ELECTROMAGNETIC COMPATIBILITY (EMC) ANALYSIS IN RAILWAY ENVIRONMENT TOWARDS CARDIAC PACEMAKER USING ANALYTICAL AND MEASUREMENT METHODS

MUHAMMAD ARIF BIN NORDIN

A thesis submitted in
fulfillment of the requirement for the award of the
Degree of Master of Electrical Engineering

Faculty of Electrical and Electronic Engineering
Universiti Tun Hussein Onn Malaysia

AUGUST 2023

DEDICATION

For my beloved mother

Habsah Binti Buang

And to my family

Special thanks to my supervisor and co supervisor

Thank you for everything

ACKNOWLEDGEMENT

First and foremost, syukur Alhamdulllah for granting healthy on my 2 years journey to finish my Master. I would like to express the deepest appreciation to my supervisor Assoc. Prof. Dr. Syarfa Zahirah Binti Sapuan who continually and convincingly conveyed a spirit of good guidance throughout journey, and an excitement in regard to their teaching in finishing my thesis. Without their guidance and persistent help, this would not have been possible.

Secondly, my completion of this research could not have been accomplished without the support of Sirim QAS. I would like to express my sincere gratitude to the them for providing me the equipments used in measurement as well as letting me to join in the measurement on the site even with the strictness and the limited of time.

Lastly, I would like to thanks and sincerest gratitude to my family especially my mother, Habsah Binti Buang for her ongoing support and encouragement during my studies in Universiti Tun Hussein Onn Malaysia (UTHM). Not to forget I would like to thanks to all my lecturers in Universiti Tun Hussein Onn Malaysia (UTHM) for all their sincerest teaching and guidance to finish my course study and project. Besides that, I would like to express my gratitude to my friends for their endless support during my up and down throughout the years.

ABSTRACT

This thesis is about the ambient electromagnetic fields that come from the railway environment in Malaysia and if its exceeds the limit level of cardiac pacemaker. In Malaysia, the development of public transportation in the railway system is consistent throughout the years since the 90's. The electric train is one of the transportation mode that is widely used across the world to transport peoples and goods. With the complex environmental system, they were highly exposed to electromagnetic fields especially during the train stations. At present, Malaysia is still expanding its railway transportation system especially in the Klang Valley. Calculation, measurement and analysis of electromagnetic fields is the main purpose of this study in certain railway environment. An electromagnetic emission from apparatus (non-intentional transmitter) and intentional transmitters in the railway environment has been calculated. Both results show that the electric field value were not exceeded cardiac pacemaker immunity level. Magnetic field from high voltage power cables were taken into account as it can also gives effect towards cardiac pacemaker and the result shows it did not exceeds 1mT and 163.52 dBμA/m limit level. The measurement has been conducted using a Spectrum Analyzer between 9 kH and 6 GHz. Loop Antenna and Tri-log antenna has been used for this frequency range to measure its ambient electromagnetic field. Measurement results were presented and analyzed. Analysis of ambient measurement result shows that the highest electromagnetic field at station area is at 111.99 dBμV/m which is at Kampung Batu Station. The calculation of electric field and magnetic field from apparatus and intentional transmitter as well as high voltage power cables show that the emission is relatively lower than immunity for cardiac pacemaker. In particular, the emission of electromagnetic field interference from railway environment in did not give adverse effect towards cardiac pacemaker and safe for passenger to be around the environment.

