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JUDUL: **AUTOMATIC PET FEEDER WITH CLIENT/SERVER APPLICATION**

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AUTOMATIC PET FEEDER WITH CLIENT/SERVER APPLICATION

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UNIVERSITI MALAYSIA PAHANG

AUTOMATIC PET FEEDER WITH CLIENT/SERVER APPLICATION

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A thesis submitted in fulfilment of the
requirements for the award of the degree of
Electrical Engineering (Electronics)

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“I hereby acknowledge that the scope and quality of this thesis is qualified for the
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To my beloved father, Mohd Yakop B. Abd Hamid and mother, Siti Mariam Bt. Ismail
Who always pray for me and give me courage to finish this thesis.

And also to those people who have guided and inspired me throughout my journey.
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ABSTRACT

This project explains about designing and developing an automatic pet feeder that comes with the client/server application. Not like the ordinary pet feeding product in the market today that requires the user to set the times of feeding, this automatic pet feeder use the ultrasonic sensor that placed in front of the device to sense the presence of the pet. The purpose and concept of this project is the same with other device like it, to feed the pet without the present of the owner. This project was developed using Motorola MC68HC11A1P microcontroller that play the role as the main controller system. The microcontroller used in this project is programmed using assembly language. The microcontroller controls the rotation of the motor and send signal to the server computer to update the database at the server. The server and client application for this project is developed using Visual Basic 6.0 software. Finally, this project allows the user to view the information about the feeding from other computer where internet becomes the medium of interaction.

ABSTRAK

Projek ini menerangkan tentang langkah mereka dan membangunkan sebuah pemberi makanan binatang peliharaan automatik yang datang bersama aplikasi pelanggan/pelayan. Tidak seperti pemberi makanan binatang peliharaan automatik yang berada di pasaran hari ini yang memerlukan pengguna untuk menetapkan masa pemberian makanan, pemberi makanan automatik ini menggunakan pengesan ultrasonik di hadapannya untuk mengesan kehadiran binatang peliharaan. Tujuan dan konsep projek ini adalah sama seperti alat lain sepertinya iaitu memberi makanan kepada binatang peliharaan tanpa kehadiran pemilik. Projek ini dibangunkan menggunakan pengawal mikro Motorola MC68HC11A1P yang memainkan peranan sebagai pengawal utama keseluruhan system. Pengawal mikro yang digunakan dalam projek ini diprogram menggunakan bahasa pengaturcara. Pengawal mikro yang digunakan mengawal pusingan motor dan menghantar isyarat kepada komputer pelayan untuk mengemaskini data didalamnya. Aplikasi pelanggan dan pelayan untuk projek ini dibangunkan menggunakan perisian Visual Basic 6.0. Akhirnya, projek ini membenarkan pengguna untuk mendapatkan informasi tentang proses pemberian makanan menggunakan komputer lain dimana internet menjadi medium untuk berinteraksi.

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CHAPTER 1

INTRODUCTION

1.1 Background

Pet care should be fun, not burdensome and so the goal of this project is to assist owner with pet care by providing an automatic pet feeder. The purpose of the project helps the owner of the pet feeding their pet on time even when they are not at home. Other than that, it also can help the owner know the diet of their pet. Knowing the diet of the pet is very important for the owner to make sure that the pet is in good health.

This system assist pet owner to feed the pet. The system act in two ways, one is feeding the pet and sends the feeding information to owner. After it feed the pet, the system will stop responding for certain time in order to make sure that the pet do not eat too much.

1.2 Objective of Project

The objectives of this project are:-

- i. To create a device that can automatically feed pets without the present of the owner by developing a microcontroller based system that response to the ultrasonic sensor, connected to a PC (server).
- ii. To develop a client/server application using Visual Basic.

1.3 Problem Statement

It is common to know that pet care is a burden to the pet owner. Any pet need to be taken care and the owner need to be there to take care of them. Some pet cannot control their diet and will eat as long as there's food for them. Other pet will just eat a certain type of food. In other word, the owner cannot leave the pet on its own.

The problem occurs when the owner has to leave their pet for certain time and there's no one there to watch them. Therefore to solve the problem, system that can automatically feed the pet without the presence of the owner is needed to make sure that the pet stay healthy.

1.4 Scope of Project

The system is built using:

- i. MC68HC11A1P microcontroller
- ii. The Permanent Magnet Stepper Motor as the output from the controller.
- iii. Visual Basic 6.0 as the main software development program.
- iv. Ultrasonic sensor as the input of the system.

1.5 Methodology

Step taken to archive the objectives of this project are:

- Studies on the hardware that needed for this project such as controller, motor, ultrasonic sensor and others.
- Do studies on the compatible software that available and related to the project in order to perform certain tasks like developed GUI, used internet services and others.
- Designing the hardware of the project such as microcontroller circuit and ultrasonic sensor based on the literature review that has been done.
- Do simulation for the program that will be burn into the microcontroller to make sure that the program work as wanted.

- Designing the client/server application using the software that has been decided.
- Communication test between the hardware and the software used in this project to make sure it operates as a system.
- Integrate the software and hardware to complete the project.
- Collect result get from the test and simulation that has been done.
- Analysis the data in order to make sure that the system work perfectly.

1.6 Thesis Outline

This thesis contains five chapters. Chapter 1 is about the introduction of the project which consists of background, problem statement, scopes, methodology, objectives of the project and also the thesis outline.

Chapter 2 provides a literature review on sending data using client/server application in general and discusses about controlling motor using microcontroller and how it can be integrated with the server as the control panel. This chapter is based on the journal and other reference that has been use to complete this project.

Chapter 3 discusses all about the design system of the project. This chapter includes step by step explanation on implementing ideas onto the hardware that has been

chosen. Then creating the graphical user interfaces (GUI) for PC server and PC client until all of the components combined together as one perfect system.

Chapter 4 will be the outcomes or result from the project which consists of figure of the hardware project, table of simulation result and other related stuff. The discussion focused on the result is base on the experiment.

Finally, chapter 5 explains the summary of the project where it concludes overall of the project, obstacle faces and some recommendations for future development.

CHAPTER 2

LITEATURE REVIEW

2.1 Introduction

In completing this project, some literature review has been done on several resources. The theories and descriptions have been taken as guidance in completing this project. This chapter will present and give an overview about some application that use client/server application, the use of ultrasonic motion detector and other related project that use microcontroller as the main controller.

2.2 Visual Basic

Visual Basic (VB) is the third-generation event-driven programming language and integrated development environment (IDE) from Microsoft for its COM programming model. VB is also considered a relatively easy to learn and use programming language,

because of its graphical development features and BASIC. [Wikipedia, 2008]. It is easier to do the programming using Visual Basic because it is an Object Oriented Programming.

A specific button can be program using the Visual Basic application. The position of the buttons and other components can be adjusted without using a coding. Visual Basic program display a Windows style screen (called a form) with a boxes into which users type (and edit) information and buttons that they click to initiates action. The buttons and boxes are referred to as control. Forms and control are called objects.[D.I Schneider, 1999].

2.3 Client/Server Application

A client/server application is a piece of software that runs in client computer and make request to a remote server. Many such application are written in high level visual programming language where the user interface, forms and most business logic reside in the client application. Often the server act as the database and the client is a program that requesting data or info.

Client/server describes the relationship between two computer programs in which one program, the client, makes a service request from another program, the server.[Wikipedia, 2008]. In order to develop this unit, knowledge in some of software programming such as Visual Basic are required.

Client is a program that initiates request to the remote server. After request is made, the client will waits for replies from the server. The clients are usually

connected to small number of server at a time and typically interact directly with end user using Graphical User Interface. Server in other hand is a program that will never initiates request. It just waits for request and response to request from connected client. The server can remotely install or uninstall application and transfer data to the client.

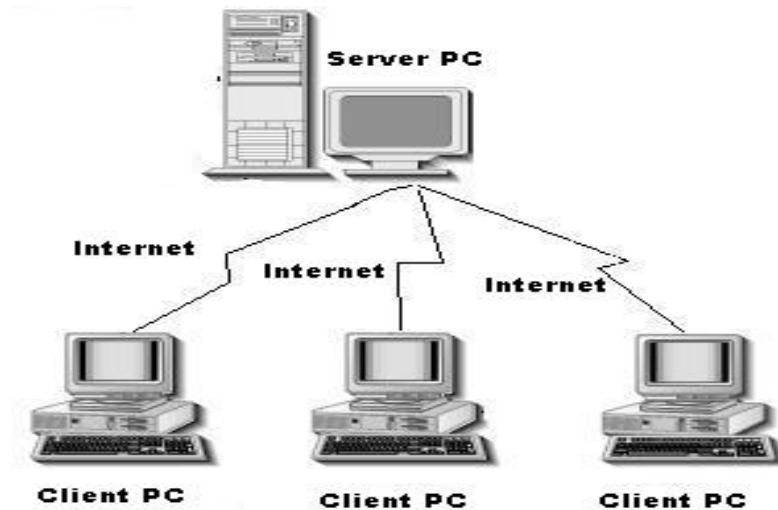


Figure 2.1: Overview of client/server application

2.4 Microcontroller

There are many types of microcontroller used in the market as the control unit for various types of application. The suitable microcontroller is chosen by the industries based on their need. In this project, the microcontroller acts as the brain of the system because it controls all the action made by the system. In this project, 6811 microcontroller is used.

Microcontrollers store their programs and data in memory. Memory is organized as a contiguous string of addresses, or locations. Each memory location contains eight bits of data. The entire amount of memory that a processor can access is called its address space. [Motorola Incorporation, 1996]. The 6811 has an address space of 65,536 memory locations, corresponding exactly to 16 bits of address information. This means that a 16-bit numeral can be used to point at, or address, any of the memory bytes in the address space of the 6811.

2.5 Introduction to Serial Port

Two standards of interface between PCs and other devices are parallel and serial port communications. Parallel port communication sends data at the same time while serial communication port sends data in a serial fashion. Communication between HC11 board and the PC is through serial port for the reason that the HC11 board already has existing serial communication IC chips. A serial port is a serial communication physical interface through which information transfers in or out one bit at a time (contrast parallel port). [Wikipedia, 2008]. Figure 2.2 shows the DB9 pin out connector.

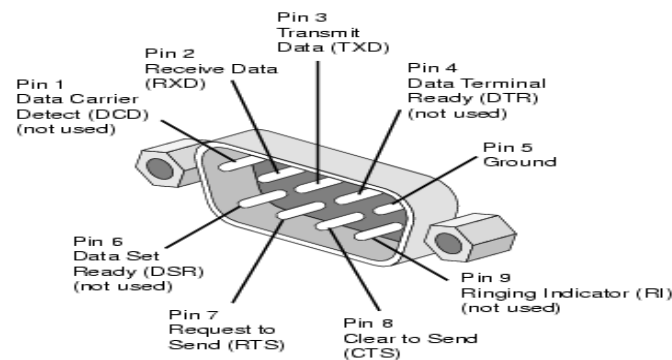


Figure 2.2: RS232 DB9 pin out.

2.5.1 Hardware

The RS232 connector was originally developed to use 25 pins. On personal computers, the smaller DB9 version is more commonly used today.[Lammertbies, 2008]. The most used pin in DB9 is pin2 (RXD), to receive data and pin 3 (TXD), to transmit data. Usually male DB9 is attached to the PC and female DB9 is attached to the device.

2.6 Stepper Motor

A stepper motor is an electromagnetic device that converts digital pulses into mechanical shaft rotation. The shaft or spindler of stepper motor rotates in discrete step increments when electrical command pulses are applied to it in a proper sequence. [Solarbotics, 2008]. The sequence of the applied pulses is directly related to the direction of motor shafts rotation. The speed of the motor shafts rotation is directly related to the frequency of the input pulses and the length of rotation is directly related to the number of input pulses applied

A stepper motor can be a good choice whenever controlled movement is required. They can be used to advantage in applications where you need to control rotation angle, speed, position and synchronism.

When a phase winding of a stepper motor is energized with current, a magnetic flux is developed in the stator. The direction of this flux is determined by the “Right Hand Rule” which states: If the coil is grasped in the right hand with the fingers pointing in the

direction of the current in the winding (the thumb is extended at a 90° angle to the fingers), then the thumb will point in the direction of the magnetic field.[Solarbotics, 2008].

2.6.1 Stepper Motor Control Using MC68HC11 Microcontroller

In this project, stepper motor rotation is controlled by the MC68HC11 microcontroller. Therefore the basic knowledge about the stepper motor system is required in order to implementing it to the system.

