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# Automatic Transfer Switch Panel Board with Multi-Pole Double-Throw Switches: An Innovation

Emerson A. Aquino[1], Engr. Eric B. Guimbaolibot[2]
[1]*Eastern Samar State University, Guiuan, Eastern Samar, Philippines*
[2]*Eastern Samar State University, Guiuan Eastern Samar, Philippines*

***Abstract: Frequent power interruptions in residential areas pose challenges to safety, convenience, and energy efficiency, particularly in households relying on multiple power sources. This study designed, developed, and evaluated an Automatic Transfer Switched Panel Board with Multi-Pole Double-Throw Switches as an innovative solution for seamless and reliable power-source transfer among utility power, generator, and solar energy systems. The study employed a quantitative descriptive research design, using a product evaluation survey to assess the aesthetics, functional efficiency, and overall acceptability of the developed system. The innovation was subjected to three phases of testing, such as benchmark, pilot, and final tests, conducted in Guiuan, Eastern Samar. Data were analyzed using descriptive statistics, particularly weighted mean scores. Results revealed an improvement across all testing phases, with the overall evaluation yielding an overall mean of 4.88, signifying high acceptability. Findings suggest that the developed ATS panel board provides efficient automatic power transfer, enhanced safety, and ease of use, while minimizing downtime during power interruptions. The study concludes that the proposed innovation is a reliable and practical solution for residential power management and recommends its adoption in communities experiencing frequent power outages, as well as further enhancement through innovative monitoring features.***

***Keywords: Automatic Transfer Switch, Panel Board, Multi-Pole Double-Throw Switch, Power Management, Technology Acceptance.***

## I. INTRODUCTION

Electricity is a controllable, convenient form of energy used for heating, lighting, and power (Masud et al., 2022). In the Philippines, electricity demand in the residential sector increased by 5.8% annually between 1982 and 2015, whereas demand in the industry sector increased by only 3.3% over the same period (Santos, 2021). From this, numerous theoretical models have been developed that are instrumental in explaining user acceptance (Xue et al., 2024), such as the environmental concern and knowledge for both types of energy saving behavior, which have hardly been investigated in a middle-income country like Philippines with growing middle classes and rising electricity demand which steadily increasing in electricity consumption (Bhattarai et. al, 2022).

Roldan Rodriquez (2024) defined a panel board as a single panel or group of panel units designed for assembly in the form of a single panel, including buses and automatic over current devices, and equipped with or without switches for the control of light, heat, or power circuits; designed to be placed in a cabinet or cutout box placed in or against a wall, partition, or other support; and accessible only from the front. Moreover, it receives electrical power from the main service entrance, typically a transformer or a generator, and then divides it into smaller circuits that feed various parts of the building. This ensures that electricity reaches all the outlets, appliances, and devices safely and efficiently. This also plays a crucial role in electrical safety by providing a convenient point for isolating and controlling circuits, facilitating maintenance, and safeguarding against overloads. It usually occurs when too many devices, or the wrong type of devices, are connected to a circuit, and short circuits occur when two bare conductors touch, causing the conductors' resistance to drop significantly (Paninsoro et al, 2024; Bwambale et al., 2022).

According to Teja and Deb (2024), a switch is a device that interrupts current flow in a circuit. When the contacts of a switch are closed, the switch creates a closed path for current to flow, and the load consumes power from the source. When the contacts of a switch are open, the load will consume no power. There are four most common types of switches in circuit design: Single Pole Single Throw (SPST), Single Pole Double Throw (SPDT), Double Pole Single Throw (DPST), and Double Pole Double Throw (DPDT). A switch pole describes the number of circuits that the switch controls, whereas switch throw describes the number of output connections each pole of the switch can have. An article by Thomasnet (2020) explains that there are four (4) types of electrical switches: single-pole throw, single-pole double-throw, double-pole single-throw, and double-pole throw. The switch consists of a single set of electrical contacts, so it has two terminals: one from each contact. It is a simple on-off switch: when open, no electricity flows; when closed, the contacts meet, and electricity is transferred.