ABSTRAK

Tesis ini adalah mengenai medan elektromagnet ambien yang berasal dari persekitaran kereta api di Malaysia dan jika ianya melebihi had level perenta jantung. Di Malaysia, pembangunan pengangkutan awam dalam sistem kereta api adalah konsisten sepanjang tahun sejak 90-an. Kereta api elektrik adalah salah satu mod pengangkutan yang digunakan secara meluas di seluruh dunia untuk mengangkut orang dan barangan. Dengan sistem persekitaran yang kompleks, mereka sangat terdedah kepada medan elektromagnet terutamanya semasa berada di stesen kereta api. Pada masa ini, Malaysia masih mengembangkan sistem pengangkutan kereta api terutamanya di Lembah Klang. Pengiraan, pengukuran dan analisis medan elektromagnet adalah tujuan utama kajian ini di persekitaran kereta api tertentu. Pemancar yang tidak disengajakan dan disengajakan dalam persekitaran kereta api telah dikenalpasti dan medan elektrik dikira dan ianya tidak melebihi imuniti perentak jantung. Medan magnet daripada kabel kuasa voltan tinggi telah diambil kira kerana ia juga boleh memberi kesan kepada perentak jantung dan tidak melebihi had 1mT dan 163.52 dBμA/m. Beberapa julat frekuensi telah dipilih iaitu dari 9 kHz hingga 6 GHz menggunakan beberapa peralatan dan antena seperti Spectrum Analyser, Loop Antena dan Tri-log antena untuk mengukur medan elektromagnet ambiennya. Keputusan pengukuran telah dibentangkan dan dianalisis. Analisis hasil pengukuran ambien menunjukkan bahawa medan elektromagnet tertinggi di kawasan stesen adalah pada 111.99 dBμV/m di stesen Kampung Batu. Pengiraan medan elektrik dan medan magnet daripada pemancar yang disengajakan dan tidak disengajakan serta kabel kuasa voltan tinggi menunjukkan bahawa pelepasan secara relatifnya lebih rendah daripada imuniti untuk perentak jantung. Khususnya, pelepasan gangguan medan elektromagnet dari persekitaran kereta api tidak memberi kesan buruk terhadap perentak jantung dan selamat untuk penumpang berada di sekitar persekitaran.

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS AND ABBREVIATIONS

AF	-	Antenna Factor
B	-	Magnetic field in vector
BCC	-	Backup Control Centre
BS EN	-	British Standard European Norm
BTN	-	Backbone Transmission Network
CCTV	-	Closed-Circuit Television
COMSS	-	The telecommunications
CMTS	-	Commercial Mobile Telecommunication System
DCC	-	Depot Control Centre
dB	-	Decibel
EMI	-	Electromagnetic Interference
EMF	-	Electromagnetic Field
EMC	-	Electromagnetic compatibility
EIRP	-	Effective Isotropic Radiated Power
ERP	-	Effective Radiated Power
E	-	Electric Field
K	-	Constant of 7 for free space propagation in the far field
GIRN	-	Government Integrated Radio Network
G	-	Gain
H	-	Magnetic Field
ITS	-	Information Technology System
I	-	Current
KVMRT	-	Klang Valley Mass Rapid Transit
m	-	meter

MRT	-	Mass Rapid Transit
mT	-	milli Tesla
NAP	-	Network Access Points
OCC	-	Operation Control Centre
PABX	-	Private Automatic Branch Exchange
PAS	-	Public Adress System
P_D	-	Power density
RS	-	Radio System
RF	-	Radiofrequency
SA	-	Spectrum Analyser
TER	-	Telecommunication Equipment Room
$\mu_c(y)$	-	Combined uncertainty
$u_i^2(y)$	-	Standard uncertainty
μ_0	-	permeability of free space $4\pi\times10^{-7}$
VAC	-	Voltage Alternate Current
VDC	-	Voltage Direct Current
V/m	-	volt per meter
WDCS	-	Wireless Data Communication System
W	-	watt
λ	-	Wavelength

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Background of Study

In Malaysia, the development of the railway system for public is consistent throughout the years since 90's. The users of this mode of transportation are increasing especially in urban areas such as Kuala Lumpur and its surrounding areas. It is widely spread along the way from north to south of east peninsular Malaysia for another type of railway system. At the current level, it can be seen to be a method to improve existing service making it more effective and no longer just to fit a needs. To improve Malaysian economy, some plans have been discussed by the government to develop a more advance High-Speed Train system across the country to boost its tourism with improving the existing train service. And another same project from Klang Valley to Tumpat, Kelantan [1]The upgraded railway system believed to be used widely by all Malaysians from different backgrounds including patients with a cardiac pacemaker. Figure 1 shows a medical device called the cardiac pacemaker and its position on the human body.

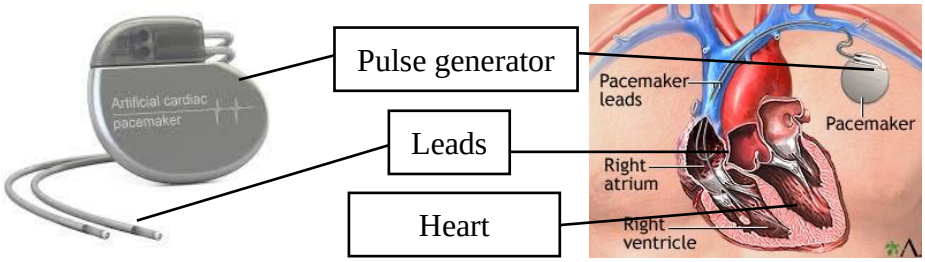

Figure 1: Cardiac pacemaker and its position

It is a device implanted in the chest to control the heartbeat by generating electrical impulses delivered by electrodes to the chamber of the heart. Patients with a pacemaker are especially at risk in case of electromagnetic interference (EMI). For example mobile or cellular phones may interact with pacemaker function by inhibiting the pacing output, asynchronous pacing and ventricular triggering. Carrying the cellular phone on the same side of the body as the implanted pacemaker and while using the phone may cause interference. It should be held at least 15 cm away from the pacemaker and on the opposite ear [2].

