A SINGLE BROADBAND ANTENNA

THE LOG PERIODIC ANTENNA

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This report is submitted in partial fulfillement of the requirement for the award of Bachelor of Electronic Engineering (Wireless Communication) With Honours

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THE LOG PERIODIC ANTENNA

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Date	: ....

Special dedication to my lovely husband and daughter :

Hashim Bin Ahmad

&

Lisa Suriyani Binti Hashim.

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ABSTRACT

In telecommunication, the frequency spectrum is a rare commodity and each band is assigned for a specific application. A log-periodic antenna is a broadband, multi-element, unidirectional, narrow-beam antenna that has impedance and radiation characteristics that are regularly repetitive as a logarithmic function of the excitation frequency.

The active log periodic antenna as suggected in the title of the project ia a single broadband antenna whose characteristics vary as a periodic function of the logarithm of the frequency. This project is to look into the design of a broadband antenna that covers the important TETRA band and extend to measurement of unusable signal sources up to 18GHz. Apart from application as a high quality measurement-antenna and direction finder, this antenna is also very well suited as a directional-antenna for WLan, WiFi, and other directional communication applications. A small physical antenna-size plus low weight will make this antenna a specialty for mobile use and the detection of unusable signal sources like military radar, various satellite services and very high frequency bugs.

ABSTRAK

Di dalam bidang telekomunikasi, spektrum frekuensi merupakan komoditi langka dan setiap jalur telah ditetapkan untuk aplikasi tertentu. Satu antena log berkala merupakan satu jalur lebar, banyak-elemen, satu arah, ruang sempit antena yang mempunyai ciri galangan dan radiasi berulang-ulang secara teratur sebagai fungsi logaritma dari frekuensi teruja.

Antena log aktif berkala ini bertujuan sebagai antena satu jalur lebar yang mempunyai ciri-ciri jalur lebar yang berbeza-beza sebagai fungsi berkala dari frekuensi logaritma. Projek ini adalah untuk mencipta antena jalur lebar yang merangkumi jalur TETRA dan untuk pengukuran sumber isyarat yang boleh digunakan sehingga 18GHz. Selain aplikasi sebagai pengukuran antena yang tinggi dan petunjuk arah, antena ini juga sangat sesuai sebagai antena satu arah untuk WLAN, WiFi, dan aplikasi komunikasi yang terarah. Sebuah antena yang bersaiz kecil dari segi fizikal dan berat yang ringan akan membuatkan antena ini sesuai untuk kegunaan telefon mudah alih dan pengesan sumber isyarat yang tidak boleh digunakan seperti radar tentera, pelbagai perkhidmatan satelit dan peralatan yang menggunakan frekuensi yang sangat tinggi.

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CHAPTER 1

INTRODUCTION

1.1 Introduction to The Project

The intensive development and wide application of new generations of communication systems have increased the demand for new antenna designs. The most common requirements these systems pose on antennas are large bandwidth, high radiation efficiency, small size, and integration with integrated circuits and MMICs. Considering these requirements, printed mm-wave antennas appear to be a suitable choice of antenna technology for new wireless communication systems, as they avoid the need for bulky horn antennas and associated losses resulting from routing signals off-chip to a transition from the active MMIC to the horn.

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The active log periodic antenna that the title for A Single Broadband Antenna whose characteristics vary as a periodic function of the logarithm of the frequency. This project is to look into the design of a broadband antenna that covers the important TETRA band and extend to measurement of unusable signal sources up to 18GHz. Apart from application as a high quality measurement-antenna and direction finder, this antenna is also very well suited as a directional-antenna for WLan, WiFi, and other directional communication applications. A small physical antenna-size plus low weight will make this antenna a specialty for mobile use and the detection of unusable signal sources like military radar, various satellite services and very high frequency bugs.

1.2 Project Objective

The main objective of this active log periodic antenna for a single broadband is to achieve the antenna that commonly using microstrip antenna. Apart from application as a high quality measurement-antenna and direction finder, this antenna is also very well suited as a directional-antenna for WLan, WiFi, and other directional communication applications. A small physical antenna-size plus low weight will make this antenna a specialty for mobile use and the detection of unusable signal sources like military radar, various satellite services and very high frequency bugs.