In this case, there are three terminals—one terminal (A), faces two opposing terminals (B and C), and can be connected to either, depending on the mode. It is called a “double throw” because there are two positions this switch can operate in—A is either connected to B or to C. In a double-pole, single-throw switch, there are two poles—two sets of connectors—but only one viable position in which they connect. Each pole’s terminals connect. The first pole consists of terminals A and B, which are connected. A double-pole double-throw switch is comprised of two SPDTs. Each pole has two possible throws. The first pole, with three terminals, is comprised of A, B, and C. A can be connected to B, or A can be connected to C, as the two possible throw positions. In the second pole, there are also three terminals, D, E, and F, and two possible throws.

In the event of a power loss, an automated transfer switch (ATS) is an essential piece of electrical equipment that automatically switches the load from the primary to the backup power source. This smooth transition ensures that vital systems, such as medical facilities, data centers, and manufacturing plants, will always have power. These switches enable the secure connection or separation of various power sources from an electric load (Kaas et al., 2023).

However, despite the availability of studies on panel board functionality, circuit safety, and ATS applications, there is still limited exploration of the integration and reliability of automatic transfer switch panel boards equipped with multi-pole double-throw switches. Thus, this study was conducted to address the gap by developing an automatic transfer switch panel board with multi-pole double-throw switches, focusing on ease of use, aesthetics, functional efficiency, and cost.

### *A. Objectives of the Study*

This study was designed to develop and evaluate the acceptability of the innovative Automatic Transfer Switch (ATS) Panel Board, utilizing Multi-Pole Double-Throw (MPDT) switches, to ensure safer, seamless power transition between primary and secondary power sources.

Specifically, sought to attain the following:

1) To develop an automatic transfer switch panel board with multi-pole double-throw switches; and
2) To determine the level of acceptability based on the following criteria:

- aesthetics; and
- efficiency of its functions

## II. METHODOLOGY

### *A. Research Design*

This study employed a quantitative, descriptive design. A quantitative study, as defined by Creswell (1994), is an inquiry into a social or human problem in which numerical data are collected and analyzed using statistical tools. The study focused on statistical analysis of data collected via a survey instrument. Additionally, the standard-compliant specification and simulated operational values were derived from respondents' assessments, without undertaking product fabrication or experimental validation.

### *B. Research Locale*

The study was conducted in Guiuan, Eastern Samar. Most specifically, the residential houses in the town proper of Guiuan, Eastern Samar. This study site was selected due to the accessibility of respondents and the significant number of households in the area that use electricity as their primary source of power and pay an average monthly bill, which is believed to benefit the residents of Guiuan, Eastern Samar.

### *C. Respondents of the Study*

The respondents of the study were the residents of Guiuan, Eastern Samar, who are using three power sources, such as electricity from ESAMELCO, solar power, and a generator. The respondents were selected using a purposive sampling, considering that the respondents of this study are only those who are using three power sources. The respondents of the study were selected according to specific inclusion and exclusion criteria. For the inclusion criteria, the respondents must be residents of Guiuan, Eastern Samar, ageing 18 years old and above and were either household owners or authorized adult representative, actively using three power sources-electricity supplied by ESAMELCO, a solar power, and a generator set for atleast six (6) months, eligible and has sufficient experience in managing and utilizing multiple power sources, and available and willing to participate in the study. However, respondents were excluded from participation if they used only two (2) power sources and were not permanently residing in Guiuan, Eastern Samar, such as visitors, tourists, and minors. Likewise, those who are not directly responsible for or knowledgeable about their household power system, and who are not available or willing to participate.

### *D. Research Instrument*

In this study a survey questionnaire was used to gather data from the respondents. According to Churchill (1979), a product evaluation survey questionnaire is a tool used to systematically collect data from users or participants about their experiences, perceptions, and satisfaction with a product. Thus, this tool is useful in evaluating the respondents' responses with regards to the functionality and acceptability of the product. In connection to this, the survey questionnaire was divided into three (3) parts. Divided as Part I Aesthetics, Part II: Efficiency of its function, and Part III; Acceptability of its Product. The instrument was validated by experts in the field to ensure that the instrument suited to the study and appropriate to the locale of the study.

