"Saya akui bahawa saya telah membaca karya ini, pada pandangan saya karya ini adalah memadai dari skop dan kualiti untuk tujuan penganugerahan Ijazah Sarjana Muda Kejuruteraan Elektronik & Komputer"

NORIZAN BIN MOHAMAD

8/5/2006

WIRELESS BLUETOOTH DIGITAL OSCILLOSCOPE

AMRIL AZ BIN MAT YASIR

Laporan ini dikemukakan sebagai memenuhi sebahagian daripada syarat untuk penganugeraah Ijazah Sarjana Muda Kejuruteraan Elektronik & Komputer.

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Kolej Universiti Teknikal Kebangsaan Malaysia

APRIL 2006

"Saya akui laporan ini adalah hasil kerja saya sendiri kecuali ringkasan dan petikan yang tiap-tiap satunya telah saya jelaskan sumbernya".

Tandatangan  .

Nama Penulis : Amril Az Bin Mat Yasir

Tarikh : 4 APRIL 2006

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Last but not least, all the invocations from my parents, families, friends and others, I would say thank you. This is was the greatest experience I ever had in my life because I've learned so much from this lesson.

ABSTRACT

The purpose of this project is to design and build a system that mimic an oscilloscope which displays a waveform at a personal computer from a triggering device without using any wires. Currently, most existing oscilloscopes are created in wired, thus creating a limited usage when triggering at a place that is difficult to trigger. Also, most existing oscilloscopes are expensive and some of them have limited functionality. So, the objective of this project is to make a monitoring measurement tool wirelessly in which Bluetooth is chosen as a medium. The oscilloscope is self powered device that transmit data to a personal computer and the result will show up instantly to the monitor by using Bluetooth thus eliminates wires. An analogue signal is triggered and processed through an Analogue to Digital converter circuit in which a PIC16F877 is used, and then the data will be transported to a personal computer by using Bluetooth. A user friendly program called Bluetooth Oscilloscope will process the data and shows the data in wave form. This Bluetooth Oscilloscope program will be created by using Microsoft Visual Basic. In this program also do have some features such as saving the data waveform and printing the data waveforms. This project is capable to let user to trigger any analogue signals and monitor the output at the personal computer at any points or area without worrying the distance because the Bluetooth is capable to operate between 10 meters to 100 meters. This project can be commercialized because it is cheap to built, easy to use, portable and also the program is easy to use.

ABSTRAK

Tujuan projek ini adalah untuk mencipta dan membina satu sistem yang menyerupai fungsi sebuah osiloskop yang boleh memaparkan gambarajah gelombang di komputer dari satu alat pengesan tanpa menggunakan wayar. Kebanyakan osiloskop yang tercipta pada zaman sekarang masih menggunakan wayar , jadi ia menyebabkan penggunaannya terhad. Seperkara lagi , kebanyakan osiloskop adalah mahal. Jadi , objektif projek ini adalah untuk membina sebuah alat pengukur yang tidak menggunakan wayar. Isyarat Analog akan diukur dan diproses melalui litar penukar analog ke digital dimana PIC16F877 digunakan, selepas itu , data yang telah diproses tadi akan dihantar ke komputer melalui Bluetooth. Satu program mesra pengguna yang dinamakan Bluetooth Oscilloscope akan memproses data yang diterima tadi dan memaparkan keputusannya dalam bentuk gelombang pada skrin. Program Bluetooth Oscilloscope dihasilkan dengan menggunakan Microsoft Visual Basic. Didalam program ini juga mempunyai fungsi fungsi seperti menyimpan dan mencetak gelombang yang terhasil. Projek ini sangat berguna kepada pengguna kerana ia berupaya untuk mengukur isyarat analog ditempat tempat yang sukar diukur kerana Bluetooth berupaya untuk beroperasi dari 10 meter hingga 100 meter . Projek ini juga boleh dikomersialkan kerana ia adalah murah , mudah dibina, mudah dibawa kemana mana dan programnya mudah digunakan.

