Electrical System Design for a Telecommunication Tower at Site Mdn302 Mabar Gudang, Medan City

Wahyu Pranata[1], Dino Erivianto[2], Parlin Siagian[3]
Universitas Pembangunan Panca Budi, Medan, North Sumatera, Indonesia
Email: wahyupranata25@gmail.com

This study discusses the analysis of the electrical system at the MDN302 Mabar Gudang Site, which is used to support the operation of telecommunications equipment. The electricity supply at the site comes from a three-phase PLN network with a voltage of 380/220 V, but the installed operational loads use a single-phase system (phase–neutral). The study was conducted through field surveys, electrical parameter measurements, and technical calculation analysis to evaluate the performance of the electrical distribution system. The analysis includes power calculations, system current, distribution cable voltage drop, MCB capacity selection, and evaluation of the grounding and lightning protection systems. Voltage drop calculations were performed using a single-phase system approach with copper conductors and international units (SI). The calculation results show that the voltage drop value on all distribution lines is below the maximum limit of 5% according to the 2011 PUIL standard. The grounding resistance value obtained of 0.5 Ω also indicates that the grounding system has met safety requirements. In addition to technical aspects, this study also presents a Bill of Quantities (BoQ) as part of the electrical system material planning. The selection of MCB capacity and relatively large cable sizes was carried out as a long-term planning strategy to anticipate future load increases. Based on the analysis results, the electrical system at Site MDN302 Mabar Gudang was declared safe, reliable, and feasible for operation.

Keywords:electrical system, telecommunication site, voltage drop, grounding, MCB.

Corresponding Author:
Wahyu Pranata
Universitas Pembangunan Panca Budi, Medan, North Sumatera, Indonesia
wahyupranata25@gmail.com

1. Introduction

Telecommunication towers are vital infrastructure supporting wireless communication systems that operate 24/7. The operational reliability of telecommunications equipment depends heavily on a stable, secure electrical system that complies with applicable technical standards. Disruptions to the electrical system can lead to reduced service quality and even the disruption of communication networks. Electrical system planning on telecommunication towers must consider power capacity, voltage quality, protection systems, and grounding systems. National standards such as the 2011 General Requirements for Electrical Installations (PUIL) stipulate technical limitations that must be met to ensure the safety of equipment and personnel. Therefore, this study was conducted to analyze and evaluate the electrical system planning at Site MDN302 Mabar Gudang, Medan City, so that the system used can meet the aspects of safety, reliability, and operational sustainability.

The telecommunications tower's electrical system consists of a power source, a power distribution system, a protection system, and a grounding system. The power source generally comes from the PLN grid in a single-phase or three-phase configuration. The power is then distributed through the main distribution panel (MDP) and subsequent panels such as the Alternate Current Power Distribution Box (ACPDB).

Protection systems serve to protect installations and equipment from overcurrents, short circuits, and voltage surges caused by lightning. One commonly used protection component is the Miniature Circuit Breaker (MCB). Furthermore, the grounding system plays a crucial role in channeling fault currents to the ground, thereby reducing the risk of equipment damage and personnel harm. PUIL 2011 recommends a maximum grounding resistance of 5 Ω for electrical installations.

2. Research Methods

This research uses both qualitative and quantitative approaches. The qualitative approach is conducted through direct observation of the electrical system conditions in the field, while the quantitative approach is conducted through measurements and technical calculations. Data collected includes system voltage, load current, conductor length and type, and grounding resistance values. The analysis is carried out by calculating the power and current requirements of a single-phase system using the equation:

$$I = P / (V \times \cos \varphi)$$

Additionally, voltage drop calculations are performed on the conductors to ensure that the voltage received by the equipment remains within safe limits. The calculation results are then compared with applicable technical standards, specifically PUIL 2011.

3. Results And Discussion

The results and discussion in this study are based on field measurement data, technical calculations, and an evaluation of the electrical system's compliance with applicable standards. The discussion focuses on the existing system conditions, electrical parameter measurements, calculation analysis, and their implications for the operational reliability of telecommunications towers.

Existing Condition of Electrical System

The MDN302 Mabar Gudang site receives its electricity supply from the three-phase PLN network with a nominal voltage of 380/220 V and an installed capacity of 10,600 VA. Although the supply is available in a three-phase configuration, all site operational loads use a single-phase system (phase–neutral 220 V). This configuration is commonly applied in telecommunications sites because most BTS equipment, rectifiers, and lighting systems are designed to operate on single-phase voltage.

The power distribution system uses a Main Distribution Panel (MDP) as the main panel and an Alternate Current Power Distribution Box (ACPDB) as a secondary panel. The MDP distributes power from the PLN source, while the ACPDB supplies power to specific loads such as rectifiers, outdoor lighting, and garden lights.

