INFRARED DETECTOR

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This report is submitted in partial fulfillment of the requirements for the award of Bachelor of Electronic Engineering (Computer Engineering) With Honours

Faculty of Electronic and Computer Engineering
Universiti Teknikal Malaysia Melaka

May 2008

UNIVERSTI TEKNIKAL MALAYSIA MELAKA
FAKULTI KEJURUTERAAN ELEKTRONIK DAN KEJURUTERAAN KOMPUTER

BORANG PENGESAHAN STATUS LAPORAN
PROJEK SARJANA MUDA II

Tajuk Projek : INFRARED DETECTOR

Sesi Pengajian : 2007/2008

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Dedicated to my beloved family especially my parents

ACKNOWLEDGEMENT

I would like to take this opportunity to express my gratitude and regards to all those who have support me in the process of completing this project. I am deeply indebted to my supervisor Maisarah Bt. Abu for his supervision, stimulating suggestions and encouragement that he provided from the very early stage of this research through out the development of this project. I also would like to record my gratitude to the FKEKK technicians for their help and cooperation while doing this project especially for the guidance given in handling some delicate equipments and hardware materials used to complete this project. Last but not least, to all whom had helped me both directly or indirectly, it is a pleasure to convey my gratitude to them all in my humble acknowledgements.

ABSTRACT

This thesis presents a development of remote control receiver that should be able to display the respected signal wave of each individual control. Five different type of remote control displayed through this receiver and the data should be able to be used to control the appliance. Different types of modulation techniques that being used by individual remote control have been presented.

ABSTRAK

Tesis ini membentangkan tentang pembangunan sebuah penerima alat kawalan jauh yang boleh memaparkan gelombang isyarat bagi setiap alat kawalan jauh yang digunakan. Lima jenis gelombang isyarat alat kawalan jauh yang berlainan dipaparkan menerusi pengesan ini dan data yang diperolehi boleh digunakan untuk mengawal peralatan lain. Beberapa teknik modulasi yang digunakan oleh alat kawalan jauh individu juga turut dibentangkan dalam tesis ini.

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ASK	-	Amplitude Shift Keying
CMOS	-	Complimentary Metal Oxide Semiconductor
IC	-	Integrated Chip
IR	-	Infrared Radiation
LED	-	Light Emitting Diode
PC	-	Personal Computer
PCB	-	Printed Circuit Board
PM	-	Pulse Modulation
TTL	-	Transistor-Transistor Logic

CHAPTER I

INTRODUCTION

1.1 Overview

Nowadays, infrared technologies have assimilates into our life without realizing it. These technologies actually have improved and simplified our way of living in many different aspects. Researchers keep contributing their efforts by continuously studies and propose new invention in order to implement the technologies and make life even simpler. There are different types of infrared detection circuits available which are built for different purposes [1]. In this project, the purpose of studies is to get the carrier frequency of the signal transmitted by typical remote controllers. Infrared serial communication is seen most frequently in remote controls and short message beaming from cell phones and other handheld devices. Infrared communication requires a line of sight between the transmitter and the receiver [2]. It is suitable for applications where a person has to point at an object to activate it. Some of infrared modulation techniques and simple applications of infrared which are chosen to be reviewed will be explained below.

1.2 Types of infrared modulation.

Infrared is modulated by rapidly turning the emitter "on" and "off". The resulting pulsed signal is then detected by a demodulator that is tuned to the particular frequency of the modulation. The detector has to sense several "on" flashes in a row so that the decoder can determine its frequency and decode it [3]. Most of infrared remote controllers for electronic appliances use modulation to make sure the transmitted signals get to the receiver without errors. There are several modulation techniques which are commonly used to code the signals of controller such as amplitude shift keying (ASK) and phase shift keying (PSK). Figure 1.1 illustrates the carrier wave, data signal and ASK implementation.