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LIST OF ABBREVIATION

PIC	Peripheral Interface Controller
ADC	Analogue to Digital Converter
TTL	Transistor Transistor Logic
V	Voltage
VCC	Supply Voltage
VDD	Supply Voltage
VI	Input Voltage
VIN	Input Voltage
Vo	Output Voltage
VOUT	Output Voltage
VSS	Ground
WWW	World Wide Web
X	Horizontal
XTAL	Crystal frequency
Y	Vertical
Ω	Ohms
UART	Universal Asynchronous Receiver Transmitter
USART	Universal Synchronous Asynchronous Receiver Transmitter
USB	Universal Serial Bus
SPBRG	Serial Port Baud-Rate Generator
RS232	Standard 9-pin PC serial port
RISC	Reduced Instruction Set Computer
ROM	Read Only Memory
R	Resistor
RAM	Random Access Memory

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

The main objective in doing this project is to build an oscilloscope that can transmit data to personal computer wirelessly. The following detail explains the development and implementation of a Wireless Bluetooth Oscilloscope. This project attempts to achieve the same functionality as a traditional oscilloscope, using a PIC microcontroller for data acquisition which transfers the data to the personal computer (via Bluetooth). A Windows based software application will then display the waveform as it would appear on a traditional CRT oscilloscope. This software application will have additional features not present on a traditional oscilloscope (e.g. printing / saving waveforms) with greater flexibility as additional features can be added as their developed without the need for new hardware.

The digital based oscilloscope should display very low frequency waveforms in real-time. Digital storage oscilloscopes have two main advantages over traditional analogue scopes:

1. The ability to observe slow and very slow signals as a solid presentation on the screen. "Slow moving signals in the 10-100 Hz range are difficult to see and measure on a normal analogue oscilloscope due to the flicker of the trace and the short persistence of the spot on the screen. Very slow moving signals, less than 10 Hz, are impossible to view on an analogue scope. As fast as the spot traces out the waveform, the image fades and disappears before a complete picture can be formed.
2. The ability to hold or retain a signal in memory for long periods.

1.2 PROBLEM STATEMENTS

Oscilloscope is a measurement tool that is very useful to the users to measure various kind of waveform. A lot can be done by using this tool but still here is not much product that built today using wireless method. Oscilloscopes traditionally are hardware based using a Cathode Ray Tube or Liquid Crystal Display designed to display voltage variations as they are bulky, expensive and have difficultly displaying low frequency waveforms. In this project with the implementation of Bluetooth as communication medium, some problems stated below could be proven

i. Large high-resolution display (as display at personal computer)
ii. Windows / GUI advantage such as cut & paste into documents.
iii. Low-cost to build (expected to be under RM300)
iv. Software Upgradeable.
v. Wireless
vi. Large Display
vii. Portable
viii. Cheap to construct

Wireless Bluetooth Digital Oscilloscope could be applied to many possible applications such as:

i. Monitoring of sound waves, which are difficult to monitor on a traditional oscilloscope due to the low frequencies involved.

ii. Monitoring of an ECG signal, again because this is such a low frequency traditional oscilloscopes would have difficultly monitoring such a signal. ECG data could be logged and emailed directly to the doctor for diagnosis, or perhaps real-time TCP/IP internet communication so that the doctor could remotely monitor the ECG signal in real-time.

iii. The Wireless Bluetooth Oscilloscope is ideal for demonstration purposes, for example using data projector a class of student could be introduced to the oscilloscope, with real waveforms being monitored (signal generator, or even a microphone for sound waves) and displayed on a large projector display.

iv. Because of the low cost of the Wireless Bluetooth Digital Oscilloscope, it is economical for a school / technical college to have large quantities available for students. Unlike traditional analogue scopes which are expensive and students are forced to share equipment, because it is not economical to purchase enough scopes for every student

v. Wireless Bluetooth Digital Oscilloscope can be use in any place because it's a handy tool. It can be pinpoint anywhere (in selected measurements) such as in a narrow places or a place where traditional oscilloscope can't be reached or it can be a monitoring device in a specific place

1.3 PROJECT OBJECTIVES

This project is consisted of three parts. The first part is the objective of this work to familiarize with the radio frequency signal, the circuit, the data obtained and the transmission signal. The second part is the primary technical objective of the proposed project is to design the Digital Oscilloscope trigger and implement a microcontroller using the PIC16F877 to process and transmit the data by Bluetooth.

