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THE TCR 5000 CONSTANT CURRENT REGULATOR'S SAFETY DESIGN UTILIZING PROGRAMMABLE LOGISTIC CONTROL

Basil Aldrian Prawiraatmaja[1], Arini Zulfa Himayati[1], Annisa Baby Callista[2], Vania Nadhifa Azzahra[2]

[1]Politeknik Penerbangan Indonesia Curug, [2]Politeknik Penerbangan Palembang,
Correspondence e-mail: arzul28@ppicurug.ac.id

Abstract

Air transportation must have security procedures from landing to taking off the plane in the application of the plane guided by the Airfield Lighting System (ALS). CCR type 5000 is one of them to provide visible information on the aircraft. At Husein Sastranegara Airport, damage often occurs on the module due to a poor grounding system and non-standard insulation resistance. This research aims to design CCR safety with TCR 5000 type, which can be applied to Husein Sastranegara International Airport concerning regulatory standards and will be outlined in this research. This research has the following objectives: to design a safety device for the CCR with TCR 5000 type, to prevent damage to the CCR module, and to be used as a reference for airport management. This study's research and development (R&D) methodology begins with observation. According to the study's findings, the PLC-based CCR 5000-type CCR safety design can reduce damage to the CCR module. The PLC will turn off the CCR's power supply if it detects an overcurrent. The buzzer will sound to facilitate technicians' ability to determine whether the CCR type TCR 5000 is experiencing overcurrent.

Keywords: Constant Current Regulator, PLC, TCR 5000, Safety

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Introduction

In the modern era, the Republic of Indonesia is a country that has a relatively large and developed area and is required to follow developments in other developing countries in the world to become one of the most developed countries in the world. Transportation is a significant component in living, government, and social systems. The socio–demographic conditions of the region influence transportation performance. The population density level will significantly influence the ability of transportation to serve community needs. The trend is a high population increase in urban areas due to the birth rate and urbanization. The level of urbanization has implications for increasing population density, which directly or indirectly reduces the competitiveness of transportation regions (Bisaschi et al., 2021).

The increase in population density made Indonesia prepare all aspects of welfare, education, transportation, infrastructure, and others to support this. The availability of transportation or transportation services must support it. Transportation is the heart of activities, especially in Indonesia, because Indonesia is an archipelagic country. To keep this, Indonesia has three types of transportation, namely land, sea, and air transportation, to connect regions or islands in Indonesia so that economic growth can accelerate and equalize. Of the three types of transportation, service users prefer air transportation because it is valued as more efficient and less time-consuming than other transportation services that take longer and are tiring. Air transportation can also reach places that can't be reached by land or sea, if possible, moves faster, has a straighter trajectory, and is practically hassle-free (Baiq, 2015). Therefore, each year, there will be an increase in passengers, cargo, airlines, and aviation, as well as significant airport development of air transportation services.

Airports, as a part of air transport service areas on land and or water certain boundaries, are used as a place for aircraft to land and take off, boarding and disembarking passengers, loading and unloading goods, and places of intra- and inter-modal movement transportation, which is equipped with facilities for aviation safety and security, as well as facilities basic and other supporting facilities (Pratama & Haryati, 2023). With the yearly increase in air transportation services, relying on sophisticated and adequate technology is insufficient. Husein Sastranegara International Airport is a civil enclave airport (in the TNI-AU environment) that serves scheduled commercial flights with domestic routes, international flights, and general aviation. It is located in the Bandung area of West Java and has the ICAO code WICC and the IATA code BDO. The airport is managed internationally by PT. Angkasa Pura II (Persero) (Dina, 2017).

Another important thing besides the equipment is human resources, so the Indonesian government has created a series of educational programs to produce human resources with competence and insight in aviation. Based on personnel competency standards in Airport Electrical Engineering by KP 22 of 2015, Airport Electrical Engineering personnel expert level can maintain, carry out maintenance and maintenance, repair maintenance, analyze problems or damage, and plan or design installations or change airport electrical facilities and equipment systems. Facilities include an Airfield Lighting System, Constant Current Regulator, Transmission and Distribution, Generator Set/ACOS, Uninterruptible Power Supply and Solar Cell, and Aircraft Docking Guidance System.

