REMOTE RF CONTROL FOR HOME APPLIANCE DEVELOPMENT BOARD

MUHAMMAD ZAKUAN BIN AHMAD SALIM

This thesis is submitted as partial fulfillment of the requirements for the award of the Bachelor of Electrical and Electronics Engineering (Hons.) (Power System)

FACULTY OF ELECTRICAL & ELECTRONICS ENGINEERING
UNIVERSITY MALAYSIA PAHANG

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WIRELESS CONTROL SYSTEM FOR MODERN HOUSE BOARD

MUHAMMAD ZAKUAN BIN AHMAD SALIM

UNIVERSITY MALAYSIA PAHANG

"I hereby acknowledge that the scope and quality of this thesis is qualified for the award of the Bachelor Degree of Electrical Engineering (Power Systems)"

Signature : ___________________________

Name : P.M DR AHMED N ABD ALLA

Date : ___________________________

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Signature : __________________

Author : MUHAMMAD ZAKUAN BIN AHMAD SALIM

Date : __________________

To my beloved mother, father, brother, and sisters

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ABSTRACT

Modern house nowadays are becoming more advance as many innovation inventions are invented in a fast rate as technologies are rapidly increasing. Some of the features for the control system for modern house are mail notification, power saving, water saving and smoke detection. An RF control system for modern house consists of two parts; transmitter and receiver. The transmitter is operated as a remote control and the receiver receive data from transmitter and then control the device. The system used wireless as the medium between remote control and controlled devices. This project is design for modern house to create the appliance control, efficient control and security system for modern house.

ABSTRAK

Rumah moden sekarang ini menjadi lebih maju dan maju setelah banyaknya inovasi penciptaan tercipta dalam pembangunan teknologi yang pesat dan pantas. Sesetengah ciri-ciri sistem kawalan rumah moden ialah pemberitahuan mel, penjimatan kuasa, penjimatan air, dan pengesan asap. Satu sistem kawalan frekuensi radio untul mengawal rumah moden ini merangkupi dua bahagian iaitu “trannsmitter” dan “receiver”. “Transmitter” beroperasi sebagai alat kawalan jauh dan “receiver” menerima data daripada “transmitter” dan seterusnaya mengawal peralatan rumah yang berkaitan. Sistem ini tidak menngunakan wayar (wireless) sebagai medium antara alat kawalan jauh dan peralatan yg dikawal. Projek ini direka untuk menghasilkan kawalan peralatan, kawalan yang cekap, dan sistem keselamatan untuk rumah moden.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

With the development of civilization and the evolution of work and lifestyle, the role of home and its functions have change gardually. In ancient times, a home was considered as a shelter that could protect people from threats in the world, such as inclement weather and dangerous animals. It was a crude construction and humans lived there on a temporary basis. In argricaltural society, some new construction methods were invented which made the home more durable and solid than before. However, the level of comfort within the home was primotive due to limitations in building meterials and techniques, and in home appliances.

Stepping into industrial society, the home became private dwelling the served as living quaters for one family[1]. Homes were invariably well built and the living conditions of the inhabitants improved significantly thanks to deserve design of the buildings and abundant home appliances.

In the twentieth century, people sought to explore ways of creating autonomous and adaptive household appliances employing the emerging technologies and innovations. In the 1950s, home components were expected to have the ability to operate intelligently, undertaking the tedious domestic tasks. After several decades, this ruogh vision was developed and generalized into the concept of Smart Home.

Smart Home refers a domestic environment where all kinds of smart devices are continuously working to make the inhabitants' lives more comfortable[2]. According to Consumer Electronics Association (CEA), the smart home system involves five fundamental segments, home automation, security and access control, multimedia entertainment, remote communication, and networking protocolsand regulations. These five elements can be intergrated to work together. The design of the Smart Home System applies knowledge to generate a flexible, comfortable,healthy and efficient environment that enhances the quality of residents' life.

1.2 Basic of remote control

A remote control is a component of an electronics device, most commonly a television set, DVD player and home theater systems originally used for operating the television device wirelessly from a short line-of-sight distance. Remote control has continually evolved and advanced over recent years to include Bluetooth connectivity, motion sensor enabled capabilities and voice control[3][4].

The main remote control technology used in the home is infrared. The signal between a remote control handset and the device it is controlling are infrared pulses, which are invisible to the human eye. The transmitter in the remote control handset sends out a pulse of infrared light when a button is pressed on the handset. A transmitter is often a light emitting diode (LED) which is built into the pointing end of the remote control handset. The infrared light pulse represents a binary code that corresponds to a certain command, such as (power on). The receiver passes the code to a microprocessor, which decodes it and carries out the command [5].

The remote control is usually contracted to remote. It is known by many other names as well, such as converter, clicker, power rod, the box, jingle stick, flipper, hoofer-doofer, the tuner, 'the zapper', the changer, or the button. Commonly, remote controls are Consumer IR devices used to issue commands from a distance to televisions or other consumer electronics such as stereo systems, DVD players and dimmers. Remote controls for these devices are usually small wireless handheld objects with an array of buttons for adjusting various settings such as television channel, track number, and volume. In fact, for the majority of modern devices with this kind of control, the remote contains all the function controls while the controlled device itself only has a handful of essential primary controls. Most of these remotes communicate to their respective devices via infrared (IR) signals and a few via radio signals. Earlier remote controls in the 1970s used ultrasonic tones. Television IR signals can be mimicked by a universal remote, which is able to emulate the functionality of most major brand television remote controls.

1.3 Remote appliance control

Remote appliance contro is the idea of having a higher level of control over device, using the internet. A higher level of control means that a user has greater access to the device, granting the user more options of maintaining the device. When the television was created, the only method of control was to manually turn the dial. When a remote was invented, users increase their control over the television to include control at a visible range of the device. Control remotely over the internet further increases the approachability of a device.

It s also important to realize that with wireless devices becoming more and more popular, their effect on remote controlling needs to be taken into account. Because of the growing impact of wireless devices, this thesis covers their usage to control appliances remotely. This creates an even higher level of control by including the technology that society is adopting at a great rate. Figure 1.1 shows the example of home appliance that can controlled by RF system.

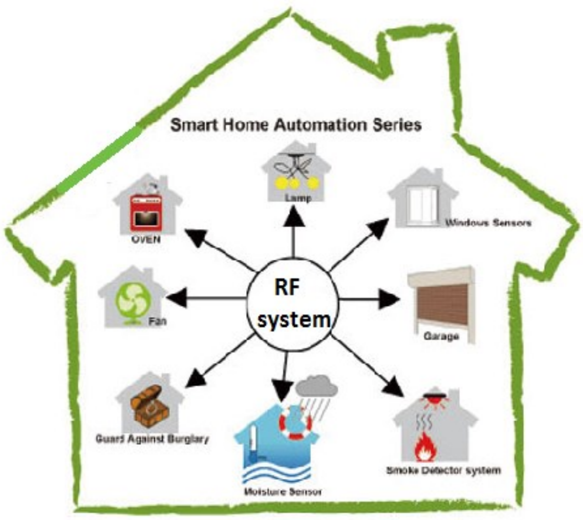


Figure 1.1 : smart home controlled by RF system

1.4 Objective

The main objective of this project is to design the remote RF control for home appliance development board. Home equipment can easily and effectively controlled by a remote RF control. By using this technology, it will reduce the cost of wiring the electric equipment, work more faster abd it also help disable person to do their work. There are 3 objective need to be achieved which are:

1. Study the RF system.
2. To developed hardware of wireless RF system.
3. Test the wireless RF system to the appliance related.

1.5 Scope of project

the scope of the project:

1. This remote RF control can be used to control home appliances within a range of 30 meters.
2. RF system module includes transmitter and receiver part. Transmitter (remote) operates using 9V battery. Receiver (bulb controller) operates using 240Vac power.
3. Transmitter module has a LCD to show system operation. There are 3 buttons on transmitter module used to control receiver module.
4. Receiver module is mainly used to receive transmitter command and control bulb brightness through TRIAC driver.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Most remote controls for electronic appliances use a near infrared diode to emit a beam of light that reaches the device. A 940 nm wavelength LED is typical. This infrared light is invisible to the human eye, but picked up by sensors on the receiving device. Video cameras see the diode as if it produces visible purple light.

With a single channel (single-function, one-button) remote control the presence of a carrier signal can be used to trigger a function. For multi-channel (normal multi-function) remote controls more sophisticated procedures are necessary: one consists of modulating the carrier with signals of different frequency. After the demodulation of the received signal, the appropriate frequency filters are applied to separate the respective signals. Nowadays digital procedures are more commonly used. One can often hear the signals being modulated on the infrared carrier by operating a remote control in very close proximity to an AM radio not tuned to a station.

Radio remote control (RF Remote Control) is a way to control distance objects using a variety of radio signals transmitted by the remote control device. By using radio remote control system, you can control a variety of mechanical or electronic devices to complete various operations, such as closing circuit, move handle, start motor, etc. As a complementary method to infrared remote control type, the radio remote control is widely used in garage door remote control, electric gate remote control, automatic barrier remote control, burglar alarm, industrial remote control and wireless home alarm systems.

2.2 Previous work on remote control

In the 1980s Steve Wozniak of Apple started a company named CL 9. The purpose of this company was to create a remote control that could operate multiple electronic devices. The CORE unit (Controller Of Remote Equipment) was introduced in the fall of 1987. The advantage to this remote controller was that it could “learn” remote signals from different devices. It had the ability to perform specific or multiple functions at various times with its built-in clock. It was the first remote control that could be linked to a computer and loaded with updated software code as needed.

The CORE unit never made a huge impact on the market. It was much too cumbersome for the average user to program, but it received rave reviews from those who could. These obstacles eventually led to the demise of CL 9, but two of its employees continued the business under the name Celadon. This was one of the first computer-controlled learning remote controls on the market.

2.3 Other remote control

Other remote control have been developed before. There some example of the other remote control.

2.3.1 ZigBee smart-home wireless

"ZigBee" derives from the ZigZag shapes dance which is created by the bees to exchange information of pollen location with the others. Because of the similar method of exchanging information, a new generation of wireless technology has been so named. ZigBee operates in licensefree 2.40HZ and 900MHZ band, with data rate ranging from 20kbps to 250kbps. Its network architecture with Master / Slave attributes, can achieve bi-directional communication. ZigBee technology is wireless networking protocol targeted towards home automation and remote control applications. The ZigBee protocol consists of IEEE 802.15.4 standard and ZigBee standard, which describe the specification of PHY and MAC and Network and Application Lay, respectively.

IEEE 802.15.4 specification is used in ZigBee protocol as MAC and PHY standard. ZigBee wireless sensor network can adopt many types of network configuration. But each of them must contain coordinator node (gateway) and terminal node. The device in ZigBee network can be classified into three roles: coordinator, terminal device and router. The coordinator is a special FFD (full function device) which is used for achieving a lot of ZigBee services. The terminal device can be a FFD or RFD (reduce function device). A FFD can be used as anyone of the three roles, while a RFD can only act as the terminal device. Router is optional equipment of ZigBee which may be needed in some special network configuration.

2.3.2 Infrared (IR) remote control

Since infrared (IR) remote controls use light, they require line of sight to operate the destination device. The signal can, however, be reflected by mirrors, just like any other light source.

If operation is required where no line of sight is possible, for instance when controlling equipment in another room or installed in a cabinet, many brands of IR extenders are available for this on the market. Most of these have an IR receiver, picking up the IR signal and relaying it via radio waves to the remote part, which has an IR transmitter mimicking the original IR control.

Infrared receivers also tend to have a more or less limited operating angle, which mainly depends on the optical characteristics of the phototransistor. However, it's easy to increase the operating angle using a matte transparent object in front of the receiver.

2.4 Overview of remote RF control

A radio remote control system commonly has two parts: transmit and receive.