Active integrated antennas receive a great deal of attention because they can reduce the size, weight, cost of the transceiver system and minimizes the connection losses. Due to the mature technology of microwave integrated circuit (MIC) and monolithic microwave integrated circuit (MMIC), the active integrated antenna becomes an area of growing interest in the recent years. Active integrated antennas have many potential applications in wireless communications such as low cost and compact transceivers, detectors and sensors. Various antennas have been integrated into active devices that can be classified into oscillator type, amplifier type and frequency conversion type.

1.3 Problem Statement

By using active log periodic antenna for a single broadband there are some inconveniences and problem that will be encountered. The first configuration has a single amplifier connected at the input of the LPA. In this configuration, the five element passive LPA works as an individual antenna with the amplifier integrated onto the same board. The second configuration has a single amplifier embedded in the middle of the five element LPA. The amplifier can be connected either after two elements or three elements. For this work, the amplifier was connected after three elements.

The third configuration has an amplifier embedded into each individual patch. The amplifier is integrated at the inset feed of the antenna. The fourth configuration is the integration of an amplifier with an antenna and a filter. The amplifier is integrated at the inset feed and the filter is integrated at the input of every transmission line for each branch. This configuration is designed to avoid the buffering effect of the amplifier. When the amplifier is integrated into each individual patch and combined as an active LPA, the amplifier will work as a buffer. The band pass filter is tuned to the same frequency as the antenna. Therefore, the power will be transferred to the antenna. This configuration will have a better log periodic action because the out of band mismatch of the filters can be used to create the right impedance environment to allow the appropriate antenna to be excited at each frequency as in the passive design process.

1.4 Scope Of Works

The scopes of work for the project include the following areas :

1. The study and understanding of log periodic antenna.
2. Identification of the parameters and limitating errors to be considered in this project.
3. The understanding of the circiut operation of the project.
4. The devolopment of a prototype for the project.
5. The analysis of the output data from the project circuit.
6. Finally to conduct and verify the functionality of the antenna.

Other scope of work include :

1. Design and production of the requirement circuit board for the project.
2. Prepare the necessary documents.
3. Publishing final report.
4. Project presentation.

1.5 Project Methodology

Project Planing

- Understanding the concept nd theory of the project.
- Prepare K-Chart for guidelines of project.
- Prepare Gantt Chart for guidelines and progress of the project.

Literature Review

- Background reading and references
- Search for suitable and practical circuit
- List down and identify the suitable circuit for this antenna
- Design the prototype circuit boards and assembling
- Test and do analysis to the antenna

Finishing

- Testing of final assembly antenna in operation, application record the result.
- Presentation of the project
- Finishing the technical report of the project