System Voltage and Current Measurement Results

Voltage measurements were conducted to determine the stability of the power supply from the PLN network. The measurement results showed that the interphase voltage was in the average range of 380 V, while the phase-neutral voltage was in the range of 220 V. These values are still within standard tolerance limits, so the quality of the supply voltage can be categorized as stable and suitable for the operation of telecommunications equipment.

Table 1. Interphase Voltage Measurement

Measurement	R–S (V)	S–T (V)	R–T (V)
1st	379	380	381
2nd	380	379	380
The 3rd	381	380	379

4th	380	381	380
Average	380	380	380

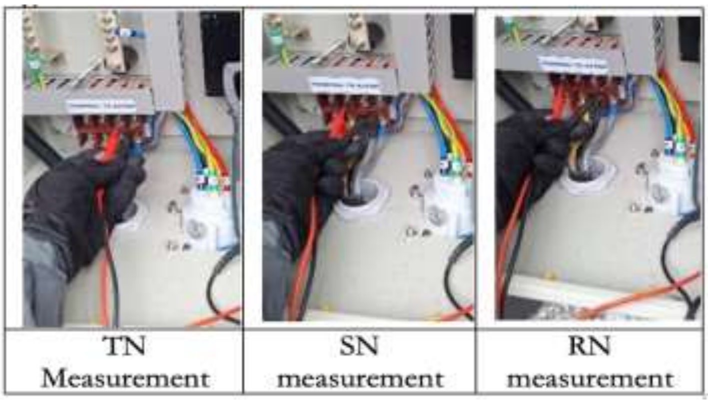

Figure 1. Interphase Voltage Measurement

Table 2. Phase - Neutral Voltage Measurement

Measurement	R–N (V)	S–N (V)	T–N (V)
1st	219	220	221
2nd	220	219	220
The 3rd	221	220	219
4th	220	221	220
Average	220	220	220

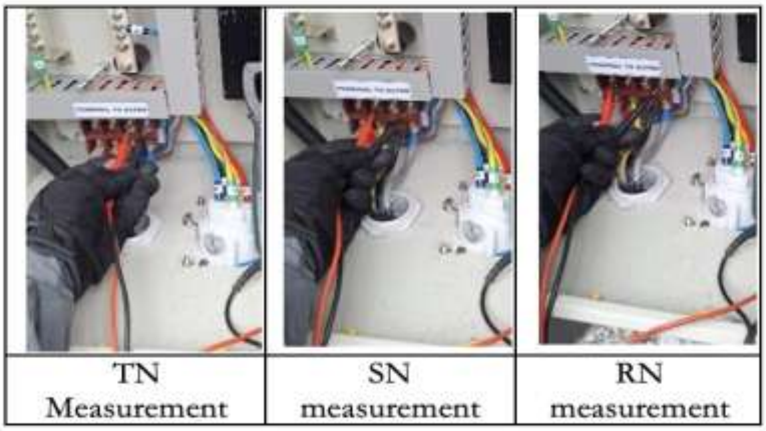

Figure 2. Phase - Neutral Voltage Measurement

In addition to voltage, the system's load current was also measured. The measurements showed the actual load current was in the range of 2.2 A to 2.7 A. This value is relatively small compared to the installed power capacity, indicating that the system still has a significant capacity reserve.

System Power and Current Requirements Analysis

Based on load identification, the total active power used at Site MDN302 Mabar Gudang is 2,900 W. Assuming a power factor of 0.85 and a system voltage of 220 V, the theoretical system current is 15.5 A. This theoretical current value is used as a basis for planning the protection system and selecting conductors.

 ISSN 2722-4635

Table 3. Phase Load Measurement

Measurement	R (A)	S (A)	T (A)
1st	2.3	2.5	2.4
2nd	2.7	2.6	2.5
The 3rd	2.9	2.8	2.6
4th	2.6	2.7	2.5
Average	2.6	2.7	2.5

R Phase Load Measurement	S-Phase Load Measurement	T-Phase Load Measurement

Figure 3. Phase Load Measurement

When compared to actual measurements, which showed currents ranging from 2.2 A to 2.7 A, a significant difference is observed. This difference is due to the site's new conditions and the fact that not all loads were operating simultaneously. Nevertheless, using theoretical currents as a planning reference is still necessary to ensure system reliability under maximum load conditions and for future expansion.

Voltage Drop Analysis on Conductors

Voltage drop analysis is performed to ensure that the voltage received by telecommunications equipment remains within safe limits according to standards. Voltage drop calculations in a single-phase system are performed by considering the load current, conductor resistance, and distribution cable length. The calculation results show that the voltage drop on the main distribution line and the line leading to the load is below 1% of the nominal voltage. This value is much smaller than the maximum voltage drop limit of 5% as recommended in PUIL 2011. Therefore, the selection of the cable type and size used meets technical requirements.