Transmitter part is generally divided into two types, namely, rf remote control and transmitter module, by the way of using, the rf remote control can be used independently as a whole while the transmitter module is used as a component in the circuit, the advantage of using transmitter model is it can be seamlessly connected with application circuit, and it's size is small, but users must have a knowledge of circuit to use the transmitter module, the rf remote control is much more easy to use at this point.

Receiver part also is generally divided into two types, namely, the super-regenerative receiver and the superheterodyne receiver, super-regenerative receiver is actually working like the regeneration of under intermittent oscillation detection circuit. While Superheterodyne type is working like the one in radio receiver. Superheterodyne receiver features stability, high sensitivity and the anti-interference ability is relatively good, while super-regenerative receiver features a small package and the price is also cheaper.

2.5 Different appliances

There are many different appliances that humans use every day. From the lamp to the refrigerator, there is an appliance for almost every situation of daily life. These different appliances can be categorized into three distinct types; simlpe, variable, and inventory. All three were developed for use in RACS and are explained in detail.

2.5.1 Simple appliances

A simple appliances has only two states, on and off. Such appliances are easy to control and require title interaction with a user. These are the most common appliances including such devices as a light and coffee maker. Modelling of this appliance means defining a simple control switch that turns the device on and off. The interface between the user and the device is, therefore, very simple.

2.5.2 Variable appliances

A variable appliance is a device that has a range of values, including off. These types of devices provide more funtionality and interaction with the user. A thermostat is such a device. It has a range of values that represent the temperature setting for a house. This type of appliances also has little interaction between the user.

2.5.3 Inventory appliances

An inventory appliances contains a listing of items associated with it. This would include appliances like a refrigerator. The appliance itself is has no real state like a simple or variable appliance, but contains a catalog of items that defines the appliance. There are more interaction between the user and such a device, as addition and deletion of items from the appliance is required.

2.6 House design

The most important aspect of the RACS is the idea of creating a relationship between the house and the appliances. The house, in the thesis, is the representation of a physical house containingg all appliances that could be controlled using RACS.

However, the concept of house could be applied to a school, office building, or laboratory.

The RACS house, like any other house, has any number of rooms and any number of appliances hook up inside those rooms. The RACS need to be able to allow the user to add and delete rooms from the house. Appliances could then be added into a given room. This concept of a house makes the logical connection to the physical involvement of appliances inside rooms.

2.7 Talking to appliances

Communication with devices is the main purpose of the RACS and is done through database interaction with variable and inventory appliances. Communication is simple and relies only on changing the attributes of entities represented in the database. For instance, to change the value of an inventory appliance, one needs to modify the value entry in the database corresponding to the user and a variable or inventory appliance.

CHAPTER 3

METHODOLOGY

3.1 Introduction

In making this project, the I have used are computer software, laser printer, PCB developement tools, PCB assembly tools, and programing developement tools. There are some explanation how to use them.

3.1.1 Computer software

The computer is used to draw schematic and PCB for the system. Computer can be used to compile and download program into PIC through C-compiler and downloader software.

3.1.2 Laser printer

The laser printer is used to print the PCB drawing for PCB fabrication.

3.1.3 PCB development tools

The tools that used to developed a PCB are blade, fluorescence light, and PCB developer, etching poeder and thinner. Blade is used to cut suitable size for

PCB. Fluorescence light used to do photo etching for PCB. While PCB developer, etching powder and thinner used to develop track from PCB.

3.1.4 PCB assembly tools

To assemble the PCB, tools required are cutter, pliers, soldering iron, and mini drill. Cutter used to cut wire and components legs. Pliers used to bend component legs and place components on PCB. Soldering iron used to solder components on PCB. Mini drill used to drill holes on PCB to place components.

3.1.5 Programming development tools

In developing the programming, the tools used are PCW C-Compiler, Winpic800 USB Downloader Software, and Universal PIC Programmer.

PCW C-Compiler is used to edit and compile C-language program. It will generate .hex file for downloading application. The trial version of C-compiler can download from www.ccsinfo.com.

Winpic800 USB Downloader Software is used to download program to PIC. This software comes with Bizchip USB PIC programmer.

Universal PIC Programmer is an electronics device used to download PIC program into PIC. Through Winpic800 USB downloader software, this programmer can download PIC program (machine code, .hex file) into PIC. The programmer can buy from www.bizchip-components.com

3.2 Project workflow

To make this project done in time, I have made a workflow. This workflow guide me to do systematic work and I can do step by step. Figure 3.1 shown the project workflow.

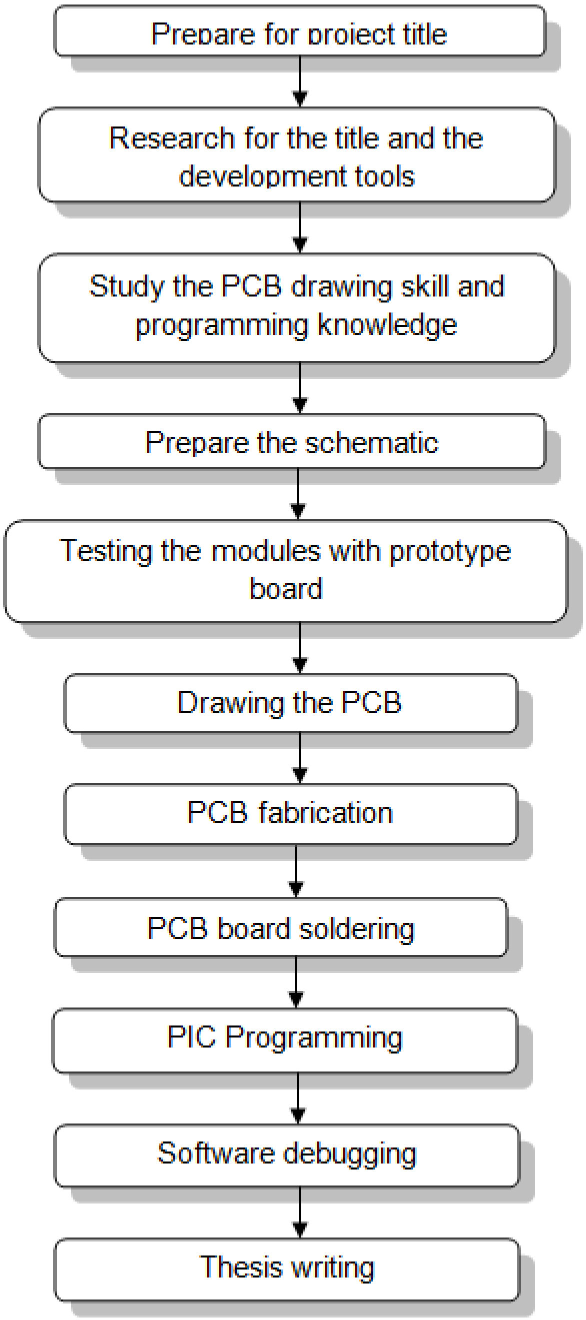


Figure 3.1: project workflow

3.3 Project development flowchart

Figure 3.2 shown the flowchart of project development.

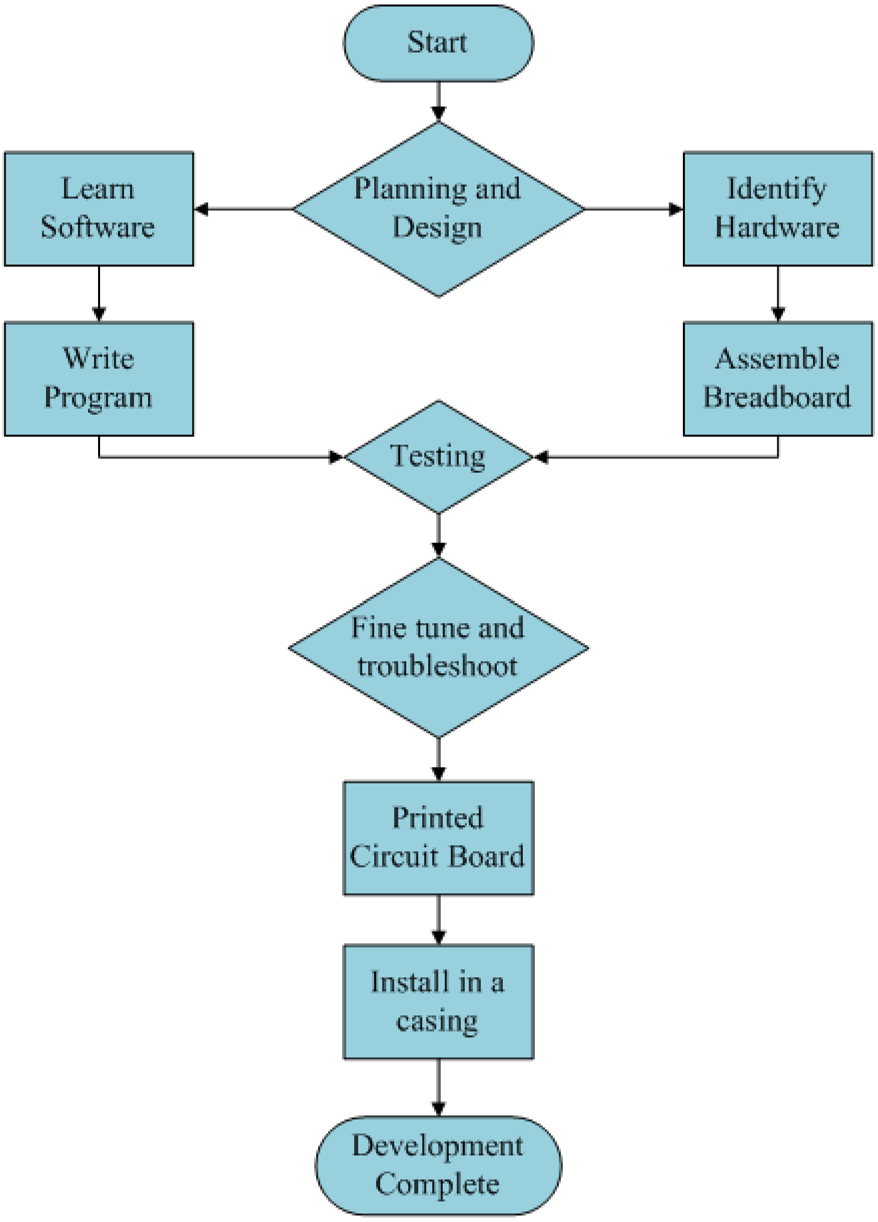


Figure 3.2: project development flowchart

A simple diagram of RF system to control home appliance are shown in figure 3.3. RF tramsmitter module and RF receiver module were implemented.