For 7.5 degree stepper motor:

- The clockwise movement requires a sequence as follow: \$09, \$0A, \$06, \$05
- The counter clockwise movement requires a sequence as follow: \$05, \$06, \$0A, \$09[Embedded Controller Technology, 2007]

Table 2.1: Normal 4-step sequence

Step #	T1	T2	T3	T4	Sequence
1	1	0	0	1	\$09
2	1	0	1	0	\$0A
3	0	1	1	0	\$06
4	0	1	0	1	\$05

For 7.5 degree stepper motor, it requires 48 step of sequence. “For each sequence, a short delay (10ms) is required to allow motor to stable and to produce certain speed.”[Embedded Controller Technology, 2007]

2.7 Introduction To Ultrasonic

The term "ultrasonic" applied to sound refers to anything above the frequencies of audible sound, and normally includes anything over 20,000 Hz. Sounds in the range 20-100kHz are commonly used for communication and navigation by bats, dolphins, and some other species. Much higher frequencies, in the range 1-20 MHz, are used for medical ultrasound. Such sounds are produced by ultrasonic transducers.[Hyperphysics, 2008].

Ultrasonic sound can be produced by transducers which operate either by the piezoelectric effect or the magnetostrictive effect. The magnetostrictive transducers can be used to produce high intensity ultrasonic sound in the 20-40 kHz range for ultrasonic cleaning and other mechanical applications.[Hyperphysics, 2008].

2.7.1 Ultrasonic Sensor

Ultrasonic sensor consists of two component, transducer and detector. An ultrasonic transducer is a device that converts energy into ultrasound, or sound waves above the normal range of human hearing. Piezoelectric crystals have the property of changing size when a voltage is applied, thus applying an alternating voltages (AC) across them causes them to oscillate at very high frequencies, thus producing very high

frequency sound waves. Since piezoelectric crystals generate a voltage when force is applied to them, the same crystal can be used as an ultrasonic detector. Some systems use separate transmitter and receiver components while others combine both in a single piezoelectric transceiver. [Wikipedia, 2008].

CHAPTER 3

SYSTEM DESIGN

3.1 Introduction

This chapter elaborates about the project development process. Hardware design and software development process is explained here. All operations of the component and method used in the project are also included in this chapter.

The project is divided into two major parts which are integrated appropriately at the end of the project development process. The hardware controlling module consists designing the electronic circuit with the microcontroller as the main element that control the system and the ultrasonic sensor circuit.

The second part is the software development module where it present the explanation on creating the PC server and PC client interface, programming development process using Visual Basic software and the protocol needed in order to meet the internet services capability. The system for this project is showed in figure 3.1 using a simple overview diagram representation.

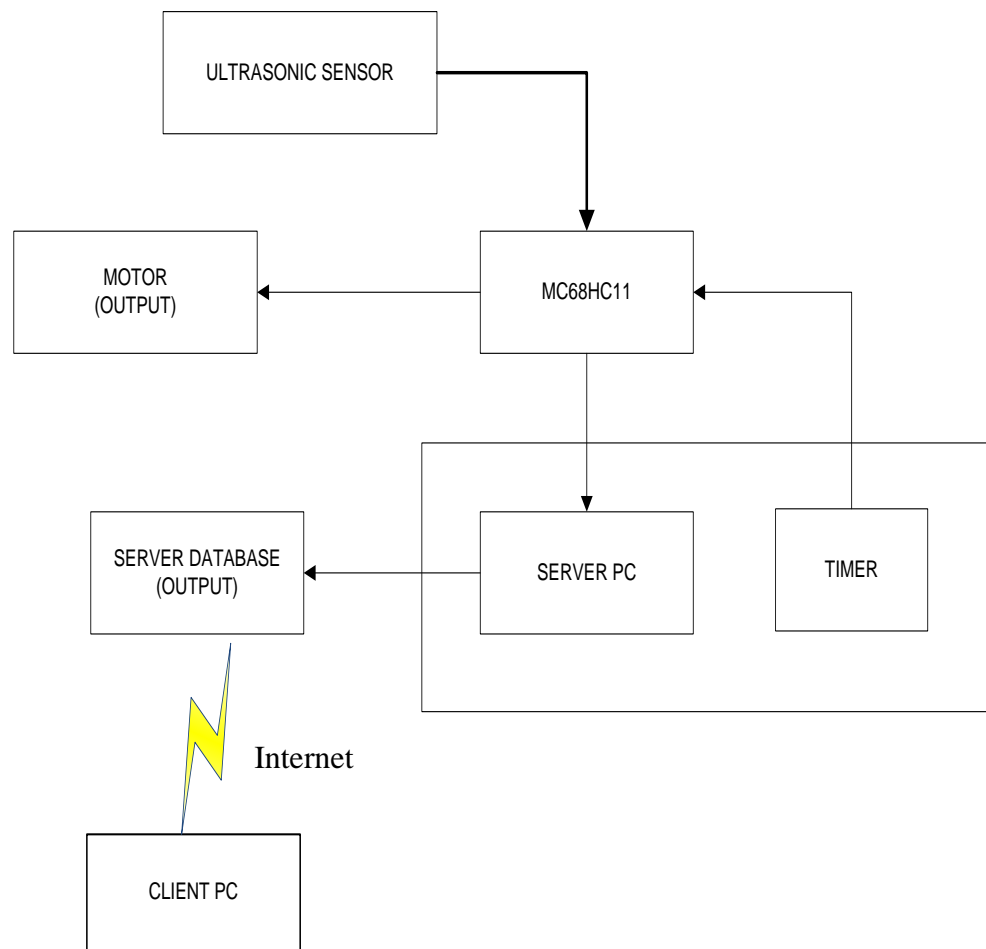


Figure 3.1: Overview system diagram

3.2 Hardware Design Module

From the analysis and the literature review that have been done in the previous chapter, the process of developing the overall project starts with completing the hardware module. The hardware module consists of few components and method that need to work together as a system. All the specification of each electronic component that used in this project are selected and tested accordingly. The construction of hardware design for this project is separated into three main parts which are.

- Microcontroller Module
- Motor Module
- Ultrasonic Sensor Module

3.2.1 Microcontroller Module

This project uses a Motorola MC68HC11A1P microcontroller as the main element. This microcontroller supported four mode of operation that are single chip, expanded, bootstrap, and special test mode. Figure 3.2 shows the microcontroller unit that used in this project.

This project only uses one microcontroller to control the whole system. This microcontroller consists of 256 RAM and one of Motorola high performance 8-bit microcontroller. Port C will be use to receive the signal from ultrasonic sensor and port A will be use as the output port to run the motor.

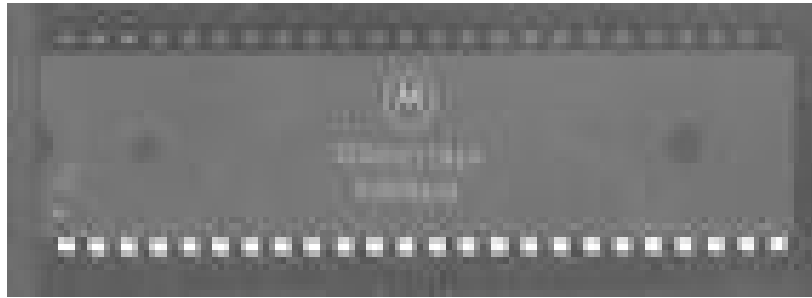


Figure 3.2: Motorola MC68HC11A1P microcontroller

The single chip, expanded, bootstrap, and special test mode are the basic operation that support the MCU and of course fit the hardware design that need to be developed. For this project the bootstrap mode was chosen since there are no requirement for extra I/O ports and additional memory. In addition, this mode requires less additional components and easy troubleshooting if any obstacle occurred during the construction work. This mode also consist of combination of a few circuits that supported the operation of microcontroller which are the power circuit, reset circuit clock circuit and the serial communication module as shown in the figure 3.3.

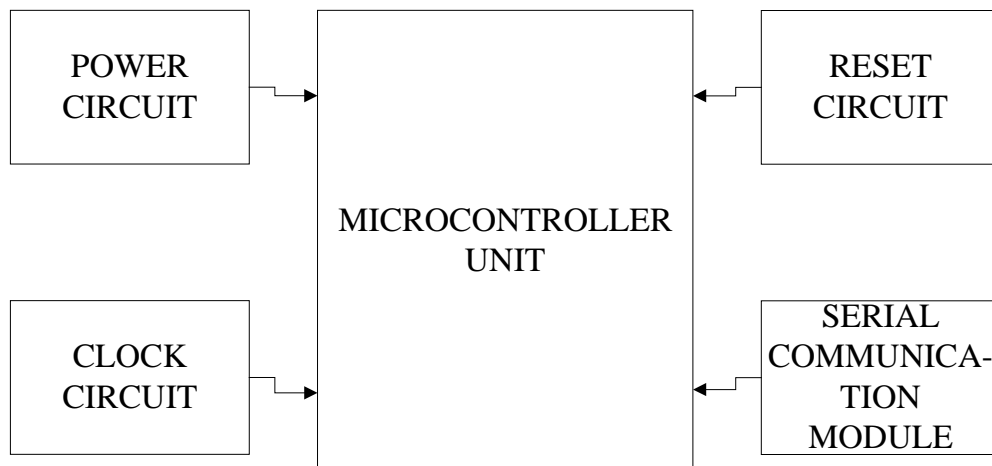


Figure 3.3: Microcontroller module

As the procedure, in order to set the microcontroller to operate in bootstrap mode, both pins MODA and MODB at pin 24 and 25 need to be grounded to get the logic “0”. Figure 3.4 shows the microcontroller connection to set the microcontroller to operate in bootstrap mode.

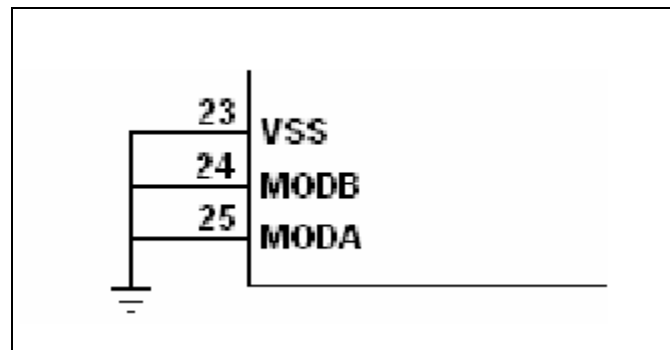


Figure 3.4: Bootstrap Mode Operation Activation

3.2.1.1 Power Circuit

The power circuit is the elements that supply power to the microcontroller and all other component used. As a precaution, the power range that supplied to the microcontroller need to be filtered to make sure that no component used is damaged. Figure 3.5 (a) and (b) show the power circuit used to provide exactly 5V power to the microcontroller.

The 7805 voltage regulator is used to ensure that the microcontroller get 5V constantly at all time. The capacitors are used to filter some of the fluctuation in power

supply voltage. The power circuit is provided with a LED just to show that the power circuit is functioning supplying voltage to the microcontroller.

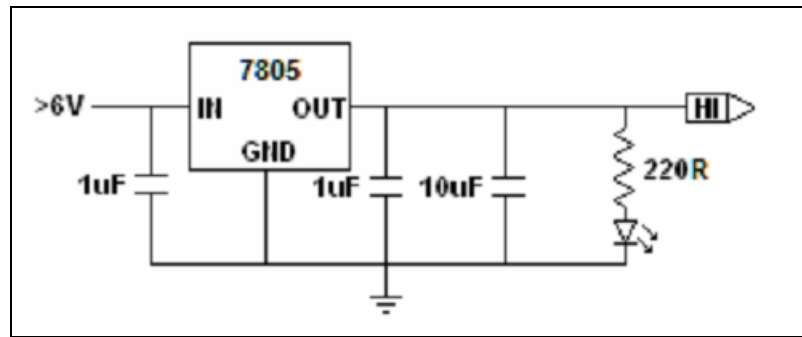


Figure 3.5(a): Power Circuit

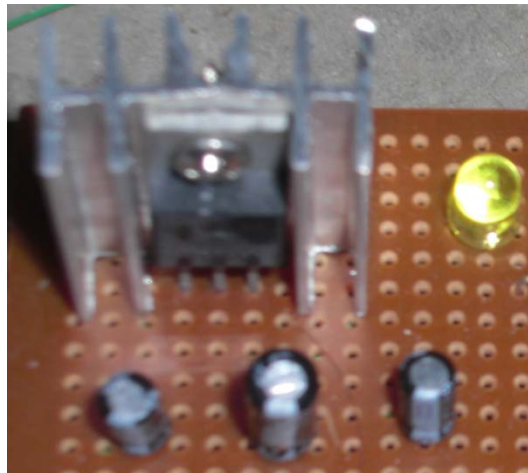


Figure 3.5(b): Power circuit (real component)

3.2.1.2 Reset Circuit

The reset circuit provides the reset function to the microcontroller. This circuit will trigger low input to the microcontroller to activate the reset function. The output of the reset circuit is connected to pin 39 of the microcontroller (reset pin). The reset function of the microcontroller is active low means that it only functions when pin 39 of the microcontroller is provided with low input.

Figures 3.6 (a) and (b) shows the operation of this reset circuit which started when the push button is not pressed, the 10K pull-up resistor keeps the signal high. Pressing the push button causes the pin to be pulled low, thus forcing a reset. The capacitor is used to provide clock to the circuit. The value of this entire component must be chosen properly so that the value must be greater than 6 clock cycles to distinguish from internal RESET.