For the third part, the objective is to write the program using the Microsoft Visual Basic 6.0 as a programming tool in order to show the output waveform that obtained from the trigger module. The study of microprocessors and electronic circuits will be used to interface the Bluetooth with the Microcontroller. For this project, the scopes of works are:

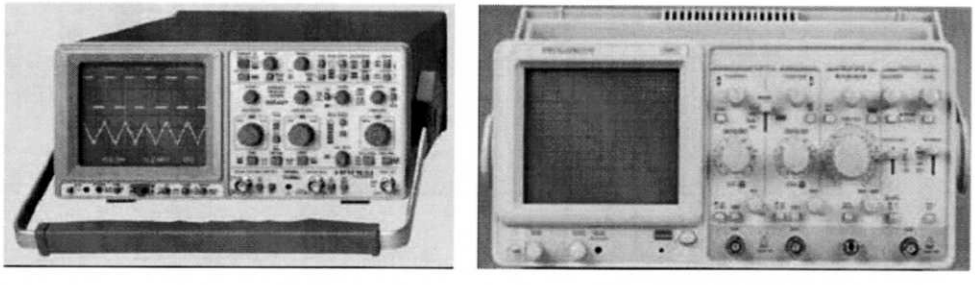
i. PIC C to compile the Assembler language for the PIC16F877
ii. ICPROG 1.5 (to download the HEX file to the PIC Microcontroller)
iii. Microsoft Visual Basic (Bluetooth Oscilloscope software)
iv. Assembly to interface the Microcontroller with Bluetooth and establish the transmission between Digital Oscilloscope trigger and computer

CHAPTER 2

LITERATURE REVIEW

2.1 [illegible]

Oscilloscopes traditionally are hardware based using a CRT (Cathode Ray Tube) designed to display voltage variations (periodic or otherwise); they are bulky, expensive and have difficultly displaying low frequency waveforms.



[illegible].1 Types of Analog Oscilloscope

The word 'Oscilloscope' is an etymological hybrid. The first part derives from the Latin 'oscillare', to swing backwards and forwards; this in turn is from, 'oscillum', a little mask of Bacchus hung from the trees, especially in vineyards, and thus easily moved by the wind. The second part comes from the Classical Greek 'skopein', to observe, aim at, examine, from which developed the Latin ending 'scopium', which has been used to form names for instruments that enable the eye or ear to make observations. [1] The heart of the traditionally CRT oscilloscope is the display screen itself, the CRT. The CRT is a glass bulb which has had the air removed and then been sealed with a vacuum inside. At the front is a flat glass screen which is coated inside with a phosphor material. This phosphor will glow when struck by the fast moving electronics and produce light, emitted from the front and forming the spot and hence the trace. The rear of the CRT contains the electron 'gun' assembly. A small heater element is contained within a cylinder of metal called the cathode. When the heater is activated by applying a voltage across it, the cathode temperature rises and it then emits a stream of electrons.[1]

