DEVELOPMENT OF AUTOMATED TESTING EQUIPMENT FOR VERY HIGH FREQUENCY RADIO

By

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LIST OF ABBREVIATIONS

AC	Alternating Current
AM	Amplitude Modulation
ATE	Automated Testing Equipment
CDCSS	Continuous Digital Coded Squelch System
CTCSS	Continuous Tone Coded Squelch System
dB	Decibel
DC	Direct current
DUT	Device Under Testing
EMC	Electromagnetic compatibility
EMI	Electromagnetic Interference
FM	Frequency Modulation
GPIB	General Purpose interface bus
HP	Hewlet Packard
IF	Intermediate frequency
IM	Intermodulation
kHz	KiloHertz
LNA	Low noise amplifier

LPF	Low pass filter
MHz	MegaHertz
RF	Radio frequency
RX	Receiver/receive
TX	Transmitter/transmit
UUT	Unit Under Testing
SINAD	Signal to Noise and Distortion Ratio
SNR	Signal To Noise Ratio
VI	Virtual instrument
VISA	Virtual instrument software architecture

LIST OF SYMBOLS

Ω	Ohm
μ	Micro
λ	Lambda
P	Power
V	Voltage
I	Current

ABSTRAK

Radio dua hala merupakan satu alat telekomunikasi yang terdapat di pasaran sejak dulu lagi dalam bidang telekomunikasi. Beroperasi secara dua hala, radio dua hala digunakan dalam pelbagai bidang seperti ketenteraan, radio amatur, bomba serta banyak lagi bidang komersial. Untuk melaksanakan analisis Radio Frekuensi (RF) terhadap radio dua hala, banyak industi menggunakan kaedah manual di mana manusia terpaksa melakukan pengujian RF dan kaedah ini memakan tenaga serta masa. Thesis ini membincangkan cara untuk menyelesaikan masalah ini. Objektif utama bagi Penghasilan Peralatan Pengujian Automatik(ATE) bagi Radio Frekuensi Tinggi adalah untuk menganalisa keupayaan radio dua hala, melaksanakan pengujian RF berlandaskan TIA603C dan menghasilkan program bagi Peralatan Pengujian Automatik (ATE) untuk melaksanakan analisis tersebut. Untuk menjayakan projek ini, beberapa kaedah telah diaplikasikan dari segi perisian dan perkakasan. NI LabVIEW adalah perisian yang diguna pakai sebagai program ATE. Satu program automasi telah direka menggunakan perisian NI LabVIEW untuk melakukan pengujian ATE bagi radio dua hala selepas melakukan analisis RF berlandaskan standard TIA603. Manakala buat aspek perkakasan, satu kotak kawalan laluan RF telah direka bentuk. Kotak kawalan ini dikawal menggunakan program automasi yang direka dengan NI LabVIEW. Data yang diperoleh telah disusun dalam bentuk jadual. Data yang digunakan bagi perbandingan adalah menggunakan data automasi dan data kaedah manual. Bila dibandingkan, data yang disusun agak sama; membuktikan bahawa proses pengautomasian dalam projek ini berjaya. Di samping itu, masa untuk melakukan analisis RF juga dipendekkan. Kesemua analisis ini telah dilaksanakan mengikut Telecommunication Industry Association (TIA).

ABSTRACT

Walkie-talkie is an important telecommunication device that has been for quite a long time in the telecommunication field. Being a duplex mode communication transceiver, it is widely used around the world in variety of field such as military purpose, amateur radio, fire and rescue department along with many other commercial usage. To perform the Radio Frequency (RF) analysis on the radio, many industries still using the outdated manual testing method using man power, consequently spending a lot of effort and investments in the process. This paper discusses the method to overcome this problem. The main objectives of this Development of Automated Testing Equipment For Very High Frequency Radio project are to analyse the performance of a portable walkie-talkie radio, perform radio frequency analysis based on TIA603 standard and develop Automated Testing Equipment (ATE) program to perform the analysis. In order to complete this project, several approach was utelised in term of software and hardware basis. NI LabVIEW software was used as ATE testing development program software as the adoption of software-defined test systems. An automation sequence using NI LabVIEW was developed to perform the ATE testing after researching on the RF analysis aspect based on the mentioned TIA603 standard aspect. Wherelse the hardware mentioned was developing a RF path switching control box. This control box was controlled by the developed automation program using the NI LabVIEW software. The outcome obtained through this project was further compiled in table form. The data used for comparison purpose were the test outcome using the manual method with the automation method. These data when compared are almost similar; thus proves that the automating process of the manual method was a success.

Besides that, the time to perform the RF analysis also was managed to shortened; resulting in a shorter testing duration. All this aspects was measured and analysed in accordance with the Telecommunication Industry Association (TIA) in this project.

