DESIGN AND DEVELOPMENT AMATEUR RADIO TRANSMITTER

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This report is submitted in partial fulfillment of requirements for the award of Bachelor of Electronic Engineering (Telecommunication Electronics) with honours

Fakulti Kejuruteraan Elektronik Dan Kejuruteraan Komputer
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Special dedication to my beloved mom and dad, my entire sibling and my kind hearted supervisor Mr. Mohamad Zoinol Abidin Bin Abdul Aziz and my dearest friends.

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ABSTRACT

This project deals with the design and development Amateur Radio transmitter using wireless personal for long distance communication. Local communication was done over wires as this presented a cost effective way of ensuring a reliable transfer of information. For long distance communication, transmission of information over radio waves was needed. Although this was convenient from a hardware standpoint, radio waves transmission raised doubts over the corruption of information and was often dependent on high power transmitter to overcome weather conditions, large building and interference from other sources of electromagnetic. This project using 3.5 MHz of frequency spectrum (shortwave) broadcasts. This project deals with the design power regulator, buffer and oscillator to be part of each transmitter unit's. The regulator, oscillator, buffer and transmitter circuit will be simulating by the using Multisim. The project then proceeds with the hardware development of the transmitter and antenna. Lastly, the prototype / design transmitter have been tested and working successfully.

ABSTRAK

Projek ini berkaitan tentang rekabentuk dan pembangunan pemancar Radio Amatur untuk komunikasi peribadi pada jarak yang jauh. Komunikasi tempatan menggunakan wayer adalah salah satu cara untuk mengurangkan kos dan juga dapat memastikan penghantaran isyarat berlaku dengan berkesan. Untuk komunikasi jarak jauh, penghantaran maklumat dalam bentuk gelombang radio adalah diperlukan. Walaupun teknik ini sering digunakan daripada titik bangun perkakasan,transmisi gelombang radio akan meningkat sebanyak dua kali ganda daripada informasi yang telah terganggu dan selalunya informasi ini bergantung pada penghantaran berkuasa tinggi untuk mengatasi masalah cauca, bangunan besar serta sumber-sumber elektromagnetik yang lain. Projek ini menggunakan frekuensi spectrum pada 3.5 MHz (gelombang pendek) untuk penyiaran. Projek ini melibatkan pembangunan penyusun kuasa setiap bahagian daripada unit penghantar. Untuk permulaan, litar pengatur, pengayun, penghad dan pemancar akan disimulasi menggunakan perisian MULTISIM. Seterusnya projek ini akan melibatkan pembangunan perkakasan bagi pemancar dan antena. Akhir sekali, prototaip pemancar akan diuji dan proses tersebut akan berjalan dengan lancar.

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LIST OF ABBREVIATION

ISI	-	Symbol of interference
RF	-	Radio Frequency
AM	-	Amplitude modulation
FM	-	Frequency modulation
IF	-	Intermediate frequencies
SSB	-	Single sideband
IRLP	-	Internet Radio Linking Project
APRS	-	Automatic Position Reporting System
DSBSC	-	Double-sideband suppressed carrier
DSBRC	-	Double-sideband reduced carrier
CW	-	Continuous wave
SCRs	-	Silicon controlled rectifiers
LFO	-	Low-frequency oscillator
VCO	-	Voltage-controlled oscillator
PM	-	Phase modulation
PWM	-	Pulse width modulation
AF	-	Audio frequency
C	-	Capacitor
V	-	Voltage
R	-	Resistor
I	-	Current
GPRS	-	General Packet Radio Service
Z	-	Impedance
gm	-	Tran conductance
fo	-	Frequency

CHAPTER I

INTRODUCTION

1.1 Research Background

Radio frequency refers to that portion of the electromagnetic spectrum in which electromagnetic waves can be generated by alternating current fed to an antenna. Communication is a term given to communication over great distances and popular among the amateur radio system. When using High-Frequency bands, the ionosphere is utilized to reflect the transmitted radio beam. The beam returns to the Earth's surface, and may then be reflected back into the ionosphere for a second bounce.