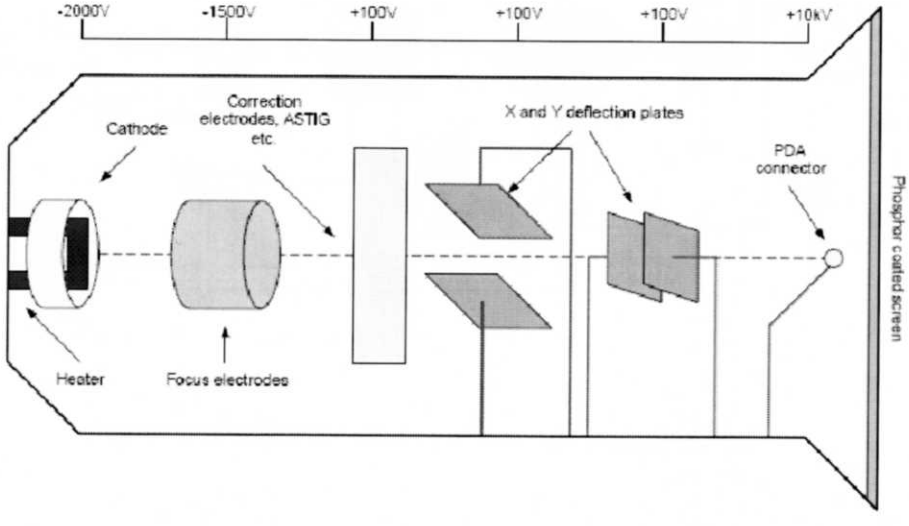


Figure 2.2: Types of Analog Oscilloscope [1]

2.1.1 The Basic CRT Oscilloscope

An oscilloscope draws its trace with a spot of light (produced by a deflectable beam of electrons) moving across the screen of its CRT (see Figure 2.3). Basically an oscilloscope consists of the CRT, a 'time base' circuit to move the spot steadily from left to right across the screen at the appropriate time and speed, and some means (usually a 'Y' deflection amplifier) of enabling the signal to deflect the spot in the vertical or Y direction. [1]

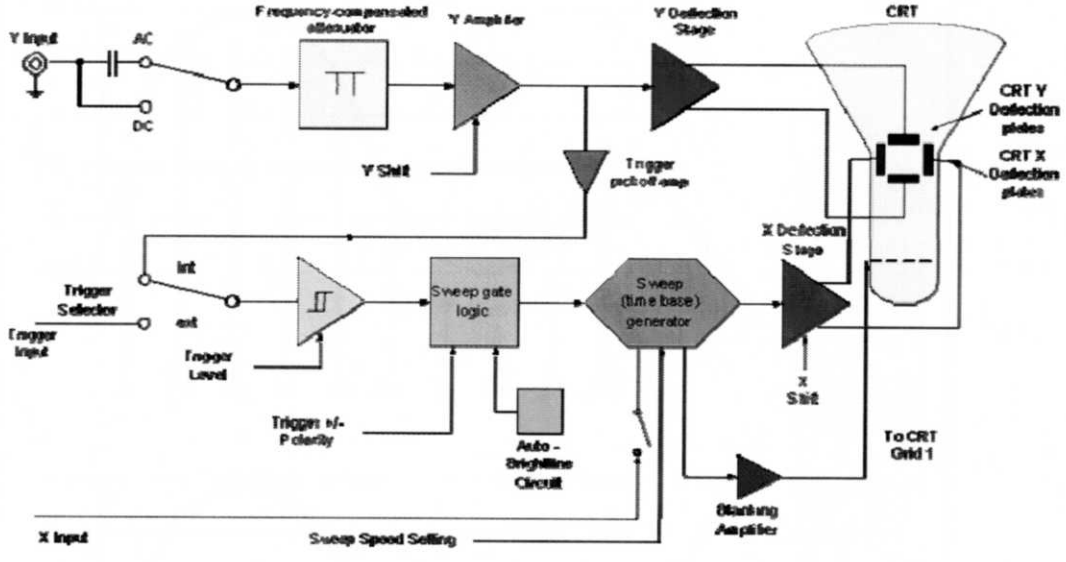


Figure 2.3: Block diagram of a basic CRT oscilloscope

This type of oscilloscope is known as a 'real-time' oscilloscope. This means that the vertical deflection of the spot on the screen at any instant is determined by the Y input voltage at that instant. Not all CRT oscilloscopes are real-time instruments.

2.1.2 Digital Sampling Oscilloscopes

Digital sampling oscilloscopes use an ADC (analogue-to-digital converter) to converter analogue voltages to binary representation. The sampling rate specifies the number of samples taken per second. Figure 2.4 demonstrates clearly how an analogue wave-form is digitally sampled and displayed onto the screen.