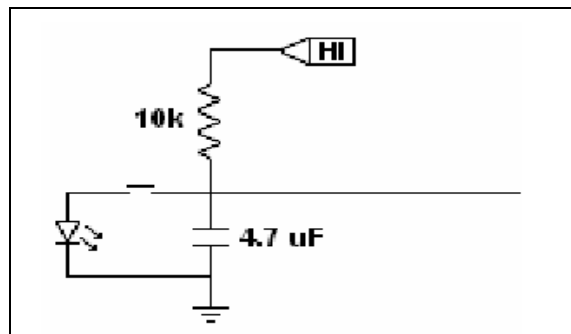


Figure 3.6(a): RESET circuit

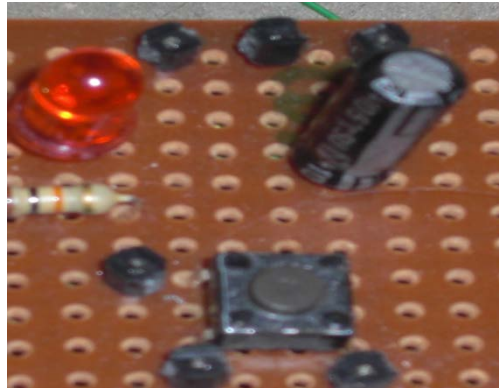


Figure 3.6(b): RESET circuit (real component)

3.2.1.3 Clock Circuit

The Clock circuit that used in this hardware design are consist of a 8MHz crystal, a 10M resistor and two 22pF capacitors. The circuit configuration is as shown in figure 3.7 (a) and (b). In order to generate clock for the microcontroller, the output of the clock circuit must be connected to the microcontroller's XTAL and EXTAL on pin 29 and 30.

Since the internal clock frequency is one-fourth of that supplied to the crystal pins, the clock speed (frequency) become 2MHz that can be referred as E clock. An oscilloscope can be used measured the E clock by connecting it on pin 27 of the microcontroller.

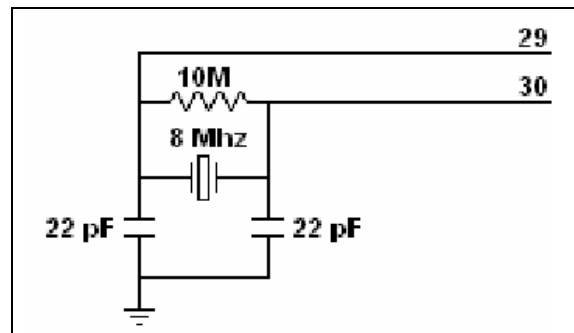


Figure 3.7(a): Clock circuit

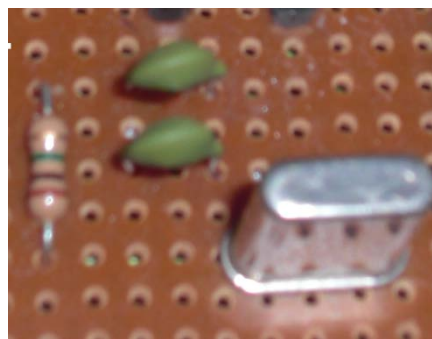


Figure 3.7(b): Clock circuit (real component)

3.2.1.4 Serial Communication Module

The MC68HC11A1P microcontroller are operating only when the EPROM are ready with the certain programming. To program the microcontroller, a communication between the microcontroller and computer with software that use to burn the program is

required. So the serial communication module is needed to complete the task. MAX 233 is used as the interface between the microcontroller and the computer.

As showed in figure 3.8(a) and (b), the pin two, T_{in} and pin three, R_{out} of the MAX233 are connected to the MC68HC11A1P via pin 43 and pin 42 for port TxD and RxD . The DB9 interface of T_{out} pin five and R_{in} pin four will connected to the out in computer to allow the process happened.

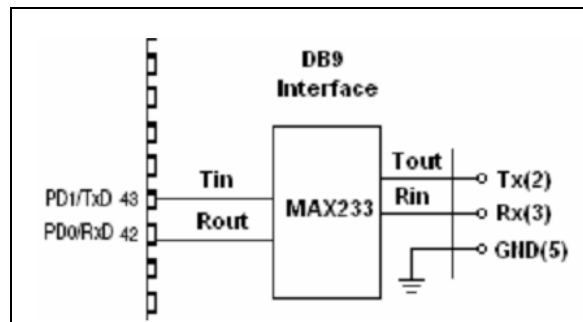


Figure 3.8(a): Serial communication module

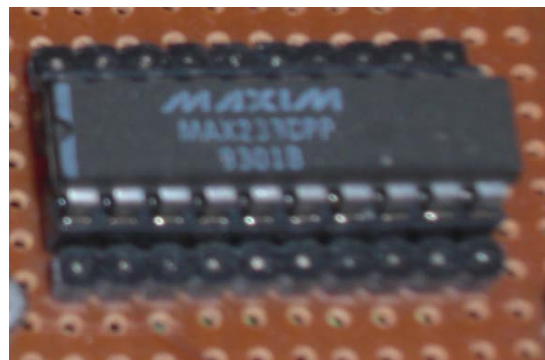


Figure 3.8(b): Serial communication module (real component)

3.2.2 Motor Module

In order to enable the controlling motion of the project, the specific type of the motor is needed and the feeder that holds the motor is designed appropriately. Figure 3.9 showed the block diagram of the motor module of this project

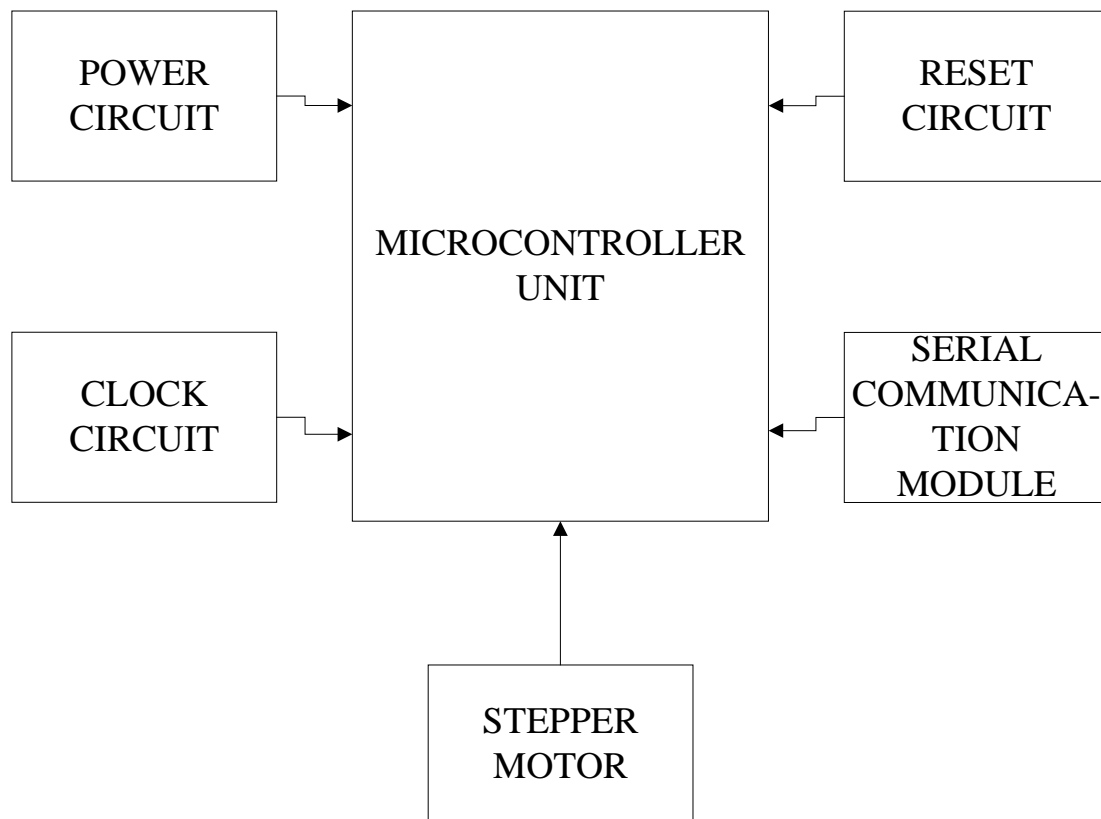


Figure 3.9: Block diagram of motor module

3.2.2.1 Stepper Motor

This project uses the PM35L-D48-HPH7 permanent magnet stepper motor as the motor that control the flow of the food. Stepper motor can be programmed to rotate in desired angle and easy to control because it moves step by step.

To make the motor shaft turn, first one electromagnet is given power, which makes the gear's teeth magnetically attracted to the electromagnet's teeth. In that way, the motor can be turned to a precise angle. For this type of motor, it has 48 steps which mean each step enable 7.5 degree of rotation. Figure 3.10 shows the stepper motor used in this project.



Figure 3.10: Stepper Motor

3.2.2.2 Motor Driver

There are many types of drivers available in the market in order to control the rotation of the stepper motor as well as few features like preventing back emf from driver circuit and so on. This project used the ULN2003AN stepper motor driver. This driver is a high-voltage, high-current Darlington drivers comprised of seven NPN Darlington pairs. This driver suit the requirement of the project because it can produce maximum 500mA output current (single output) and the most important features that are compulsory to be have is high sustaining voltage output where can reach 50 volts. Figures 3.11 (a) and (b) shows the ULN2003AN driver.

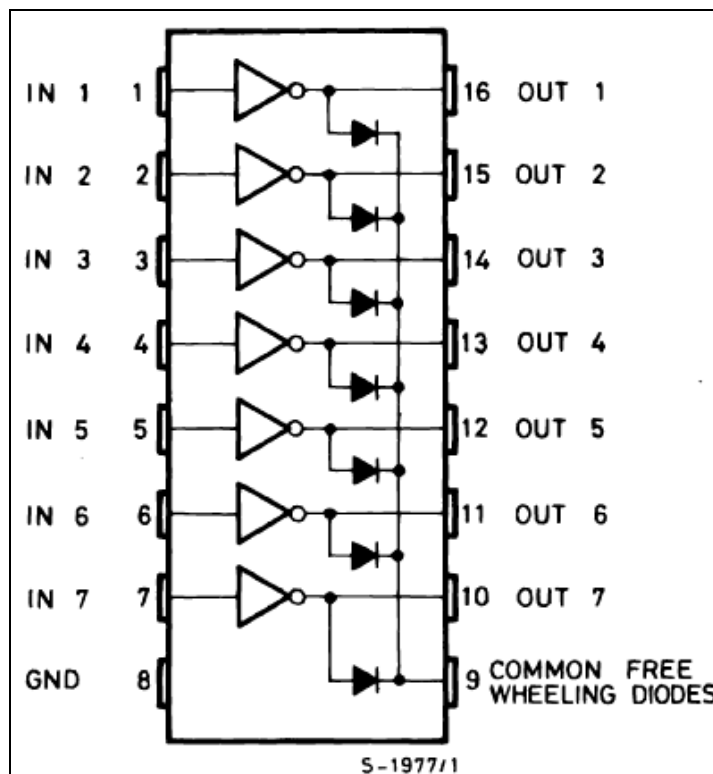


Figure 3.11(a): ULN2003AN Driver



Figure 3.11(b): ULN2003AN Driver (real component)

3.2.3 Ultrasonic Sensor

For this project, the sensor used is an ultrasonic sensor that will trigger a low output when it detects a movement. The ultrasonic transducer at the sensor will transmit the ultrasonic wave. Ultrasonic sensors generate high frequency sound waves and evaluate the echo which is received back by the sensor. The wave that been deflected by the object in front the sensor will be detected by the ultrasonic detector. This systems use a transducer which generates 40 kHz sound by turning electrical energy into sound.

The wave is then be analyzed by the detector circuit to determine whether the object in front is moving or not. If the object is moving, then the sensor will trigger and give a signal to the microcontroller to run the motor and update the data in the server. Moving object in front of the sensor will cause the wave deflected to have an extremely high frequency. The disturbed frequency is the key to the ultrasonic sensor to determine the presence of the object in front of the sensor.

3.3 Software Development Module

This project use certain software to burn the program into the microcontroller. There are also a software used to simulate the program that will be use in the microcontroller design. To design the graphical user interface (GUI) that support internet service, another software is used. In overall, there are three different software used in this project.

3.3.1 WP11 Software

For this project the WP11 software is chose since it the common and simplest software that can be used. The communication test between the microcontroller and the computer is needed before initializing the microcontroller. This software enable the user to initialize, burn a program, and erase the program that been burned in to the microcontroller. User also can check whether the microcontroller is burned with a program or not using the “Blank Check” button.

The microcontroller needs to be initialized first before a program can be burned into it. This step can be done by clicking the “Initialize Device” button. All program in the microcontroller need to be erased before a new program can be burned. The “Erase EEPROM and Config Reg” button is responsible to perform this action. After the microcontroller is erased, a new program can be burned into it by clicking the “Program EEPROM” button.