### *E. Data Collection Procedure*

The data gathering procedure for the innovation involving an automatic transfer switch (ATS) panel board with multi-pole throw switches began with the preparation and sending of a formal request letter to the identified participants. This letter explained the purpose of the study, the significance of the innovation, and the role of participants in providing relevant insights. Once consent was obtained, questionnaires were distributed to the participants, and the demonstration of the product was done by the researcher, which focused on the performance, efficiency, reliability, and usability of the ATS panel board innovation. After allowing sufficient time for responses, the completed questionnaires were collected for analysis. The gathered data served as the basis for evaluating the effectiveness of the innovative ATS design in real-world applications. Moreover, the data gathered was handled with strict cconfidentiality and was used solely for research purposes.

### *F. Data Analysis*

After the data was collected and tallied, it was run through SPSS to get the descriptive results of the data for analysis of the respondents' evaluation of the automatic transfer switch (ATS) panel board with multi-pole throw switches. Mean was used in presenting the results using the following indicators:

| Range | Scale | Description | Interpretation |
|---|---|---|---|
| 4.21 – 5.00 | 5 | Strongly Agree | Highly Acceptable |
| 3.41 – 4.20 | 4 | Agree | Acceptable |
| 2.61 – 3.40 | 3 | Neutral | Moderately Acceptable |
| 1.81 – 2.60 | 2 | Disagree | Not Acceptable |
| 1.00 – 1.80 | 1 | Strongly Disagree | Highly Not Acceptable |

## III. RESULTS AND DISCUSSION

This section presents the product development process and the results of product acceptability based on respondents' assessments. The presentation starts from the different materials used in the development of the product followed by the developmental procedure. Lastly, is the assessment of the product in its level of acceptability considering the ease of use, aesthetics, efficiency of its functions, and cost.

### *A. Materials and Equipment Used*

Core Electrical Components

| Component | Description / Function |
|---|---|
| Automatic Transfer Switch (ATS) | Automatically switches the load between the main power source and a backup generator. |
| Safety Breaker | Provides a manual disconnect and localized protection for specific circuits. |
| Circuit Breaker | Protects the system from overcurrent and short circuits. |
| Panel Board | Having the dimensions of 40cm (W) x 50cm (L) x 20cm (T). Houses all breakers and the ATS. |
| Wire (6.0 mm²) | Heavy-duty wiring suited for high-current applications. |
| Fasteners | Screws and Bolts are used for securing components to the panel and frame. |

The essential hand tools for precise assembly and wiring of the panel board included long-nose, side-cutting, and diagonal pliers, as well as electrical tape. However, to test the power, a multi-tester (multimeter), screw tester, and electric drill were also used by the researcher.

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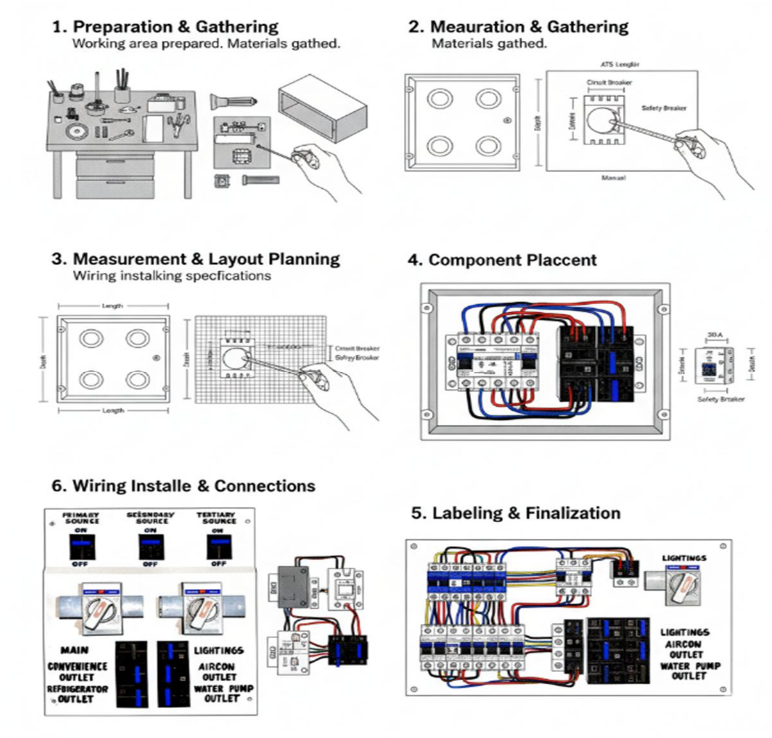