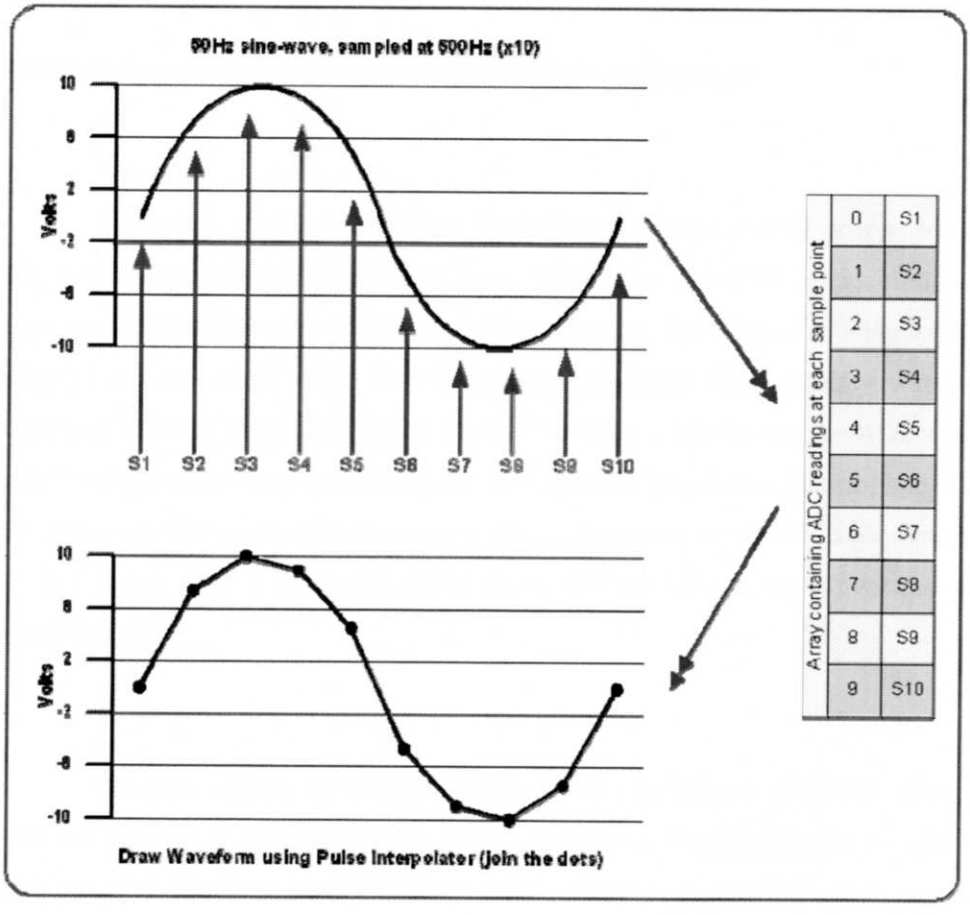


Figure 2.4: ~~Types of Analog Oscilloscope~~

This project attempts to achieve the same functionality as a traditional oscilloscope, using a PIC Microcontroller for data acquisition which transfers the data to the Personal Computer via Bluetooth. A Microsoft Windows based software application will then display the waveform at screen. This software application will have additional features not present on a traditional oscilloscope (e.g. printing / saving waveforms) with greater flexibly as additional features can be added as their developed without the need for new hardware.

2.2 Background of Wireless Bluetooth Digital Oscilloscope

Figure 2.5, shows a simplified block diagram of the overall system. It is clear the PIC is connected to the Bluetooth remote. Notice that the clock is specified as 20MHz, as a slower clock speed would reduce power consumption (critical if using battery power supply) and less noise would have been generate; hence ADC readings would be more accurate, allow it is possible to put the PIC to sleep while taking the ADC reading, the ADC will send an interrupt waking the PIC once the acquisition is complete. This is not an option for this application because it takes a long time for the PICs oscillator to return to full speed, after a sleep operation; hence this would severely affect the maximum sampling rate.

The main reason for using a 20MHz clock was because at slower clock speeds it was not possible to obtain a good 115kbps baud rate. The C compiler used to write the PIC program. The reason why 115kbps is important is because the serial communication is the bottleneck when operating in real-time mode; hence it makes sense to use the maximum baud rate possible. Note the PIC is capable at 20MHz of generating baud rates higher than 115kbps, but most PIC's have a maximum baud rate of 115kbps.