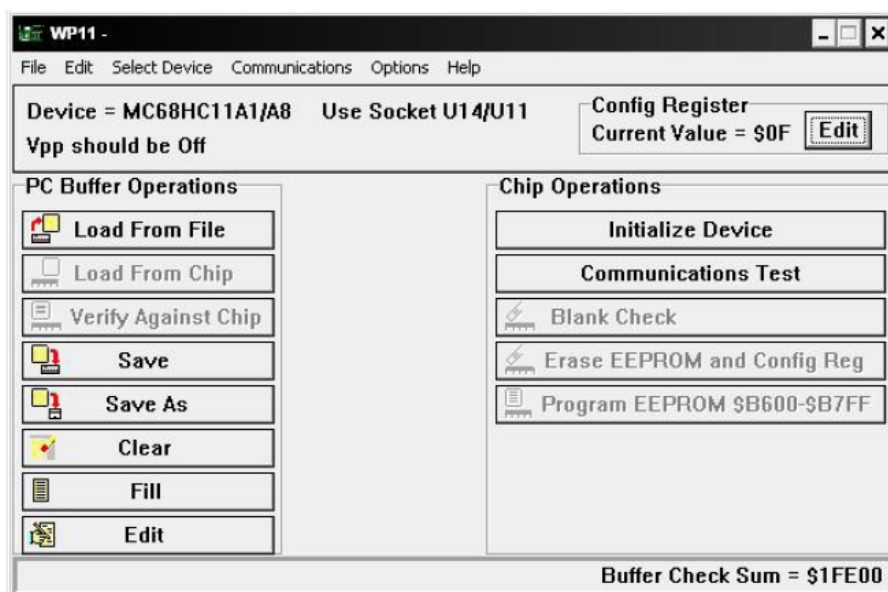


Figure 3.12: WP11 Software

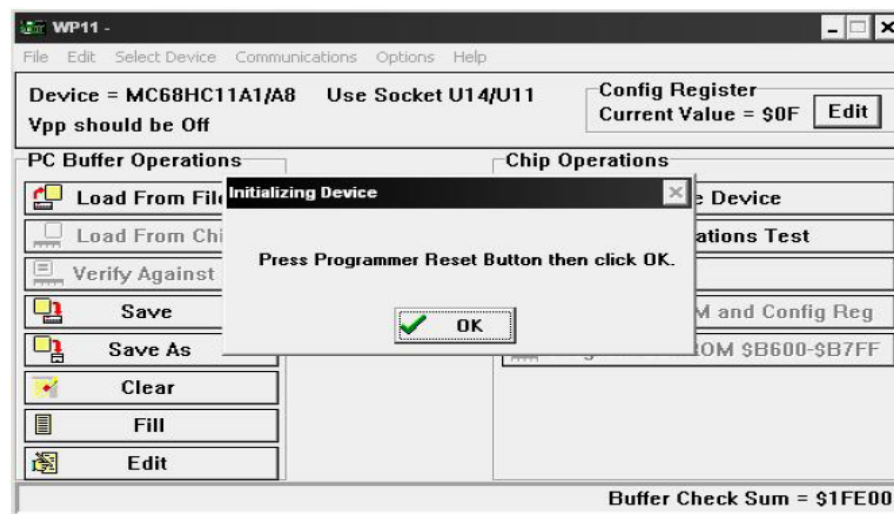


Figure 3.13: WP11 Software (initializing the microcontroller)

3.3.2 THRSim11 Software

Before a program is burned into the microcontroller, it needs to be tested with a simulator to ensure it works properly. The simulator can play all part of the components just like the real components in the hardware design. This is very important because the outcome from the simulator will show whether the program is successful or not. Figures 3.14 and 3.15 show the THRSim11 software that acts as the simulator. It is used to make and test any programs that written in the assembly language.

All the register in the microcontroller such as CPU and I/O register can be and view using this simulator. The THRSim11 software enables the user to connect the microcontroller with other external components such as LEDs and switches.

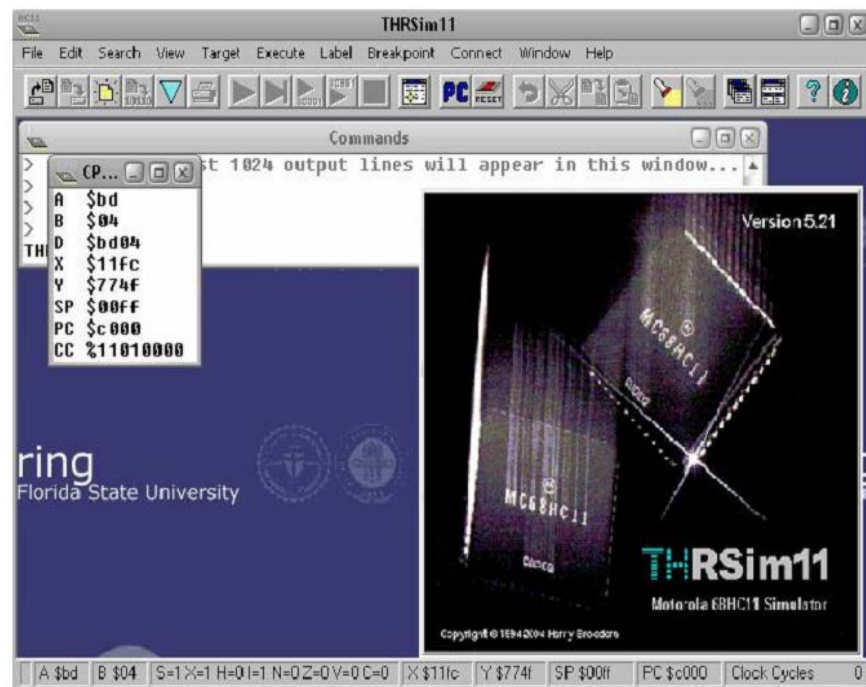


Figure 3.14: THRSim11 Software

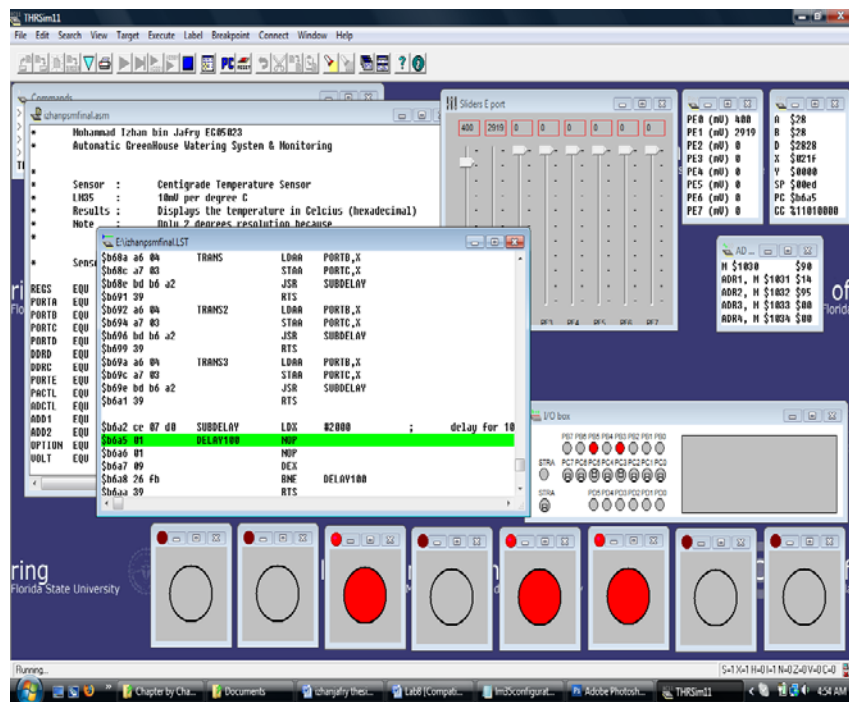


Figure 3.15: Simulating program in THRSim11 Software

3.3.3 Visual Basic 6.0

The software that develop the system for client and server interfaces are the Visual Basic, VB 6.0 program. This software has good graphics capabilities and it is easy to produce pseudo panel meters and many more. Moreover, the software are more practical because everything that required can be placed onto the form using components rather than the line of code like C++ programming and so on. In the VB program, there are a few components that have been used for this project. Since the program is an Object Oriented Program, OOP the component can be grab easily from the toolbar where it can easily be find from the program.

3.3.3.1 GUI

For the client interface, the VB construction is showed in figure 3.16. The GUI consists of the few VB components like command buttons, text boxes, and the Winsock control component. This interface will require an IP address of the server interface before it can be used to connect to the server.

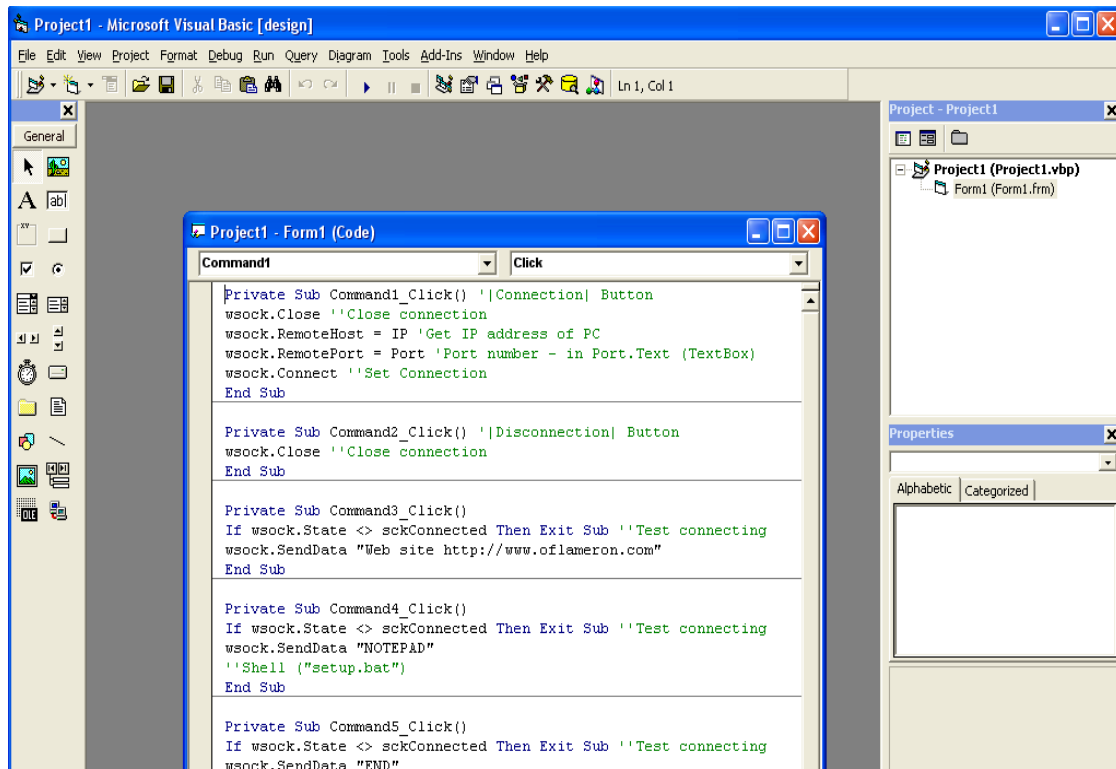


Figure 3.16: Client GUI on Visual Basic

Other interface that been developed is the server GUI. This GUI will be place in the computer that act as the server of the system and also has been attached together with the hardware design. When the system is operated, the server will waiting for client side

to be connected. After the connection is possible, the server will allow the client to deliver the signal, and send act base on the command received. Figure 3.17 showed the construction of server GUI.

