DIRECT CONVERSION 700 MHZ RF TRANSMITTER

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PROJEK SARJANA MUDA II

Tajuk Projek : DIRECT CONVERSION 700 MHZ RF TRANSMITTER

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To my dearest parent,
Mohd Noor Abu Bakar and Zaharah Ismail,
my friends,
who have always sincerely pray for my
success and glory.
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ABSTRACT

This project presents the Direct Conversion 700 MHz RF Transmitter which was designed to produce transmitted output power of 22 dBm. The design of this 700 MHz RF transmitter consist of five section altogether. First section is 25 MHz high pass filter, followed by 35 MHz low pass filter. A 700 MHz Mixer, Gain Block, and Power Amplifier complete the design. All component and circuit involved in this design are based on manufacturer`s recommended application circuit. The software used when designing the modules are Cadence OrCAD tools and Advance Design System 2008 (ADS2008). The direct conversion transmitter produces gain of 22 dBm and bandwidth of 30 MHz.

ABSTRAK

Projek ini menerangkan tentang penghantar isyarat penukaran terus frekuensi radio pada 700 MHz yang telah dihasilkan untuk mengeluarkan kuasa hantaran sebanyak 22 dBm. Penghantar isyarat ini direkabentuk daripada lima bahagian. Bahagian pertama adalah penapis isyarat tinggi 25 MHz, diikuti oleh penapis isyarat rendah 35 MHz. Pencampur frekuensi 700 MHz, blok peningkat, dan penguat kuasa juga melengkapkan lagi modul ini. Semua bahagian dan litar yang terlibat dalam rekabentuk isyarat ini pada dasarnya telah dicadangkan oleh pengeluar. Alatan rekaan bantuan komputer seperti Cadence OrCAD dan perancangan sistem termaju 2008 (ADS2008) daripada Teknologi Agilent digunakan bagi membantu proses merekabentuk setiap modul di dalam penghantar isyarat ini. Penghantar isyarat ini menghasilkan keluaran 22 dBm dan lebar jalur 30 MHz.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

CHAPTER I:

INTRODUCTION

1.1 Background

Nowadays, the communications environment, especially in urban areas is often called hostile because it imposes severe constraints to the transceiver design. Wireless communications systems are greatly expected to play a major role in providing access to future information services. Complexity, power dissipation, cost and the numbers of external components have been the primary criteria in selecting and determining the transceiver architecture itself[1].

As integrated circuit (IC) technologies evolved, the importance of these criteria changes allowing the approaches that once seemed impractical to be used as a possible solutions. In the past, most wireless designs have been optimized for either high performance or energy-efficient operation.

The narrow bandwidth available to each user also impacts the design of the RF section. For example, the transmitter must employ narrowband modulation, amplification and filtering to avoid leakage to the adjacent channels while the receiver must be able to process the desired channel while strongly rejecting all neighboring interference signals [2]. In contrast to the variety of approaches invented in the RF receiver, transmitter architecture is found to be designed in a few forms. This is because the issue such as noise, interference rejection and the band selectivity are more relaxed in transmitters than in receivers.

A transmitter may create RF interfere with not only towards other wireless devices, but with many type of non-RF electronic equipment [3]. Harmonics and spurious output wideband and close-in noise, frequency and amplitude stability, and peak including average output powers, are but a few of the critical parameters that must be addressed before any transmitter design can be realized.

1.2 Objectives

i. To designs and develop the 700 MHz transmitter with maximum transmit output power of 25 dBm.
ii. To design and simulate 25 MHz Chebyshev high pass filter and 35 MHz Chebyshev low pass filter.

1.3 Scope of work

Scope of work for this project is regarding to all of the objectives that have been stated. The most important thing for this project is to understand clearly about the transmitter system in radio frequency like the basic and standard operation of the system, the component that been used for the system and the advantages and disadvantages of the system. It also important to know the parameter and characteristic that will affect the APS system.

This project is to build a transmitter that transmits a 700MHz carrier signal. A direct-conversion approach is used in developing this RF transmitter. A signal bandwidth of 30MHz is inserted to the filter to leave only needed frequency signal. Then, an up conversion mixer is used to converts the signal into 700MHz RF carrier signal for transmitting. Power amplifier (PA) and Gain block provide gain to the system.

1.4 Project activity

The first need to know is to understanding the problem related with the final year project`s title that is this project of Direct Conversion 700MHz RF Transmitter. Then the understanding with literature review like survey and project management must be mastered before this project can be realized. The next step involved is in fabrication process. The PCB board layout must be design, assembly and tested precisely so it can work according to the specification. The final step involved is analyzing the result and conclude the finding if there are any.

1.5 Organization of the Report

The structure of this project report was planned to provide a clear explanation about the project entirely. This thesis is divided into five chapters.

Chapter I introduces background, objectives, scope of work, project activity, and company background. In this chapter, some general knowledge about transmitting system will be presented. Due to the subsidizing from TM R&D for this project, there is some review on it.

