



**BUSITEMA
UNIVERSITY**
Pursuing excellence

**FACULTY OF ENGINEERING AND
TECHNOLOGY**

DEPARTMENT OF ELECTRICAL ENGINEERING

FINAL YEAR PROJECT REPORT

**ASSESSMENT OF EARTHING AND LIGHTNING ARRESTOR
PERFORMANCE AT BUSITEMA UNIVERSITY**

By

MUTIIBWA IMMACULATE

BU/UP/2023/1003

SUPERVISED BY

MAIN SUPERVISOR: ENG. GEORGE KILAMA

CO-SUPERVISOR: MR. PATRICK MUGWANYA

**A FINAL YEAR PROJECT SUBMITTED TO THE DEPARTMENT OF ELECTRICAL
ENGINEERING IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR AN
AWARD OF DIPLOMA IN ELECTRONICS AND ELECTRICAL ENGINEERING**

ABSTRACT

Earthing means the connection of conductive part of the system with the ground mass to avoid any accident and smooth functioning of the power system. The act of ensuring effective earthing resistance is and optimal lightning arrester performance is critical for the safety and reliability of electrical installations at Busitema University. This project assesses the earthing systems and lightning protection measures across university structures to evaluate their compliance with international standards (IEEE, IEC) and their effectiveness in mitigating electrical faults and lightning strikes. Field measurement of earth resistance were conducted using the Fall of Potential method, while lightning arrester performance was analyzed through visual inspections, continuity tests and surge protection efficiency evaluations. The findings revealed variations in earthing resistance values across different sites, with some exceeding recommended thresholds, indicating potential safety risks. Lightning arrester were generally functional and some were damaged which requires maintenance to ensure long term reliability. Recommendations were developed which included; improving soil conductivity, upgrading earthing electrodes and implementing routine maintenance schedule for lightning protection systems.

Key words: earthing, lightning arrester and performance.

DECLARATION

I MUTIBWA IMMACULATE affirm that this report being submitted is to the best of my knowledge and the result of my assessment. It has never been offered to any university and some of the sources of work here has been clearly referenced.

Signature: *lit*

Date: ... 16th June, 2025

Tel: +256760504471/+256700441835

Email: immaculatemutibwa@gmail.com

SUPERVISOR'S APPROVAL

This research project is submitted as a partial fulfillment for the award of Diploma in Electronics and Electrical Engineering at Busitema University, with our approval as the academic supervisor.

Main supervisor: **ENG. GEORGE KILAMA**

Signature:

Date: 24/11/2025

Co-supervisor: **Mr. PATRICK MUGWANYA**

Signature: F. J. Mugwanya

Date: 24/11/2025

ACKNOWLEDGMENT

Sincere gratitude is expressed to the almighty God for His gift of wisdom, knowledge, and protection to us.

For the academic and emotional support I would like to thank the Head of Department Electrical engineering at Busitema University faculty of engineering, supervisors, all other lecturers in the department and to everyone who contributed to the successful completion of this project titled “Assessment of Earthing Resistance and Lightning Arrester Performance at Busitema University.”

Special thanks go to Eng. Abdallah Nasser Ntumwa (UEDCL Tororo) and Mr. Mafaabi Zaidi (UEDCL Namayengo) who guided us on the process of taking the measurements for earthing resistance.

TABLE OF CONTENTS

ABSTRACT.....	I
DECLARATION.....	III
ACKNOWLEDGMENT	V
List of figures	VIII
List of tables	IX
List of abbreviations	X
CHAPTER 1 :INTRODUCTION	1
1.1 BACKGROUND	1
1.2 PROBLEM STATEMENT.....	2
1.3 OBJECTIVES	2
1.3.1 Main objective.....	2
1.4 JUSTIFICATION.....	2
1.5 SCOPE OF THE STUDY	3
1.5.1 Geographical Scope	3
1.5.2 Technical Scope	3
1.5.3 Time scope	4
CHAPTER 2 LITERATURE REVIEW.....	5
2.1 INTRODUCTION	5
2.2 Earthing systems	5
2.2.1 Types of earthing systems.....	5
2.2.2 Earth system resistance.....	7
2.2.3 Methods of earthing	8
2.2.4 Causes of earthing system failures.....	9
2.3 Lightning Protection Systems	9
2.3.1 Early Streamer Emission (ESE) Lightning Arresters	11
2.4 Determining the area protected by a lightning arrester	13
2.4.1 Factors influencing Protection Area	14
2.4.2 Determining the recommended separation distance between earthing systems.....	14
2.5 Importance of Earthing and Lightning Arresters	15
2.6 Review of related studies	16
2.7 Literature gaps summary	17
2.8 Chapter summary.....	17
CHAPTER 3 METHODOLOGY	19