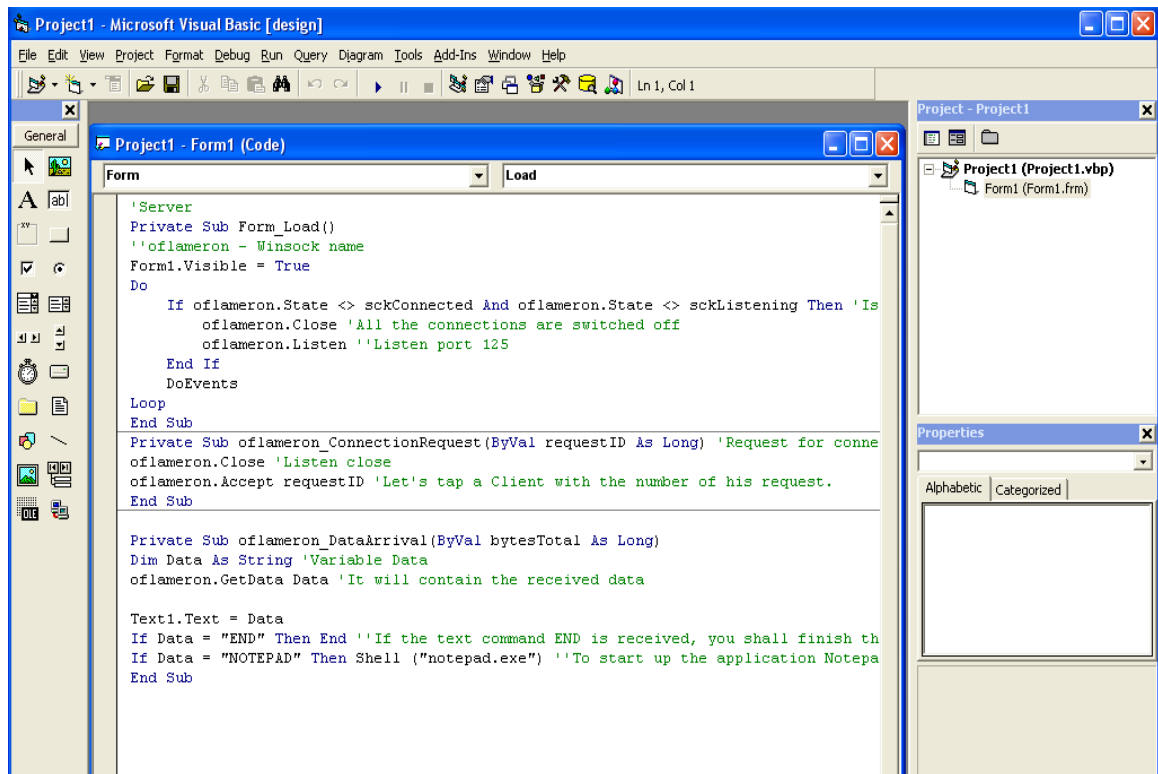


Figure 3.17: Server GUI on Visual Basic

CHAPTER 4

RESULT & ANALYSIS

4.1 Introduction

This chapter discusses all the results obtained from all tests that have been done accordingly. The discussion will state all the outcomes from each module that have been already discussed in the previous chapters. This chapter also consists of how each part can produce such result. Also a few discussion on the assumption that been done in this project will be explain.

4.2 Hardware Output

The hardware testing is important to ensure that each hardware that used in this project is working properly. There are four parts of the testing in hardware development which consist of microcontroller, stepper motor, and ultrasonic sensor test.

4.2.1 Microcontroller Test

The microcontroller used in this project is tested before it was connected with other parts like motor and sensor. The microcontroller in this project use 8MHz crystal that will produce 2MHz of clock signal within the microcontroller. The clock signal can be determined by connecting pin 27 of the microcontroller with the oscilloscope. A digital signal with 2MHz frequency is required in order to make sure that the microcontroller that been use is working.

The oscilloscope actually shows the digital signal with 2MHz frequencies when pin 27 is connected to the oscilloscope. Figure 4.1 shows the result produce by the microcontroller clock test. From the result, it can be assumed that there's nothing wrong with the microcontroller.

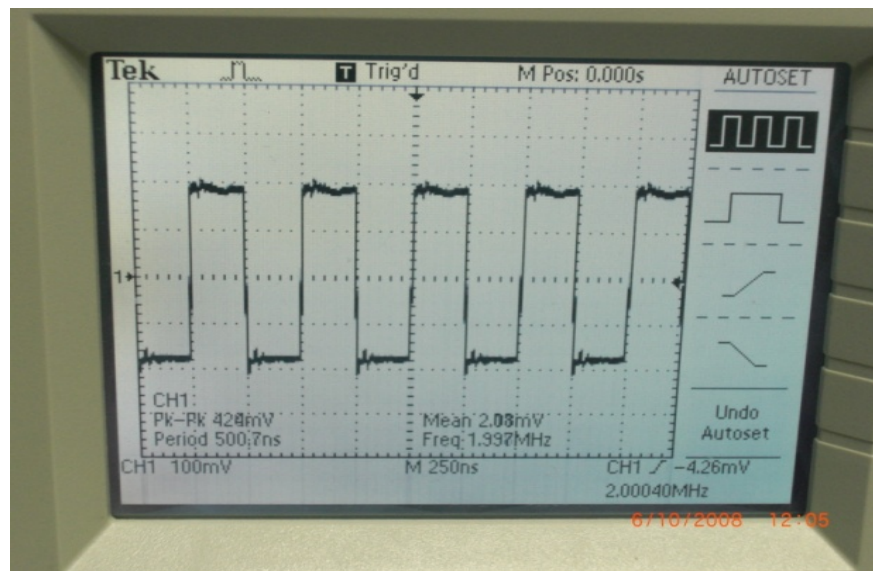


Figure 4.1: Microcontroller clock test

4.2.2 Stepper Motor Test

Manually, stepper motor in the motor module is controlled using a push button. The stepper motor that attach to the feeder run perfectly according to the program that been burned into the EEPROM of the microcontroller.

The stepper motor actually turns for 360 degree when the input is given from the push button that representing the ultrasonic sensor. The degree of rotation of the motor is been determined by the number of input sequence given to it. In this project, the stepper motor used is a 7.5 degree per step stepper motor. Table 4.1 shows the step and input sequence required to run the stepper motor.

For 7.5 degree stepper motor:

7.5 degree = 1 step

$$360 \text{ degree} = \frac{360}{7.5} = 48 \text{ steps}$$

Table 4.1: Input sequence to run the stepper motor

Step #	T1	T2	T3	T4
1	1	1	1	0
2	1	1	0	1
3	1	0	1	1
4	0	1	1	1

This sequence need to be give to the stepper motor for 12 times in order to make the motor move for 48 steps (360 degree).

4.2.3 Ultrasonic Sensor

Ultrasonic sensor is used to sense the present of the pet in front of the device. Ultrasonic transducer will produce an ultrasonic wave and will be receive by the ultrasonic detector. If the signal is the same, the sensor will not trigger. The sensor will only trigger when the ultrasonic wave that been receive by the detector is been disturbed by the motion of the object.

Oscilloscope is connected to the transmitter in order to determine the waveform that been produced by the transducer. The result is shown in figure 4.2. The waveform of the ultrasonic signal that entered the detector also been recorded to prove that the signal disturbance occurred during the movement of an object. Figure 4.3 shows the signal receive by the detector without movement while figure 4.4 show the signal receive when there's a movement in front of the sensor.

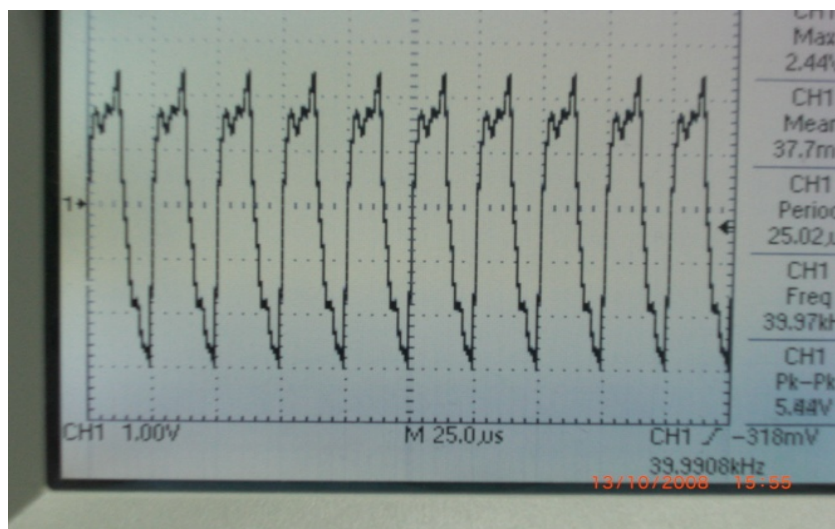


Figure 4.2: Ultrasonic waveform at the transducer

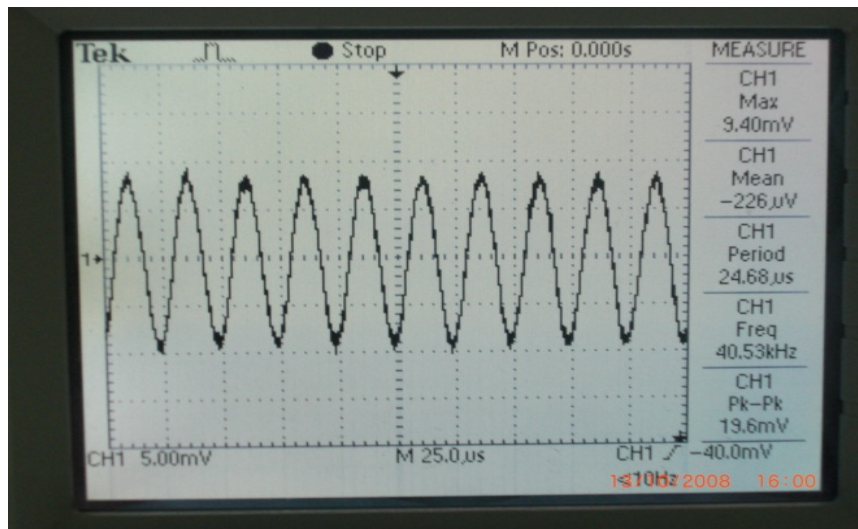


Figure 4.3: Waveform at the detector (without movement)

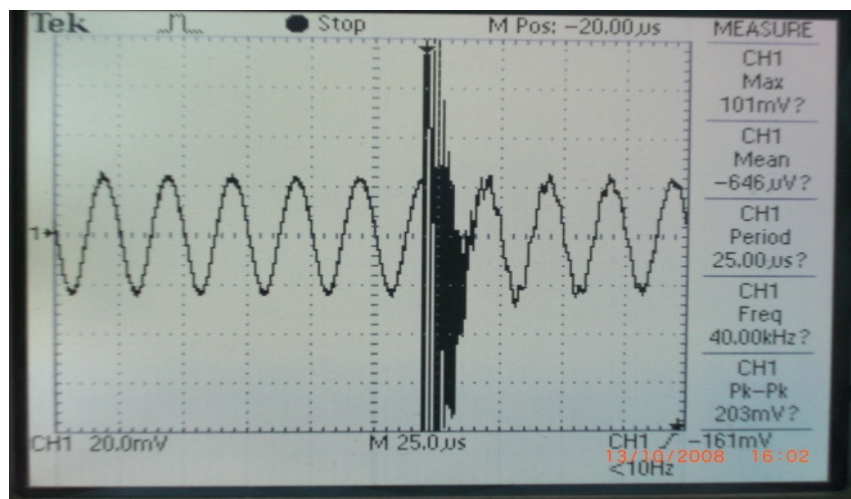


Figure 4.4: Waveform at the detector (with movement)

Figure 4.5 show the complete hardware design for this project. Ultrasonic sensor is placed at the left of the figure. In the middle is the microcontroller with the supported circuit while at the right side is the stepper motor that have been connected to the feeder.

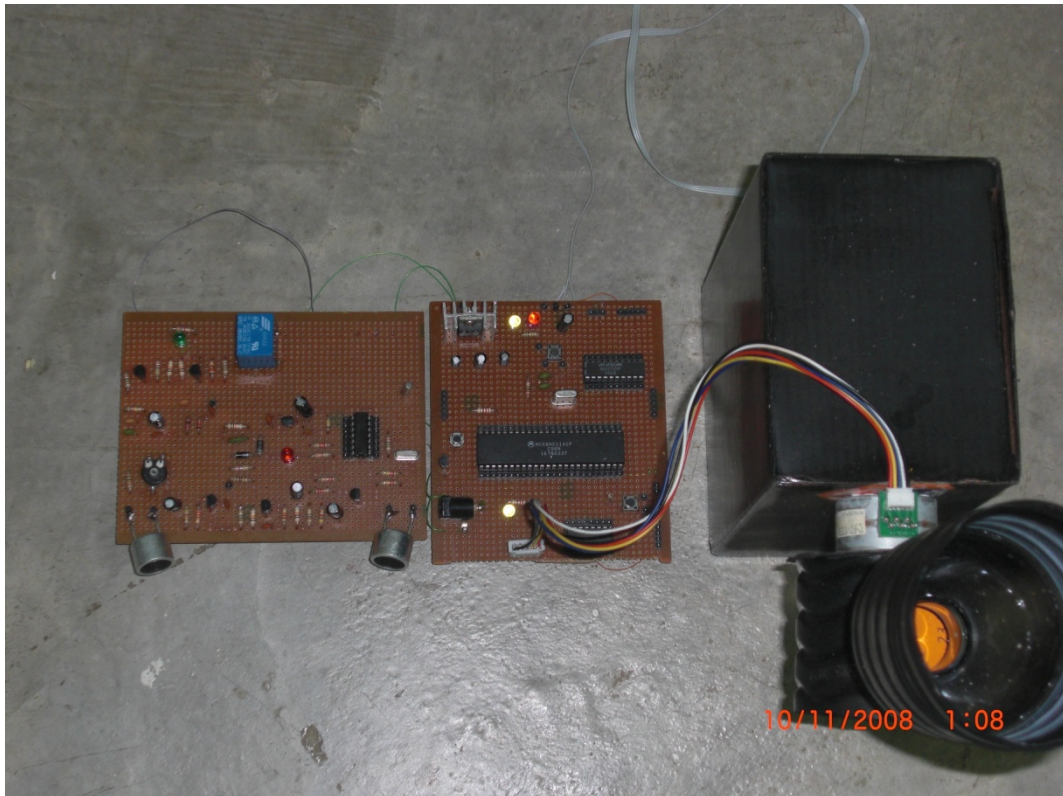


Figure 4.5: Hardware Circuit

4.3 Result in GUI

The software testing is done to make sure that the internet connection needed for this project is available and connecting the client and server are possible. Two different GUIs which are client and server are needed in establish a connection between two computers. Both of the GUIs is programmed using Visual Basic program. As the result, these two GUIs are success in making connection with each other using the internet service as the medium. Figure 4.6 shows the client GUI for this project. The “Connect” button are use to request a connection with the server. Client is needed to enter the server IP address in order to connect to a specific server.