The new electric train that is developed were located at the Greater Kuala Lumpur. With the increase growth rate from 2.40% from last year, in 2023 the Greater Kuala Lumpur will have population of 8 622 000 [3]. It is a home to compact residential and commercial areas. No previous work were done in the past to measure the ambient electromagnetic field on this new electric train environment. The growth of technology is a concern as there has been an increase in base stations, power transmission lines and power cables, broadcast transmitters, and cellular phones. These are all major environmental exposures as all electrical technologies produce electromagnetic field (EMF) [4]. All these can be seen near the urban railway system. Thus, all the passengers are vulnerable to this electromagnetic fields but due to these different conditions such as location and condition, how emitted radiation affects health is still not known.

The objectives of this research are to calculate the electric and magnetic fields of apparatus, transmitter and train power supply as well as to measure the ambient electromagnetic fields produced by the railway system in Malaysia. All possibles source of electromagnetic interference are accounted for such as the railways system, train signalling and power supply. This is to evaluate if the electromagnetic field radiated by a railway system line whether it is exceeds the limit level provided by the standard and whether it is safe for passengers with cardiac pacemaker to be around in the environment of a railway system. The number of pacemaker user in Malaysia were not to be found. However, the data will not affected the findings of this research.

1.2 Problem Statement

The awareness of Malaysians living in urban areas to use train for their mobility is increasing over the years. Besides using the car, they mostly use trains to go to the workplace or a place accessible through the train network. This happened partly because of the improvement in the efficiency as well as well-planned upgradation of the train system by government and partly to avoid traffic congestion along the road to enjoy travelling at a much cheaper cost. People having a heart rhythm disorder and a cardiac pacemaker implanted in their body also travel by train for the same reasons. A pacemaker is a very complicated and challenging device and it may be affected by many internal and external factors.

The biggest challenge for all engineers is to manufacture electronic devices which are not only compact, but also electromagnetically compatible. Electromagnetic compatibility (EMC) can be defined as immunity measure a device possesSes unwanted electric field and magnetic field interference. The concern here is electromagnetic emission, which affects human health. All electronic equipment generate and emit unwanted electrical signals which cause electromagnetic interference that can lead to performance degradation of other electrical or electronic equipment by inducing unwanted currents and voltages in its circuitry. Also a railway system has rolling stock, signalling system and power supply that each of these sub-systems interacts and gives rise to electromagnetic interference phenomenon. Before the final design of the train station, the existing ambient electromagnetic field in the surrounding area must be measured and the results are useful for the installation of equipment and the train station design that follows the standard.

In this research, emission from train apparatus, equipments and power supplies are calculated and the findings are compared to limit level of cardiac pacemaker. This study is one of the requirement in a tender document at the design stage for all railway project (LRT3-SYS-307-Design, manufacture, supply, delivery, installation, testing and commissioning of power supply and distribution system).

1.3 Objectives

The final objectives of this project are as follows:

1. To calculate maximum radiated emission of railway apparatus and from Intentional transmitter between 30 MHz and 6 GHz towards cardiac pacemaker.
2. To calculate magnetic field emitted by the 750 VDC and 33kVAC power supply in railway system for cardiac pacemaker electromagnetic compatibility.
3. To measure the ambient electromagnetic field (EM) radiated emission at railway station from 9 kHz to 6 GHz towards cardiac pacemaker.
4. To analyse total emission for railway system with immunity limit of cardiac pacemaker based on British Standard BS EN 45502-2-1-2003.