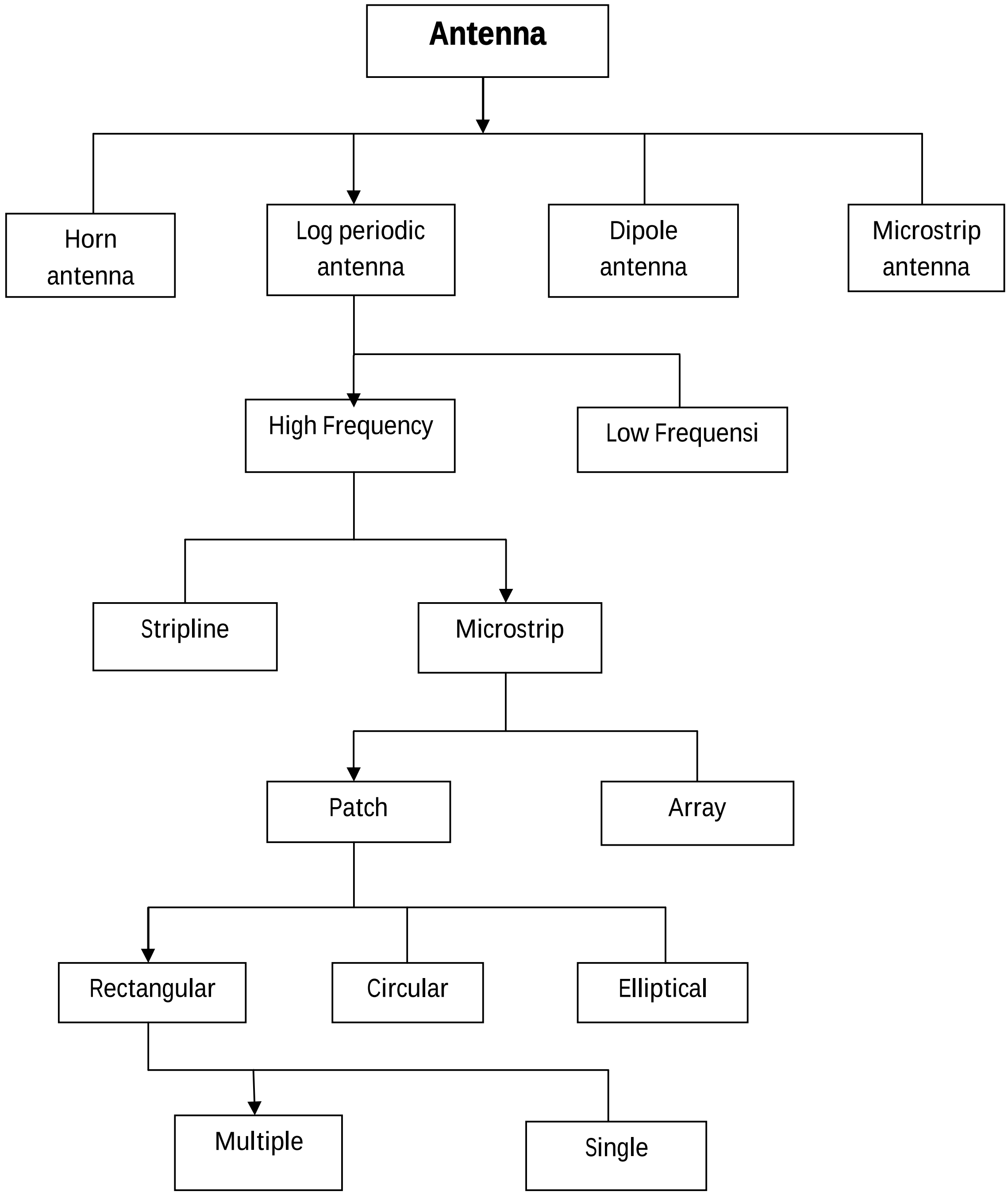


Figure 1 : Project K- Chart

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In this chapter the various aspects and the methods on research methodology on the proposed project will be studied and analyzed one by one. Past projects and thesis which were related to the proposed project would be referred. Existing related projects will be referred to make the proposed project fulfill the project objectives and outcomes. Besides, this chapter will show the actual concept of active log periodic antenna for single broadband antenna and the various related analysis. Several technologies on design antenna will be studied by analyzing the pros and cons on each technology.

2.2 Antenna

By definition, all of today's wireless communication systems contain one key element, an antenna of some form. This antenna serves as the transducer between the controlled energy residing within the system and the radiated energy existing in free space. In designing wireless systems, engineers must choose an antenna that meets the system's requirements to firmly close the link between the remote points of the communications system. While the forms that antennas can take on to meet these system requirements for communications systems are nearly limitless, most antennas can be specified by a common set of performance metrics.

2.2.1 Antenna - Signal Acquisition

Normally the TSCM (Technical Survirllance Counter Measures) specialist will use several types of antenna or ridged wave guide to search for eavesdropping signals while performing TSCM services. This equipment often includes various type of loop probes, omnidirectional whips, discones, log periodic, and microwave waveguide.

Table 1:The most popular "band splits" and matching antenna

Range	**Antenna Type**	**Comment**
100 Hz - 400 MHz	Transient Limiter/RF Coupler	(VLF and AC Mains Devices)
3 kHz - 50 MHz	Active HF Loop Antenna	(Directional)
9 kHz - 70 MHz	Active HF Whip/Rod Antenna	(Omnidirectional)
40 MHz - 1.5 GHz	Discone	(Omnidirectional)
70 MHz - 1 GHz	Log Periodic	(Directional)
480 MHz - 2 GHz	Crossed Log Periodic	(Highly Directional)
1 GHz - 3 GHz	Spiral Log Periodic	(Highly Directional)
1 GHz - 8 GHz	Dual Ridge Wave Guide	(with Preamplifier)
8 GHz - 18 GHz	Dual Ridge Wave Guide	(with Preamplifier)
18 GHz - 26 GHz	Dual Ridge Wave Guide	(with Preamplifier)
26 GHz - 40 GHz	Dual Ridge Wave Guide	(with Preamplifier)
40 GHz - 75 GHz	Wave Guide/Reflector Plate	(with Preselected Mixer)
75 GHz - 110 GHz	Wave Guide/Reflector Plate	(with Preselected Mixer)
110 GHz - 325 GHz	Wave Guide/Reflector Plate	(with Preselected Mixer)