Low voltage drops contribute to stable telecommunications equipment operation, particularly base transceiver stations (BTS) and rectifiers, which are sensitive to voltage drops. Furthermore, this condition indicates that the distribution system still has sufficient margin to accommodate future load increases.

Evaluation of MCB Capacity Selection and Protection System

Miniature Circuit Breaker (MCB) capacity selection is based on the system's theoretical current and the application of a safety factor. The MCB used has a capacity greater than the actual load current, thus providing protection against overcurrent and short circuits. Using a relatively large MCB capacity also serves as a long-term planning strategy. With this capacity, the electrical system can still accommodate additional loads without requiring replacement of key protection components, thereby improving operational and maintenance efficiency. The grounding system at Site MDN302 Mabar Gudang uses copper conductors connected to grounding electrodes. Measurements show an average grounding resistance of 0.5 Ω, well below the maximum limit of 5 Ω recommended by PUIL 2011.

ISSN 2722-4635

Table 4. Phase Load Measurement

Measurement Point	Average (Ω)
Tower legs	0.49
Panel	0.48
Cable tray	0.32
Fence	0.54

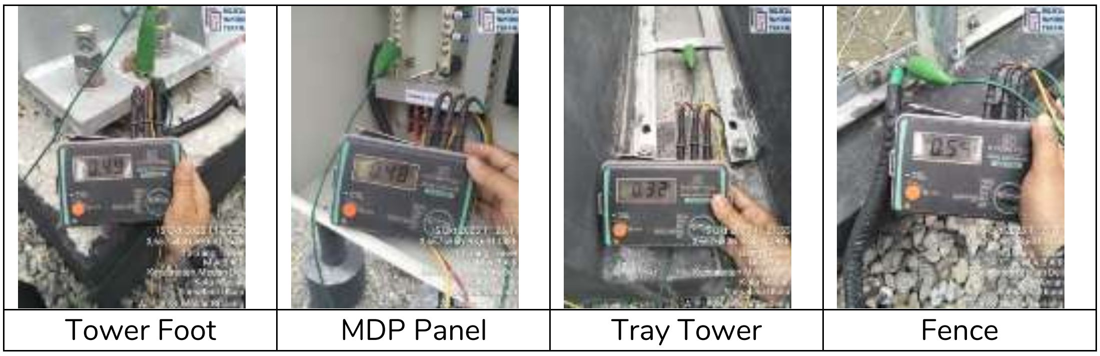

Figure 4. Grounding Measurement

A low grounding resistance value indicates that the grounding system is effectively channeling fault currents and lightning currents to the ground. Therefore, the grounding and lightning protection system meets safety requirements and protects equipment and personnel from potential electrical hazards.

Integrated Panel Design as an Alternative for System Development

Based on the analysis of load, current, and voltage drop, an integrated panel concept was designed that combines the functions of the MDP and ACPDB. The integrated panel design aims to shorten cable distribution routes, centralize protection systems, and improve installation neatness.

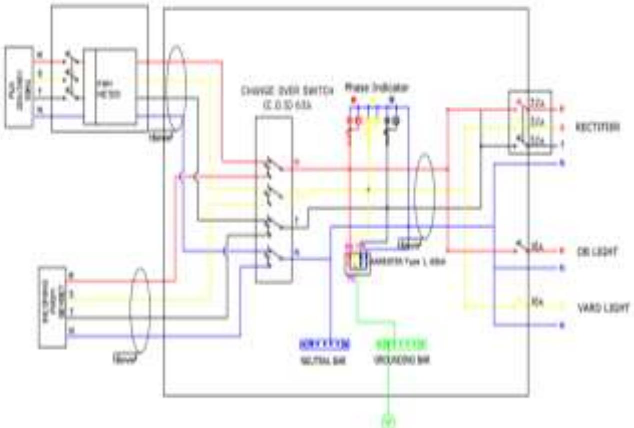

Figure 5. Integrated Panel Diagram Design

The integrated panel concept is considered more effective from an operational and maintenance perspective because all major components are housed within a single panel. Furthermore, integrated panels provide reserve space for future equipment additions, supporting long-term electrical system planning.