1.4 Scopes

The research is done based on the following scopes:

1. Electromagnetic waves' radiation levels are recorded in 3 railway environments based on worst-case criteria.
2. An electric field radiation level is measured using an electromagnetic radiation detector such as an antenna and spectrum analyser in the railway environment from 9 kHz up to 6 GHz of frequency.
3. The pacemaker's immunity level provided by British Standard is compared with the measured ambient electromagnetic interference (EMI).
4. The ambient measurement were done in 10 locations and 3 locations with the highest ambient measurement were chose to measure its ambient electromagnetic field after the final design of the train station.
5. This research were done without the testing on the cardiac pacemaker.
6. This analysis limit to railway apparatus, cable to be used fo railway system and intentional transmitter installed for railway signalling and communication system.
7. This study only focussed on cardiac pacemaker user at the railway platform because its indicate the highest emission received from the nearby cables,

apparatus at the stations, antenna on the train rooftop and the antenna at the station.

8. The ambient measurement set-up were done for worst case scenario at the height of 2m from the ground floor and 3m from the center of the railway track.
9. As mention in Chapter 2 Section 2.6 railway environment, this research was done under the following circumstances of it is defined as an area up to 10 m from the centre of the nearest running line and 3 m from railway power sub-station including the communication, signalling and power equipment. In this several criterias such near residential and commercial areas are taken into account.

1.5 Research Contribution

This study contributes to several significance study as follows:

1. This study is one of the requirements in a document tender throughout all the railway projects.
2. This study defined the method used to calculate and measure the ambient electromagnetic field in a railway environment in Malaysia.
3. No ambient measurement has been made in the railway environment in Malaysia especially for an urban train.
4. The ambient EM-field measurement data before the development of the train station in this study can be used for further research related to electromagnetic fields in urban areas.
5. A new analytical method to calculate maximum radiated emission of railway apparatus and from Intentional Transmitter in a train is proposed in this study.
6. The data analysis can be used for further research on how to make the railway environment safer in terms of electromagnetic field interference.
7. In railway environment, user with cardiac pacemakers in Malaysia should be vigilant about radiation exposure and for future reference, the railways environment at all the locations should be safe for all kind of passengers for daily commute.
8. Uncertainty calculation of ambient electromagnetic field in railway environment is derived in this research to increase the accuracy of the findings

for ambient measurement.

1.6 Report Outline

The inscriptions of this study are divided into seven chapters. Chapter one briefly introduces this study as well as problems related to this study. Additionally, the objectives and scope of the study, and the contributions of this research to the general public, are discussed in detail for a proper understanding of this research.

Chapter two presents a review of previous study while also considering the limitations of the current research. A basic understanding of the cardiac pacemaker is also discussed for a better understanding and how electromagnetic field interference affects the device. Some theories regarding electromagnetic fields are presented and studies related to the fields in railways are referred to in this chapter. Chapter three shows the overall methodology flowchart. It describes that this study are divided into two which are analytical method and ambient measurement method. For analytical method, there are three subsections. Each subsection is for analytical method for non-intentional transmitter, intentional transmitter and lastly for power cables. This chapter also explain briefly about the ambient measurement methodology. Method of on-site measurement is discussed and the total uncertainty was calculated in this chapter.

Chapter four is primarily concerned with the findings of the analytical and ambient measurement methods. The results of the calculations of electric field of non-intentional and intentional transmitter are presented as along with the magnetic field from power cables. Both results are compared with the British Standard to see if it exceeds the immunity level of cardiac pacemakers. Lastly, chapter five concludes the study and gives recommendations for future work. Several suggestions are presented for future studies related to the topic.

REFERENCES

[1] C. Phones, “Effects of electromagnetic interference on the functional usage of medical equipment by 2G / 3G / 4G cellular phones : A review,” *J. Adv. Res.*, no. May, 2016, doi: 10.1016/j.jare.2016.04.004.

[2] “Cardiac device wearers should keep distance from smartphones -- ScienceDaily,” 2015. https://www.sciencedaily.com/releases/2015/06/150622071207.htm (accessed Jun. 23, 2022).

[3] “Kuala Lumpur, Malaysia Metro Area Population 1950-2023 | MacroTrends.” https://www.macrotrends.net/cities/206411/kuala-lumpur/population (accessed Jul. 05, 2023).

[4] S. O. Ezennaya, “Review of the effects of electromagnetic fields on the environment,” no. August, p. 9, 2017.

[5] EN 50527-2-1: 2016, “Procedure for the assessment of the exposure to electromagnetic fields of workers bearing active implantable medical devices - Part 2-1: Specific assessment for workers with cardiac pacemakers,” 2016.

[6] R. McVenes and K. Stokes, “Implantable Cardiac Electrostimulation Devices,” vol. 25, no. 2, pp. 221–251, 2009, doi: 10.1007/978-0-387-77261-5_7.