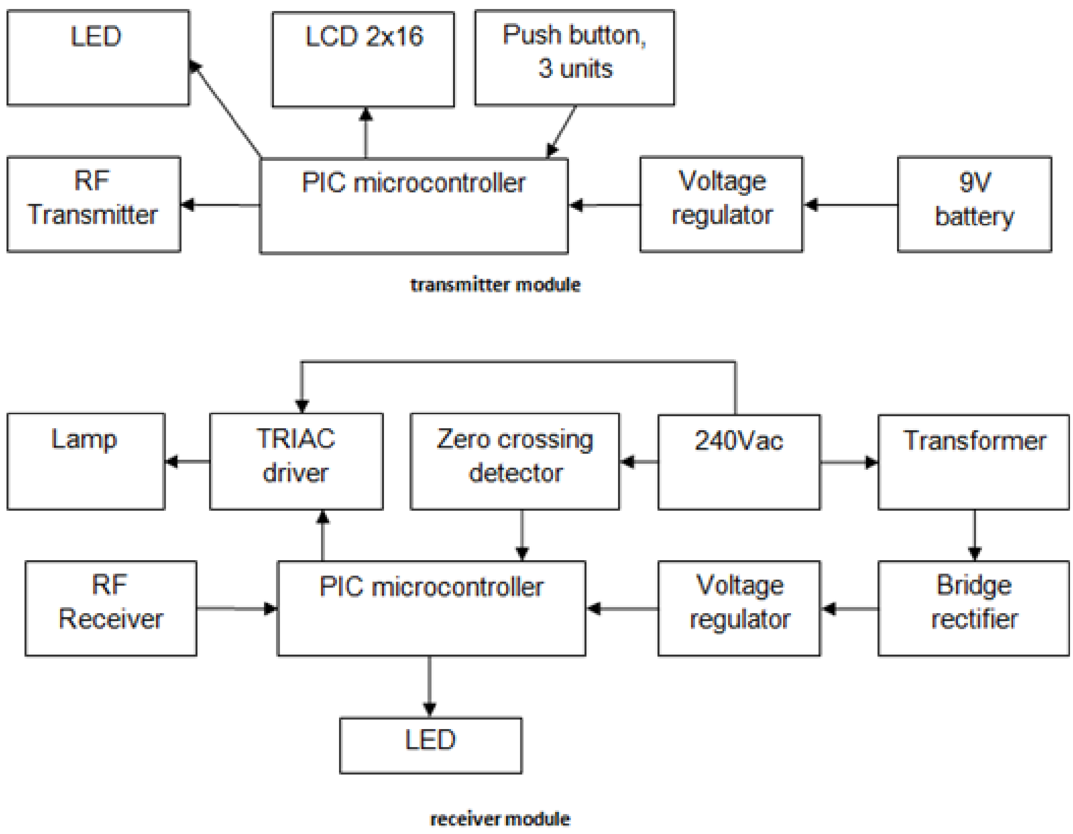


Figure 3.3: diagram of RF system to control home appliance

3.4 Microcontroller system board module

The main brain of the system is microcontroller PIC16F877A. There are many reasons I choose the controller to operate my patient module. It is designed using flash technology. So the PIC can read/write program for more than 100,000 times. The PIC 16F877A has 8 K words or program memory. Since each word in the midrange family is 14 bits long the program memory can also be expressed as 14 Kbytes. The unit has 368 bytes of data ram and 256 bytes of EEPROM. It has 8 channels of A/D with 10 bit resolution. The unit has 2 8 bit Timer/Counters and a single 16 bit Timer/Counter. In addition to this it has several different types of serial communication functions such as SPI, I2C, and normal pc type serial communications functions. Figure 2.2 shown the microcontroller PIC16F877A layout.

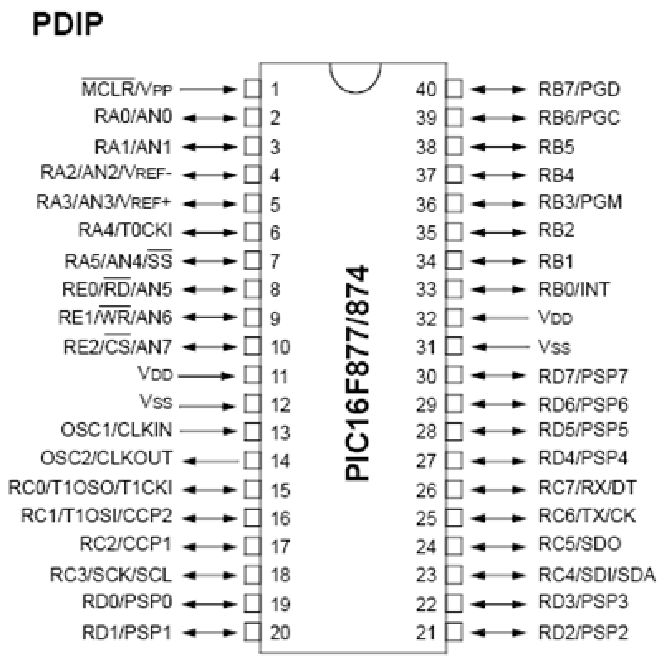


Figure 3.4: microcontroller PIC16F778A layout

OSC1 and OSC2 pins are connected to 20MHz crystal to execute every single program line in the system. 20MHz crystal is used because this is the maximum frequency that the PIC can support. If over frequency the PIC will burn. Else if crystal speed less than 20MHz then PIC response speed will slower. The MCLR pin of the PIC is pull up to 5V through a 10KR resistor.

The PIC can operate using 4.5V to 6.0V DC voltage. In the project is operating at 5.0V (by using 7805). It is DIP layout (dual in line package) and suitable for student project. It has 40 pins but only 33 I/O pins can be set as digital input or digital output. The digital output of the PIC is 5V (for signal 1) and 0V (for signal 0) these signals will be directly connected to actuators for control purpose. When the PIC pin is set as digital input, It will detect input voltage 5V as signal 1 and 0V as signal 0. Any voltage less than 0V or more than 5V will damage PIC.

3.5 Voltage regulator module

The voltage regulator module is used to protect PIC and other connected sensors / actuators from over voltage. This is because PIC and all other connected sensors, actuators all support 5V DC only. Over voltage will cause any of the module burn. Figure 3.5 shown the circuit diagram of voltage regulator.

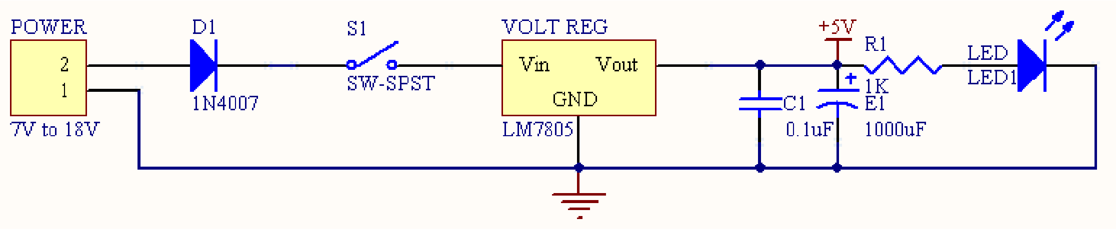


Figure 3.5: Voltage regulator circuit diagram

LM7805 is used to regulate voltage in the system and output 5V DC (max output current: 1000mA). It supports input voltage from 7V DC to 18V DC. If the input voltage is over, the LM7805 will burn or auto shutdown due to overheat.

The generated 5V from LM7805 will be noise filtered by 0.1uF ceramic capacitor and a 1000uF electrolytic capacitor. This is to avoid high frequency oscillation on the outputs which may cause system hang or unstable.

A diode is connected at the input of the LM7805. This is to avoid voltage connected reversely. An on/off switch is used to turn on/off the system and a LED (5V, 5mA) is used to indicate the system is power on/off. The LED is connected through 1KR resistor to limit current pass through LED is 5mA.

3.6 RF module

These RF modules are adopting RF integrated circuit with super-heterodyne working mode and SAW resonance. Its features are stability and strong ability of anti-jamming. It is widely used at some spot of industrial control that has high requirement. Figure 3.6 and 3.7 shown the RF transmitter module and RF receiver module.

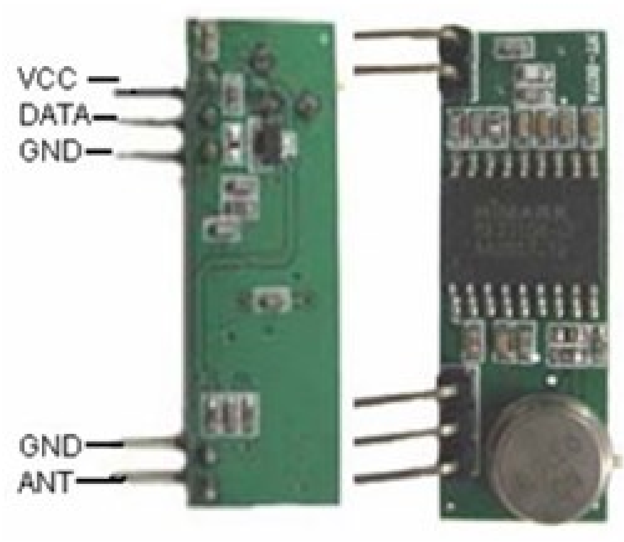


Figure 3.6: RF transmitter module

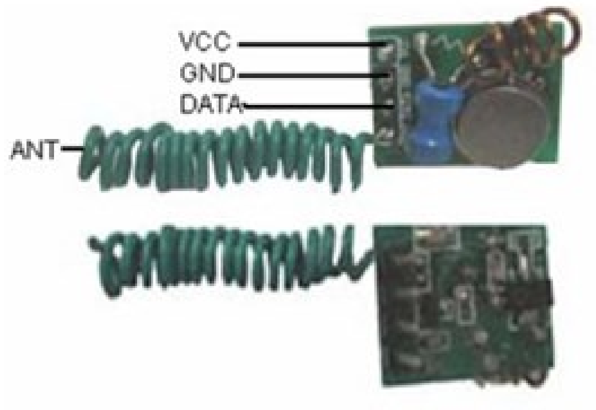


Figure 3.7: RF receiver module

Technical specifications of the RF module:

- Control range : 20-50 meters
- Communication : Serial 8-bit data
- Resonance mode : sound wave resonance (SAW)
- Modulation mode : AM/OOK/ASK
- Working frequency : 315MHz
- Transmitting velocity : <9600bps
- Antenna length : 24cm

3.7 Steps to download PIC program into PIC Microcontroller

1. Connect PIC programmer to computer via serial port / USB port.
2. Insert PIC into the programmer socket (figure 3.8).

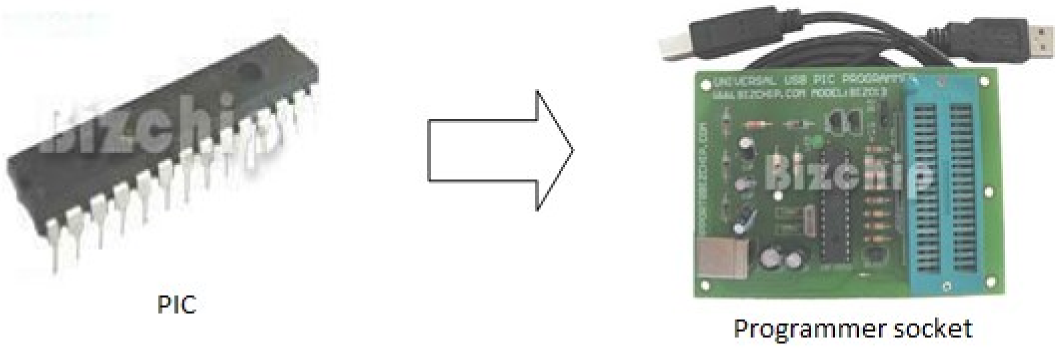


Figure 3.8: Insert PIC into the programmer socket

3. Copy ‘Winpic800’ folder to Desktop
4. Look for Winpic800.exe in the folder (figure 3.9).

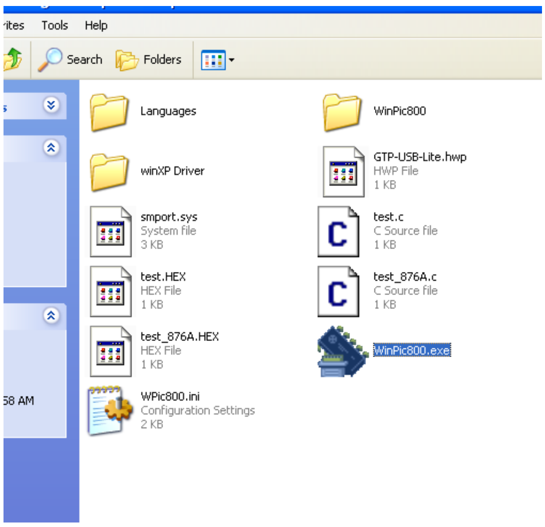


Figure 3.9: Winpic800.exe in folder “Winpic800”