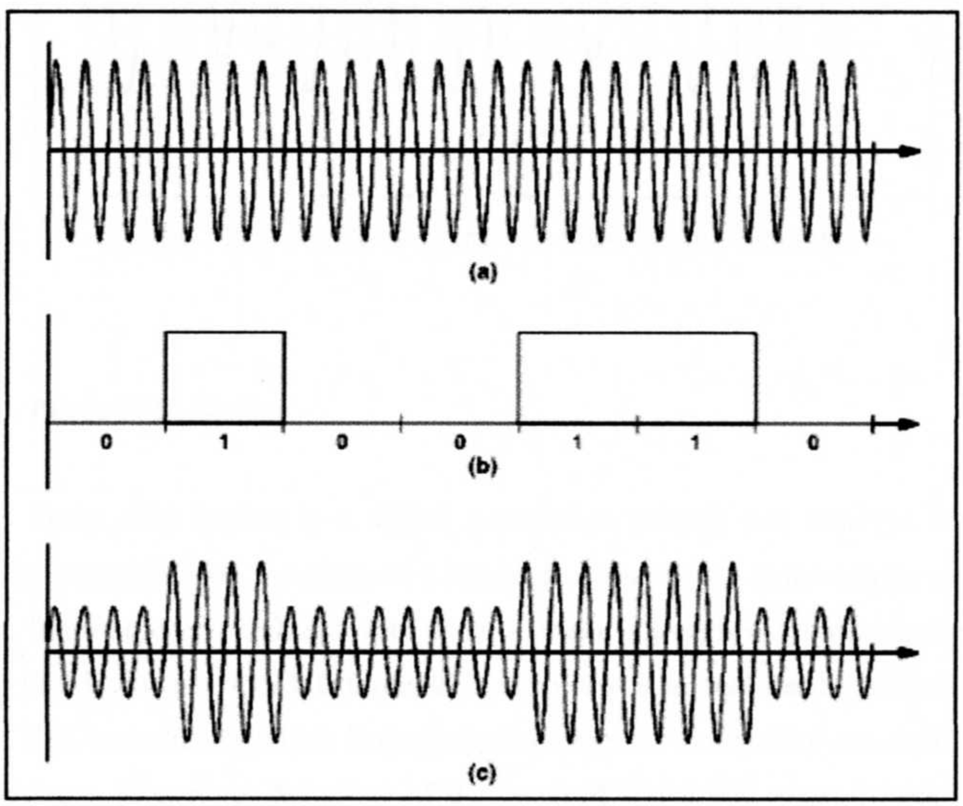

Figure 1.1: Illustration of carrier wave, digital signal and ASK implementation

1.2.1 Amplitude Shift Keying

Amplitude shift keying is a form of a modulation that represents digital data as variations in the amplitude of a carrier wave. The amplitude of an analog carrier signal varies in accordance with the bit stream (modulating signal) keeping the frequency and phase constant. The level of amplitude can be used to represent binary logic 0s and 1s [4]. Figure 1.2 shows the example of an amplitude shift keying modulation technique.

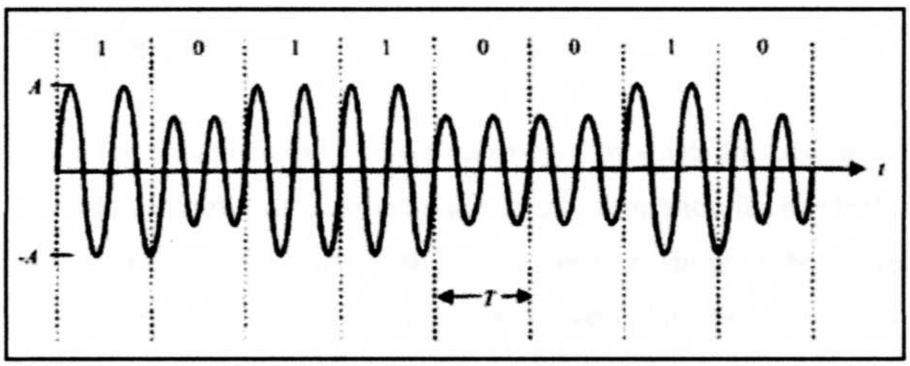

Figure 1.2: Example of Amplitude Shift Keying technique

1.2.2 Phase Shift Keying

Phase shift keying is a digital modulation scheme that conveys data by changing or modulating the phase of a reference signal which is the carrier wave. It uses a finite number of phases with each of them is assigned a unique pattern of binary bits. Each pattern of bits forms the symbol that is represented by the particular phase. The demodulator which is design specifically for the symbol-set used by the demodulator, determines the phase of the received signal and maps it back to the symbols it represents, thus recovering the original data [4]. Figure 1.3 shows the example of the phase shift keying modulation technique.