[7] L. Santini, G. B. Forleo, and M. Santini, “Implantable devices in the electromagnetic environment,” *J. Arrhythmia*, vol. 29, no. 6, pp. 325–333, 2013, doi: 10.1016/j.joa.2013.06.004.

[8] M. Tiikkaja *et al.*, “Electromagnetic interference with cardiac pacemakers and implantable cardioverter-defibrillators from low-frequency electromagnetic fields in vivo,” *Europace*, vol. 15, no. 3, pp. 388–394, 2013, doi: 10.1093/europace/eus345.

[9] P. Safavi-Naeini and M. Saeed, “Pacemaker troubleshooting: Common clinical scenarios,” *Texas Hear. Inst. J.*, vol. 43, no. 5, pp. 415–418, Oct.

2016, doi: 10.14503/THIJ-16-5918.

[10] A. Napp, D. Stunder, M. Maytin, T. Kraus, N. Marx, and S. Driessen, "Are patients with cardiac implants protected against electromagnetic interference in daily life and occupational environment?," *European Heart Journal*, vol. 36, no. 28. Oxford University Press, pp. 1798–1804, Jul. 21, 2015, doi: 10.1093/eurheartj/ehv135.

[11] R. Beinart and S. Nazarian, "Effects of external electrical and magnetic fields on pacemakers and defibrillators from engineering principles to clinical practice," *Circulation*, vol. 128, no. 25. NIH Public Access, pp. 2799–2809, Dec. 24, 2013, doi: 10.1161/CIRCULATIONAHA.113.005697.

[12] M. Tiikkaja *et al.*, "Testing of common electromagnetic environments for risk of interference with cardiac pacemaker function," *Saf. Health Work*, vol. 4, no. 3, pp. 156–159, 2013, doi: 10.1016/j.shaw.2013.06.002.

[13] M. Tiikkaja *et al.*, "Testing of common electromagnetic environments for risk of interference with cardiac pacemaker function," *Saf. Health Work*, vol. 4, no. 3, pp. 156–159, Sep. 2013, doi: 10.1016/j.shaw.2013.06.002.

[14] H. W. Nugroho, M. I. Sudrajat, A. N. Bakti, Yudhistira, and R. H. Arjadi, "Measurement of magnetic fields on electric train," *IOP Conf. Ser. Mater. Sci. Eng.*, vol. 722, no. 1, 2020, doi: 10.1088/1757-899X/722/1/012023.

[15] "Important Topic of Physics: Electromagnetic Waves - Infinity Learn." https://infinitylearn.com/surge/blog/neet/important-topic-of-physics-electromagnetic-waves/ (accessed Jul. 05, 2023).

[16] "What is EMI: Electromagnetic Interference » Electronics Notes." https://www.electronics-notes.com/articles/analogue_circuits/emc-emi-electromagnetic-interference-compatibility/what-is-emi-basics-tutorial.php (accessed Jul. 05, 2023).

[17] S. Ross, "The Search for Electromagnetic Induction 1820–1831," *Ninet. Attitudes Men Sci.*, pp. 84–125, 1991, doi: 10.1007/978-94-011-3588-7_3.

[18] "Leadership in fusible circuit protection solutions."

[19] M. Unibertsitatea, L. Abrahamsson, and J. Sanz, "Electrical railway power supply systems : current situation and future trends," no. July, 2017, doi: 10.1016/j.ijepes.2017.05.008.

[20] "Maklumat Teknikal – MRT Corp." https://www.mymrt.com.my/ms/awam/rts-link/maklumat-teknikal/ (accessed

Jul. 07, 2023).

[21] M. N. Halgamuge, C. D. Abeyrathne, and P. Mendis, “Measurement and analysis of electromagnetic fields from trams, trains and hybrid cars,” *Radiat. Prot. Dosimetry*, vol. 141, no. 3, pp. 255–268, 2010, doi: 10.1093/rpd/ncq168.

[22] “BSI Standards Publication Railway applications — Electromagnetic compatibility Part 3-1 : Rolling stock — Train and complete vehicle,” 2015.

[23] T. W. Dawson, K. Caputa, M. A. Stuchly, R. B. Shepard, R. Kavet, and A. Sastre, “Pacemaker interference by magnetic fields at power line frequencies,” *IEEE Trans. Biomed. Eng.*, vol. 49, no. 3, pp. 254–262, 2002, doi: 10.1109/10.983460.