Figure 1. The Developmental Process

### B. *Evaluation of the Product*

The researcher conducted three tests to assess the acceptability and functionality of the Automatic Transfer Switch Panel Board with Multi-Pole Double-Throw Switch. In testing the model, the researcher used three (3) measurement instruments; each criterion was explained to respondents for rating purposes. Initially, the researcher conducted the benchmark test with assistance from his research adviser. After evaluating the product, the researcher conducted pilot testing with faculty experts at Eastern Samar State University, and end users evaluated for the final test.

1) Evaluation of the Product in terms of Aesthetics: It is presented in table 1 the results of the evaluation from different tests conducted.

Table 1
Evaluation of the Product in terms of Aesthetics

| Items | Mean | | | Overall Acceptability | Interpretation |
|---|---|---|---|---|---|
| | *Benchmark Test* | *Pilot Test* | *Final Test* | | |
| It is visually appealing to me. | 3.91 | 4.63 | 4.82 | 4.45 | Highly Acceptable |
| It is well-designed. | 4.01 | 4.71 | 4.94 | 4.55 | Highly Acceptable |
| The product's appearance aligns with my personal preference. | 3.93 | 4.80 | 4.91 | 4.55 | Highly Acceptable |
| The design is modern and up-to-date. | 4.04 | 4.72 | 4.90 | 4.55 | Highly Acceptable |
| The product's appearance is unique and distinctive. | 4.04 | 4.74 | 4.87 | 4.55 | Highly Acceptable |
| Overall Mean | 3.98 | 4.72 | 4.88 | 4.55 | Highly Acceptable |

4.21-5.00 – Highly Acceptable; 3.41, 4.20 – Acceptable; 2.61 – 3.40 – Moderately Acceptable; 1.81 – 2.60 – Not Acceptable; 1.00 – 1.80 – Highly Not Acceptable

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As reflected in the table, there is a consistent improvement of the product in terms of its aesthetic quality as reflected in the increasing mean scores from the different tests. During the benchmark test, the items "The design is modern and up-to-date" and "The product's appearance is unique and distinctive" obtained the highest mean score (M=4.04), interpreted as "Acceptable." In contrast, the item on visual appeal got the lowest mean (M=3.91) and personal preference (M=3.93), which implies a need for potential aesthetic enhancement.

After the refinement of the product, the pilot test was conducted by experts, and there was an increase in mean scores across all indicators. As shown, the item "The product's appearance aligns my personal preference" received the highest mean score (M=4.80), indicating that the researcher's adjustment to the product resonates with experts' expectations. Furthermore, considering the changes in the mean score of all the indicators significantly implies that there was an effective enhancement of the product's visual appeal.

In the final test, the item "It is well-designed" got the highest mean score (M=4.94), highlighting a strong approval from the respondents concerning the overall form and layout of the product. Having the overall mean of 4.88 and consistently having a high mean score across other items suggests that the product not only improves but also stabilizes at a high acceptable level.

The overall mean of 4.55, with an interpretation of "Highly Acceptable," signifies that the product has a strong aesthetic design that meets the expectations of the users. The upward trends based on the results from benchmark to final test underscore the iterative design process as well as validate the significance of incorporating user feedback on the development of the product. Generally, the product is well-crafted and distinctive, which has potential for wider adoption.