5. Double click Winpic800.exe to start the program (figure 3.10).

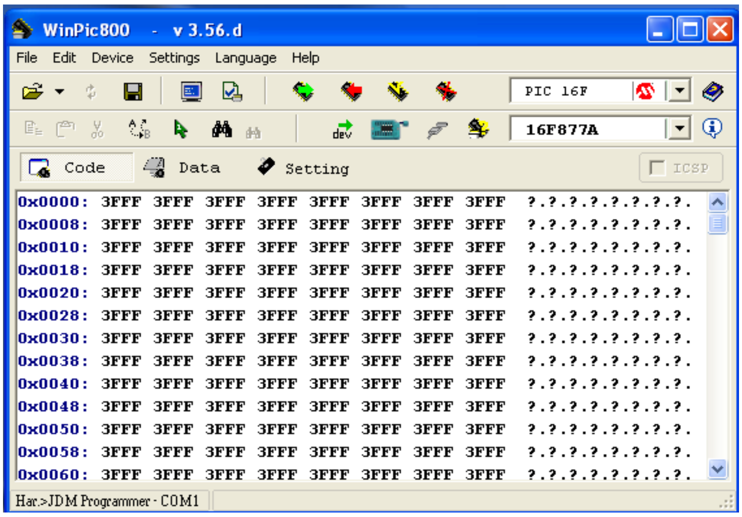


Figure 3.10: Start the program Winpic800.exe

6. Select proper PIC name in the top right combo box (figure 3.11).

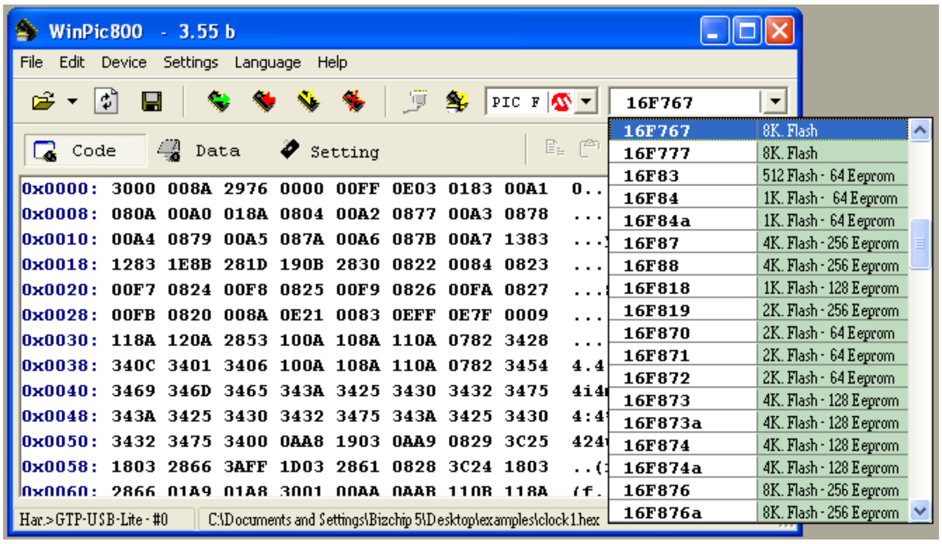


Figure 3.11: select the name of PIC(16F877A)

7. Open the .hex file which you want to download into PIC e.g. if your .c filename is 'abc.c', suppose you need to download 'abc.hex' into PIC.
8. Go to 'Device' -> 'Program All' to start download program into your PIC (figure 3.12).

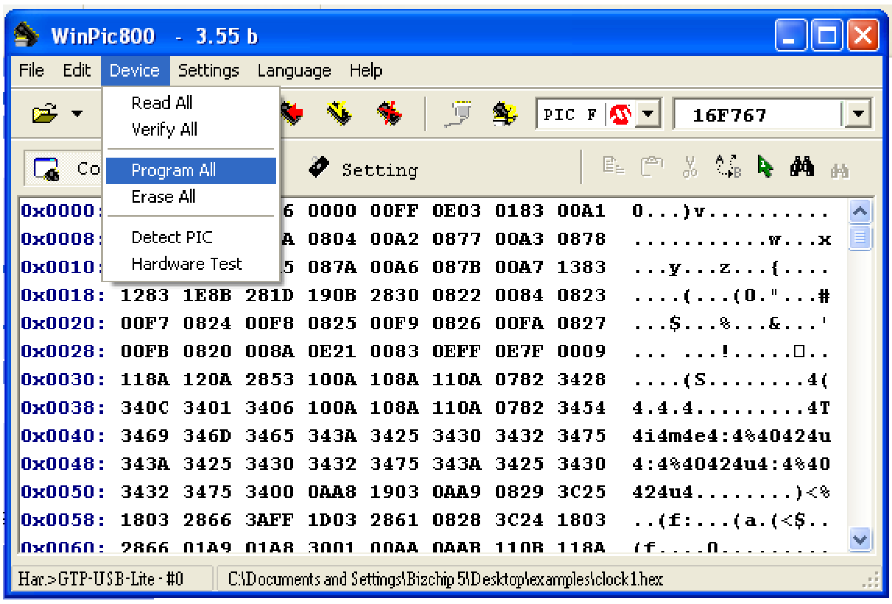


Figure 3.12: Start download program into PIC

3.8 Steps to use PCWH C-Compiler

1. Open PCW C-Compiler Start->All Programs->PIC-C->PIC C Compiler.
2. ‘File’ -> ‘New’ to start a new file.
3. Save the file as .c file, it is advisable to put the main file name within 8 chars length, extended file name must be .c, e.g. myprog1.c.
4. Type / Edit your program.
5. Save program before compile.
6. Compile your program using F9.
7. If any error occurs, please check your program and compile again. Otherwise you won’t get your .hex file.

3.9 Printed Circuit Board (PCB)

A printed circuit board, or PCB, is used to mechanically support and electrically connect electronic components using conductive pathways, tracks or signal traces etched from copper sheets laminated onto a non-conductive substrate. It is also referred to as printed wiring board (PWB) or etched wiring board. Printed circuit boards are used in virtually all but the simplest commercially produced electronic devices.

A PCB populated with electronic components is called a printed circuit assembly (PCA), printed circuit board assembly or PCB Assembly (PCBA). In informal use the term "PCB" is used both for bare and assembled boards, the context clarifying the meaning.

in prepairing the PCB, i have used many steps to complete it. The steps are as belows:

1. PCB Drawing: PCB drawing is designed using Protel DXP 2005, this software can automatically convert schematic file to PCB automatically.
2. Film Printing: After PCB file is generated, use laser printer to print it on transparency (figure3.13).

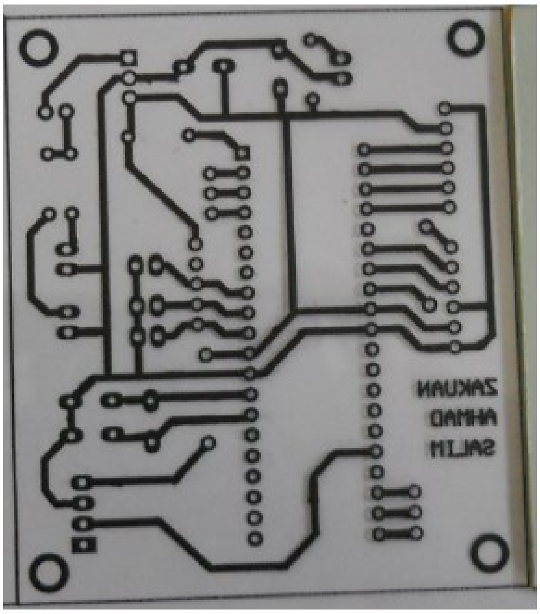


Figure 3.13: print PCB file on transparency

3. PCB Cutting: Cut photo PCB size according to the film size (figure 3.14).

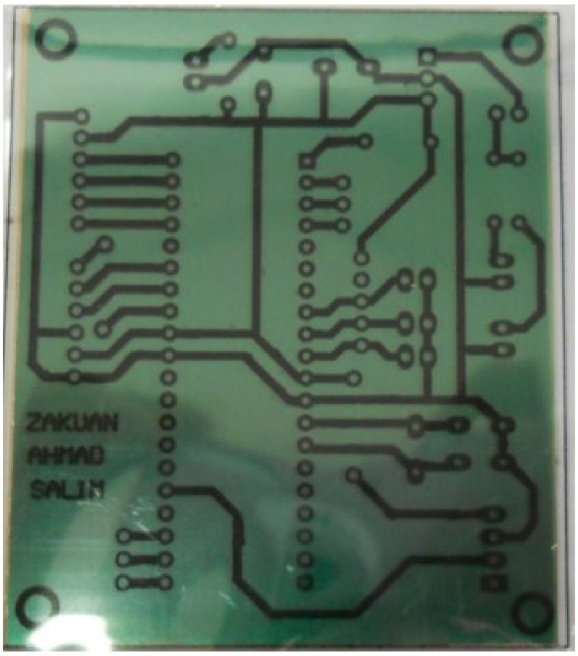


Figure 3.14: Cut photo PCB size according to the film size

4. PCB Photo Etching: Expose the photo PCB in photo etching kit for 8-10minutes (figure 3.15).

Figure 3.15: PCB Photo Etching

5. PCB Developing: Wash the PCB using PCB developer (white powder) for 2 min.

6. Acid Etching: After PCB is developed, put it in Ferric Chloride liquid. Add in hot water (80C) and shake the water until you see unused part

is ‘washed’ and left only the tracks (figure 3.16). The etching process takes around 30 min.

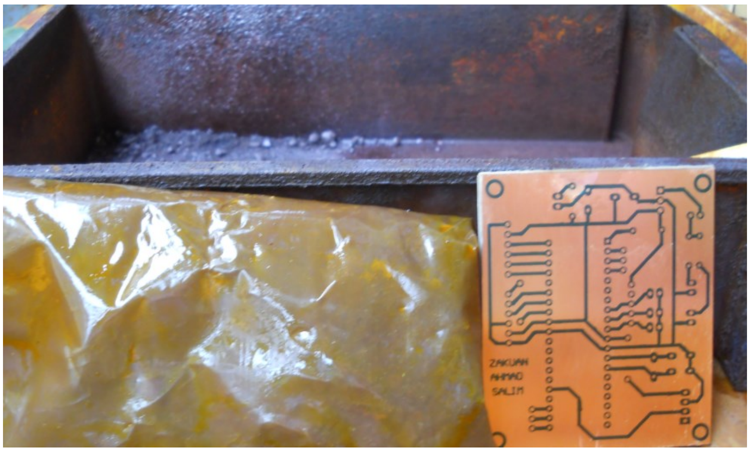


Figure 3.16: Acid etching

7. Alcohol Washing: Wash the PCB with alcohol to get rid off the green coating (figure 3.17).

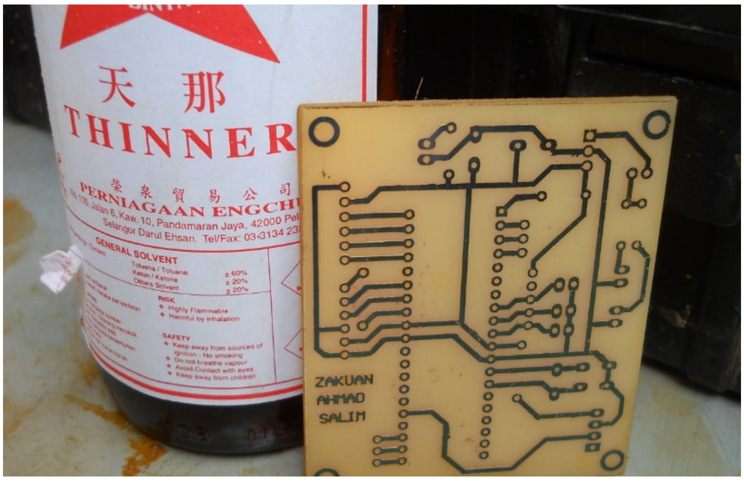


Figure 3.17: Alcohol washing

8. Drilling: Drill PCB after alcohol washing, use drill bit 0.8mm, 1.0mm and 1.2mm (figure 3.18).

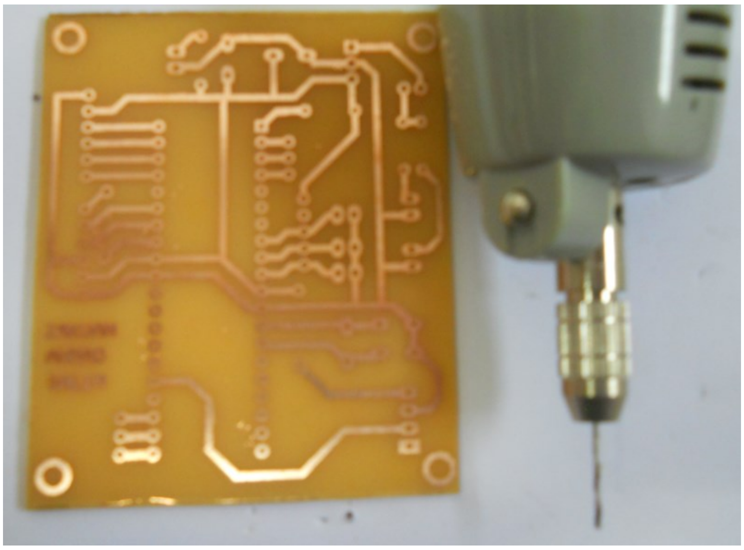


Figure 3.18: Drilling

9. Soldering: Place all components on the PCB, use tape to stick all components tightly on the PCB and then solder the components using soldering iron and lead.