[24] I. Tandogan *et al.*, “The effects of mobile phones on pacemaker function,” *Int. J. Cardiol.*, vol. 103, no. 1, pp. 51–58, Aug. 2005, doi: 10.1016/j.ijcard.2004.08.031.

[25] A. Trigano, O. Blandeau, M. Souques, J. P. Gernez, and I. Magne, “Clinical study of interference with cardiac pacemakers by a magnetic field at power line frequencies,” *J. Am. Coll. Cardiol.*, vol. 45, no. 6, pp. 896–900, Mar. 2005, doi: 10.1016/j.jacc.2004.10.072.

[26] A. Babouri and M. Nadi, “Electromagnetic compatibility study of cardiac pacemaker to low frequency interferences,” no. May, 2006.

[27] T. W. Salome Tyf, Firat Duru, “Interference of neodymium magnets with cardiac pacemakers and implantable cardioverter-defibrillators:an in vitro study.,” no. June 2014, 2009, doi: 10.5167/uzh-6215.

[28] A. Napp *et al.*, “Electromagnetic interference with implantable cardioverter-defibrillators at power frequency: An in vivo study,” *Circulation*, vol. 129, no. 4, pp. 441–450, 2014, doi: 10.1161/CIRCULATIONAHA.113.003081.

[29] N. Raghu, V. N. Trupthi, N. Krishnamurthy, K. Rasagnya, and D. A. Darshan, “Effects of Electromagnetic Field on Patients With Implanted Pacemakers,” no. 5, pp. 38–41, 2016.

[30] C. Gercek, D. Kourtiche, M. Nadi, I. Magne, P. Schmitt, and M. Souques, “Computation of pacemakers immunity to 50 hz electric field: Induced voltages 10 times greater in unipolar than in bipolar detection mode,” *Bioengineering*, vol. 4, no. 1, Mar. 2017, doi: 10.3390/bioengineering4010019.

[31] “BSI Standards Publication Electromagnetic compatibility (EMC) Part 6-4:

Generic standards - Emission standard for industrial environments (IEC 61000-6-4:2018),” vol. BS EN IEC, 2019.

[32] “BSI Standards Publication Electromagnetic compatibility (EMC),” no. March, 2019.

[33] “FCC Procedure For Measuring RF Emissions From Computing Devices.pdf.” Federal Communications Commision Authorization And Evaluation Division, p. 24, 1987.

[34] Federal Communications Commission, “Guidelines for Determining the Effective Radiated Power (ERP) and Equivalent Isotropically Radiated Power (EIRP) of a RF Transmitting System,” p. 5, 2015, [Online]. Available: https://apps.fcc.gov/eas/comments/GetPublishedDocument.html?id=204&tn=255011.

[35] “Strength of an Electric Field & Coulomb’s Law - Video & Lesson Transcript | Study.com.” https://study.com/academy/lesson/strength-of-an-electric-field-coulombs-law.html (accessed Jul. 07, 2023).

[36] Paul and Clayton R, *Introduction to Electromagnetic Compatibility {Wiley Series in Microwave and Optical Engineering; 2nd Ed.}*. 2006.

[37] G. Gärskog and G. Gärskog, “Numerical calculation method for magnetic fields in the vicinity of current-carrying conductors the vicinity of current-carrying conductors,” 2018.

[38] “Antenna Theory - Loop.” https://www.tutorialspoint.com/antenna_theory/antenna_theory_loop.htm (accessed Jul. 07, 2023).

[39] A. Winter, “R & S ® Field Strength and Power Estimator Application Note,” pp. 1–21.

[40] I. G. Basso, “Uncertainty in the measurement of electromagnetic field with isotropic broadband sensor and selective E & H field analyzer,” pp. 1–9, 2009.

APPENDIX F

VITA

The author was born in 27 July 1993, in Parit Raja, Batu Pahat, Johor. He went to local school of Sekolah Menengah Kebangsaan Tun Ismail for his secondary school. He pursued his diploma at Politeknik Sultan Abdul Halim Muadzam Shah in Jitra, Kedah since 2011 to 2014 for Electrical Engineering. Upon graduation, he worked for a year as assistant technician to gather some experience. In here, he learnt many things about electronic and mechanical field before quitting to further study. He then enrolled at Universiti Tun Hussein Onn Malaysia (UTHM) at Batu Pahat, Johor for degree in Electronic Engineering. With scholarship from Yayasan Sultan Iskandar Johor to fund the study for four years from 2015 to 2019.