DESIGN AND IMPLEMENTATION OF A LOW COST PORTABLE AND COMPACT 2.4 GHZ SPECTRUM ANALYZER

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UNIVERSTI TEKNIKAL MALAYSIA MELAKA
FAKULTI KEJURUTERAAN ELEKTRONIK DAN KEJURUTERAAN KOMPUTER

BORANG PENGESAHAN STATUS LAPORAN
PROJEK SARJANA MUDA II

Tajuk Projek : **PORTABLE,COMPACT AND LOW COST 2.4GHZ SPECTRUM ANALYZER**

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The thesis is dedicated to my parents who have given me the opportunity of an education from the best institutions and support throughout my life.

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ABSTRACT

In recent years, a high number of new electronic and telecommunication equipment deploying 2.4 GHz ISM band have been introduced. There is also a lot of measurement equipment in the market used to analyze the frequency spectrum used by the communication device. In the paper, the design of portable, compact and low cost 2.4GHz Spectrum Analyzer are presented. The spectrum analyzer enables to be functioning same as to the spectrum analyzer but it has the simplest design instead of portable and affordable price. It will be able to detect the signal in the range of 50 meter and display the frequency spectrum detected in the LCD screen. The microcontroller is the control center of the system which is will control the LCD display and also the transceiver in the device. The spectrum analyzer will be economically which is less than RM 200.00 and it is very affordable for consumers in comparison to the similar product in the market.

ABSTRAK

Dalam kebelakangan tahun ini, banyak peralatan elektronik dan telekomunikasi yang menggunakan 2.4 GHz ISM band telah diperkenalkan. Terdapat juga banyak alat-alat pengukuran dalam pasaran yang digunakan untuk menganalisis spektrum frekuensi yang digunakan oleh peralatan elektronik komunikasi tersebut. Dalam laporan ini, 2.4GHz Penganalisis Spektrum yang mempunyai reka bentuk kos yang mudah alih, padat dan mempunyai harga yang berpatutan akan dibentangkan. Penganalisis spektrum ini mempunyai fungsi yang sama kepada penganalisis spektrum lain tetapi ia mempunyai reka bentuk yang paling mudah selain mudah alih dan mempunyai harga yang berpatutan. Ia dapat mengesan isyarat dalam lingkungan 50 meter dan memaparkan spektrum frekuensi yang akan dipaparkan pada skrin LCD. Mikrokontroler adalah pusat kawalan sistem yang akan mengawal paparan LCD dan juga transceiver dalam peranti. Penganalisis Spektrum ini mempunyai harga yang mampi dimiliki oleh pengguna-pengguna di luar sana dimana kos untuk menghasilkan alatan ini adalah hanya kurang daripada RM200.00 sahaja jauh lebih murah dari alatan sama yang boleh didapati di pasaran

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LIST OF ABBREVIATION

CMOS	-	Complementary-Symmetry Metal–Oxide
EEPROM	-	Electrically Erasable Programmable Read-Only Memory
ETSI	-	European Telecommunication Standards Institute
FCC	-	Federal Communication Commission
GCC	-	GNU Compiler Collection
IC	-	Integrated Circuit
ISM	-	Industrial Scientific and Medical
LCD	-	Liquid-Crystal Display
MCMC	-	Malaysian Communication Multimedia Commission
MCU	-	Microcontroller Unit
MLF	-	Micro Lead Frame Package
PCB	-	Printed Circuit Board
PDIP	-	Plastic Dual Inline Package
PWM	-	Pulse Width Modulation
RF	-	Radio Frequency
RISC	-	Reduced Instruction Set Computing
SRAM	-	Static Random Access Memory
TQFP	-	Plastic Quad Flat Package
USB	-	Universal Serial Bus
Wi-Fi	-	Wireless Fidelity

CHAPTER 1

INTRODUCTION

This chapter will give an overview of the project such as project background, project objective, project scope, project methodology and a summary of this project

1.1. Project Background

There are many wireless devices available on the market now that broadcast in the 2.4GHz spectrum including Bluetooth, 802.11a/b Ethernet (Wi-Fi), Zigbee, wireless USB, cordless phones, wireless mice and keyboards and the microwave oven. Depending where people live in the world, the government has allocated a roughly 80MHz block for transmitting all manner of data starting at 2.4-2.486 GHz frequency [1].

The problem occurred when it is getting a bit crowded in this band, especially for the people that live in a built up urban area. It is because; 2.4GHz band is often filled with the transmission of many different devices, all competing for valuable space and each trying to make its signal heard above the noise. The reason of this problem was because the ISM band was an unlicensed band for communication. Thus, a lot of wireless equipment producer tend to make a product that operate in this frequency to decrease the transmission cost [2].