Air transportation must have security procedures from landing to taking off the plane in the application of the aircraft guided by the Airfield Lighting System (ALS). The purpose of ALS is to provide visible information on the aircraft. This system includes aircraft luminaires during approach, landing, and taxi operations (RI Sudjoko et al., 2021). So, the facilities and infrastructure at Husein Sastranegara International Airport require electricity, which must be of high quality. According to KP 2 of 2013, Airfield Lighting (AFL) is a visual landing aid that assists and serves aircraft during take-off, landing, and taxi to move efficiently and safely. Light-assisted landing aids or lights will be on both day and

night to help aircraft movements on the runway, taxiway, and apron areas.

All equipment AFL can be operated remotely from the tower by the Air Traffic Controller or ATC and directly (locally) by an electrician, namely on equipment. To keep the current constant to fulfill Airport Lighting System lighting circuit power supply requirements, CCR is required. Radiation intensity light from visual aids can be grouped at high, medium, and low intensity. The light emission intensity must meet International Civil Aviation Organization (ICAO) standards according to existing technical specifications (Nadya, 2020).

CCR is a power supply used in aviation to provide electrical power to the airport lighting system. Where is the electric power given to the airport lighting? It is maintained to provide a power supply with a steady current (Kustori, 2017). CCR is used at Husein Sastranegara International Airport, one of which is CCR with type TCR 5000. At this airport, damage often occurs on the module due to a poor grounding system, non–standard insulation resistance (below that specified by regulations), and frequent overcurrent from the PLN supply.

Load voltage CCR must be deciphered and analyzed to see regulation of the amount of current is, of course, aimed at getting the same intensity at every point on the foundation to support operations, security, and comfort of air transportation service users at the airport (Afandi et al., 2020).Based on the background above, the researchers will design CCR safety with TCR 5000 type, which can be applied to Husein Sastranegara International Airport concerning regulatory standards and will be outlined in this research. This research has the following objectives: to design a safety device for the CCR with TCR 5000 type, to prevent damage to the CCR module, and to be used as a reference for airport management.

This research was conducted to safeguard CCR under applicable procedures and regulations. In light of the background provided, several questions arise within the scope of this research. Firstly, what is the safety system on the TCR 5000 type of CCR against overcurrent goods? The next question is whether the insulation resistance of the TCR 5000 type of CCR is based on existing regulations. The result of the problem boundaries in writing this research is adding a safety system to the CCR-based TCR 5000 type located at Husein Sastranegara Airport to minimize damage to the CCR module due to over-current.

Methods

This research uses the research and development (R&D) method, a process or steps to develop a new product or improve existing products. Developmental research is one type of research that can bridge or break the gap between basic research and applied research. (Okpatrioka, 2023). Ali Maksum suggests that the term product can be interpreted as hardware or software, such as interactive learning models, guidance models, etc. Interactive learning model, guidance model, and so on (Vebrianingtyas et al., 2022). Based on this understanding, the researcher uses a method in this writing, starting with observation. Observations were made when researchers conducted on-the-job training at Husein Sastranegara International Airport. The purpose of compliance is to describe the research that produces theories and hypotheses or, in research, can be used to test ideas and beliefs (Hayim, 2017).

Techniques for collecting data were also applied to the literature study. A literature review is a technique for gathering information or references pertaining to the subject matter covered in the study. Researchers gather data when searching by looking through national journals, citations, books, and theses relevant to their study's topic(Syarifah, 2017).

After observation and literature study, the researchers collected any data needed to support solving assignment writing this research. Interview techniques are also fundamental. The interview aims to collect complete, fair, and accurate information. At the event's start, a good interviewer must ask interesting questions (Harahap, 2019). An interview is a face-to-face situation between the interviewer and the respondent intended to dig up information expected and aims to obtain data about respondents with minimum and maximum bias efficiency (Lukman, 2013). Interview techniques are also used to collect subjective data such as sources' opinions,

attitudes, and behavior regarding a phenomenon (Hansen, 2020). This research interviewed several electrical technicians at the Electrical Mechanical Equipment Facility who work at Husein Sastranegara International Airport, Bandung.