CHAPTER I

INTRODUCTION

In this chapter the introduction on the project will be discussed. The project was developed as a requisite for the automation improvement of performing the Automation Testing Equipment (ATE) based RF tests for Very High Frequency (VHF) band. This automated application implementation may contribute hugely to the advancement of ATE within RF analysis and will also ease the understanding in application requiring similar service.

1.1 Project Introduction

Based on the title; Development of Automated Testing Equipment for Very High Frequency Radio, the proposed research is intended to be a major setback and outcome emphasized research that will largely contribute to the engineering world, especially in ATE program development, analysis and research of Radio Frequency (RF) oriented departments in companies. The emphasized band that will be utilized in this research would be the VHF band, which is in between 30MHz to 300MHz. Besides that, LabVIEW which stands for Laboratory Virtual Instrument Engineering Workbench software also will contribute largely in the research.

The software is a major system developing with physical interface bridge that widely used in industries to develop automation programs. Developed by the National Instruments Corporation, this software also will be used in accordance with the research's objective. The brief summary of the project is performing the RF analysis on device under test (DUT) using manual method, developing the automation program, perform the analysis again using the developed automation program and finally, verify the data obtained using automation with the manual procedure test as result reference.

1.2 Problem Statement

Experienced with electronic field; regardless industry based nor tertiary education, introduces electronic background people towards the daily problems faced by the respective field, no matter Multi National Company (MNC) or locally established companies. Such is the walkie-talkie industries in Malaysia. Though walkie-talkie or more frequently called as radios as in industrial term, are used widely and have been available for quite some time, often a lot of parametric failures and problems are being faced daily. For walkie-talkie radios, the major issues will be occurring in either the transmitting or receiving part. Accordingly, VHF band is considered one of the pioneer bands in walkie-talkie and radio industry. Ranging from 30MHz to 300MHz, a lot of products are being used for wireless transmitting and receiving purpose under this band.

For ATE testing, this band is considered very critical as a lot of parametric failures are being encountered though some are even waived even if met minimum test outcome specification. This condition doesn't only happen for ordinary general usage radios but also high end professional based models as well.

This does not mean other bands are working perfectly, but the most frequent parametric failures are often identified in in this particular VHF band models. The other bandwidth based radios such as UHF (Ultra High Frequency) also often displays similar problems as VHF but due to the shorter wave compared to UHF, often the testing outcome is better compared to VHF band modules.

1.3 Objectives

The main objective of the research is to conduct RF analysis and testing measurements based on NI LabVIEW automation software on a portable VHF radio (walkie-talkie) with 5 Watts operating power and nominal voltage of 7.5V. The test standard that will be followed is based on the Telecommunication Industry Association (TIA) standard that has been accredited by the America National Standards Institute (ANSI). Two (2) objectives identified from this project:

(a.) Develop RF analysis and testing measurement using NI LabVIEW software.

(b.) Perform the TIA603 analysis on a portable VHF radio and validate the outcome.

1.4 Project Scope

In order to complete the project successfully, the scope of the research is as follows:

a) Project design using hardware and software based appliance.

The hardware part includes the equipment on the ATE test station, the programming cable to interface the DUT with the automation program using a workstation (computer), audio cable to direct audio from DUT to ATE test station, coaxial cables, RF connectors with combiners, workstation (PC) and the attenuators. As for the software part, automation software to be used for the automation tool development for the project and NI LabVIEW has been identified for this purpose

b) Easy operation of the project.

The project will be designed to be user friendly and only few procedures will be involved in operating and controlling it. The automation program will be direct to utilize mode. Thus the end user will face less complication when operating the automation program. The automation program control can be accessed via a workstation terminal point though the ATE test station will be located in a remote location.

c) Used for effective and automation testing purpose.

The major contribution of this research would be the effectiveness and time saving by implementing ATE automation testing. Rather than using ordinary manual method, which will be performed using the man power, the research imposes and emphasizes the automation method which indirectly will reduce the amount of man power directed to perform the testing.

Since the methodology of the tests remains unchanged, thus the precision level of the testing and the final output data also does not deviate excessively. The deviation is still under the controlled marginal specs which was pre-planned and estimated before the thesis execution.

d) Cost reduction and human error overcome method.

Using the developed automation program, the human power to handle the ATE test station can be reduced. This is due to the condition that the ATE station does not require constant manual configuration of human since it is fully automated. However, for the section where DUT is needed to be connected to the program and station, the manual connection using manpower is still required. Besides that, this automation design; like other automation tool, can reduce the error caused by human in a testing methodology.