Radio waves "hop" from the Earth to the ionosphere and back to the Earth. When a radio wave reaches the ionosphere, the electric field in the wave forces the electrons in the ionosphere into oscillation at the same frequency as the radio wave. Some of the radio wave energy is given up to this mechanical oscillation. The oscillating electron will then either be lost to recombination or will re-radiate the original wave energy back downward again. Total reflection can occur when the collision frequency of the ionosphere is less than the radio frequency, and if the electron density in the ionosphere is great enough.

The critical frequency is the limiting frequency at or below which a radio wave is reflected by an ionosphere layer at vertical incidence. If the transmitted frequency is higher than the plasma frequency of the ionosphere, then the electrons cannot respond fast enough, and they are not able to re-radiate the signal. A radio wave is an electromagnetic wave propagated by an antenna. Radio waves have different frequencies, and by tuning a radio receiver to a specific frequency you can pick up a specific signal.

Table 1.1: Radio spectrum

	Frequency(Hz)
ELF	3 - 30
SLF	30 – 300
ULF	300 – 3K
VLF	3K – 30K
LF	30K – 300K
MF	300K – 3M
HF	3M – 30M
VHF	30M – 300M
UHF	300M – 3G
SHF	3G – 30G
EHF	30G – 300G

This project objective is to design and development amateur radio transmitter using wireless personal for long distance communication. Local communication was done over wires as this presented a cost effective way of ensuring a reliable transfer of information. For long distance communication, transmission of information over radio waves was needed. Although this was convenient from a hardware standpoint, radio waves transmission raised doubts over the corruption of information and was often dependent on high power transmitter to overcome weather conditions, large building and interference from other sources of electromagnetic.

This project will used 3.5 MHz of frequency spectrum (shortwave) broadcasts. The project start with the design power regulator and oscillator to be part of each transmitter unit's. Then, the circuit will be simulated by using Multisim, followed by the hardware development of the transmitter and antenna. Lastly, the transmitter prototype will be tested.

1.2 Problem Statements

There are so many aspects that have to be considered in the transmitter design for data transmission. This is because there will be a loses of power which make the signal weak for long distance. On the other hand, buildings that exist between the receiver and transmitter will be obstacle for the transmission part that will cause the inter symbol of interference (ISI). As an example our country are facing the monsoon tropical that carry heavy rain , that will cause the transmitted signal become week and loss of power .

Since radio link between bridges can be quite long, the time taken for the radio signal to travel between the radios can become significant. The distance parameter is used to adjust the various timers used in radio protocol to compensate for the delay.

1.3 Objectives

These are the objectives of the project. The first objective is to study the short wave application in design amateur radio transmitter. Then to study the specification of RF transmitter 3.5 MHz. After that it will involve the design of the transmitter circuit by using electronic design from simulation (MULTISIM). The last objective is to fabricate and test the transmitter circuit for 3.5 MHz.

1.4 Scopes Of work

These are the scopes of work for the project. The first one is transmitter shortwave frequency 3.5 MHz. the next scope is simulating the transmitter circuit using Multisim software. Then, the transmitter circuit will be fabricated and lastly testing the transmitter circuit.

CHAPTER II

LITERATURE REVIEW

2.1 Radio wave

Radio waves are a form of electromagnetic radiation, created whenever a charged object such as an electron accelerates with a frequency that lies in the radio frequency (RF) portion of the electromagnetic spectrum. In radio, this acceleration is caused by an alternating current in an antenna. Radio frequencies occupy the range from a few tens of hertz to three hundred gigahertz, although commercially important uses of radio use only a small part of this spectrum.

Other types of electromagnetic radiation with frequencies above the RF range, are microwave, infrared, visible light, ultraviolet, X-rays and gamma rays. Since the energy of an individual photon of radio frequency is too low to remove an electron from an atom, radio waves are classified as non-ionizing radiation.