The researchers analyze the results obtained in the field and plan the design safeguards to be created. After the design plan has been determined, the researchers prepare the design based on the data obtained as the researcher's reference for making the design. After completing the invention, the researchers checked the result of the plan. This process is carried out with guidance from an expert electrical technician.

Results And Discussions

The Airfield Lighting System (ALS) uses a device called a Constant Current Regulator (CCR) to manage the brightness and constant current of the visual aids (Rifdian et al., 2020). Where is the electric power provided for airport lighting? Provides a steady current power supply to maintain light stability constantly.

They have added protection system protection system to CCR type TCR 5000 at Husein Sastranegara International Airport. A protection system is needed to maintain the security of an electrical system, which is very good; a safe situation will be created when the electrical network experiences excess current or voltage drop caused by use, short circuit, or other disturbances (Widiantoro Anang et al., 2018). Installing a protection system on the CCR aims to minimize damage to the CCR module due to increased current.

The following conditions are generally based on the data the researchers got after doing observations in the field or at Husein Sastranegara International Airport. No protection system minimizes damage to the CCR module caused by increased current. Because no alarm or buzzer can be activated if there is an increase in current in the CCR, technicians must check the condition of the CCR indicator directly—remembering the location of the CCR at Husein SastranegaraInternational Airport, which is separate from technicians' waiting room. So, there is often an increase in current, but the technician does not notice it.

Knowing this, the researcher has the idea to design a protection system in the event of an increase in current that can trigger an alarm to make it easier for technicians to know if the recent additions are above the tolerance limit. The researcher's design is for one type of CCR at Husein Sastranegara International Airport. However, it does not rule out the possibility that this design can also be applied at all airports that use CCR of the TCR 5000 type. This design focuses on a control system to regulate the voltage connected to the CCR if excessive current occurs. It will increase effectiveness so technicians can take precautions before damage to the CCR nodules caused by excessive current occurs.

Based on the theories put forward in this research, the researchers will use them as a reference in explaining the design process. In this design, the researcher uses hardware and software design. The conditions desired by the researcher are as:

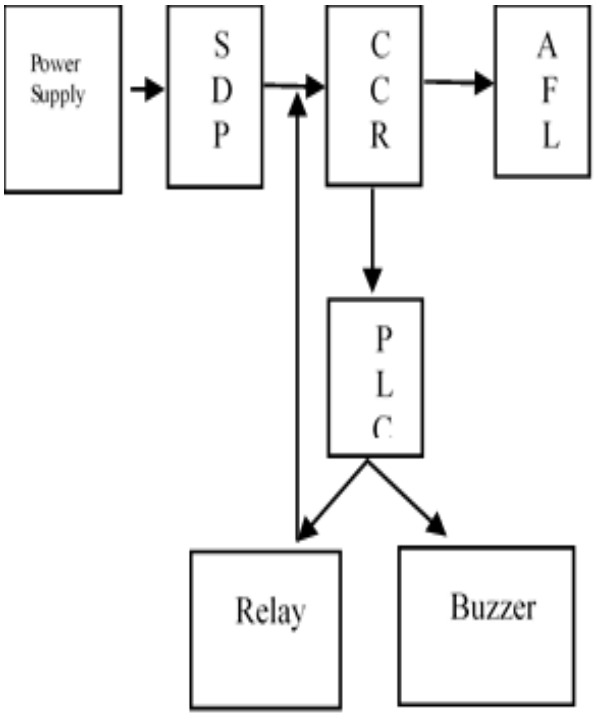

Figure 1. Desired Condition

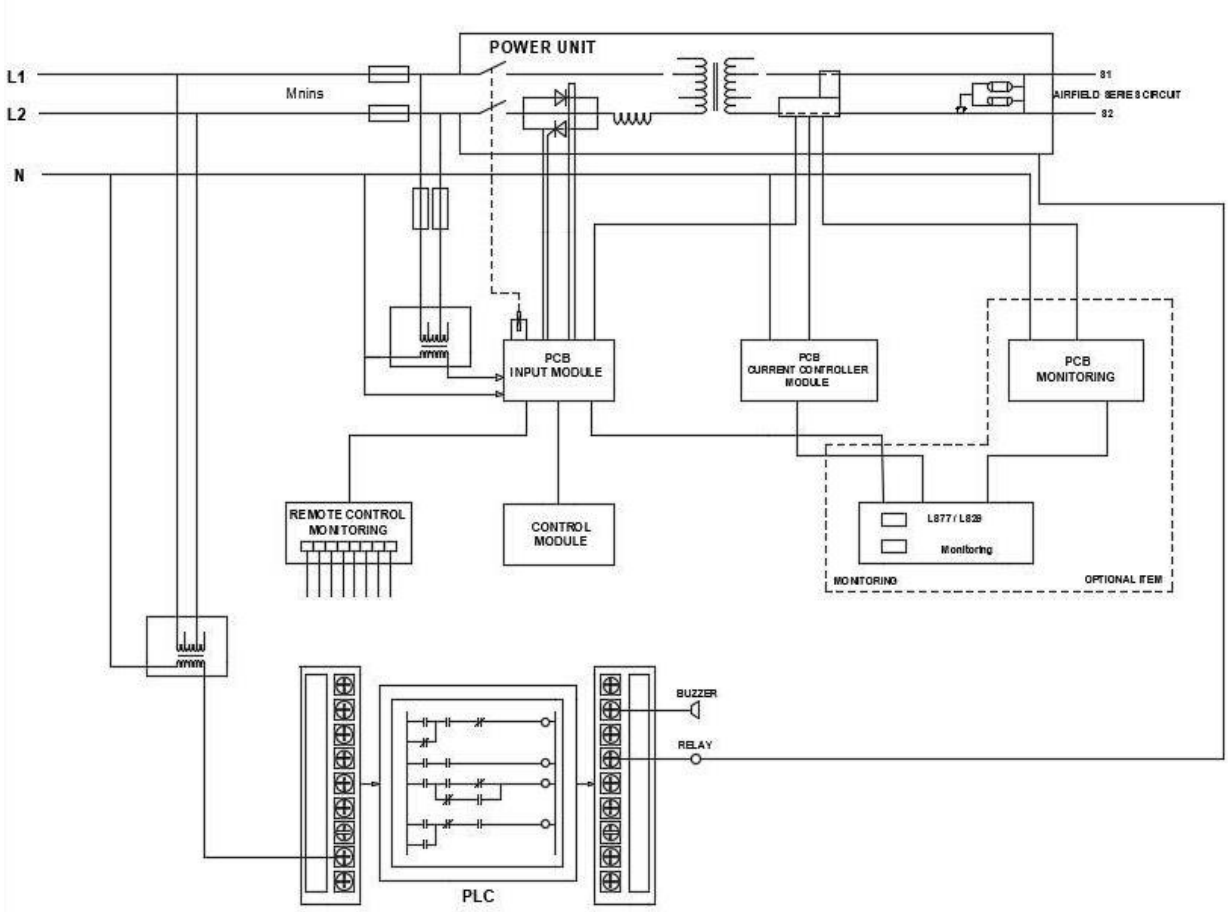

Figure 2. Diagram Block Design

Based on the block diagram above, the condition desired by the researcher is if the power source supplies the CCR. The PLC established a TCR 5000 type CCR safety design system that the researcher will design using a Mitsubishi PLC as the control center of this design. This is because the Mitsubishi PLC is easy to understand. The PLC is connected to several components, such as the CCR, which will give a signal if it detects excessive current. The relay functions as a switch to turn the CCR off or on. So, in this design, the researcher designs that if an overcurrent occurs, the relay will automatically turn off the CCR from the results of the program created by the PLC.