CHAPTER 4

RESULT AND DISCUSSION

4.1 Introduction

In this chapter, I will discuss more about the operation of the system. To make it more clear, I include the function of the component used to operate the remote control.

4.2 Project component list

To build the RF remote control, many component were used. Table below shows the list of the component used.

Table 4.1 shown the transmitter module

Table 4.2 shown the receiver module

Table 4.1: Transmitter module

Component	Value	Quantity
Microcontroller	PIC16F877A	1
IC Socket	40 pin	2
Crystal	20MHz	1
Capacitor	18pF	2
Voltage regulator	LM7805	1
Capacitor	0.1uF, 50V	1

Capacitor	1000uF, 16V	1
LED	5mm	1
Resistor	1KR	1
Diode	1N4007	2
Switch	On/Off	1
PCB photo	300mm*150mm	1
Etching powder	1Kg	1
PCB Developer	50g	1
Battery	9VDC	2
Connector	Battery snap	2
LCD	2x16, green	1
Resistor	10KR, 1/4W, 5%	1
Switch	Push button, big	3
RF Transmitter	5V, 4800bps	1

Table 4.2: Receiver module

Component	**Value**	**Quantity**
Microcontroller	PIC16F877A	1
IC socket	40 pin	2
Crystal	20MHz	1
Capacitor	18pF	2
Voltage regulator	LM7805	1
Capacitor	0.1uF, 50V	1
Capacitor	1000uF, 16V	1
LED	5mm	1
Resistor	1KR	1
Switch	On/Off	1
PCB photo	300mm*150mm	1
Etching powder	1Kg	1

PCB Developer	50g	1
Connector	Screw Terminal, 2 way	1
Transformer	240Vac : 12Vac	1
Power Cord	1.2 meter	1
Power Plug	3 pin	1
Diode	1N4007	4
Resistor	1KR	1
LED	5mm	1
Resistor	470R	1
Resistor	4M7R	1
Resistor	180R	1
Resistor	1M5R	1
Resistor	10KR, 1/4W, 5%	1
RF Receiver	5V, 4800bps	1

4.2.1 Project wiring

Table 4.3 shown the transmitter module

Table 4.4 shown the receiver module

Table 4.3: Transmitter wiring module

PIC I/O Pin	**Connect to**	
	Sensor / Actuator	**Function**
RB0	Pin E LCD	Display data on LCD
RB1	Pin RS LCD	Display data on LCD
RB2	Pin R/W LCD	Display data on LCD
RB4	Pin DB4 LCD	Display data on LCD

RB5	Pin DB5 LCD	Display data on LCD
RB6	Pin DB6 LCD	Display data on LCD
RB7	Pin DB7 LCD	Display data on LCD
RC6	RF Transmitter	Send data to RF receiver
RE0	Push button	Detect button pressed
RE1	Push button	Detect button pressed
RE2	Push button	Detect button pressed

Table 4.4: Receiver wiring module

PIC I/O Pin	**Connect to**	
	Sensor / actuator	**Function**
RA0	Optocoupler Module	Control lamp
RB7	Optocoupler Module	Control lamp
RC1	LED	LED blink when data received
RC7	RF Receiver	Receive data from RF Transmitter

4.2.2 Operation

Auto bulb controller will maintain room brightness. The whole system is controlled using PIC16F877A. It uses PIN_B7 to trigger the bulb and use A0 to get the feedback of the bulb. A1 of the PIC is connected to a LDR to detect environment brightness.

The auto bulb controller is a mains voltage controlling device which controls which amount of each mains half wave gets to lamp and which does not. This is done by controlling the conduction angle (time after zero cross) in which the mains switching element (usually TRIAC) starts to conduct. When TRIAC starts to conduct, it will conduct up to the next zero crossing of mains voltage (time when current decreases zero).

4.2.3 PIC 16F877A microcontroller

PIC16F877A-I/P microcontroller is used to control the whole system. OSC1 and OSC2 pins are connected to 20MHz crystal to execute every single program line in the system. 20MHz crystal is used because this is the maximum frequency that the PIC can support. The PIC can operate using 4.5V to 6.0V DC voltage. In the project is operating at 5.0V (by using 7805).

4.2.4 Voltage regulator module

The voltage regulator module is used to protect PIC and other connected sensors / actuators from over voltage. This is because PIC and all other connected sensors, actuators all support 5V DC only. Over voltage will cause any of the module burn.

LM7805 is used to regulate voltage in the system and output 5V DC (max output current: 1000mA). It supports input voltage from 7V DC to 18V DC. If the input voltage is over, the LM7805 will burn or auto shutdown due to overheat.

4.2.5 TRIAC

A **TRIAC**, or **TRIode for Alternating Current** is an electronic component approximately equivalent to two silicon-controlled rectifiers joined in inverse parallel (paralleled but with the polarity reversed) and with their gates connected together. This results in a bidirectional electronic switch which can conduct current in either direction when it is triggered (turned on). It can be triggered by either a positive or a negative voltage being applied to its gate electrode. Once triggered, the device continues to conduct until the current through it drops below a certain threshold value, such as at the end of a half-cycle of alternating current (AC) mains power. In addition, applying a trigger pulse at a controllable point in an AC cycle allows one to control the percentage of current that flows through the TRIAC to the load (so-called phase control).

4.2.6 Bridge Rectifier

A rectifier is an electrical device that converts alternating current (AC) to direct current (DC), a process known as rectification. Rectifiers have many uses including as components of power supplies and as detectors of radio signals. Rectifiers may be made of solid state diodes, vacuum tube diodes, mercury arc valves, and other components.

A device which performs the opposite function (converting DC to AC) is known as an inverter.

When only one diode is used to rectify AC (by blocking the negative or positive portion of the waveform), the difference between the term diode and the term rectifier is merely one of usage, i.e., the term rectifier describes a diode that is being used to convert AC to DC. Almost all rectifiers comprise a number of diodes in a specific arrangement for more efficiently converting AC to DC than is possible with only one diode.

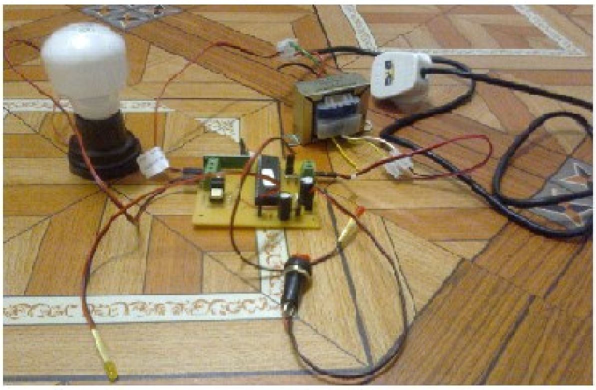
4.2.7 Optocoupler

In electronics, an optocoupler is a device that uses a short optical transmission path to transfer a signal between elements of a circuit, typically a transmitter and a receiver, while keeping them electrically isolated — since the signal goes from an electrical signal to an optical signal back to an electrical signal, electrical contact along the path is broken.

4.3 Run the project

4.3.1 Turn on the receiver and transmitter

To make sure this project is working, we need to test it first. Firstly we need to plug in the power supply to the receiver side to make sure the light bulb can turn on. After the plug is on, push the red button at the receiver to turn on the receiver. Figure 4.1 shows the circuit and circuit diagram of the receiver.



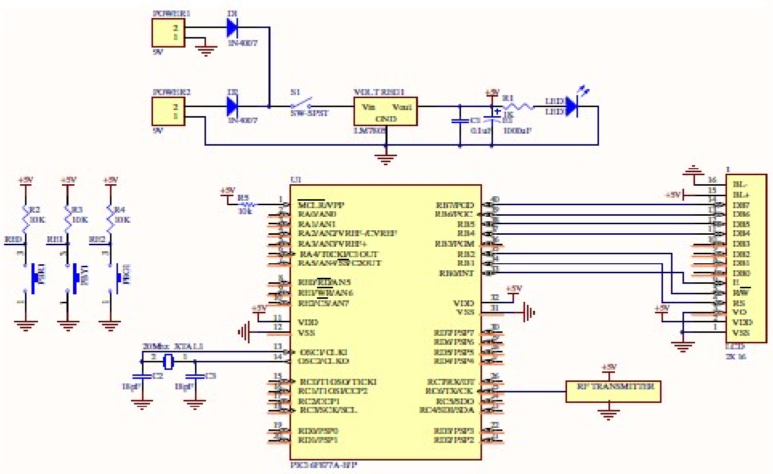


Figure 4.1: circuit and circuit diagram of receiver

Then, to turn on the transmitter, push the yellow button at the transmitter. Its used power supply from 9V battery. Figure 4.2 shows the circuit and circuit diagram of transmitter.

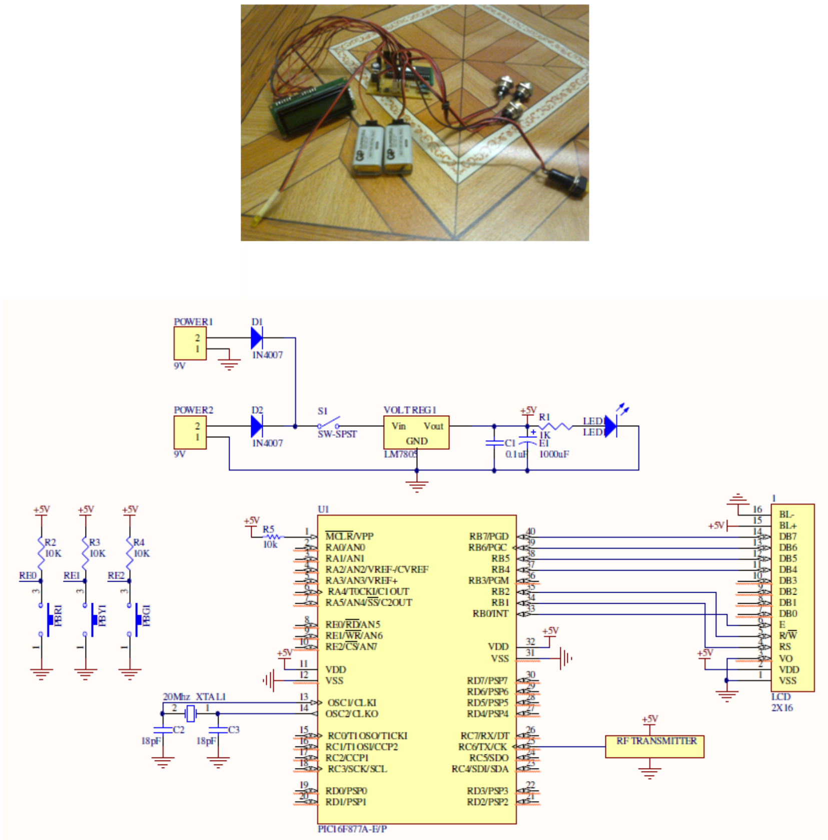


Figure 4.2: Circuit and curcuit diagram for transmitter

4.3.2 Run

After both receiver and transmitter turned on, we can now simply turn the lightbulb on by press yellow button at the transmitter. The lightbulb turned on in 100% of brightness. Figure 4.3 shows the normal mode of brightness.