1.5 Report Structure

The Optimization Designing for VHF radio ATE Testing research is completely reported in this thesis, right from the introduction, planning, layout, designs, and implementation methods up to the desired outcome of the final stage. In order to compile the proper project execution in a standardized structure, the report is equipped with several chapters and sub topics, which provide easy access for individuals that require further research on the project. The chapters involved are as below:

(a) Introduction

In this chapter, there are sections such as project introduction, objectives of the project, problem statement, scope of project and report structure. Basically, this chapter serves as the introductory chapter that allows reader to have a general idea on what the project is about and the project scope to solve the problem statement.

(b) Literature Review

This section relates the project with theory and concept through the available models and diagrams. Besides that, a brief explanation on the perspective and method used in previous research also will be discussed; emphasizing how current project is related to the previous work. On top of that, this chapter relates the objectives and problem statement in a move general and wider scope with emphasis on the theory and concept used to solve the problems in project. Hypothesis; assumption on starting point of investigation or research related to the methodology also will be defined clearly in this chapter.

(c) Methodology

For the Optimization Designing for VHF radio ATE Testing research, a step by step procedure such as data collection, data processing and detailed processing of data, models, flow charts and also other form of researches will be shown in this chapter. As for the selection of the proper method in the approach of the project, the necessary factors were identified and their advantages also analysed in order to set a proper methodology guideline in the project execution.

(d) Results & Discussion

This chapter consist of the final outcome of the automation program together with the data that were collected before and the development of the automation program. The results obtained with the designed program were explained in this chapter.

(e) Conclusion

The final outcome of the project was briefly summarized and the project objective whether achieved or not were explained in this chapter.

CHAPTER 2

LITERATURE REVIEW

Literature review on this work covered some important details, theories and perspectives related to this project in term of fulfilling the objectives as stated earlier in the report. In this section, there will be several organised sub-chapters such as theories related to project, concepts of previous researches related to Optimization Designing for VHF Radio ATE Testing, project outcome and LabVIEW program panel. Through all the compiled details, a complete report consisting of accurate, detailed, factual and trusted facts regarding the project is consequently produced. This chapter also discusses briefly on few researches that were previously conducted and used as guidance for this research.

2.1 Theories Related To Research

In this research, there are several theories needed to be emphasized as the theories related may form the basis of the applications related to the project. Several theories have been identified that will be the basis of the project such as the VHF frequency band, ATE station basic configuration and also TIA603 (Signalling) tests to be automated.

2.1.1 VHF Frequency Band

Radio frequency is considered rather important transmission aspect in this thesis. This is due to the reason that this thesis on Optimization Designing for VHF Radio ATE Testing was emphasized on the range of VHF band of 136MHz and half duplex data transmission at speed up to 40 Kbit /s over 30 meter distance. Thus VHF transmission theories and explanation can be considered relatively important aspect of the project. [Johnson, 1997]

International Telecommunication Union (ITU) designates VHF as an electromagnetic waves producing radio frequency in a scale of 30MHz and 300MHz. Besides that, VHF is also recognized as the decimetre band or decimetre wave as the wavelengths range from one to ten decimetres, approximately 10 centimetres to 1 metre. [ITU-R, 1994] Radio waves with frequencies greater than the UHF band (300MHz to 3GHz) fall into the Super-High Frequency (SHF) or microwave frequency range. [Roberts, 2008] Lower frequency signal on the other hand, falls into the Very High Frequency (VHF) or lower bands. VHF radio waves broadcast on a short distance. [Johnson, 1997]

Other than that, buildings and hills often plays as the barriers even though the signal broadcasted through building walls is satisfactory for indoor reception. [Roberts, 2008] Usually, the VHF band is used as analogue VHF television transmission purpose. Numerous variables influence the point to point transmission and this includes the reception of TV and radio signals. [Johnson, 1997]

Atmospheric dampness; solar wind; physical obstacles, such as mountains with buildings and time of day all affect the signal broadcast and the degradation of signal reception. [Johnson, 1997] Atmospheric dampness absorbs the radio waves partially, thus reduces and attenuates the power of radio signals over long distances. The frequency of the radio signals influences the degradation effect and this also influences UHF TV. This condition is also due to damp than minor bands such as VHF TV signals. The ionosphere upon the atmosphere is filled with charged atoms that reflect radio waves at a certain quantity. [Roberts, 2008] Amateur radio fans use this implementation to broadcast lower frequency (LF) and high frequency (HF) signals all around the world. The waves are trapped, vigorous moves around in the upper layers of the ionosphere until reflected back to an open receiver on the globe. This is called skywave broadcasting. [Philips Semiconductor, June 2010]