3.1	Research Design	19
3.2	Tools and Equipment used	19
3.3	Data Collection Methods	19
3.3.1	Visual Inspection	19
3.4	Earth Resistance Measurement	20
3.4.1	Fall of potential method works.	20
3.4.2	Key features of the Megger DET4TD2	20
3.4.3	Procedure followed.....	20
CHAPTER 4	RESULTS AND DISCUSSIONS	24
4.1	Earthing systems in Busitema University:	24
	Earthing resistance analysis	32
4.2	Lightning Arrester Assessment Results	33
CHAPTER 5	CONCLUSION AND RECOMMENDATIONS	37
5.1	Conclusions	37
5.2	Recommendations	38
5.2.1	Recommendations for Earthing Systems	38
5.2.2	Recommendations for Lightning Protection Systems	39
	REFERENCES.....	41
	APPENDIX.....	43

List of figures

Figure 1: The TN-C-S earthing system.....	7
Figure 2: Standard connection setup for fall-of-potential earth resistance testing.....	22
Figure 3 showing the general comparison of the Earthing Resistance values	29
Figure 4 showing the comparison of Earthing Resistance values between wet and dry conditions for halls of residence, library, faculty building and police post	30
Figure 5: showing the variation of Earthing Resistance values in wet and dry conditions in the lower staff blocks	30
Figure 6: showing the variation of the Earthing Resistance values in wet and dry conditions for the mid staff quarter blocks.....	31
Figure 7: showing the variation of the Earthing Resistance values in wet and dry conditions for upper quarters and guesthouses.....	31
Figure 8: Earthing resistance measurements at Nyerere Hall	43
Figure 9: Earthing resistance Measurements at Oogola Hall.....	43
Figure 10 showing earthing resistance measurement.....	44
Figure 11 showing earthing resistance measurement at Njuki Hall.....	44
Figure 12 shows earthing resistance measurement at the library.....	45
Figure 13 shows how continuity testing was done.....	45
Figure 14 shows a properly functioning lightning arrestor at the library.....	46
Figure 15 shows vandalized lightning conductors at the halls of residence	46
Figure 16: The main administration building showing some of the arresters that are out of service	47
Figure 17: Lightning arrester continuity tests	47
Figure 18: Earthing resistance measurements at the halls of residence	48
Figure 19: Earthing inspection point at the library showing the moist ground.....	48
Figure 20: Earthing resistance measurements at the staff quarters	49
Figure 21 : Moving to the different earthing points in the university	49
Figure 22: Group photo with Eng. Abdallah after the final assessments at the main administration building	50
Figure 23: Megger DET4TD2 showing the C1, P1 and C2 terminals	50
Figure 24: Rod earthing	Error! Bookmark not defined.
Figure 25: Megger DET4TD2 used in our assessment	51
Figure 26: Showing the digital multimeter we used	52

List of tables

Table 1: Showing the results obtained from the measurements during wet condition.....	25
Table 2: Showing the results obtained from the measurements during dry condition	26
Table 3: Showing the variation Earthing Resistance values during wet and dry conditions.....	27
Table 4: Results obtained from the lightning arrester inspection.....	34
Table 5: lightning arrester earthing resistance measurements taken in wet conditions.....	35
Table 6: lightning arrester earthing resistance measurements taken in hot conditions	35

List of abbreviations

C1	Current Electrode 1 (Black terminal)
C2	Current Electrode 2 (Red terminal)
DET	Digital Earth Tester
IEC	International Electro technical Commission
IEEE	Institute of Electrical and Electronics Engineers
IT	Isolated Terra (Earthing system where the neutral is not connected to earth, or connected via a high impedance)
LV	Low Voltage
P1	Potential Electrode 1 (Green terminal)
P2	Potential Electrode 2 (Yellow terminal)
PPE	Personal Protective Equipment
TN-C	Terra Neutral-Combined (Neutral and protective earth are combined in one conductor throughout)
TN-C-S	Terra Neutral-Combined and Separate (Combined in part of the system and separate in others)
TN-S	Terra Neutral-Separate (Neutral and protective earth are separate throughout the system)
TT	Terra-Terra (The consumer has their own local earth electrode separate from the supply earth)
Ω	Ohm