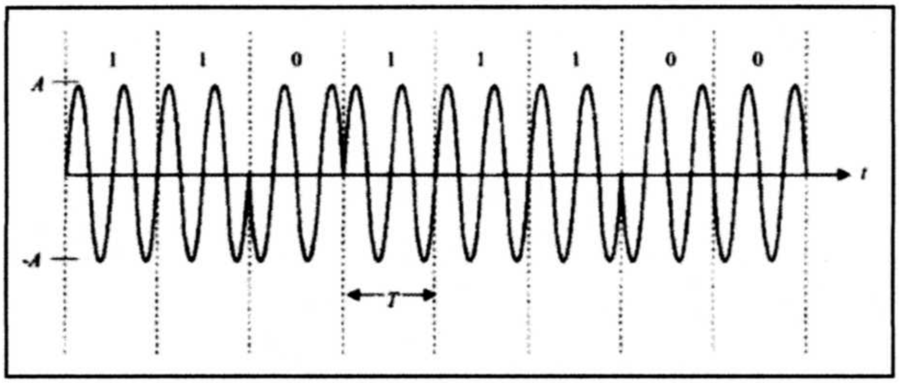

Figure 1.3: Example of Phase Shift Keying technique

1.3 Infrared application

Infrared applications can be seen mostly on products for consumer such as remote controller, infrared audio system and data transmission for handheld mobile. Other application field of infrared also can be seen on simple robot development where it is used to detect a line or the distance between the robot and an object such as a wall [5]. An example of a robot that used infrared is a line following robot. Infrared LED is used to continuously transmit the infrared pulses to the floor. Reflected infrared will be detected by a receiver next to the transmitter. Infrared cannot be reflected by dark surface or line. So, if any infrared signal is detected by the receiver, it will trigger the microcontroller on the robot to drive the motor according to the command programmed by the user on the microcontroller unit. Figure 1.4 shows the line following robot transmitting and detecting the infrared signal

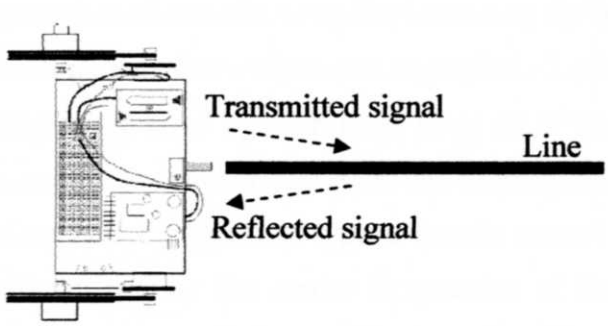

Figure 1.4: Line following robot

CHAPTER II

OBJECTIVE

2.1 Objective

The objective of this project is to build a circuit that is able to detect infrared signal from typical remote controls and display the respected carrier frequency of the signal on a computer. The signal received will be analyzed to evaluate the possibilities of interfacing it with personal computer as an input to any application such as home appliances or the software on the computer itself.

2.2 Problem statement

Applications using infrared transmission include television, video recorder, computer peripherals and medical equipments can be seen anywhere [6]. These also results in increasing number of manufacturers implementing the infrared technology in their devices. Therefore, a medium which can controlled all of these devices such as a personal computer is preferred by most users since all of those devices bought normally come with a remote control. Thus, at the end of this project, a circuit which is able to detect and analyze the signal of typical remote control will be built. The circuit should be able to display the carrier frequencies of the signals used by different remote control and manufacturers. The signals will be analyzed on the possibilities to interface it to a personal computer as an input for any application.

2.3 Scope of work

The main scope of this project is to design and fabricate a circuit which will be able to detect any signal transmitted from typical infrared remote control and display its respected carrier frequency. The output display unit also will be designed to display the waveform of the signal detected and its carrier frequency.

CHAPTER III

LITERATURE REVIEW

3.1 Introduction

In this chapter, the circuits and data collected through research that have been studied and tested during experimental process will be explained. The description and the operation of each circuit will be explained.

3.2 IR remote control modulation detector

Figure 3.1 shows the block diagram representing the operation of the circuit designed by Andy Collision from Massachusetts Institute of Technology [7]. The circuit is designed to measure and extracts the modulated carrier of an infrared remote control. When signal is transmitted to the circuit, it amplifies the complete signal received in order to enable the signal to be displayed either on an oscilloscope or a frequency counter. The circuit is said to be able to measure frequencies in a range of 1 kHz to several Megahertz which would be enough to measure a remote control signal.