These findings are supported by Murphey et al. (2021), who strongly noted that testing and refining of products based on the evaluation and observation of the validators allows the product to transcend from mere functionality to a stabilized high-quality outcome. Similarly, Pandey and Sinha (2022) suggested that visual appeal serves as a primary signal of product quality, aligning with user preferences.

*2)* Evaluation of the Product in terms of the Efficiency of its Function: In Table 1, the evaluation results from various tests assessing the product's functional efficiency are presented.

Table 2
Evaluation of the Product in terms of the Efficiency of its Function

| Items | Mean | | | Overall Acceptability | Interpretation |
|---|---|---|---|---|---|
| | *Benchmark Test* | *Pilot Test* | *Final Test* | | |
| It is easy to use. | 4.17 | 4.31 | 4.78 | 4.42 | Highly Acceptable |
| It is intuitive and straightforward to operate. | 3.94 | 4.63 | 4.83 | 4.47 | Highly Acceptable |
| It requires minimal effort to use. | 3.91 | 4.51 | 4.71 | 4.38 | Highly Acceptable |
| It performs its intended function well. | 3.96 | 4.32 | 4.96 | 4.41 | Highly Acceptable |
| I am satisfied with the speed and effectiveness of its functionality. | 4.03 | 4.58 | 4.84 | 4.48 | Highly Acceptable |
| Overall Mean | 4.00 | 4.47 | 4.82 | 4.43 | Highly Acceptable |

4.21-5.00 – Highly Acceptable; 3.41, 4.20 – Acceptable; 2.61 – 3.40 – Moderately Acceptable; 1.81 – 2.60 – Not Acceptable; 1.00 – 1.80 – Highly Not Acceptable

Table 2 presents the results for the efficiency of the product in terms of its function from the benchmark to the final test. As reflected in the results, for the benchmark test, the highest mean score is observed for the item "It is easy to use" (M=4.17), which entails that the product is user-friendly. However, a low mean score for the item "It requires minimal effort to use" (M=3.91), which serves as an area that needs to be focused on for further improvement. The overall mean score of 4.00 indicates that the product is perceived as "Acceptable".

The pilot testing was run after the enhancement was made based on the results of the pilot testing. Notably, the item "It is intuitive and straightforward to operate" (M=4.63) obtained the highest mean score, signifying that the design and functional adjustment effectively improved user understanding and operational simplicity. The overall mean score of 4.47 suggests that the modification made from the benchmark test enhanced the product's usability.

The final test resulted in an overall mean score ranging from 4.71 to 4.96, which signifies a "Highly Acceptable" product in terms of its efficiency. The item "It performs its intended function well" (M=4.96) attained the highest mean score, which encapsulates the product's effectiveness and reliability. Additionally, a high mean score from all other items, such as ease of use, minimal effort required, and satisfaction with the speed, indicates that the product performs efficiently and meets the expectations of the users.

The overall acceptability of the product's efficiency has a mean score of 4.43, interpreted as "Highly Acceptable," indicating that users highly regard the product's efficiency. It is easy to use, efficient, and reliable, making it suitable for broader implementation.

The results are supported by Phasio (2025) on the iterative testing framework, which they concluded the critical need for reducing efforts, which are the common findings in early-stage engineering. However, based on the results of the study, the subsequent increase in the mean rating score signifying an operational simplicity confirms that the design of the product, from its enhancement, effectively harmonized the product's technical capabilities for end users' convenience.

## IV. CONCLUSIONS

The findings of the study confirm that the Automatic Transfer Switch Panel Board with Multi-Pole Double Throw Switches is a highly effective and reliable innovation for automatic power transfer. The consistent increase in mean scores from the benchmark test to the final test indicates a significant enhancement in the product performance and user satisfaction. The final evaluation results, rated highly acceptable, validate the innovation's capacity to enable seamless and safe transitions between power sources, minimizing electrical downtime and improving overall energy system efficiency. It is recommended that the innovation be adopted in settings requiring a reliable backup power system, especially in areas prone to frequent power outages. Users and electricians may be provided with training materials to ensure proper installation, operation, and maintenance of the system. Moreover, future exploration may focus on scaling the design for larger or more complex power systems. Likewise, it may add features such as remote monitoring, system diagnostics, and mobile alert as add-ons to the product to enhance its functionality.