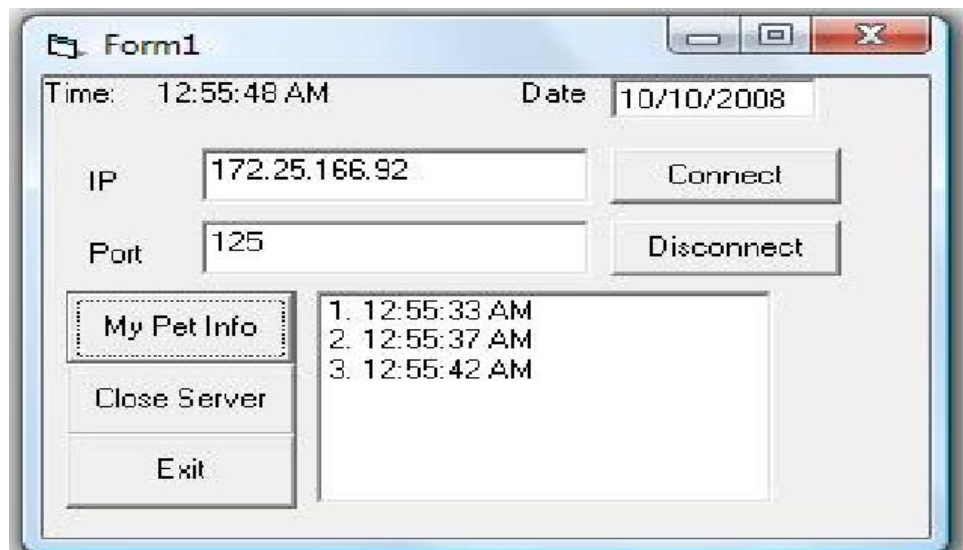


Figure 4.6: Client GUI

Figure 4.7 showed the server GUI that located at the server PC where the hardware is located. The GUI is currently showed how many times the feeding process was done and the time when each of the process executes. The information only will appear when the microcontroller at the feeder send a signal using serial interface telling the server that the process is done.

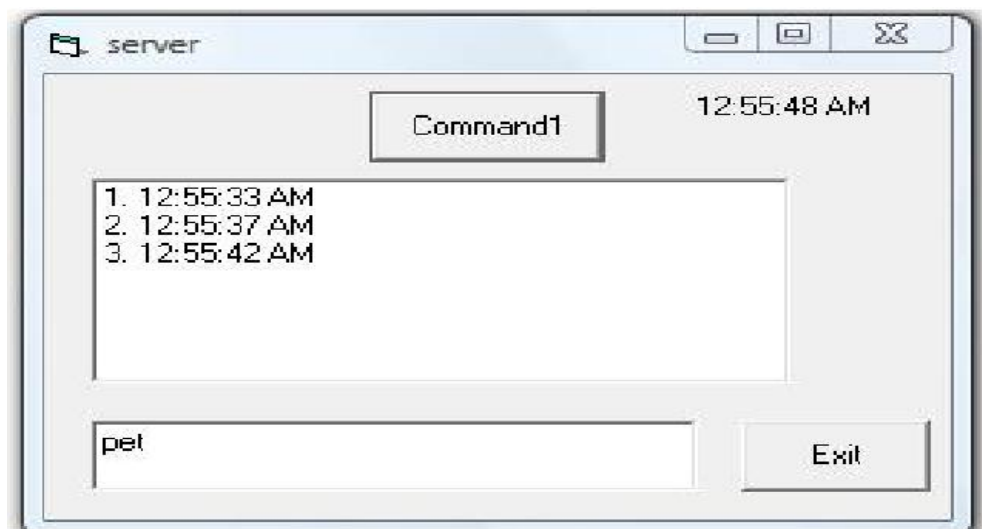


Figure 4.7: Server GUI

4.4 The Complete System

The hardware and software that have been tested finally been connected with each other as a complete system. The complete system that has been developed is showed in figure 4.8. These two computers are actually connected with each other, means that the information at the server can be view by the client. Communications between these two computers are based on internet service. The server is equipped with the hardware circuit and the server GUI on the computer.



Figure 4.8: The complete system

CHAPTER 5

CONCLUSION & RECOMMENDATION

5.1 Conclusion

Overall, this project is successfully developed by the time it needs to be submitted. Internet as the most powerful source of information and knowledge that been use was very useful during the time this project is in process. Plus, the integration of the electronics circuit with the well-established software programming like Visual Basic 6.0 that used in this project become the key of success as long as it well feed with equivalent efforts and hard works.

By using this automatic pet feeder, the user can feed their pet even if there are not at home. The owner also can know how many times the pet is feed and the exact time of the feeding process takes place by using the client/server application. This automatic pet feeder will make sure that the pet stay healthy and pet care will be more fun.

Furthermore, the GUI in client/server application seems very useful to the project because it make the project become user friendly. The connection between the client and server is successfully established.

5.2 Discussion

From the research and the result that have been done, a few discussion about the project is been made.

- i. The MC68HC11A1P that been use is capable to control the rotation speed and angle of the stepper motor base on the software programming that burned into the chip. The timer that needed for this project is also can be done by the microcontroller using the loop command.
- ii. The permanent magnet stepper motor used in this project is very suitable and fit the requirement of the hardware circuit. The motor is successfully running in 360 degree rotation and it response perfectly to the input sequence that been provided by the microcontroller.
- iii. The sensor used in this project is capable in detecting a movement in front of the device. The requirement for the sensor is also fit with the other component used in the hardware circuit like the microcontroller and the stepper motor.

- iv. Visual Basic 6.0 that been used in this is very suitable in developing the GUI for the project. The program is equipped with many useful features especially the features that enable the connectivity using internet and reading the data receive at the serial port. Moreover, the software is Object Oriented Programming (OOP) which is easy to handle and faster to get familiar into it.

5.3 Future Recommendation

For the future research, there are several recommendations to upgrade the project such as:

- i. Using web server instead of client/server application.

Since this project used internet as the medium in connection between the client and server, the project can be improve by using web server in transmitting information. Web server is more practical because it allow more clients to access the information in the server. The privacy of the information can be done by putting the login user interface before the info can be access.

- ii. Upgrade the sensor

In this project, the sensor used is an ultrasonic sensor that will detect any motion in front of the feeder. This sensor is not very practical in sensing the presence of the pet because it will react to all objects passing by don't care whether it a living thing or not. For replacement, Passive Infrared sensor that only detect living thing can be use. It will be better if the sensor have the ability to detect the size of the object in order to determine whether the object is the pet or just a disturbance.

- iii. Determine the weight of the food delivered to the bowl.

This is useful in avoiding the food delivered to the bowl from split out. The weight of the food delivered also can be use in determining the amount of the food eaten by the pet in previous feeding process.

5.4 Costing and Commercialization

This project is developed involving the cost about RM200.00. This total cost is including the cost of hardware components such as purchasing the ultrasonic sensor, stepper motor and others. Therefore, this project is considered affordable to most people.

Furthermore, this project have the value of commercialization because it use a few interesting elements like microcontroller and the internet services. With some modification, this project can become a valuable product in the market.

REFERENCES

Peter Hsieh, John Ping Ju Kuo, Steven Kun Liu, Farnoush Mirmoeini, Ashkan Olyaei, Pendar Yousefi , (2002). *Automatic pasenger counting system: Group 7*

(1996). *M68HC11 Reference Manual* :Motorolla Inc

Nurulfadzilah Bt Hasan, (2002): *Mengawal Transceiver Melalui Internet*: Bachelor Thesis, Universiti Teknologi Malaysia.

RS 232 Serial Cable Pinout: Citing Internet Source URL:

[www. lammertbies.nl](http://www.lammertbies.nl)

Client-Server. Citing Internet Source URL:

<http://en.wikipedia.org/wiki/Client-server>

Simple System Client/Server in VB. Citing Source URL:

<http://www.oflameron.com>

David I. Schneider (1999). *Computer Programming Concept and Visual Basic*. New Jersey : Pearson Custom Publishing

APPENDIX

DATA SHEETS

MC68HC11A8
MC68HC11A1
MC68HC11A0

Technical Summary
8-Bit Microcontrollers

1 Introduction

The MC68HC11A8, MC68HC11A1, and MC68HC11A0 high-performance microcontroller units (MCUs) are based on the M68HC11 Family. These high speed, low power consumption chips have multiplexed buses and a fully static design. The chips can operate at frequencies from 3 MHz to dc. The three MCUs are created from the same masks; the only differences are the value stored in the CONFIG register, and whether or not the ROM or EEPROM is tested and guaranteed.

For detailed information about specific characteristics of these MCUs, refer to the *M68HC11 Reference Manual* (M68HC11RM/D).

1.1 Features

- M68HC11 CPU
- Power Saving STOP and WAIT Modes
- 8 Kbytes ROM
- 512 Bytes of On-Chip EEPROM
- 256 Bytes of On-Chip RAM (All Saved During Standby)
- 16-Bit Timer System
 - 3 Input Capture Channels
 - 5 Output Compare Channels
- 8-Bit Pulse Accumulator
- Real-Time Interrupt Circuit
- Computer Operating Properly (COP) Watchdog System
- Synchronous Serial Peripheral Interface (SPI)
- Asynchronous Nonreturn to Zero (NRZ) Serial Communications Interface (SCI)
- 8-Channel, 8-Bit Analog-to-Digital (A/D) Converter
- 38 General-Purpose Input/Output (I/O) Pins
 - 15 Bidirectional I/O Pins
 - 11 Input-Only Pins and 12 Output-Only Pins (Eight Output-Only Pins in 48-Pin Package)
- Available in 48-Pin Dual In-Line Package (DIP) or 52-Pin Plastic Leaded Chip Carrier (PLOC)

This document contains information on a new product. Specifications and information herein are subject to change without notice.





Figure 3 48-Pin DIP Pin Assignments

2 Operating Modes and Memory Maps

In single-chip operating mode, the MC68HC11A8 is a monolithic microcontroller without external address or data buses.

In expanded multiplexed operating mode, the MCU can access a 64 Kbyte address space. The space includes the same on-chip memory addresses used for single-chip mode plus external peripheral and memory devices. The expansion bus is made up of ports B and C and control signals AS and R/W. The address, R/W, and AS signals are active and valid for all bus cycles including accesses to internal memory locations. The following figure illustrates a recommended method of demultiplexing low-order addresses from data at port C.

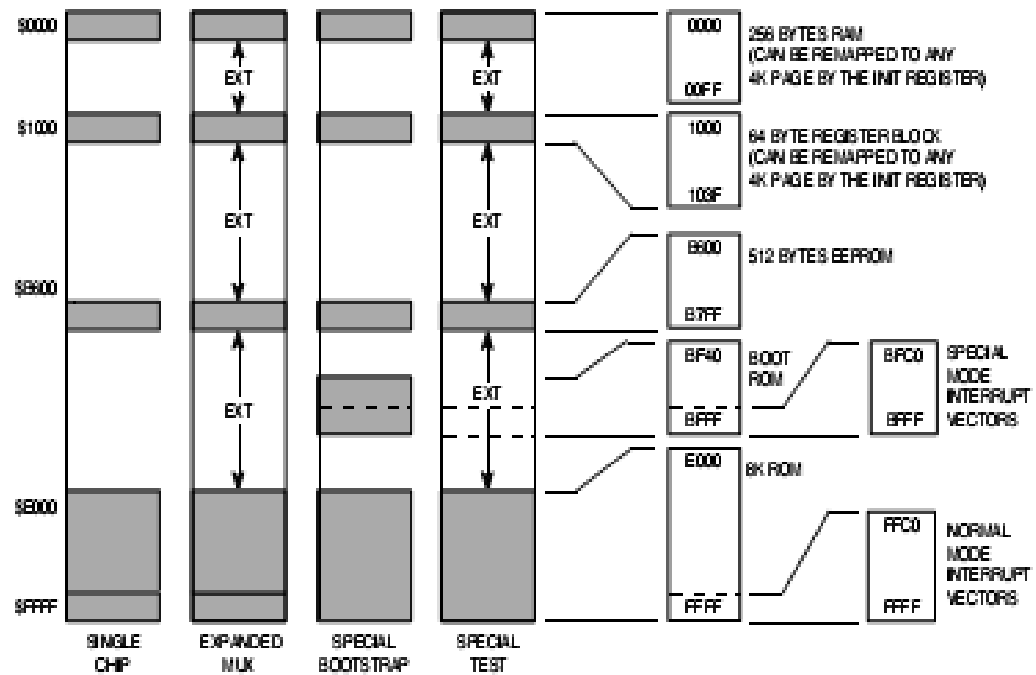


Figure 5 Memory Map

Table 3 MC68HC11A8 Register and Control Bit Assignments (Sheet 1 of 2)
(The register block can be remapped to any 4K boundary.)