.5 GHz - 40 GHz	Spinning Parabolic Reflector and Waveguide with Dual Polarized Crossed Log Periodic	(ACES DF System)
200 MHz - 3 GHz	Waveguide on Expandable Pole	(Non-Linear Junction Detector)

2.2.2 Antenna Performance Metrics

In order to satisfy the system requirements and choose a suitable antenna, system engineers must evaluate an antenna's performance. Typical metrics used in evaluating an antenna includes the input impedance, polarization, radiation efficiency, directivity, gain and radiation pattern.

2.3 Input Impedance

Input impedance is the parameter which relates the antenna to its transmission line. It is of primary importance in determining the transfer of power from the transmission line to the antenna and vice versa. The impedance match between the antenna and the transmission line is usually expressed in terms of the standing wave ratio (SWR) or the reflection coefficient of the antenna when connected to a transmission line of a given impedance. The reflection coefficient expressed in decibels is called return loss.

2.4 Polarization

The polarization of an antenna is defined as the polarization of the electromagnetic wave radiated by the antenna along a vector originating at the antenna and pointed along the primary direction of propagation. The polarization state of the wave is described by the shape and orientation of an ellipse formed by tracing the extremity of the electromagnetic field vector versus time. Although all antennas are elliptically polarized, most antennas are specified by the ideal polarization conditions of circular or linear polarization. The ratio of the major axis to the minor axis of the polarization ellipse defines the magnitude of the axial ratio. The tilt angle describes the orientation of the ellipse in space. The sense of polarization is determined by observing the direction of rotation of the electric field vector from a point behind the source. Right-hand and left-hand polarizations correspond to clockwise and counterclockwise rotation respectively.

2.5 Directivity

It is convenient to express the directive properties of an antenna in terms of the distribution in space of the power radiated by the antenna. The directivity is defined as 4p times the ratio of the maximum radiation intensity (power radiated per unit solid angle) to the total power radiated by the antenna. The directivity of an antenna is independent of its radiation efficiency and its impedance match to the connected transmission line.

2.6 Gain

The gain, or power gain, is a measure of the ability to concentrate in a particular direction the net power accepted by the antenna from the connected transmitter. When the direction is not specified, the gain is usually taken to be its maximum value. Antenna gain is independent of reflection losses resulting from impedance mismatch.

2.7 Radiation Efficiency

The radiation efficiency of an antenna is the ratio of the power radiated by the antenna to the net power accepted at its input terminals. It may also be expressed as the ratio of the maximum gain to the directivity.

2.8 Radiation Pattern

Antenna radiation patterns are graphical representations of the distribution of radiated energy as a function of direction about an antenna. Radiation patterns can be plotted in terms of field strength, power density, or decibels. They can be absolute or relative to some reference level, with the peak of the beam often chosen as the reference. Radiation patterns can be displayed in rectangular or polar format as functions of the spherical coordinates q and f.

The radiation pattern is a graphical depiction of the relative field strength transmitted from or received by the antenna. Antenna radiation patterns are taken at one frequency, one polarization, and one plane cut. The patterns are usually presented in polar or rectilinear form with a dB strength scale. Patterns are normalized to the maximum graph value, 0 dB, and a directivity is given for the antenna. This means that if the side lobe level from the radiation pattern were down -13 dB, and the directivity of the antenna was 4 dB, then the sidelobe gain would be -9 dB.

Links to Figures 1 thru 14 depict various antenna types and their associated characteristics. The patterns depicted are those which most closely match the purpose for which the given shape was intended. In other words, the radiation pattern can change dramatically depending upon frequency, and the wavelength to antenna characteristic length ratio.

The gain is assumed to mean directional gain of the antenna compared to an isotropic radiator transmitting to or receiving from all directions. The half-power (-3 dB) beamwidth is a measure of the directivity of the antenna. Polarization, which is the direction of the electric (not magnetic) field of an antenna is another important antenna characteristic. This may be a consideration for optimizing reception or jamming.