The PLC orders the alarm or buzzer to function as a warning to the technician if an excess current in the CCR exceeds the existing tolerance limit, namely 10% of the existing wind based on SPLN 1, 1995. Meanwhile, the relay is inactive during normal conditions, so the CCR remains on, and the alarm is static if no over-current exists. This can reduce the occurrence of damage that will occur due to overcurrent, such as the problem that happened with the TCR 5000. Stages of design making: this design consists of hardware and software. First is hardware design. In this hardware design, the researcher will discuss each series of hardware used in the plan that the researcher has created: a power supply circuit and a programmable logic control circuit.

A power supply circuit requires a power supply that will later be used as a power supply source whose output produces voltage to run the CCR. A programmable logic control circuit is the design of a PLC that acts as a device to receive signals from the CCR, which are then read and processed according to the program created and processed to provide signals to activate the relay and alarm or buzzer. In this PLC design, the call from the CCR is connected to pin X01, the alarm or

buzzer is connected to pin Y01, and the relay is connected to pin Y03.

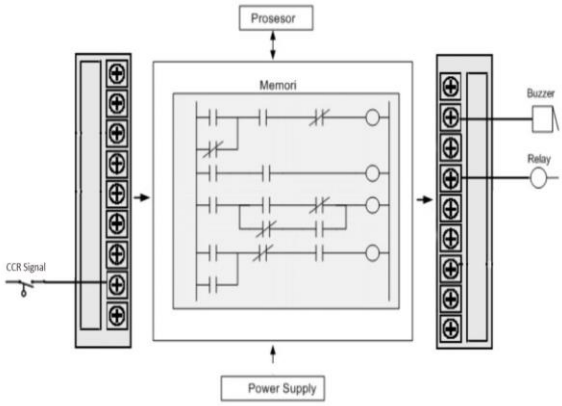

Figure 3. PLC Circuit

The second involves installing the Mitsubishi GX Developer Application and following the subsequent software design steps. It takes programming for a PLC to function at its best and become a functional system. The researcher uses the Mitsubishi GX Developer application in this design because it facilitates program creation for users. Even beginners can quickly pick up Mitsubishi GX Developer thanks to its extensive functions and straightforward programming language.

Then, use Mitsubishi GX Developer software in the following way. After ensuring that Mitsubishi GX Developer has been installed, open the application. Once open, wait a few moments until the project display appears. Click Project and New Project to create a ladder diagram program as desired, and click F4 to start simulating the program designed.

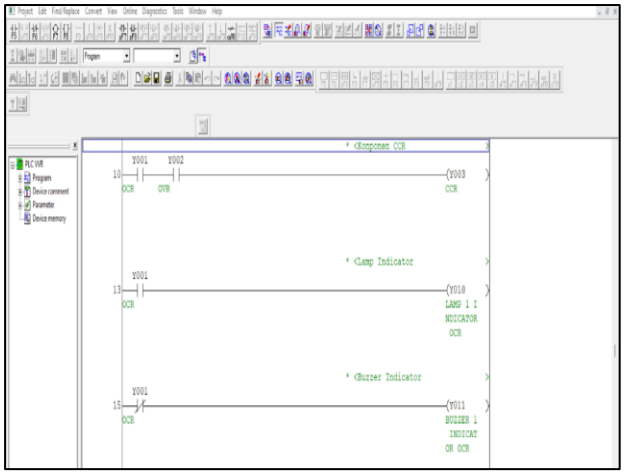

Figure 4. Mitsubishi GX Developer Window

The final stage of software design is program creation. After the Mitsubishi GX Developer application is installed, the next step is creating a PLC program. The program on the PLC is a ladder program that will later run the PLC according to what has been designed in the Mitsubishi GX Developer application—namely, CCR signals to control relays and alarms or buzzers. When excessive current is detected on the CCR, the relay will activate and cut off the voltage to the CCR so that the CCR is not damaged and activate the alarm or buzzer to the technician because there is no excessive current signal on the CCR; the PLC will trigger a relay to connect the voltage to the CCR and turn off the alarm or buzzer to indicate that conditions are expected.