	Bit 7	6	5	4	3	2	1	Bit 0	
\$1000	PA7	PA6	PA5	PA4	PA3	PA2	PA1	PA0	PORTA
\$1001									Reserved
\$1002	STAF	STAI	CWOM	HNDS	ON	PLS	EGA	INVB	PIDC
\$1003	PC7	PC6	PC5	PC4	PC3	PC2	PC1	PC0	PORTC
\$1004	PB7	PB6	PB5	PB4	PB3	PB2	PB1	PB0	PORTB
\$1005	PCL7	PCL6	PCL5	PCL4	PCL3	PCL2	PCL1	PCL0	PORTCL
\$1006									Reserved
\$1007	DDC7	DDC6	DDC5	DDC4	DDC3	DDC2	DDC1	DDC0	DDRC
\$1008	0	0	PD5	PD4	PD3	PD2	PD1	PD0	PORTD
\$1009	0	0	DDD5	DDD4	DDD3	DDD2	DDD1	DDD0	DDRD
\$100A	PE7	PE6	PE5	PE4	PE3	PE2	PE1	PE0	PORTE
\$100B	FOC1	FOC2	FOC3	FOC4	FOC5	0	0	0	CFORC
\$100C	OC1M7	OC1M6	OC1M5	OC1M4	OC1M3	0	0	0	OC1M
\$100D	OC1D7	OC1D6	OC1D5	OC1D4	OC1D3	0	0	0	OC1D
\$100E	Bit 15	14	13	12	11	10	9	Bit 8	TCNT (High)
\$100F	Bit 7	6	5	4	3	2	1	Bit 0	TCNT (Low)
\$1010	Bit 15	14	13	12	11	10	9	Bit 8	TIC1 (High)
\$1011	Bit 7	6	5	4	3	2	1	Bit 0	TIC1 (Low)
\$1012	Bit 15	14	13	12	11	10	9	Bit 8	TIC2 (High)
\$1013	Bit 7	6	5	4	3	2	1	Bit 0	TIC2 (Low)
\$1014	Bit 15	14	13	12	11	10	9	Bit 8	TIC3 (High)
\$1015	Bit 7	6	5	4	3	2	1	Bit 0	TIC3 (Low)
\$1016	Bit 15	14	13	12	11	10	9	Bit 8	TOC1 (High)
\$1017	Bit 7	6	5	4	3	2	1	Bit 0	TOC1 (Low)
\$1018	Bit 15	14	13	12	11	10	9	Bit 8	TOC2 (High)
\$1019	Bit 7	6	5	4	3	2	1	Bit 0	TOC2 (Low)
\$101A	Bit 15	14	13	12	11	10	9	Bit 8	TOC3 (High)
\$101B	Bit 7	6	5	4	3	2	1	Bit 0	TOC3 (Low)
\$101C	Bit 15	14	13	12	11	10	9	Bit 8	TOC4 (High)
\$101D	Bit 7	6	5	4	3	2	1	Bit 0	TOC4 (Low)
\$101E	Bit 15	14	13	12	11	10	9	Bit 8	TOC5 (High)
\$101F	Bit 7	6	5	4	3	2	1	Bit 0	TOC5 (Low)
\$1020	OM2	OL2	OM3	OL3	OM4	OL4	OM5	OL5	TCTL1
\$1021	0	0	EDG1B	EDG1A	EDG2B	EDG2A	EDG3B	EDG3A	TCTL2
\$1022	OC1I	OC2I	OC3I	OC4I	OC5I	IC1I	IC2I	IC3I	TMSK1
\$1023	OC1F	OC2F	OC3F	OC4F	OC5F	IC1F	IC2F	IC3F	TFLG1
\$1024	TCI	RTI	PAOVI	PAI	0	0	PR1	PRO	TMSK2
\$1025	TOF	RTIF	PAOVF	PAIF	0	0	0	0	TFLG2

Table 3 MC68HC11A8 Register and Control Bit Assignments (Sheet 2 of 2)
(The register block can be remapped to any 4K boundary.)

	Bit 7	6	5	4	3	2	1	Bit 0	
\$1026	DDRA7	PAEN	PAMOD	PEDGE	0	0	RTR1	RTR0	PACTL
\$1027	Bit 7	6	5	4	3	2	1	Bit 0	PACNT
\$1028	SPIE	SPE	DWOM	MSTR	CPOL	CPHA	SPR1	SPR0	SPCR
\$1029	SPIF	WCOL	0	MODF	0	0	0	0	SPSR
\$102A	Bit 7	6	5	4	3	2	1	Bit 0	SPDR
\$102B	TCLR	0	SCP1	SCP0	RCKB	SCR2	SCR1	SCR0	BAUD
\$102C	R8	T8	0	M	WAKE	0	0	0	SOCCR1
\$102D	TIE	TCIE	RIE	ILIE	TE	RE	RWU	SBK	SOCCR2
\$102E	TDRE	TC	RDRF	IDLE	OR	NF	FE	0	SCSR
\$102F	R7/T7	R6/T6	R5/T5	R4/T4	R3/T3	R2/T2	R1/T1	R0/T0	SCDR
\$1030	CCF	0	SCAN	MULT	CD	CC	CB	CA	ADCTL
\$1031	Bit 7	6	5	4	3	2	1	Bit 0	ADR1
\$1032	Bit 7	6	5	4	3	2	1	Bit 0	ADR2
\$1033	Bit 7	6	5	4	3	2	1	Bit 0	ADR3
\$1034	Bit 7	6	5	4	3	2	1	Bit 0	ADR4
\$1035									Reserved
\$1038									Reserved
\$1039	ADPU	CSEL	IRQE	DLY	CME	0	CR1	CR0	OPTION
\$103A	Bit 7	6	5	4	3	2	1	Bit 0	COPRST
\$103B	ODD	EVEN	0	BYTE	ROW	ERASE	EELAT	EEPGM	PPROG
\$103C	RBOOT	SMOD	MDA	IRV	PSEL3	PSEL2	PSEL1	PSEL0	HPRIO
\$103D	RAM3	RAM2	RAM1	RAM0	REG3	REG2	REG1	REG0	INIT
\$103E	TILOP	0	OCCR	CBYP	DISR	PCM	FCOP	TCON	TEST1
\$103F	0	0	0	0	NOSEC	NOCOP	ROMON	EEON	CONFIG



+5V-Powered, Multichannel RS-232 Drivers/Receivers

General Description

The MAX220–MAX249 family of line drivers/receivers is intended for all EIA/TIA-232E and V.28/V.24 communications interfaces, particularly applications where $\pm 12V$ is not available.

These parts are especially useful in battery-powered systems, since their low-power shutdown mode reduces power dissipation to less than 5 μ W. The MAX225, MAX233, MAX235, and MAX245/MAX246/MAX247 use no external components and are recommended for applications where printed circuit board space is critical.

Applications

Portable Computers
Low-Power Modems
Interface Translation
Battery-Powered RS-232 Systems
Multidrop RS-232 Networks

Next-Generation Device Features

- † For Low-Voltage, Integrated ESD Applications
MAX3222E/MAX3232E/MAX3237E/MAX3241E/
MAX3246E: $\pm 3.0V$ to $\pm 5.5V$, Low-Power, Up to
1Mbps, True RS-232 Transceivers Using Four
0.1 μ F External Capacitors (MAX3246E Available
in a UCSP™ Package)
- † For Low-Cost Applications
MAX221E: $\pm 15kV$ ESD-Protected, $\pm 5V$, 1 μ A,
Single RS-232 Transceiver with AutoShutdown™

Ordering Information

PART	TEMP RANGE	PIN-PACKAGE
MAX220CPE	0°C to +70°C	16 Plastic DIP
MAX220CSE	0°C to +70°C	16 Narrow SO
MAX220CWE	0°C to +70°C	16 Wide SO
MAX220C/D	0°C to +70°C	Dice*
MAX220EPE	-40°C to +85°C	16 Plastic DIP
MAX220ESE	-40°C to +85°C	16 Narrow SO
MAX220EWE	-40°C to +85°C	16 Wide SO
MAX220EJE	-40°C to +85°C	16 CERDIP
MAX220MJE	-65°C to +125°C	16 CERDIP

AutoShutdown and UCSP are trademarks of Maxim Integrated Products, Inc.

Ordering Information continued at end of data sheet.

*Contact factory for dice specifications.

Selection Table

Part Number	Power Supply (V)	No. of RS-232 Drivers/Rx	No. of Ext. Caps	Nominal Cap. Value (μ F)	SHDN & Three-State	Rx Active In SHDN	Data Rate (kbps)	Features
MAX220	+5	2/2	4	0.047/0.33	No	—	120	Ultra-low-power, industry-standard pinout
MAX222	+5	2/2	4	0.1	Yes	—	200	Low-power shutdown
MAX223 (MAX213)	+5	4/5	4	1.0 (0.1)	Yes	✓	120	MAX241 and receivers active in shutdown
MAX225	+5	5/5	0	—	Yes	✓	120	Available in SO
MAX230 (MAX200)	+5	5/0	4	1.0 (0.1)	Yes	—	120	5 drivers with shutdown
MAX231 (MAX201)	+5 and ± 7.5 to ± 13.2	2/2	2	1.0 (0.1)	No	—	120	Standard $\pm 5V$ $\pm 12V$ or battery supplies same functions as MAX232
MAX232 (MAX202)	+5	2/2	4	1.0 (0.1)	No	—	120 (84)	Industry standard
MAX233A	+5	2/2	4	0.1	No	—	200	Higher data rate, small caps
MAX233 (MAX203)	+5	2/2	0	—	No	—	120	No external caps
MAX233A	+5	2/2	0	—	No	—	200	No external caps, high data rate
MAX234 (MAX204)	+5	4/0	4	1.0 (0.1)	No	—	120	Replaces 1488
MAX235 (MAX205)	+5	5/5	0	—	Yes	—	120	No external caps
MAX236 (MAX206)	+5	4/3	4	1.0 (0.1)	Yes	—	120	Shutdown, three state
MAX237 (MAX207)	+5	5/3	4	1.0 (0.1)	No	—	120	Complements IBM PC serial port
MAX238 (MAX208)	+5	4/4	4	1.0 (0.1)	No	—	120	Replaces 1488 and 1489
MAX239 (MAX209)	+5 and ± 7.5 to ± 13.2	3/5	2	1.0 (0.1)	No	—	120	Standard $\pm 5V$ $\pm 12V$ or battery supplies single-package solution for IBM PC serial port
MAX240	+5	5/5	4	1.0	Yes	—	120	DIP or flatpack package
MAX241 (MAX211)	+5	4/5	4	1.0 (0.1)	Yes	—	120	Complete IBM PC serial port
MAX242	+5	2/2	4	0.1	Yes	✓	200	Separate shutdown and enable
MAX243	+5	2/2	4	0.1	No	—	200	Open-line detection simplifies cabling
MAX244	+5	8/10	4	1.0	No	—	120	High data rate
MAX245	+5	8/10	0	—	Yes	✓	120	High data rate, int. caps, two shutdown modes
MAX246	+5	8/10	0	—	Yes	✓	120	High data rate, int. caps, three shutdown modes
MAX247	+5	8/9	0	—	Yes	✓	120	High data rate, int. caps, nine operating modes
MAX248	+5	8/8	4	1.0	Yes	✓	120	High data rate, selective half-chip enables
MAX249	+5	8/10	4	1.0	Yes	✓	120	Available in quad flatpack package

MAXIM

Maxim Integrated Products 1

For pricing, delivery, and ordering information, please contact Maxim/Dallas Direct! at 1-888-629-4642, or visit Maxim's website at www.maxim-ic.com.