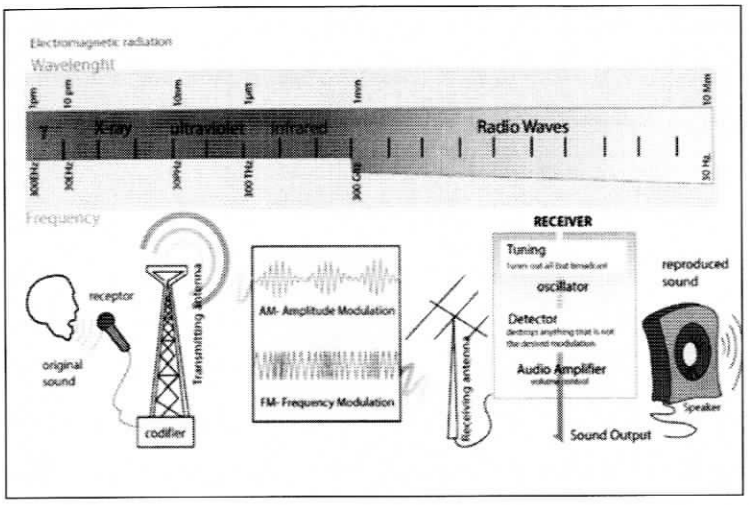

Figure 2.1 Electromagnetic spectrum and diagram of radio transmission of an audio signal.

Electromagnetic radiation travels or propagates by means of oscillating electromagnetic fields that pass through the air and the vacuum of space. It does not require a medium of transport such as the ether. When radio waves pass an electrical conductor, the oscillating electric or magnetic field induces an alternating current and voltage in the conductor. This can be transformed into audio or other signals that carry information. The word 'radio' is used to describe this phenomenon, and television, radio, and cell phone transmissions are all classed as radio frequency emissions.

2.1.1 Radio Waves Application

The prime purpose of radio is to convey information from one place to another through the intervening media such as air, space, no conducting materials without wires. Besides being used for transmitting sound and television signals, radio is used for the transmission of data in coded form. In the form of radar it is used also for sending out signals and picking up their reflections from objects in their path. Long-range radio signals enable astronauts to communicate with the earth from the moon and carry information from space probes as they travel to distant planets. For

navigation of ships and aircraft the radio range, radio compass or direction finder, and radio time signals are widely used. Radio signals sent from global positioning satellites can also be used by special receivers for precise indication of position.

Digital radio, satellite and terrestrial provide improved audio clarity and volume. Various remote-control devices, including rocket and artificial satellite operations systems and automatic valves in pipelines are activated by radio signals. The development of the transistor and other microelectronic devices led to the development of portable transmitters and receivers. Cellular and cordless telephones are actually radio transceivers. Many telephone calls routinely are relayed by radio rather than by wires where some are sent via radio to relay satellites. Some celestial bodies and interstellar gases emit relatively strong radio waves that are observed with radio telescopes composed of very sensitive receivers and large directional antennas.

2.1.2 Transmission and Reception of Radio

The propagation and reception of radio waves employe a transmitter and receiver. A radio wave acts as a carrier of information-bearing signals where the information may be encoded directly on the wave by periodically interrupting its transmission as in dot-and-dash telegraphy or impressed on it by a process called modulation. The actual information in a modulated signal is contained in its sidebands or frequencies added to the carrier wave rather than in the carrier wave itself. The two most common types of modulation used in radio are amplitude modulation (AM) and frequency modulation (FM). Frequency modulation minimizes noise and provides greater fidelity than amplitude modulation, which is the older method of broadcasting.

Both AM and FM are analog transmission systems which processed sounds into continuously varying patterns of electrical signals which resemble sound waves. Digital radio uses a transmission system in which the signals propagate as discrete voltage pulses which represent patterns of numbers. An analog audio signal is converted into a digital signal, which may be transmitted in the AM or FM frequency range before transmitted. A digital radio broadcast offers compact-disc-quality

reception and reproduction on the FM band and FM-quality reception and reproduction on the AM band.

In most common form, radio is used for the transmission of pictures and sounds such as voice and music and television. The sounds and images are converted into electrical signals by a microphone for sounds or video camera for images. Then the signal is amplified and used to modulate a carrier wave that has been generated by an oscillator circuit in a transmitter. The modulated carrier is also amplified, and then applied to an antenna which converts the electrical signals to electromagnetic waves for radiation into space. Such waves radiate at the speed of light and are transmitted not only by line of sight but also by deflection from the ionosphere.