Chapter II provides the literature review on the Transmitter system. It is about the process, the mechanism and the parameters that involved in the systems.

Chapter III describes in detail the methodology used during the project. There are 3 method that been used in this project which are calculation, simulation and measurement. In calculation part, the formula that been used to calculate in the system will be presented. But, the circuit for simulation part will be shown in chapter Four. For the measurement part, the measurement process will be introduced.

Chapter IV discuss about the result and the analysis. The result will have simulation and measurement data. The analysis and the comparison for the data will be included in this chapter.

Chapter V is about the conclusion for the project. The conclusion will be summarizing about the entire project. Recommendation for the project will also be included in this chapter.

1.6 Company background

TM R&D, an entirely owned subsidiary of Telekom Malaysia Bhd. It starts its operation on 1st January 2001 as the R&D support of future business of TM. It also has the vision to grow to be a leading force technology company in the marketplace through research, development and innovation in Information and Communication Technology (ICT) industry.

R&D management is only one of its kinds due to the unpredictable market demand for state-of-art product and services. To remain responsive and competitive, TM R&D introduced several Knowledge Management initiatives as a frame-work to manage and utilize the wealth of intellectual capital inside the organization.

At TM R&D, they get on both basic together with applied research activities. It also has aligned research programs to sustain the strategic theme that covers different technological focused areas. The research activities conducted beneath division of basic research are mostly correlated to the development of nano and micro sized device for the purpose of electronic and photonic application. TM R&D also focus on it design simulation, fabrication technology development, and testing to meet up standard and quality contingent and system integration [4].

CHAPTER II:

LITERATURE REVIEW

2.1 Introduction

This section explains about transmitter`s characteristic, parameters, transmitter architecture, and module of transmitter. Transmitter characteristic must me mastered out first before any designing can begin. In transmitter structure, there are many things and terms must be understood like transmit output power, gain, insertion loss, return loss, and other terms regarding this project.

2.1 Radio Frequency

Radio frequency (RF) was defined as a rate of oscillation in the range around 3 kHz to 300 GHz, which match to the frequency of radio waves, and the alternating currents that carries radio signals [5]. Here, RF generally refers to electrical rather than mechanical oscillations, although mechanical RF systems do exist.

The electrical currents oscillating at radio frequencies have particular properties that differ from direct current or alternating current. Energy in RF current can radiate from a conductor into space as electromagnetic waves or radio waves. This is the foundation of radio technology. Instead of penetrating deeply into electrical conductors, RF current actually flows along their surfaces known as skin effect. As a result, whilst the human body comes in contact with high power RF currents it caused burns called RF burns. The current can simply ionize air, creating a conductive path through it. It also flows through paths that contain insulating material, like the dielectric insulator of a capacitor. When circuit are conducted by an ordinary electric cable, RF current has a tendency to reflect from discontinuities in the cable such as connectors and travel back down the cable toward the source and causing state named standing waves, so RF current have to be carried by particular types of cable called transmission line [6].

2.3 Parameter

S-parameters or scattering parameters best explain the electrical performance of linear electrical networks when endure various steady state caused by electrical signals in communication design. S-parameters characterize a linear electrical network by matched loads instead of open or short circuit conditions. These terminations are easier to implement at high signal frequencies and the quantities are measured in power (dB) [7].

Lots of electrical properties of components like inductors, capacitors, and resistors may be uttered using S-parameters, such as Gain, Voltage Standing Wave Ratio (VSWR), Return Loss, Reflection coefficient, and amplifier stability. In the circumstance of S-parameters, scattering refers when traveling currents and voltages in a transmission line are affected when they meet up a discontinuity caused by the insertion of a network into the transmission line.

Even though appropriate at low or high frequency, S-parameters are mostly used for networks operating at radio frequency (RF) and microwave frequencies where energy considerations and signal power are easily quantified than currents and voltages [8].

Due to the theory of S-parameters that is changed by means of the measurement frequency, the frequency must be specified for any S-parameter measurements declared, in calculation to the characteristic or system impedance. S-parameters are generally represented in matrix form and comply with matrix algebra. By having two ports only in microwave network, that is an input and an output, the S-matrix has four S-parameters, designated like below:

$$\begin{matrix} S11 & S12 \\ S21 & S22 \end{matrix}$$

These complexes quantities in fact contain eight divided numbers (real and imaginary parts), or modulus and phase angle, of each of the complex scattering parameters. If the output port 2 is terminated, the transmission line is connected to a matched load impedance and giving rise to none reflections, and produced no input wave on port 2. The input wave on port 1 gives rise to a reflected wave at S11. And a transmitted wave at port 2 which absorbed in termination on port 2. The transmitted wave dimension is S21. If the network used has none loss or gain, the output power must equal the input power and so in this case $|S11|^2 + |S21|^2$ is matched [9].

Therefore, the sizes of S11 and S21 determine the input power that splits between the potential output paths. Clearly, if 2-port microwave network represents a good amplifier, S11 needed are rather small and S21 are quite large. In general, the s-parameters stated much power comes back or out when the