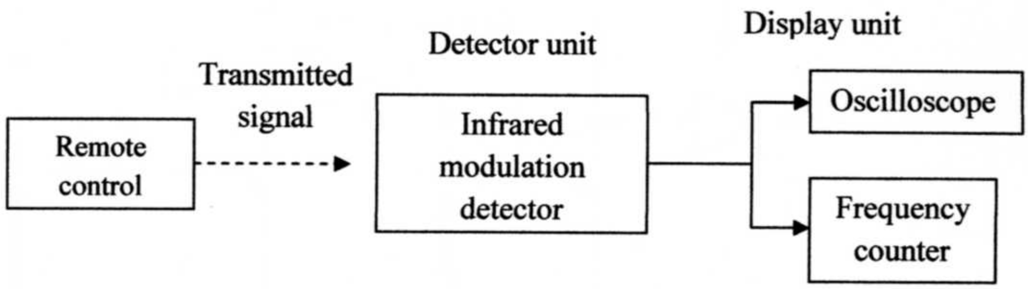

Figure 3.1: Block diagram of infrared remote control modulation detector

3.2.1 Circuit operation

This circuit in Figure 3.2 operates using a photodiode called TIL100 which is manufactured by Fairchild Semiconductor [8]. The photodiode is reversed biased by the 22kΩ resistor and will produces small changes in current when it is stroke by light which is in the infrared spectrum. The input signal which is from the photodiode is capacitively coupled to the first BC549C amplifier stage via a 10nF capacitor. The function is to stop the ambient light from passing and change the light intensity received. The high current gain of the transistor (BC549C) and a resistor will produce a voltage waveform that may be suitable to be displayed on the oscilloscope. The magnitude of the voltage waveform may vary with the proximity of the light source with the detector and the type of the remote control used. The output of the second transistor is used to display the frequency of the received signal on a frequency counter. The transistor will be on when a positive peak arrives and off for a negative peak. Normal infrared remote control operates in a range of 36 to 40 kHz of carrier frequency. However, control pulses of a typical remote control are long and this fact only allows a few waveforms to be capture and measured on the oscilloscope or frequency counter.

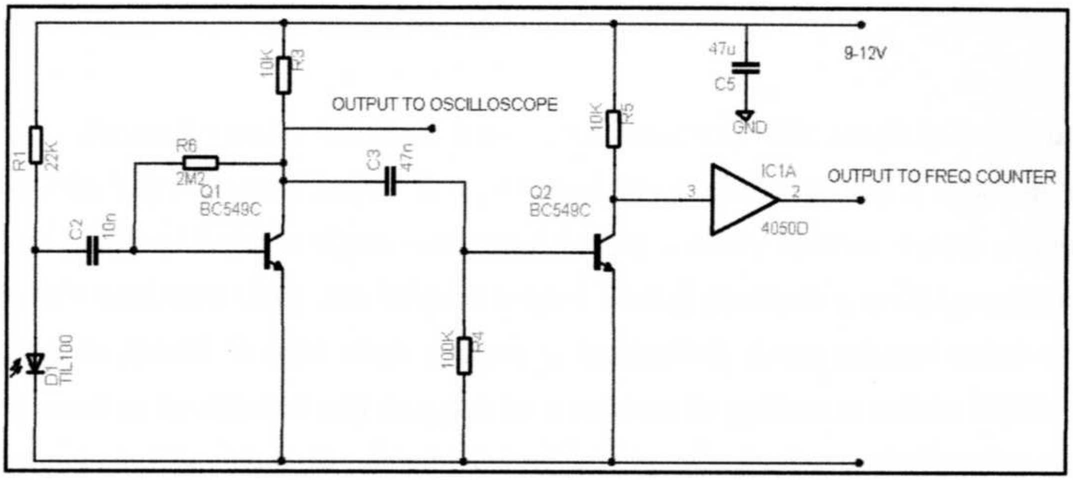

Figure 3.2: Schematic for infrared remote control modulation detector

3.2.2 Advantages and disadvantages

The advantage of this circuit is that it is able to display the waveform of the signal when a signal is transmitted. It is also able to display the nearest frequency of the signal when connected to a frequency counter. The range of frequency specified for the remote control to be measured is also suitable since typical remote control nowadays uses by consumers are below 1 MHz [7].

However, the drawback of this system is that it cannot give an accurate measurement of the signal since when measured by using an oscilloscope, a manual trigger is required as the signal is continually being modulated. Another disadvantage of this circuit is that when the signal is measured by using a frequency counter, there will be some phase shift from the input to output since the transistor is on only when the positive peak arrives. This method also caused the sinusoidal waveform of the signal turned to be a digital one. Although the phase shift occurred, the period of the wave still can be measured and extra calculation can be done to obtain the carrier frequency of the signal. As the conclusion, this circuit is not suitable for this project since the main objective is to display the respected carrier frequency of the signal transmitted.