Spectrum analyzer is an instrument that able to displays the signal energy at each frequency step across a transmission band. It will be able to display the signal of ISM bands in many areas. The device will also help users to quickly check to see if there was any interfering signal present at the time. Besides that, in term of safety matter, this device also can be used to check if there is microwave leakage in your house.

In this project, 2.4 GHz Spectrum Analyzer is design to introduce a low cost portable and compact spectrum analyzer where this will be economically affordable, portable and easily handled by consumers in comparison to other similar product in the market. It is also has high potential to be commercialized

1.2. Problem Statement

Nowadays, a lot of new electronic telecommunication device deploying ISM band have been introduced. This has rapidly leaded to the increasing of interference phenomena among wireless device especially among the device that sharing the same frequency band and spatially close each other. In these cases, the interference phenomenon may result in significant performance degradation of devices.

This project was undertaken as a solution for the traditionally spectrum analyzer which expensive and not portable. By using this, the user can easily bring the spectrum analyzer everywhere and directly can check the frequency spectrum of 2.4 GHz ISM band in the range of 50 meter. By looking to the LCD display, the user may know the frequency spectrum emitted around is and at the same time can analyze the characteristic of the frequency such as the maximum amplitude and the range of the frequency take place.

1.3. Project Objective

The objectives of this project are;

a) To produce a low cost and portable 2.4GHz spectrum analyzer design.
b) To implement the microcontroller embedded programming system and circuit design software.
c) To produce a functional compact and portable spectrum analyzer.

1.4. Project Scope

The project scopes for this project are;

1.4.1. Background Study

Reading on journal, article, electronic forum in the internet regarding the operation and also the design process related to the 2.4 GHz spectrum analyzer.

1.4.2. Software

The software that had been used in this project is WinAVR and Proteus. The WinAVR is used to create, compile and flash the code into the microcontroller. The Proteus is used for the circuit design

1.4.3. Hardware

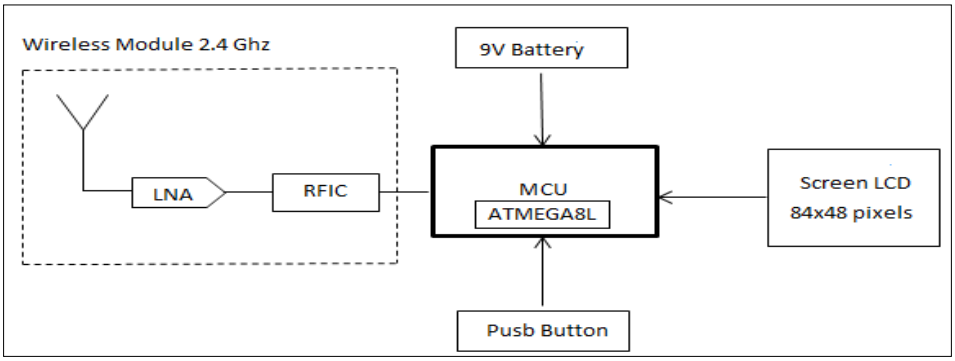

Figure 1-1: System Architecture

- **Microcontroller Unit (MCU)** - it is important to make sure that the correct system integration and inter-connecting for every module.

- **Radio Receiver**- the job scope is to conducts a test to verify device's ability to detect ISM signal.

- **Push button**- the design will implement two buttons for MODE and RESET.

- **Power Source**- it will implement the power system that has capability in providing 2.7 to 3.3V and required current to each module in the whole board. **LCD**- ensures that it will be able to display the spectrum detected

1.4.4. Performance Analysis

Analyzing the frequency spectrum signal displayed of the portable and compact 2.4GHz Spectrum Analyzer

1.5. Methodology

In this project, the spectrum analyzer is used to display the 2.4 GHz of ISM band in the range of 50 meter. In order to make an effective spectrum analyzer, this project used 2.4 GHz transceiver chip contain RSSI (Receive Signal Strength Indicator) register that lets the chip to monitor how much signal power it is receiving. The detected signal will then display in the LCD 96x 65 pixels.

The project was beginning by discussion with the supervisor and collects the data from the book, journal and others. This project was dividing in two parts which is hardware and software part. For the hardware part, it consists of circuit designing and troubleshooting. Meanwhile, for the software part it consists of ATMEGA8L application programming by using WinAVR software.

1.6. Thesis Outline

The first chapter is an introduction which is has a brief description of the project implementation such as the background, problem statement, project objectives, project scope, and methodology.

The second chapter is a literature review, where the information from other sources likes books, website related to the project that can be a guide for this project. This chapter is divided into some subsection which is having general information about the application of the spectrum analyzer.

Next chapter is methodology part. This part will explain about some of the guidelines for this project and also clearly mentioned steps that should be taken for this project. It shows the step to achieve the main objective in this thesis.