Receiving antennas intercept part of this radiation and change it back to the form of electrical signals, then feed it to a receiver. The most efficient and most common circuit for radio-frequency selection and amplification used in radio receivers is the superheterodyne. In superheterodyne system the incoming signals are mixed with a signal from a local oscillator to produce intermediate frequencies (IF) that are equal to the arithmetical sum and difference of the incoming and local frequencies. One of those frequencies is applied to an amplifier. The IF amplifier operates at a single frequency and can be built for optimum selectivity and gain. The tuning control on a radio receiver adjusts the local oscillator frequency. If the incoming signals are above the threshold of sensitivity of the receiver and if the receiver is tuned to the frequency of the signal, it will amplify the signal and feed it to circuits that demodulate it. So, the signal wave is separated from the corner wave.

There are differences between AM and FM receivers. In an AM transmission the carrier wave is constant in frequency and varies in amplitude strength according to the sounds present at the microphone. However for FM, the carrier is constant in amplitude and varies in frequency. Wideband FM receivers are inherently less sensitive to noise because the noise that affects radio signals is partly. In an FM receiver, the limiter and discriminator stages are circuits that respond solely to changes in frequency. The other stages of the FM receiver are similar to those of the AM receiver but require more care in design and assembly to make full use of FM's advantages. FM is also used in television sound systems. The basic signals have been separated from the carrier wave and are fed to a loudspeaker or a display device

usually a cathode-ray tube, then, the signal are converted into sound and visual images, respectively for radio and television receiver.

2.2 Radio

Communication between two or more points usually employed electromagnetic waves as the transmission medium. Radio waves transmitted continuously, with each cycle an exact duplicate of all others and indicate only that a carrier is present. The message must cause changes in the carrier which can be detected at a distant receiver. The method used for the transmission of the information is determined by the nature of the information which is to be transmitted as well as by the purpose of the communication system.

In code telegraphy system the carrier is keyed on and off to form dots and dashes. The technique, often used in ship-to-shore and amateur communications, has been largely superseded in many other point-to-point services by more efficient methods. However the carrier frequency for the frequency shift transmission is shifted a fixed amount to correspond with telegraphic dots and dashes or with combinations of pulse signals identified with the characters on a typewriter. This technique is widely used in handling the large volume of public message traffic on long circuits, principally by the use of teletypewriters.

In amplitude modulation, the amplitude of the earner is made to fluctuate and to conform the fluctuations of a sound wave. This technique is used in AM broadcasting, television picture transmission and many other services.

The frequency of the carrier is made to fluctuate around an average axis, to correspond to the fluctuations of the modulating wave in frequency modulation technique. This technique is used in FM broadcasting, television sound transmission and microwave relaying.

While the carrier for pulse transmission is transmitted in short pulses which change in repetition rate, width or amplitude. In complex groups of pulses which vary from group to succeeding group in accordance with the message information. These forms of pulse transmission are identified as pulse-code, pulse-time, pulse-

position, pulse-amplitude, and pulse-width or pulse-frequency modulation. Such techniques are complex and are employed principally in microwave relay systems.

The carrier is normally transmitted as short pulses. In a narrow beam which is similar to that of a searchlight in radar technology. When a wave pulse strikes an object such as an aircraft. The energy is reflected back to the station. This measures the round-trip time and converts it to distance. Radar can display varying reflections in a map like presentation on a cathode-ray tube.

Hundreds of thousands of radio transmitters exist and each requiring a carrier at some radio frequency. In order to prevent interference, different carrier frequencies are used for stations whose service areas overlap and receivers are built to select only the carrier signal of the desired station. Resonant electric circuits in the receiver are adjusted or tuned to accept one frequency and reject others.

2.2.1 Amateur radio

Amateur radio often called ham radio is a hobby and public service enjoyed by about 3 million people [1] throughout the world. An amateur radio operator, also known as a ham or radio amateur, uses two-way radio equipment to communicate with other radio amateurs for public service, recreation and self-training. Amateur radio operators enjoy personal two-way communications with friends, family members and complete strangers, all of whom must also be licensed. They support the larger public community with emergency and disaster communications.

Radio amateurs use a variety of modes of transmission to communicate with one another. Voice transmissions are the most common way hams communicate with one another, with some types of emission such as frequency modulation (FM) offer high quality audio for local operation where signals are strong. Others such as single sideband (SSB) offering more reliable communications when signals are marginal and using smaller amounts of bandwidth.

Radiotelegraphy using Morse code remains surprisingly popular, particularly on the shortwave bands and for experimental work on the microwave bands this is