electric motor. Contactor for 3 phase stater electric motor to reverse the direction of rotation of the 3 phase motor forward or backward as part of the circuit for electric motor. Reversing contactors have an interlocking or interlocking system that is used to ensure that only forward or reverse staters can be used at any given time but not at the same time. When the motor is activated, the motor will rotate in one direction and when the reversing contactor is activated, the motor will reverse the direction of rotation. The contactor consists of an electromagnetic system when the contactor is given an electric current then the magnetic field will attract the contactor.

1) Reversible Contactor: a contactor that functions to divert electricity from the banner pin. Interlock Contactor: a contactor that can lock and ensure only one circuit is capable of connecting.
2) Electromagnetic Contactors: contactors that apply electromagnetic principles to control electricity.

Mechanical locking contactors are available in a variety of applications, including:

1) Industrial electrical systems: mechanical locking contactors are used to control and regulate the flow of electricity in industrial electrical systems.
2) Building electrical system: mechanical activation contactors are used to control and regulate the flow of electricity in a building's electrical system.
3) Vehicle system motor control: the vehicle electrical system motor control locking contactor is used to control and regulate the electric current in the vehicle's electrical system.

A Time Delay Release (TDR) type contactor is a type of contactor designed to delay the opening of the contactor for a predetermined time after the control signal is lost.

Characteristics of Open Delay Type Replacement Contactor

1) Time-delay type contactors: Open-delay type contactors have a time-delay feature so that the contactor will remain in the closed position for some time after the controller's signal is removed.
2) Time request: The delay time adjusts to the app's compatibility.
3) Safety function: The open delay type contactor can be used as safety equipment to prevent dynamic interference or damage to the system.

Duration of Contact Time Opening Type

1) Industrial electrical system delay type office: Artificial contactors are made for industrial electrical systems, control and control of electrical flow.
2) Building electrical system: Open Channel delay type lever contactors are applied to the building's electrical system to regulate and suppress the flow of electricity.
3) Automatic control of the sonraki system. Sgt. sal type contactors are used to control and regulate the automatic process.

Benefits of Time Delay Breaker Type Contactors

1) Improve Safety: Open delay type contactors can improve system safety by preventing interference or damage.
2) Lower risk: Open delay type contactors can lower the risk of accidents or accidents to the system.
3) Increased efficiency: The open delay type contactor can improve the efficiency of the system by accurately controlling & adjusting the electric current.

A 1-phase contactor is a type of contactor designed to control the electric current in a 1-phase system. Most control applications use 1-phase contactors, as they do not require time and operation in terms of controlling electrical current in systems that use 1 phase, examples of applications include:

1 Phase Contactor Application

1) * Household electrical system:* A 3-phase contactor is used to control and determine the flow of electricity in a household electrical system.
2) Use of small industrial electrical systems: 1-phase contactors are used to control or control electric current in small industrial electrical systems.
3) Automatic system control: A 1-phase contactor is used in an automated system, to command and control additional automatic processes.

Contactor Type 1 Phase

1) Magnetic Contactors: Magnetic contactors work using the principle of fixed magnetism to control and regulate electric current.
2) Electromechanical Contactors: Electromechanical contactors with electromechanical principles control and regulate electric current.
3) Electronic Contactors: Electronic contactors are contactors that use electronic principles to drive and regulate the flow of electric current.

Specification of 1 Phase Contactor

1) Voltage: The 1-phase contactor has a working current of 230 VA, 240 VA ....
2) Power: (1-phase contactor) the working current varies, i.e. 10A, 20A, and others.
3) Frequency: The 1-phase contactor has a wide range of working frequencies, including 50Hz, 60Hz.

A 3-phase contactor is a type of contactor designed to control and regulate the flow of electricity in a 3-phase system. 3-phase contactors are commonly used in application systems that require the regulation and control of electrical flow in a 3-phase system, namely:

3 Phase Contactor Application

1) Industrial electrical systems: 3-phase contactors are commonly used to control the flow of electricity in industrial electrical systems.

2) Building electrical system: 3-phase contactor for flow control in building electrical systems.
3) Automatic Control System: A 3-phase contactor is used in the automatic control system to control and adjust all automatic processes.

3 Phase Contactor Type

1) Magnetic Contactors: Magnetic contactors use magnetic means to control and regulate electric current.
2) Electromechanical Contactors: Electromechanical contactors can control and anticipate the flow of electricity through electromechanics.
3) Electronic Contactors: Electronic contactors are designed using electronic principles.