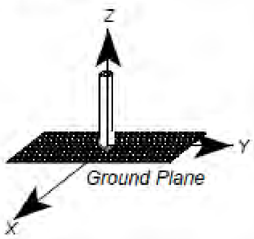
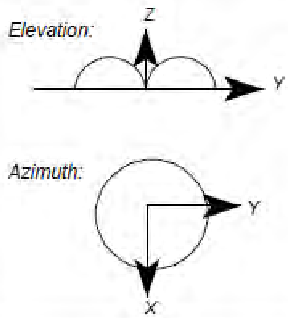
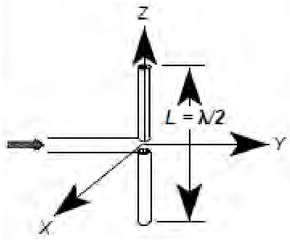
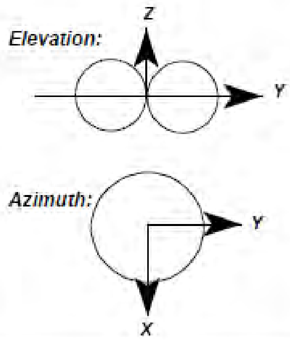
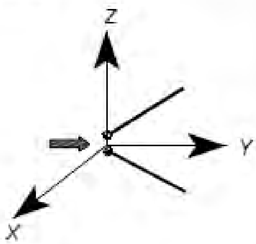
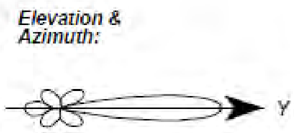
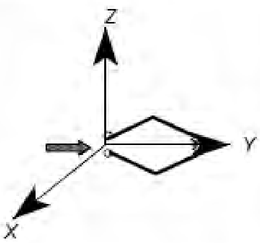
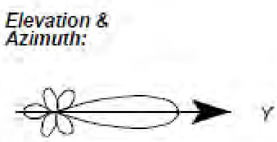
The bandwidth is a measure of how much the frequency can be varied while still obtaining an acceptable VSWR (2:1 or less) and minimizing losses in unwanted directions (See Glossary). A 2:1 VSWR corresponds to a 9.5dB (or 10%) return loss (see VSWR Section). Two methods for computing antenna bandwidth are used:

Narrowband by %, B = $\left[\frac{F_{U-F_L}}{F_C}\right]$ (100), whare FC = Centre frequency

Brodband by ratio, B $=\frac{F_U}{F_L}$

2.9 Antenna Types, Radiation Pattern and Charecteristic

Table 2: Antenna Type, Radiation Pattern and Characteristics

Antenna Type	Radiation Pattern	Characteristics
MONOPOLE 		**Polarization: Linear** Vertical as shown **Typical Half-Power Beamwidth** 45 deg x 360 deg **Typical Gain:** 2-6 dB at best **Bandwidth:** 10% or 1.1:1 **Frequency Limit** **Lower:** None **Upper:** None **Remarks:** Polarization changes to horizontal if rotated to horizontal
λ/2 DIPOLE 		**Polarization:** Linear Vertical as shown **Typical Half-Power Beamwidth** 80 deg x 360 deg **Typical Gain:** 2 dB **Bandwidth:** 10% or 1.1:1 **Frequency Limit** **Lower:** None **Upper:** 8 GHz (practical limit) **Remarks:** Pattern and lobing changes significantly with L/f. Used as a gain reference < 2 GHz.
VEE 		**Polarization:** Linear Vertical as shown **Typical Half-Power Beamwidth** 60 deg x 60 deg **Typical Gain:** 2 to 7 dB **Bandwidth:** "Broadband" **Frequency Limit** **Lower:** 3 MHz **Upper:** 500 MHz (practical limits) **Remarks:** 24KHz versions are known to exist. Terminations may be used to reduce backlobes.
RHOMBIC 		**Polarization:** Linear Vertical as shown **Typical Half-Power Beamwidth** 60 deg x 60 deg **Typical Gain:** 3 dB **Bandwidth:** "Broadband" **Frequency Limit** **Lower:** 3 MHz **Upper:** 500 MHz **Remarks:** Termination resistance used to reduce backlobes.