 ISSN 2722-4635

4. Conclusion

Based on field measurements, technical calculations, and analysis, it can be concluded that the electrical system at the MDN302 Mabar Gudang Site, Medan City, has been planned and implemented in accordance with applicable technical standards. The power supply from the PLN network is capable of supporting the site's operational loads with stable voltage conditions. The analysis results show that the voltage drop value is below the maximum limit of 5% according to PUIL 2011, the selection of MCB capacity has met the protection aspect, and the grounding system has a low resistance value. Thus, the electrical system at Site MDN302 Mabar Gudang is declared safe, reliable, and suitable to support the continuous operation of telecommunications towers. Regular electrical inspections and measurements are recommended to maintain system reliability. Furthermore, planning for future load increases should adhere to applicable technical standards to ensure the safety and quality of the power supply.

5. References

Aryza, S., & Lubis, Z. (2023). Enhanced of Electric Power Consumption Monitoring System in Household Based on Sensorless. *Jurnal Scientia*, *12*(04), 2107-2113.

B Satria, & Aryza, S. (2025). Analysis of Reactive Power Compensation Using Static Compensator (STATCOM) Technology in Distribution Networks. *INFOKUM*, *13*(04), 1280-1291.

Hamdani, H., Tharo, Z., Anisah, S., & Aryza, S. (2022). An Enhance Of Renew Source For Homes. *Budapest International Research and Critics Institute-Journal (BIRCI-Journal)*, *5*(3).

National Standardization Agency. (2011). General Requirements for Electrical Installations (PUIL 2011). Jakarta: BSN.

National Standardization Agency. (2020). SNI 03-7015-2004 Grounding System for Electrical Installations. Jakarta: BSN.

PT Dayamitra Telekomunikasi Tbk. (2021). Technical Standards for Electrical Installations of Telecommunication Sites. Jakarta: Mitratel.

Fakhri, A., Rahmaniar, & Dino Erivianto. (2025). The Effect of Using Inverters on Circulation Pumps at PT. Unilever Oleochemical Indonesia. National Journal of Computer Technology, 5(3), 263–274.https://doi.org/10.61306/jnastek.v5i3.205

Ismunandar, MS ., Satria, B. ., & Erivianto, D. . (2024). Analysis of Electrical Energy Power Usage in Office Buildings at CV. Pixxeled Indo Pratama Medan. Elektriese: Journal of Electrical Science and Technology, 14(02), 183–192.https://doi.org/10.47709/elektriese.v14i02.4649

Simatupang, AR, Wibowo, P., & Hamdani, H. (2023). Analysis of Smart Connect Implementation in Monitoring Electric Current Status at BTS with Internet of Things Technology. Jurnal Al Ulum LPPM Universitas Al Washliyah Medan, 11(2), 106–112.https://doi.org/10.47662/alulum.v11i2.542

Mhd. Ilyasa Lubis, Dino Erivianto, & Rahmaniar. (2025). Study of Solar Power Plant Planning for Fish Cultivation. National Journal of Computer Technology, 5(3), 394–406.https://doi.org/10.61306/jnastek.v5i3.230

Achmad Fauzi, Zuraidah Tharo, & Dino Erivianto. (2025). SHORT CIRCUIT DETECTION IN RESIDENTIAL ELECTRICAL INSTALLATIONS BASED ON ARDUINO. National Journal of Computer Technology, 5(3), 676–684.https://doi.org/10.61306/jnastek.v5i3.260

Tanjung, MS, Dalimunthe, ME, & Saragih, Y. (2025). Reliability Analysis of Generator Set (Genset) as Emergency Power Supply Application in Electrical System of Campus 3 UNPAB. Aisyah Journal of Informatics and Electrical Engineering (AJIEE), 7(1), 35–39.https://doi.org/10.30604/jti.v7i1.434

Sidin, US, & Herianto, R. (2021). Evaluation of the Electrical Installation System on a Telecommunication Transmission Tower at the UPD007 Telkomas Site, Makassar City. Jurnal Media Elektrik, 19(1), 13–

20.https://doi.org/10.59562/metrik.v19i1.5440

Ihsan, P., & Rahayu, T. (2017). Foundation Stability Analysis on Telecommunication Towers. Konstruksia, 8(2), 53-70.https://doi.org/10.24853/jk.8.2.53-70

Ahmad, Siagian, P. ., & Erpandi Dalimunte. (2025). ELECTRICAL SYSTEM INSTALLATION ANALYSIS IN THE DEVELOPMENT PLANNING OF PT.GROWTH ASIA INDUSTRIAL BUILDING. Journal of Informatics and Applied Electrical Engineering, 13(3S1).https://doi.org/10.23960/jitet.v13i3S1.7678

Permana, AI, Anshory, I., Jamaaluddin, J., Sulistiyowati, I., & Ahfas, A. (2025). SDP Panel Design. JREEC: Journal of Renewable Energy, Electronics and Control, 5(1), 14-17.https://doi.org/10.31284/j.jreec.2025.v5i1.7194