Figure 4.3: 100% of brightness for normal mode

When the green button pressed, the lightbulb turned dimmer than normal made. This mode called sleep mode. The lightbulb dimmed because of the TRIAC.

The TRIAC can control the current flow like I mentioned above. Figure 4.4 shows the brightness of sleep mode.

Figure 4.4: brightness of sleep mode (dim)

Just like usual, when something turned on, it must be can turned off. To turn off the lightbulb, press the red button and the lightbulb turned off as shown in figure 4.5.

Figure 4.5: lightbulb turned off

In additional, the red LED at the receiver also play its role. The red LED will blink when any button at the transmitter pressed. It shows the receiver received the data from transmitter. Figure 4.6 shows the blinking LED when button pressed.

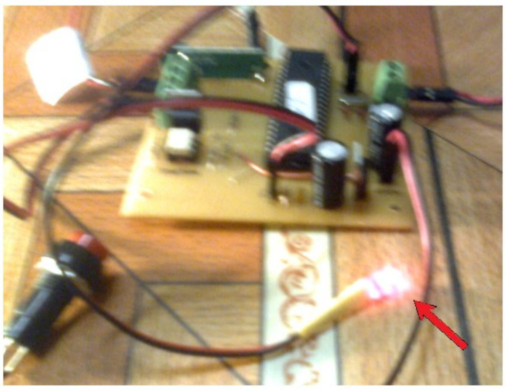


Figure 4.6: Red LED blinking when button at transmitter pressed

4.3.3 Precaution

While running this project, we need to take some precaution because we used a bit high voltage that is 240 VAC. If we are shocked it will leaved a bad effect to us like burns.

In other way, we can turn off the transmitter while we are not use it. We can turn off the transmitter by push the yellow push buttun. We can turn off even though the appliance are running. This method will save our transmitter's battery.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

The project has achieve the main objective where the RF system to control home appliance as a remote control is successfully developed and able to apply to real life. The project consist of two parts; transmitter (remote control) and reciever. The transmitter will send data to reciever when any button pushed. This data is then sent to microcontroller to process and then show the input at the appliance. In additional, LED as indicator at the reciever blinking when any button at transmitter pushed. That means the reciever recieve the data. While the LCD at the transmitter display the mode of the appliance.

5.2 Practical application

There are numerous practical applications for the RF control system. There are currently appliances that act in such a manner and if were connected to this system would create any usable applications.

The most commont usage of the RF control system could be a multi-purpose home monitoring system. This could mean cameras positioned throughout the house as well as lighting controls with access to the thermostat. If one were at work and the day started out cold, they could log onto their home system and turn up the temperature in the house.

There are also many business applications the RF control system could be used for. If a company wanted to monitor its vending machines across a certain area, it could connect them through the RF control system and be able to tell how many of each item the machine had remaining and only send service men accordingly.

The practical applications for remotely controlling appliances is endless. From home to business use, control of devices remotely controlling will begin to play a part in people's lives within this decade.

5.3 Recommendation

Just as usual, even though the project has been succesfully demonstrated the remote RF control, its must be something incomplete. Here, I listed some recommendation of improvement of this project. Future work on this project should include:

- Battery saving
- Increase the transmission range
- Can bear heavy load such as motor
- Made in smaller size

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APPENDIX A

Program for transmitter

```
#include <16f877A.h> //use pic16f877a
#use delay(clock=20000000) //20mhz
#fuses hs,noprotect,nowdt,nolvp  //fuse setting
#use rs232(baud=4800, xmit=PIN_C6, rcv=PIN_C7, parity=N) //rs232 setting
#define use_portb_lcd TRUE //set portb for lcd
#include <lcd.c>  //use lcd library

//pic io port address
#byte PORTA=5
#byte PORTB=6
#byte PORTC=7
#byte PORTD=8
#byte PORTE=9

void main()
{
  int i;
  int send_en=1;
  int bt1_en=1;
  int bt2_en=1;
  int bt3_en=1;
  char data='A';

  //set i/o for each pin
  set_tris_a(0b00000000);
  set_tris_b(0b00000000);
  set_tris_c(0b10000000);
```

```
set_tris_d(0b00000000);
set_tris_e(0b00000111);
setup_port_a(NO_ANALOGS);

lcd_init();
lcd_putc("   Smart Lamp");
lcd_putc("\n  With Remote");
delay_ms(3000);
lcd_putc("\fOff Mode");

do
{
  if(input(pin_e0)==0 && bt1_en==1) //if button1 pressed
  {
    bt1_en=0;
    data='A';
    send_en=1;
    lcd_putc("\fOff Mode");
  }
  else if(input(pin_e0)==1)  //if button1 released
  {
    bt1_en=1;
  }

  if(input(pin_e1)==0 && bt1_en==1) //if button2 pressed
  {
    bt2_en=0;
```

```
  data='B';
  send_en=1;
  lcd_putc("\fNormal Mode");
}
else if(input(pin_e1)==1)  //if button2 released
{
  bt2_en=1;
}

if(input(pin_e2)==0 && bt3_en==1) //if button3 pressed
{
  bt3_en=0;
  data='C';
  send_en=1;
  lcd_putc("\fSleep Mode");
}
else if(input(pin_e2)==1)  //if button3 released
{
  bt3_en=1;
}

if(send_en==1) //under send mode
{
  //send data to receiver
  for(i=0;i<10;i++)
  {
    putc('(');
```

```
        putc(data);
        putc(')');
        delay_ms(10);
      }
      send_en=0;
    }

    delay_ms(300);

  }while(1);
}
```

APPENDIX B

Program for reciever

```
#include <16f877a.h>            //use pic16f877a
#device adc=8                   //use 8bit adc
#use delay(clock=20000000)      //pic use 20mhz
#fuses hs,noprotect,nowdt,nolvp  //fuses setting
#use rs232(baud=4800, xmit=PIN_C6, rcv=PIN_C7, parity=N) //rs232 setting

#byte PORTA=5 //define PORT A address
#byte PORTB=6 //define PORT B address
#byte PORTC=7 //define PORT C address
#byte PORTD=8 //define PORT D address
#byte PORTE=9 //define PORT E address

//define parameters
#define ACpin  PIN_A0
#define VARpin PIN_A1
#define lamp1  PIN_B7

//AC line
int AC_phase=0;
int AC_value=0;

//Dimming variables
int lamp1_dly=0;
int dim_cnt=0;

int rx_temp1;
int rcvdata;
```

```
int rx_temp3;
int rx_set=0;
int rx_data=125;

//receive and check data from transmitter
#int_rda
void serial_isr()
{
  rx_temp1=getch();
  if(rx_temp1=='(')
  {
    rcvdata=getc();
    rx_temp3=getch();
    if(rx_temp3==')')
    {
      rx_set=1;
    }
  }

  rx_temp1=0;
  rx_temp3=0;
}

#INT_RTCC     //0.1024ms Interrupt
clock_isr()
{
  dim_cnt++;
```

```
  if(dim_cnt>=lamp1_dly)
  {
    output_low(lamp1);
  }
  if(dim_cnt>=80)
  {
    AC_value=read_adc();
  }
  if(dim_cnt==30)
  {
    lamp1_dly=rx_data;
  }
}

void main()
{
  //set io for each pic pin
  set_tris_a(0b00000001);
  set_tris_b(0b00000000);
  set_tris_c(0b10000000);
  set_tris_d(0b00000000);
  set_tris_e(0b00000000);
  setup_port_a(ALL_ANALOG);
  setup_adc(ADC_CLOCK_INTERNAL);
  set_rtcc(0);
  setup_counters(RTCC_INTERNAL, RTCC_DIV_2);
```

```
enable_interrupts(int_rtcc);
enable_interrupts(int_rda);
enable_interrupts(GLOBAL);

lamp1_dly=125; //off lamp
set_adc_channel(0);  //AC PIN

//blink led
output_high(pin_c1);
delay_ms(1000);
output_low(pin_c1);



do
{
  if(rx_set==1)  //if receive any rf data
  {
    output_high(pin_c1);
    if(rcvdata=='A')  //if receive 'A'
    {
      rx_data=125;   //off bulb
    }
    if(rcvdata=='B')  //if receive 'B'
    {
      rx_data=0;     //on 100% bulb
    }
    if(rcvdata=='C')  //if receive 'C'
```

```
        {
          rx_data=90;   //on 50% bulb
        }


        rx_set=0;
        delay_ms(200);
        output_low(pin_c1);
      }
      else  //if no data in
      {
        if(AC_value>=125 && AC_phase==0) //Zero Crossing case1
        {
          AC_phase=1;
          dim_cnt=0;
          output_high(lamp1);
        }
        if(AC_value<125 && AC_phase==1) //Zero Crossing case0
        {
          AC_phase=0;
          dim_cnt=0;
          output_high(lamp1);
        }
      }
    }while(1);
  }
```

APPENDIX C

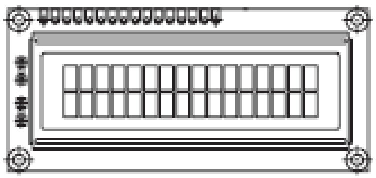
Data sheet

Data shee for LCD 2x16

LCD-016M002B

Vishay

16 x 2 Character LCD



FEATURES

- 5 x 8 dots with cursor
- Built-in controller (KS 0066 or Equivalent)
- + 5V power supply (Also available for + 3V)
- 1/16 duty cycle
- B/L to be driven by pin 1, pin 2 or pin 15, pin 16 or A.K (LED)
- N.V. optional for + 3V power supply

MECHANICAL DATA

ITEM	STANDARD VALUE	UNIT
Module Dimension	80.0 x 36.0	mm
Viewing Area	66.0 x 16.0	mm
Dot Size	0.56 x 0.66	mm
Character Size	2.96 x 5.56	mm

ABSOLUTE MAXIMUM RATING

ITEM	SYMBOL	STANDARD VALUE			UNIT
		MIN.	TYP.	MAX.	
Power Supply	VDD-VSS	- 0.3	–	7.0	V
Input Voltage	VI	- 0.3	–	VDD	V

NOTE: VSS = 0 Volt, VDD = 5.0 Volt

ELECTRICAL SPECIFICATIONS

ITEM	SYMBOL	CONDITION	STANDARD VALUE			UNIT
			MIN.	TYP.	MAX.	
Input Voltage	VDD	VDD = + 5V	4.7	5.0	5.3	V
		VDD = + 3V	2.7	3.0	5.3	V
Supply Current	IDD	VDD = 5V	–	1.2	3.0	mA
Recommended LC Driving Voltage for Normal Temp. Version Module	VDD - V0	- 20 °C	–	–	–	V
		0°C	4.2	4.8	5.1	
		25°C	3.8	4.2	4.6	
		50°C	3.6	4.0	4.4	
		70°C	–	–	–	
LED Forward Voltage	VF	25°C	–	4.2	4.6	V
LED Forward Current	IF	25°C Array	–	130	260	mA
		25°C Edge	–	20	40	
EL Power Supply Current	IEL	Vel = 110VAC:400Hz	–	–	5.0	mA

DISPLAY CHARACTER ADDRESS CODE:

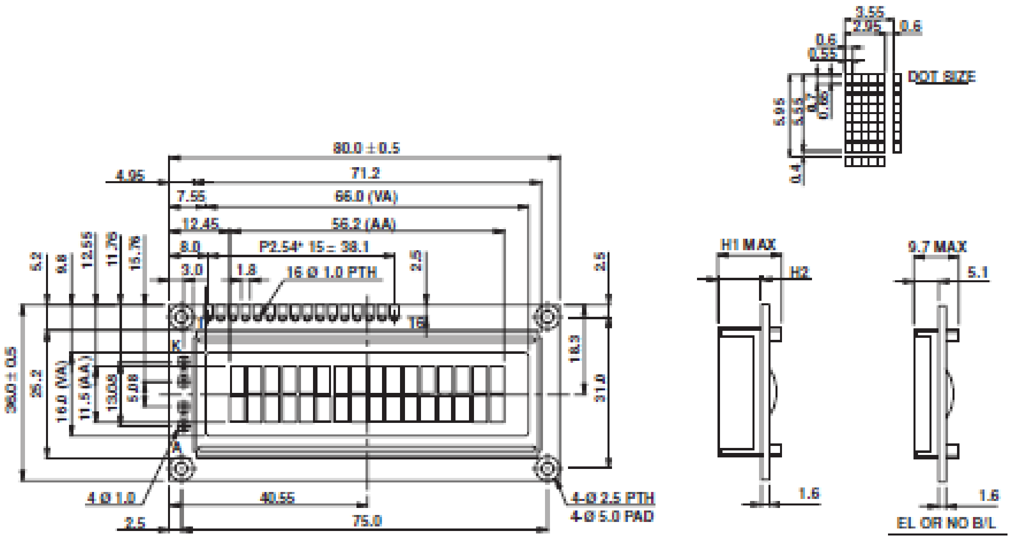
Display Position	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
DD RAM Address	00	01														0F
DD RAM Address	40	41														4F

LCD-016M002B

Vishay 16 x 2 Character LCD

PIN NUMBER	SYMBOL	FUNCTION
1	Vss	GND
2	Vdd	+ 3V or + 5V
3	Vo	Contrast Adjustment
4	RS	H/L Register Select Signal
5	R/$\overline{W}$	H/L Read/Write Signal
6	E	H → L Enable Signal
7	DB0	H/L Data Bus Line
8	DB1	H/L Data Bus Line
9	DB2	H/L Data Bus Line
10	DB3	H/L Data Bus Line
11	DB4	H/L Data Bus Line
12	DB5	H/L Data Bus Line
13	DB6	H/L Data Bus Line
14	DB7	H/L Data Bus Line
15	A/Vee	+ 4.2V for LED/Negative Voltage Output
16	K	Power Supply for B/L (OV)

DIMENSIONS in millimeters



LED - H/L B/L		
	HIGH	LOW
H1	13.2	12.1
H2	8.6	7.5

For Technical Questions, Contact: Displays@Vishay.com

Document Number: 37217
Revision 01-Oct-02

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Data sheet for regulators

National Semiconductor

September 2001

LM340/LM78XX Series
3-Terminal Positive Regulators

General Description

The LM140/LM340A/LM340/LM7800C monolithic 3-terminal positive voltage regulators employ internal current-limiting, thermal shutdown and safe-area compensation, making them essentially indestructible. If adequate heat sinking is provided, they can deliver over 1.0A output current. They are intended as fixed voltage regulators in a wide range of applications including local (on-card) regulation for elimination of noise and distribution problems associated with single-point regulation. In addition to use as fixed voltage regulators, these devices can be used with external components to obtain adjustable output voltages and currents.

Considerable effort was expended to make the entire series of regulators easy to use and minimize the number of external components. It is not necessary to bypass the output, although this does improve transient response. Input bypassing is needed only if the regulator is located far from the filter capacitor of the power supply.

The 5V, 12V, and 15V regulator options are available in the steel TO-3 power package. The LM340A/LM340/LM7800C series is available in the TO-220 plastic power package, and the LM340-5.0 is available in the SOT-223 package, as well as the LM340-5.0 and LM340-12 in the surface-mount TO-263 package.

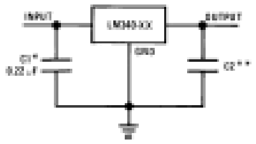
Features

- Complete specifications at 1A load
- Output voltage tolerances of ±2% at T_j = 25°C and ±4% over the temperature range (LM340A)
- Line regulation of 0.01% of V_{OUT}/V of ΔV_{IN} at 1A load (LM340A)
- Load regulation of 0.3% of V_{OUT}/A (LM340A)
- Internal thermal overload protection
- Internal short-circuit current limit
- Output transistor safe area protection
- P+ Product Enhancement tested

Device	Output Voltages	Packages
LM140	5, 12, 15	TO-3 (K)
LM340A/LM340	5, 12, 15	TO-3 (K), TO-220 (T), SOT-223 (MP), TO-263 (S) (5V and 12V only)
LM7800C	5, 8, 12, 15	TO-220 (T)

Typical Applications

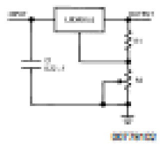
Fixed Output Regulator



*Required if the regulator is located far from the power supply filter.

**Although no output capacitor is needed for stability, it does help transient response. (If needed, use 0.1 μF, ceramic disc).

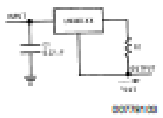
Adjustable Output Regulator



V_{OUT} = 5V + (5V/R1 + I_Q) R2 5V/R1 > 3 I_Q,

load regulation (L_r) ≈ [(R1 + R2)/R1] (L_r of LM340-5).

Current Regulator



$$I_{OUT} = \frac{V2\text{-}3}{R1} + I_Q$$

ΔI_Q = 1.3 mA over line and load changes.

Comparison between SOT-223 and D-Pak (TO-252) Packages

Scale 1:1

Absolute Maximum Ratings (Note 1)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/ Distributors for availability and specifications.

(Note 5)

DC Input Voltage	
All Devices except	
LM7824/LM7824C	35V
LM7824/LM7824C	40V
Internal Power Dissipation (Note 2)	Internally Limited
Maximum Junction Temperature	150°C
Storage Temperature Range	−65°C to +150°C
Lead Temperature (Soldering, 10 sec.)	
TO-3 Package (K)	300°C
TO-220 Package (T), TO-263 Package (S)	230°C
ESD Susceptibility (Note 3)	2 kV

Operating Conditions (Note 1)

Temperature Range (T_A) (Note 2)	
LM140A, LM140	−55°C to +125°C
LM340A, LM340, LM7805C, LM7812C, LM7815C, LM7808C	0°C to +125°C

LM340A Electrical Characteristics

I_{OUT} = 1A, −55°C ≤ T_J ≤ +150°C (LM140A), or 0°C ≤ T_J ≤ + 125°C (LM340A) unless otherwise specified (Note 4)

Symbol	Output Voltage		5V			12V			15V			Units
	Input Voltage (unless otherwise noted)		10V			19V			23V			
	Parameter	Conditions	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
V_O	Output Voltage	T_J = 25°C	4.9	5	5.1	11.75	12	12.25	14.7	15	15.3	V
		P_D ≤ 15W, 5 mA ≤ I_O ≤ 1A	4.8		5.2	11.5		12.5	14.4		15.6	V
		V_{MIN} ≤ V_{IN} ≤ V_{MAX}	(7.5 ≤ V_{IN} ≤ 20)			(14.8 ≤ V_{IN} ≤ 27)			(17.9 ≤ V_{IN} ≤ 30)			V
ΔV_O	Line Regulation	I_O = 500 mA			10			18			22	mV
		ΔV_{IN}	(7.5 ≤ V_{IN} ≤ 20)			(14.8 ≤ V_{IN} ≤ 27)			(17.9 ≤ V_{IN} ≤ 30)			V
		T_J = 25°C		3	10		4	18		4	22	mV
		ΔV_{IN}	(7.5 ≤ V_{IN} ≤ 20)			(14.5 ≤ V_{IN} ≤ 27)			(17.5 ≤ V_{IN} ≤ 30)			V
		T_J = 25°C			4			9			10	mV
		Over Temperature			12			30			30	mV
		ΔV_{IN}	(8 ≤ V_{IN} ≤ 12)			(16 ≤ V_{IN} ≤ 22)			(20 ≤ V_{IN} ≤ 26)			V
ΔV_O	Load Regulation	T_J = 25°C, 5 mA ≤ I_O ≤ 1.5A		10	25		12	32		12	35	mV
		T_J = 25°C, 250 mA ≤ I_O ≤ 750 mA			15			19			21	mV
		Over Temperature, 5 mA ≤ I_O ≤ 1A			25			60			75	mV
I_Q	Quiescent Current	T_J = 25°C			6			6			6	mA
		Over Temperature			6.5			6.5			6.5	mA
ΔI_Q	Quiescent Current Change	5 mA ≤ I_O ≤ 1A			0.5			0.5			0.5	mA
		T_J = 25°C, I_O = 1A			0.8			0.8			0.8	mA
		V_{MIN} ≤ V_{IN} ≤ V_{MAX}	(7.5 ≤ V_{IN} ≤ 20)			(14.8 ≤ V_{IN} ≤ 27)			(17.9 ≤ V_{IN} ≤ 30)			V
		I_O = 500 mA			0.8			0.8			0.8	mA
		V_{MIN} ≤ V_{IN} ≤ V_{MAX}	(8 ≤ V_{IN} ≤ 25)			(15 ≤ V_{IN} ≤ 30)			(17.9 ≤ V_{IN} ≤ 30)			V
V_N	Output Noise Voltage	T_A = 25°C, 10 Hz ≤ f ≤ 100 kHz		40			75			90		μV
$\frac{\Delta V_{IN}}{\Delta V_{OUT}}$	Ripple Rejection	T_J = 25°C, f = 120 Hz, I_O = 1A	68	80		61	72		60	70		dB
		or f = 120 Hz, I_O = 500 mA, Over Temperature, V_{MIN} ≤ V_{IN} ≤ V_{MAX}	68			61			60			dB
			(8 ≤ V_{IN} ≤ 18)			(15 ≤ V_{IN} ≤ 25)			(18.5 ≤ V_{IN} ≤ 28.5)			V
R_O	Dropout Voltage	T_J = 25°C, I_O = 1A		2.0			2.0			2.0		V
	Output Resistance	f = 1 kHz		8			18			19		mΩ

LM340A Electrical Characteristics (Continued)

I_{OUT} = 1A, −55°C ≤ T_J ≤ +150°C (LM140A), or 0°C ≤ T_J ≤ + 125°C (LM340A) unless otherwise specified (Note 4)

Symbol	Output Voltage		5V			12V			15V			Units
	Input Voltage (unless otherwise noted)		10V			19V			23V			
	Parameter	Conditions	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
	Short-Circuit Current	T_J = 25°C		2.1			1.5			1.2		A
	Peak Output Current	T_J = 25°C		2.4			2.4			2.4		A
	Average TC of V_O	Min, T_J = 0°C, I_O = 5 mA		−0.6			−1.5			−1.8		mV/°C
V_{IN}	Input Voltage Required to Maintain Line Regulation	T_J = 25°C	7.5			14.5			17.5			V

LM140 Electrical Characteristics (Note 4)