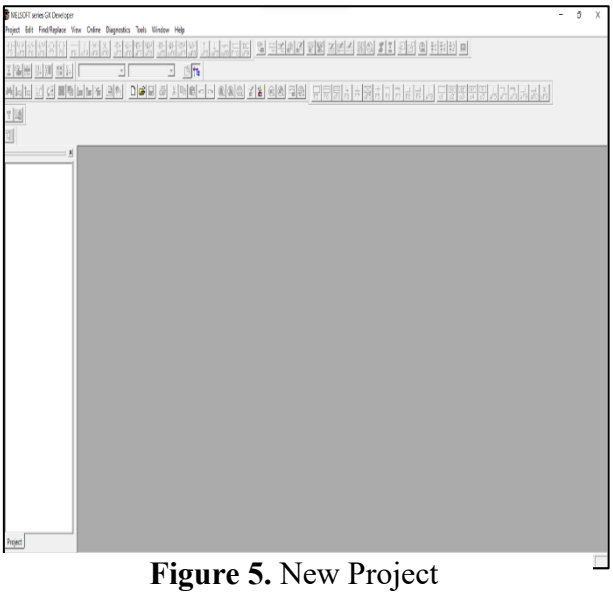

Figure 5. New Project

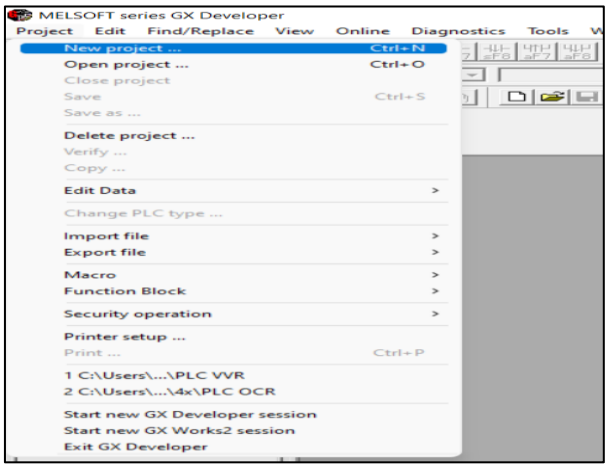

Figure 6. Ladder Diagram for PLC Program

The design will be located in the CCR room on the first floor, where there is a TCR 5000 and PLC and cable lines connecting the CCR and PLC. Meanwhile, the output of this design is in the form of a relay that will stop the CCR from working and an alarm or buzzer that will activate if an overcurrent occurs on the second floor or technician's room to make it easier for technicians to know if damage occurs to the CCR.

Based on previous research from (Rimbawati et al., 2021), PLC has become a tool used to replace conventional control system components that can be programmed by specific programming languages commonly used in automation processes. The voltage stabilizer system automatically regulates the power supplied to the dummy load whenever there is a change in frequency or voltage. Our research uses a design method with a PLC-based voltage stabilizer control system. What makes the difference with the research that the researchers made is that the concern in Rimbawa's research is voltage, but in the research that the researchers made, it is the current as discussed.

Conclusion

This research succeeded in designing CCR safety with the TCR 5000 type that applied to Husein Sastranegara International Airport concerning regulatory standards outlined in this research. This research achieved the following objectives: design a safety device for the CCR with TCR 5000 type, prevent damage to the CCR module, and be used as a reference for airport management. Based on the results and discussions the researcher has carried out, the conclusion is the PLC-based TCR 5000, the type of CCR safety design, can minimize damage to the CCR module. When overcurrent occurs, the PLC will cut off the power supply to the CCR. Also, the alarm or buzzer will be active to make it easier for technicians to know if overcurrent occurs on the TCR 5000 type of CCR. Adding a protection system to the CCR with the TCR 5000 type is essential to reduce damage to the CCR module caused by overcurrent. This design can be used as a prototype for the field.

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