The forth chapter is a about the hardware design. This chapter will provide all of the information about the hardware used in the project in depth. It also has the configuration and integration explanation of each of the component.

Next chapter is about the software design. In this chapter, the mechanism of how the software used and applied in this project will explain in detail. This part also will provide the basic source code of each module used such as for the radio receiver and LCD as well.

The project findings and analysis will be in chapter sixth. It will explain the expected result, comparison with the actual result obtained and analysis of the project. From the result, the analysis will be done to see the project is function properly.

The last chapter in this report is conclusion and recommendation. In this chapter, conclusion is made on achieving the objective of the project. The recommendation included the improvement and future work for the project.

CHAPTER 2

LITERATURE REVIEW

This chapter discusses about the theories and useful information as well as resources that relates to this project. All the collected information used as basic knowledge and guideline in order to complete and achieves the entire objective that has been stated

2.1. Introduction to Spectrum Analyzer

Figure 2-1: Portable Spectrum Analyzer

Spectrum analyzer can measure all of the individual frequency that exist in any particular RF signal and display the power level of each frequency separately

[3]. All signals can be analyzed as the sum of several sinusoidal signals at different frequencies analyzing signals in term of their frequency is call spectrum analysis. Frequency is how often an electrical signal repeats itself in one second. Figure 2.2 below shown the principle of spectrum analyzer;

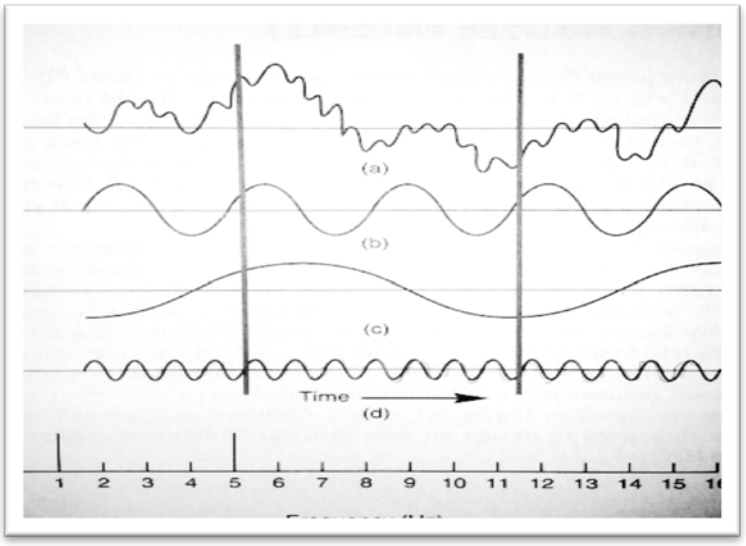

Figure 2-2: Principle of Spectrum Analyzer [3]

There is sinusoid with frequency of 1 cycle/s, another 5 cycles/s and the third at 16 cycles / s. There is several ways to analyze the signal shown above. The efficient way to analyze the signal is to view it as the summation of several perfect sinusoids at different frequency. This is because; there are many probabilities of repeaters of the signal in one second. By using the summation of several signals at different frequency, the average output will be obtained.

2.2. Wireless Radio Module CYWM6935 [4]

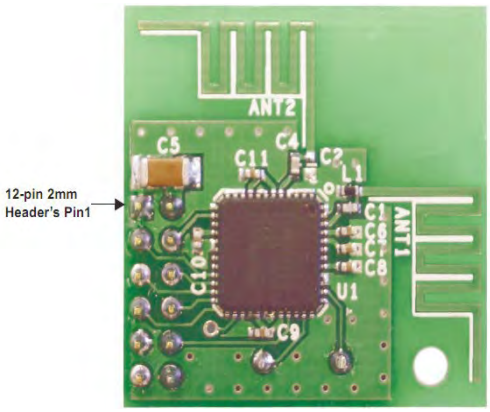

Figure 2-3: Radio Module Top View

The CYWM6935 Wireless USB Long Range (LR) Radio Module offers a complete radio module solution for integration into existing or new 2.4-GHz products. The module is supplied with dual integrated PCB trace antennas. The CYWM6935 is available in a small PCB design and can be mounted horizontally to the device PCB via a 12-pin header.

It can operate in the unlicensed ISM band 2.4 GHz-2.483GHz and can be used in the range of 50 meter or more. This complete radio module is selected because it has operating voltage of 2.7-3.6V that is compatible with ATMEGA8L and LCD module. It also can be used in other application such as remote control, lighting control alarm and security.

2.3. ISM Band

In order to prevent interference from radio signals in the United States, the Federal Communications Commission (FCC) is charged with assigning small sections of the RF spectrum for specific uses called licensed frequencies. For Malaysia, the Malaysian Communication Multimedia Commission (MCMC) is