MAX220–MAX249

+5V-Powered, Multichannel RS-232 Drivers/Receivers

MAX220-MAX249

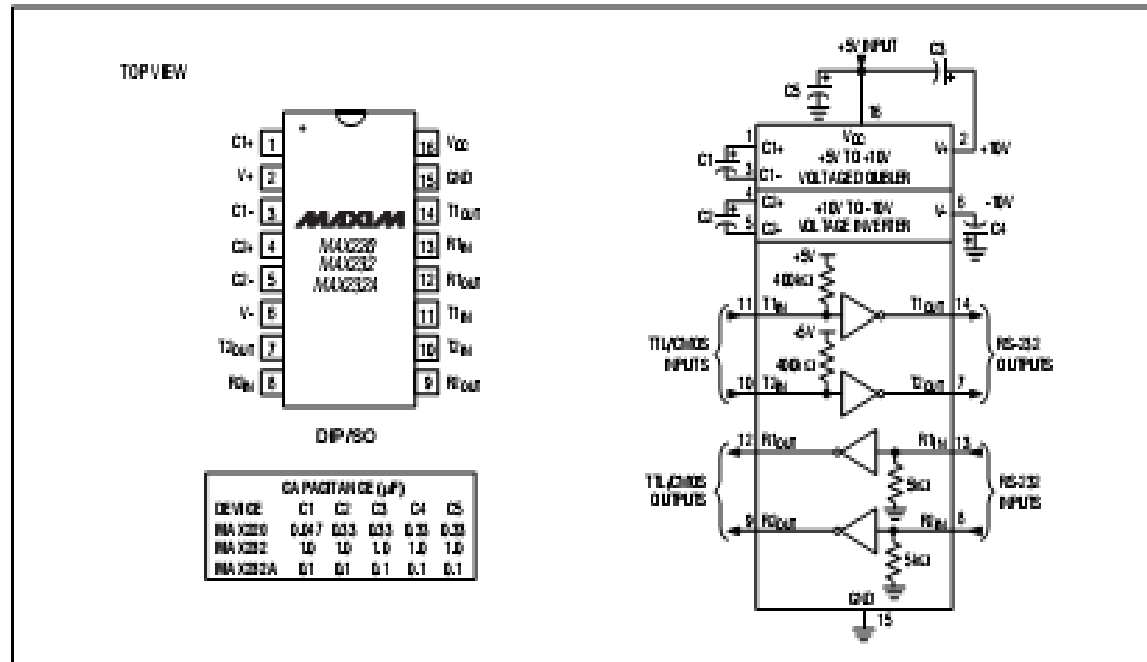


Figure 5. MAX220/MAX232/MAX232A Pin Configuration and Typical Operating Circuit

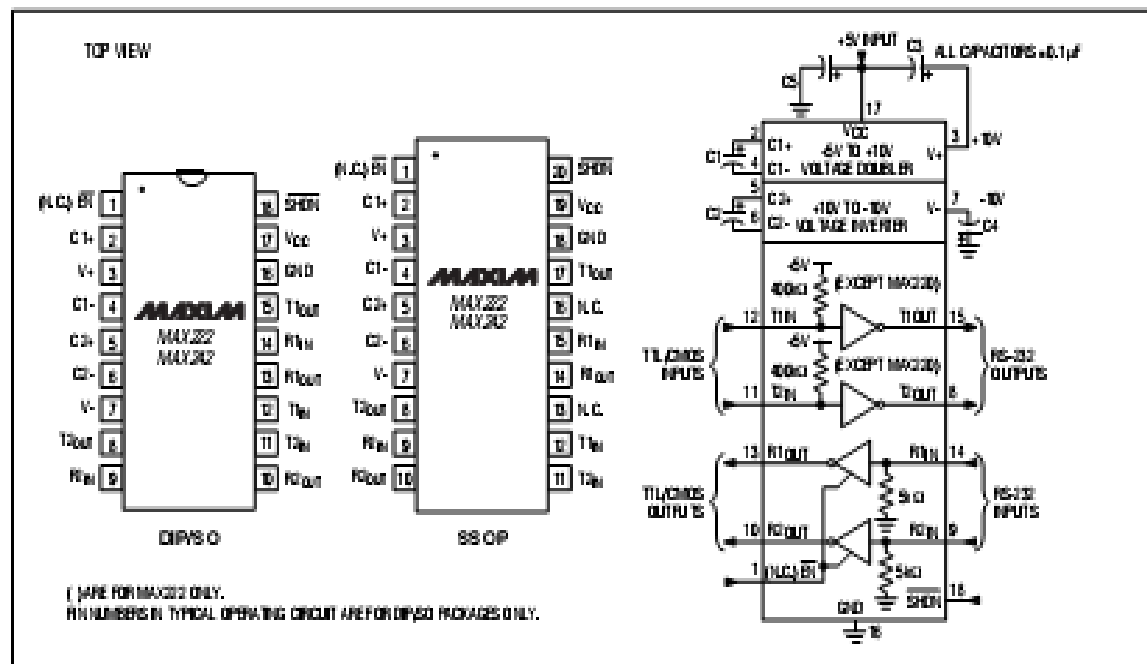


Figure 6. MAX222/MAX242 Pin Configurations and Typical Operating Circuit



ULN2001A-ULN2002A ULN2003A-ULN2004A

SEVEN DARLINGTON ARRAYS

- SEVEN DARLINGTONS PER PACKAGE
- OUTPUT CURRENT 500mA PER DRIVER (600mA PEAK)
- OUTPUT VOLTAGE 50V
- INTEGRATED SUPPRESSION DIODES FOR INDUCTIVE LOADS
- OUTPUTS CAN BE PARALLELED FOR HIGHER CURRENT
- TTL/CMOS/PMOS/DTL COMPATIBLE INPUTS
- INPUTS PINNED OPPOSITE OUTPUTS TO SIMPLIFY LAYOUT

DESCRIPTION

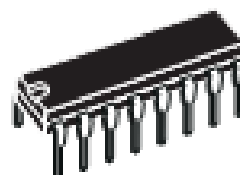
The ULN2001A, ULN2002A, ULN2003 and ULN2004A are high voltage, high current darlington arrays each containing seven open collector darlington pairs with common emitters. Each channel rated at 500 mA and can withstand peak currents of 600 mA. Suppression diodes are included for inductive load driving and the inputs are pinned opposite the outputs to simplify board layout.

The four versions interface to all common logic families :

ULN2001A	General Purpose, DTL, TTL, PMOS, CMOS
ULN2002A	14-25V PMOS
ULN2003A	5V TTL, CMOS
ULN2004A	6-15V CMOS, PMOS

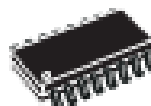
These versatile devices are useful for driving a wide range of loads including solenoids, relays DC motors, LED displays filament lamps, thermal print-heads and high power buffers.

The ULN2001A/2002A/2003A and 2004A are supplied in 16 pin plastic DIP packages with a copper leadframe to reduce thermal resistance. They are available also in small outline package (SO-16) as ULN2001D/2002D/2003D/2004D.



DIP16

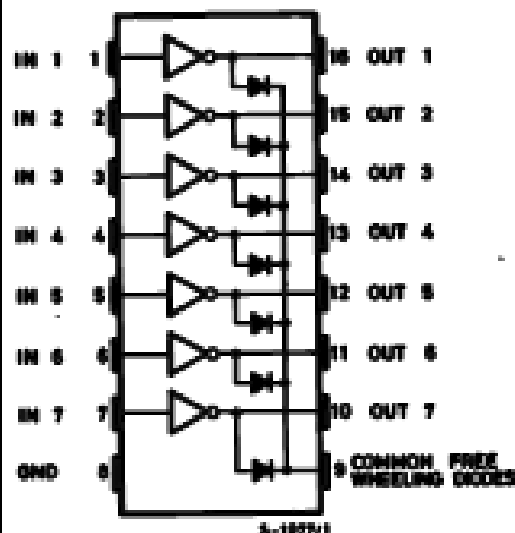
ORDERING NUMBERS: ULN2001A/2A/3A/4A



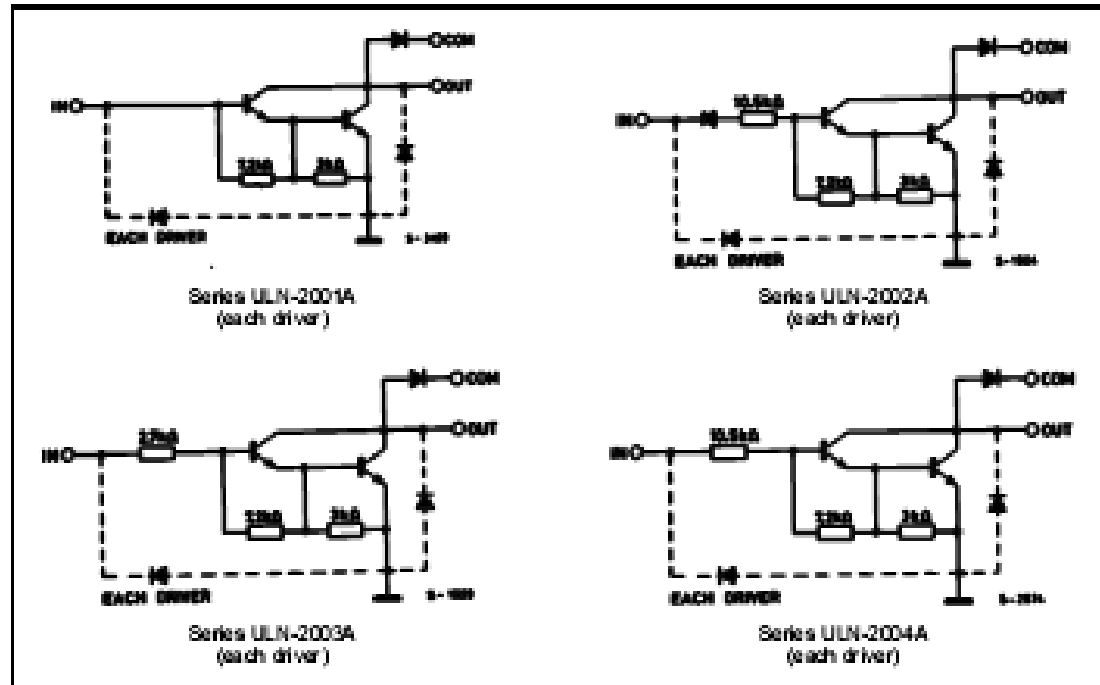
SO16

ORDERING NUMBERS: ULN2001D/2D/3D/4D

PIN CONNECTION



SCHEMATIC DIAGRAM



ABSOLUTE MAXIMUM RATINGS

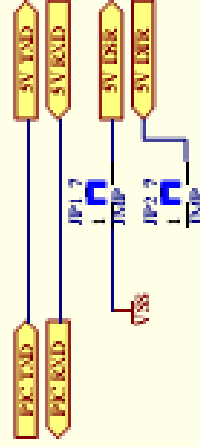
Symbol	Parameter	Value	Unit
V_o	Output Voltage	50	V
V_{in}	Input Voltage (for ULN2002A/D - 2003A/D - 2004A/D)	30	V
I_c	Continuous Collector Current	500	mA
I_b	Continuous Base Current	25	mA
T_{amb}	Operating Ambient Temperature Range	-20 to 85	°C
T_{stg}	Storage Temperature Range	-55 to 150	°C
T_j	Junction Temperature	150	°C

THERMAL DATA

Symbol	Parameter	DIP16	SO16	Unit
$R_{th(j-a)}$	Thermal Resistance Junction-ambient	Max. 70	120	°C/W

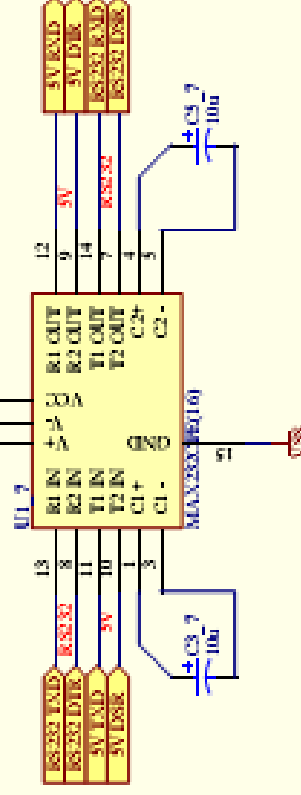
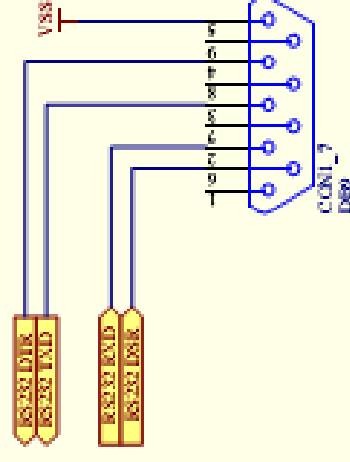
PIC16F84

(Direction seen from outside)



RS232

(Direction seen from board)



Pin	Name	Direction	Description
1	CD	Input	Carrier Detect
2	RXD	Input	Receive Data
3	TXD	Output	Transmit Data
4	DTR	Output	Data Terminal Ready
5	GND	-	System Ground
6	DSR	Input	Data Set Ready
7	RTS	Output	Request to Send
8	CTS	Input	Clear to Send
9	RI	Input	Ring Indicator