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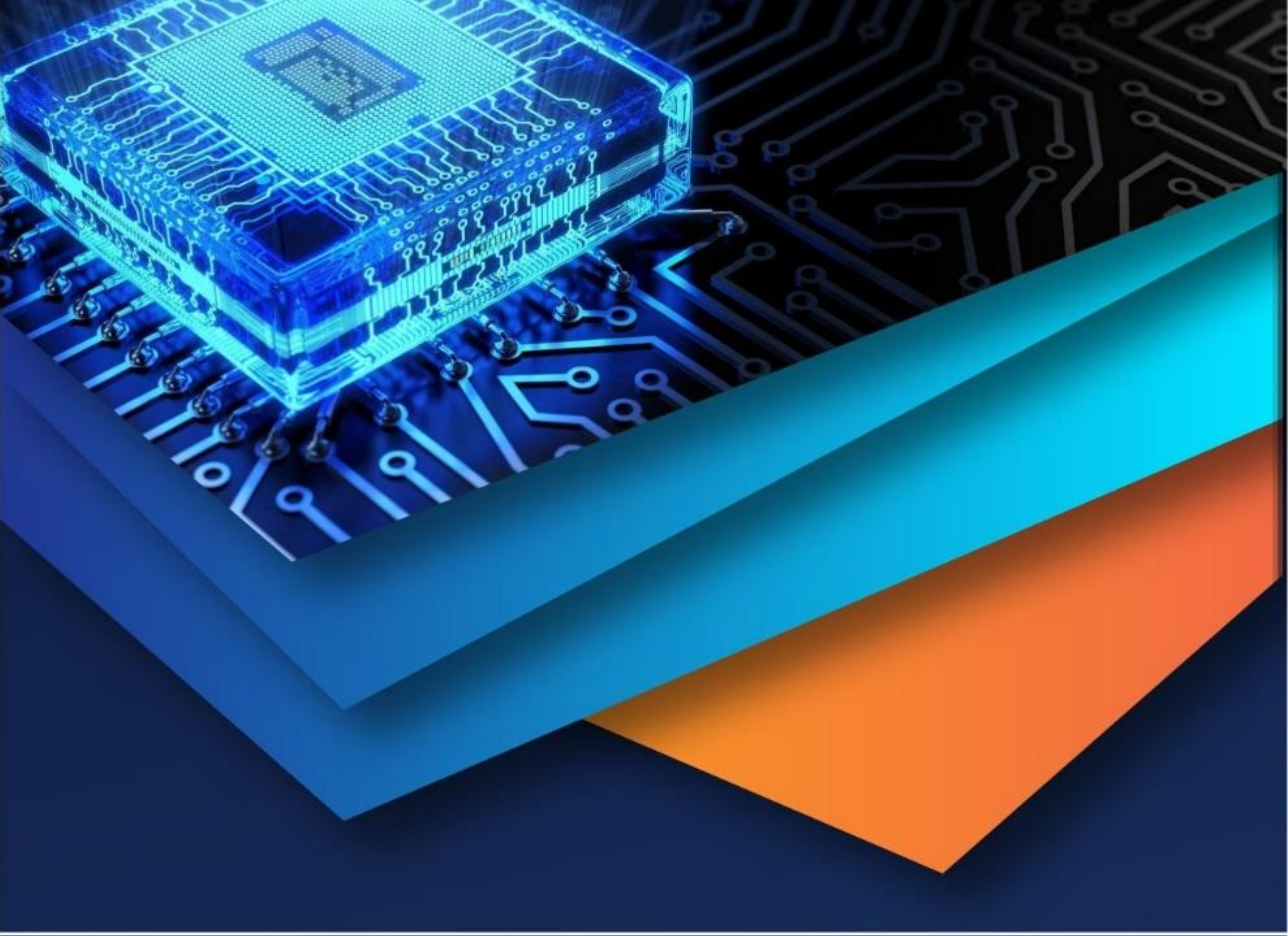


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