REFERENCES

1. IEEE. (2012). IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System (IEEE Std 81-2012). Institute of Electrical and Electronics Engineers.
2. Isaac K. Nti, Albert Y. Appiah, Owusu Nyarako- Boateng Assessment and prediction of Earthing resistance in domestic installation. – Background
3. Electrical Installation, lecture No.14 (Earthing Systems) by Dr. Mohammed Tawfeeq Alzuhairi – Types of Earthing
4. Earthing Systems Maintenance: Best Practices for Long-Term Reliability by Manav Energy |April 27, 2023)
5. G. Vijayaraghavan, M. Brown, M. Barnes: Practical Grounding, Bonding, Shielding and Surge Protection 1st Edition – July 21, 2004
6. IEC 62305-1 to 4: 2010: Protection against lightning. Geneva: IEC
7. IEC 60364-6:2016. Low-voltage electrical installations – Part 6: Verification. International Electrotechnical Commission, 2016.
8. Megger Group Limited. (n.d.). Megger DET4TD2 Earth Tester Operating Manual.
9. Electrical Engineering Portal. (2022). Understanding earth resistance and methods of measurement.
10. Adegboyega, O. A., & Odeyemi, K. (2011). Assessment of soil resistivity on grounding of electrical systems: A case study of North-East Zone, Nigeria.
11. Idoniboyeobu, D. C., Agburum, C. P., & Ogba, O. C. (2018). Assessment and evaluation of soil effect on electrical earth resistance: A case study of Woji Area, Port-Harcourt, Nigeria.
12. Nti, I. K., Ampomah, A. B., & Frimpong, P. (2020). Assessment and prediction of earthing resistance in domestic installations: A case study of Sunyani Municipality.
13. Omorogiuwa, M., & Fayose, R. S. (2018). Performance evaluation of the earthing system in Ambrose Alli University, Nigeria. African Engineering and Technology (AETE) Journal, 3(1).
14. Scope T&M. (2020, July 6). Techniques & methodologies for health assessment of surge and lightning arresters

15. Henry llewellyn tsen tze henn december, 20202: analysis on the impact of grounding on the system stability against surge and lightning
16. Earthing: Procedure, Types, and Advantages – theconstructor.org
17. Rakov, V. A., & Uman, M. A. (2003). *Lightning: Physics and Effects*. Cambridge University Press.
18. Mousa, A. M. (1998). The Applicability of Early Streamer Emission Air Terminals for the Protection of Structures against Lightning. *IEEE Transactions on Power Delivery*, 13(2), 452–458.
19. Zoro, R. (2012). A Critique of Early Streamer Emission Lightning Protection Systems. *IET Conference on Lightning Protection*.
20. NF C 17-102:2011. French Standard for Lightning Protection Systems Using ESE Air Terminals.
21. IEC 62305 Series – Protection against Lightning. International Electrotechnical Commission.
22. Dugan, R. C., McGranaghan, M. F., Santoso, S., & Beaty, H. W. (2012). *Electrical Power Systems Quality* (3rd ed.). McGraw-Hill Education.
23. Hileman, A. R. (1999). *Insulation Coordination for Power Systems*. CRC Press.
24. IEEE. (2014). IEEE Standard for Metal-Oxide Surge Arresters for AC Power Circuits (>1 kV) (IEEE Std C62.11-2012).
25. Naidu, M. S., & Kamaraju, V. (2013). *High Voltage Engineering* (5th ed.). McGraw-Hill Education.
26. International Electrotechnical Commission. (2010). IEC 62305-3: Protection against lightning – Part 3: Physical damage to structures and life hazard. Geneva: IEC.
27. IEEE Power Engineering Society. (2012). IEEE Std 998-2012 - Guide for Application of the Shielding Techniques to Protect Outdoor Substations. New York: IEEE.