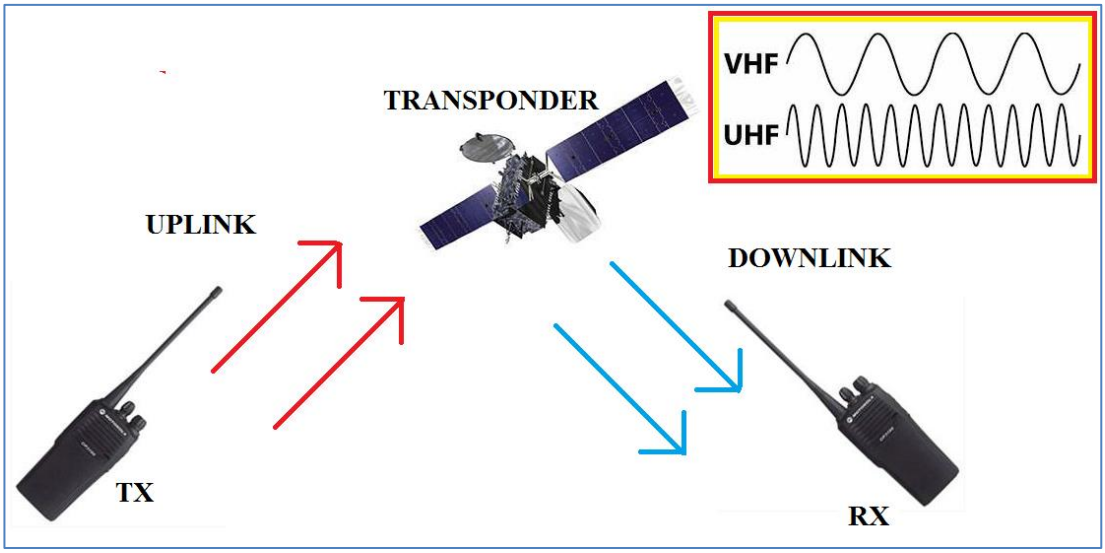

Figure 2.1: Radio Transmit and Receive Application with VHF/UHF Waveform.

Several public-safety and business communications are handled on VHF. There are still some important services depending on cellular frequencies such as: [Johnson, 1997]

a. General mobile radio service (GMRS)

b. Private mobile radio

c. Class licensed citizen's band radio service (CB)

d. WLAN standards for Wi-Fi (802.11b)

e. Global System for Mobile Communication (GSM)

f. Universal Mobile Telecommunications System UMTS cellular networks.

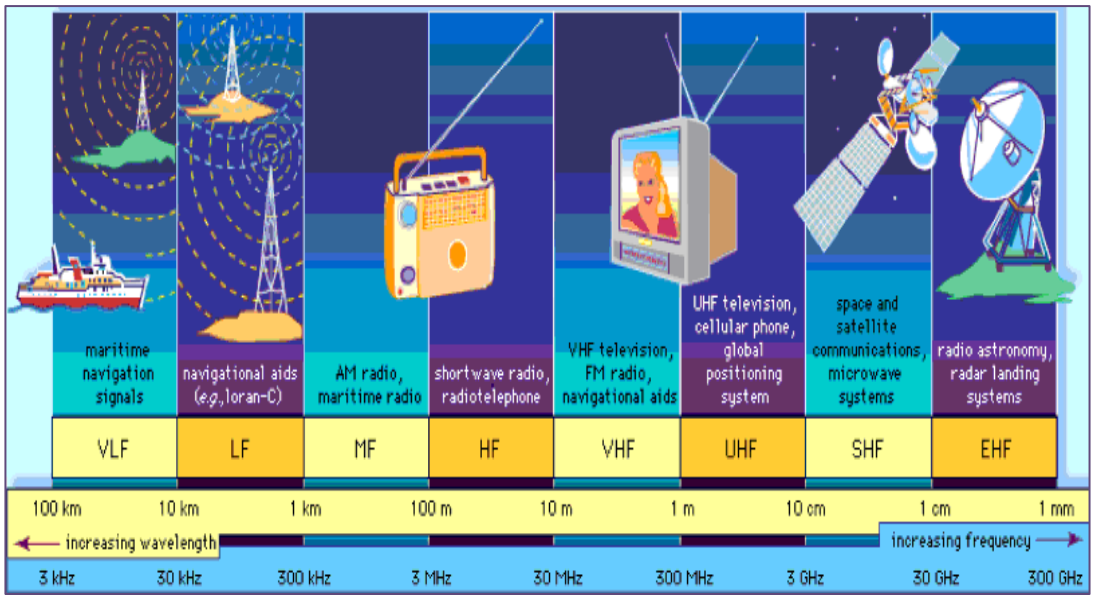

Figure 2.2: Frequency Spectrums with Applications [Johnson, 1997]