CONCLUSION

Contactors play a crucial role in electrical systems by automatically controlling the flow of electricity through the electromagnetic field generated by current flowing through their coils, which enables them to connect or disconnect circuits remotely. Widely used in various settings—from industrial environments to residential lighting—contactors provide efficient, fast, and safe operation without direct interaction with high-voltage components. Their functionality extends beyond simple switching to being essential components in automatic control systems across many applications. Future research could explore advanced control techniques and integration of smart technologies to further enhance the efficiency, reliability, and safety of contactor-based systems.

REFERENCES

De Klerk, M. L., & Saha, A. K. (2021). A Comprehensive Review of Advanced Traction Motor Control Techniques Suitable for Electric Vehicle Applications. *IEEE Access*, *9*. https://doi.org/10.1109/ACCESS.2021.3110736

El Dabaghi, N., & Vucetic, J. (2021). Electrical power systems. In *Pressurized Heavy Water Reactors: CANDU*. https://doi.org/10.1016/B978-0-12-822054-2.00006-4

Hughes, P. (2023). Electrical systems. In *Instrumentation and Control Systems for Nuclear Power Plants*. https://doi.org/10.1016/B978-0-08-102836-0.00001-1

Jabir, H. J., Teh, J., Ishak, D., & Abunima, H. (2018). Impacts of demand-side management on electrical power systems: A review. In *Energies* (Vol. 11, Issue 5). https://doi.org/10.3390/en11051050

Kurniawan, A., & Yandri, W. (2020). Operasi Motor Listrik Dengan Sistem Kendali Star Delta Menggunakan Plc Zelio Sr3B101Fu. *Jurnal Ensiklopedia*, *2*(5).

Lai, C. S., Locatelli, G., Pimm, A., Wu, X., & Lai, L. L. (2021). A review on long-term electrical power system modeling with energy storage. In *Journal of Cleaner Production* (Vol. 280). https://doi.org/10.1016/j.jclepro.2020.124298

Lemian, D., & Bode, F. (2022). Battery-Supercapacitor Energy Storage Systems for Electrical Vehicles: A Review. In *Energies* (Vol. 15, Issue 15). https://doi.org/10.3390/en15155683

Mazza, A., Bompard, E., & Chicco, G. (2018). Applications of power to gas technologies in emerging electrical systems. In *Renewable and Sustainable Energy Reviews* (Vol. 92). https://doi.org/10.1016/j.rser.2018.04.072

Nguyen, B. M., Van Nguyen, H., Ta-Cao, M., & Kawanishi, M. (2020). Longitudinalmodelling and control of in-wheel-motor electric vehicles as multi-agent systems. *Energies*, *13*(20). https://doi.org/10.3390/en13205437

Siburian, J., Jumari, [1]), Simangunsong, A., Darma, U., & Medan, A. (2021). Studi Sistem Star Motor Induksi 3 Phasa Dengan Metode Star Delta Pada Pt.Toba Pulp Lestari Tbk. *Jurnal Teknologi Energi Uda: Jurnal Teknik Elektro*, *9*(2).

Wang, Z., Ching, T. W., Huang, S., Wang, H., & Xu, T. (2021). Challenges Faced by Electric Vehicle Motors and Their Solutions. *IEEE Access*, *9*. https://doi.org/10.1109/ACCESS.2020.3045716

Wang, Z., Zhou, J., & Rizzoni, G. (2022). A review of architectures and control strategies of dual-motor coupling powertrain systems for battery electric vehicles. In *Renewable and Sustainable Energy Reviews* (Vol. 162). https://doi.org/10.1016/j.rser.2022.112455

Zhang, H., Guzman, A. R., Wippold, J. A., Li, Y., Dai, J., Huang, C., & Han, A. (2020). An ultra high-efficiency droplet microfluidics platform using automatically synchronized droplet pairing and merging. *Lab on a Chip*, *20*(21). https://doi.org/10.1039/d0lc00757a

Zhang, Y., Zhang, Y., Ai, Z., Murphey, Y. L., & Zhang, J. (2021). Energy Optimal Control of Motor Drive System for Extending Ranges of Electric Vehicles. *IEEE Transactions on Industrial Electronics*, *68*(2). https://doi.org/10.1109/TIE.2019.2947841

Zhukovskiy, Y. L., Vasilev, B. Y., Korolev, N. A., & Malkova, Y. M. (2023). Analysis of the behavior of asynchronous electric drive with a closed scalar control system when changing the inductance of the magnetizing circuit. *Indonesian Journal of Science and Technology*, *8*(1). https://doi.org/10.17509/ijost.v8i1.51983