−55°C ≤ T_J ≤ +150°C unless otherwise specified

Symbol	Output Voltage			5V			12V			15V			Units
	Input Voltage (unless otherwise noted)			10V			19V			23V			
	Parameter	Conditions		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
V_O	Output Voltage	T_J = 25°C, 5 mA ≤ I_O ≤ 1A		4.8	5	5.2	11.5	12	12.5	14.4	15	15.6	V
		P_D ≤ 15W, 5 mA ≤ I_O ≤ 1A		4.75		5.25	11.4		12.6	14.25		15.75	V
		V_{MIN} ≤ V_{IN} ≤ V_{MAX}		(8 ≤ V_{IN} ≤ 20)			(15.5 ≤ V_{IN} ≤ 27)			(18.5 ≤ V_{IN} ≤ 30)			V
ΔV_O	Line Regulation	I_O = 500 mA	T_J = 25°C		3	50		4	120		4	150	mV
			ΔV_{IN}	(7 ≤ V_{IN} ≤ 25)			(14.5 ≤ V_{IN} ≤ 30)			(17.5 ≤ V_{IN} ≤ 30)			V
			−55°C ≤ T_J ≤ +150°C			50			120			150	mV
			ΔV_{IN}	(8 ≤ V_{IN} ≤ 20)			(15 ≤ V_{IN} ≤ 27)			(18.5 ≤ V_{IN} ≤ 30)			V
		I_O ≤ 1A	T_J = 25°C			50			120			150	mV
			ΔV_{IN}	(7.5 ≤ V_{IN} ≤ 20)			(14.6 ≤ V_{IN} ≤ 27)			(17.7 ≤ V_{IN} ≤ 30)			V
			−55°C ≤ T_J ≤ +150°C			25			60			75	mV
			ΔV_{IN}	(8 ≤ V_{IN} ≤ 12)			(16 ≤ V_{IN} ≤ 22)			(20 ≤ V_{IN} ≤ 26)			V
ΔV_O	Load Regulation	T_J = 25°C	5 mA ≤ I_O ≤ 1.5A		10	50		12	120		12	150	mV
			250 mA ≤ I_P ≤ 750 mA			25			60			75	mV
		−55°C ≤ T_J ≤ +150°C, 5 mA ≤ I_O ≤ 1A				50			120			150	mV
I_Q	Quiescent Current	I_O ≤ 1A	T_J = 25°C			6			6			6	mA
			−55°C ≤ T_J ≤ +150°C			7			7			7	mA
ΔI_Q	Quiescent Current Change	5 mA ≤ I_O ≤ 1A				0.5			0.5			0.5	mA
		T_J = 25°C, I_O ≤ 1A				0.8			0.8			0.8	mA
		V_{MIN} ≤ V_{IN} ≤ V_{MAX}		(8 ≤ V_{IN} ≤ 20)			(15 ≤ V_{IN} ≤ 27)			(18.5 ≤ V_{IN} ≤ 30)			V
		I_O = 500 mA, −55°C ≤ T_J ≤ +150°C				0.8			0.8			0.8	mA
		V_{MIN} ≤ V_{IN} ≤ V_{MAX}		(8 ≤ V_{IN} ≤ 25)			(15 ≤ V_{IN} ≤ 30)			(18.5 ≤ V_{IN} ≤ 30)			V
V_N	Output Noise Voltage	T_A = 25°C, 10 Hz ≤ f ≤ 100 kHz			40			75			90		μV

LM340/LM7800C Electrical Characteristics (Note 4) (Continued)

0°C ≤ T_J ≤ +125°C unless otherwise specified

Symbol	Output Voltage		5V			12V			15V			Units
	Input Voltage (unless otherwise noted)		10V			19V			23V			
	Parameter	Conditions	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
		$I_O \le 500$ mA, 0°C ≤ T_J ≤ +125°C			1.0			1.0			1.0	mA
		$V_{MIN} \le V_{IN} \le V_{MAX}$	($7 \le V_{IN} \le 25$)			($14.5 \le V_{IN} \le 30$)			($17.5 \le V_{IN} \le 30$)			V
V_N	Output Noise Voltage	T_A = 25°C, 10 Hz ≤ f ≤ 100 kHz		40			75			90		μV
$\frac{\Delta V_{IN}}{\Delta V_{OUT}}$	Ripple Rejection	f = 120 Hz, $I_O \le 1$A, T_J = 25°C	62	80		55	72		54	70		dB
		f = 120 Hz, or $I_O \le 500$ mA, 0°C ≤ T_J ≤ +125°C	62			55			54			dB
		$V_{MIN} \le V_{IN} \le V_{MAX}$	($8 \le V_{IN} \le 18$)			($15 \le V_{IN} \le 25$)			($18.5 \le V_{IN} \le 28.5$)			V
R_O	Dropout Voltage	T_J = 25°C, I_O = 1A		2.0			2.0			2.0		V
	Output Resistance	f = 1 kHz		8			18			19		mΩ
	Short-Circuit Current	T_J = 25°C		2.1			1.5			1.2		A
	Peak Output Current	T_J = 25°C		2.4			2.4			2.4		A
	Average TC of V_{OUT}	0°C ≤ T_J ≤ +125°C, I_O = 5 mA		−0.6			−1.5			−1.8		mV/°C
V_{IN}	Input Voltage Required to Maintain Line Regulation	T_J = 25°C, $I_O \le 1$A	7.5			14.6			17.7			V

Note 1: Absolute Maximum Ratings are limits beyond which damage to the device may occur. Operating Conditions are conditions under which the device functions but the specifications might not be guaranteed. For guaranteed specifications and test conditions see the Electrical Characteristics.

Note 2: The maximum allowable power dissipation at any ambient temperature is a function of the maximum junction temperature for operation (T_{JMAX} = 125°C or 150°C), the junction-to-ambient thermal resistance (θ_{JA}), and the ambient temperature (T_A). $P_{DMAX} = (T_{JMAX} - T_A)/\theta_{JA}$. If this dissipation is exceeded, the die temperature will rise above T_{JMAX} and the electrical specifications do not apply. If the die temperature rises above 150°C, the device will go into thermal shutdown. For the TO-3 package (K, KC), the junction-to-ambient thermal resistance (θ_{JA}) is 39°C/W. When using a heatsink, θ_{JA} is the sum of the 4°C/W junction-to-case thermal resistance (θ_{JC}) of the TO-3 package and the case-to-ambient thermal resistance of the heatsink. For the TO-220 package (T), θ_{JA} is 54°C/W and θ_{JC} is 4°C/W. If SOT-223 is used, the junction-to-ambient thermal resistance is 174°C/W and can be reduced by a heatsink (see Applications Hints on heatsinking).

If the TO-263 package is used, the thermal resistance can be reduced by increasing the PC board copper area thermally connected to the package: Using 0.5 square inches of copper area, θ_{JA} is 50°C/W; with 1 square inch of copper area, θ_{JA} is 37°C/W; and with 1.6 or more inches of copper area, θ_{JA} is 32°C/W.

Note 3: ESD rating is based on the human body model, 100 pF discharged through 1.5 kΩ.

Note 4: All characteristics are measured with a 0.22 μF capacitor from input to ground and a 0.1 μF capacitor from output to ground. All characteristics except noise voltage and ripple rejection ratio are measured using pulse techniques (t_w ≤ 10 ms, duty cycle ≤ 5%). Output voltage changes due to changes in internal temperature must be taken into account separately.

Note 5: A military RETS specification is available on request. At the time of printing, the military RETS specifications for the LM140AK-5.0/883, LM140AK-12/883, and LM140AK-15/883 complied with the min and max limits for the respective versions of the LM140A. At the time of printing, the military RETS specifications for the LM140K-5.0/883, LM140K-12/883, and LM140K-15/883 complied with the min and max limits for the respective versions of the LM140. The LM140H/883, LM140K/883, and LM140AK/883 may also be procured as a Standard Military Drawing.

LM7808C
Electrical Characteristics

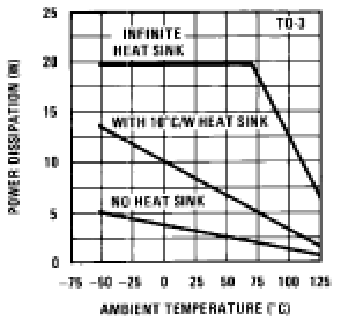
$0°C \le T_J \le +150°C$, $V_I = 14V$, $I_O = 500$ mA, $C_I = 0.33$ μF, $C_O = 0.1$ μF, unless otherwise specified

Symbol	Parameter		Conditions (Note 6)		LM7808C			Units
					Min	Typ	Max	
V_O	Output Voltage		$T_J = 25°C$		7.7	8.0	8.3	V
ΔV_O	Line Regulation		$T_J = 25°C$	$10.5V \le V_I \le 25V$		6.0	160	mV
				$11.0V \le V_I \le 17V$		2.0	80	
ΔV_O	Load Regulation		$T_J = 25°C$	$5.0\text{ mA} \le I_O \le 1.5A$		12	160	mV
				$250\text{ mA} \le I_O \le 750$ mA		4.0	80	
V_O	Output Voltage		$11.5V \le V_I \le 23V$, $5.0\text{ mA} \le I_O \le 1.0A$, $P \le 15W$		7.6		8.4	V
I_Q	Quiescent Current		$T_J = 25°C$			4.3	8.0	mA
ΔI_Q	Quiescent Current Change	With Line	$11.5V \le V_I \le 25V$				1.0	mA
		With Load	$5.0\text{ mA} \le I_O \le 1.0A$				0.5	
V_N	Noise		$T_A = 25°C$, $10\text{ Hz} \le f \le 100$ kHz			52		μV
$\Delta V_I/\Delta V_O$	Ripple Rejection		$f = 120$ Hz, $I_O = 350$ mA, $T_J = 25°C$		56	72		dB
V_{DO}	Dropout Voltage		$I_O = 1.0A$, $T_J = 25°C$			2.0		V
R_O	Output Resistance		$f = 1.0$ kHz			16		mΩ
I_{OS}	Output Short Circuit Current		$T_J = 25°C$, $V_I = 35V$			0.45		A
I_{PK}	Peak Output Current		$T_J = 25°C$			2.2		A
$\Delta V_O/\Delta T$	Average Temperature Coefficient of Output Voltage		$I_O = 5.0$ mA			0.8		mV/°C

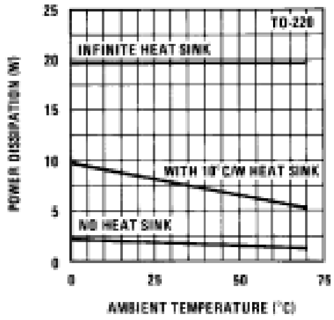
Note 6: All characteristics are measured with a 0.22 μF capacitor from input to ground and a 0.1 μF capacitor from output to ground. All characteristics except noise voltage and ripple rejection ratio are measured using pulse techniques ($t_w \le 10$ ms, duty cycle ≤ 5%). Output voltage changes due to changes in internal temperature must be taken into account separately.

Typical Performance Characteristics

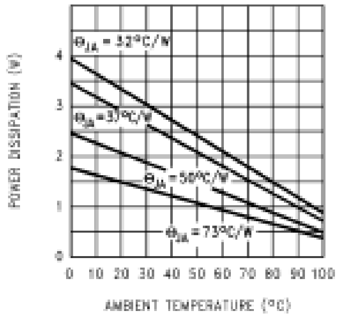
Maximum Average Power Dissipation



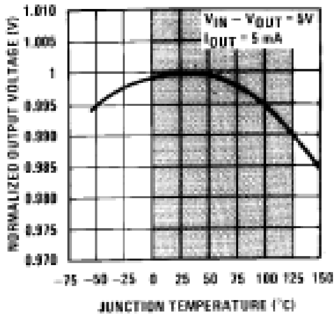
Maximum Average Power Dissipation



Maximum Power Dissipation (TO-263)
(See Note 2)

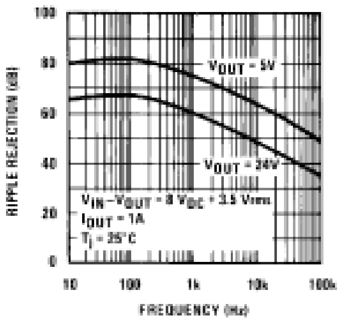


Output Voltage (Normalized to 1V at T_J = 25°C)

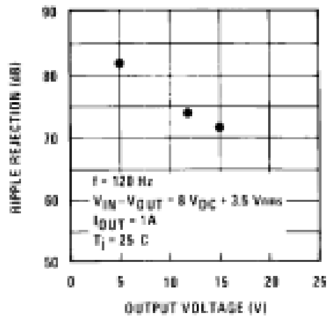


Note: Shaded area refers to LM340A/LM340, LM7805C, LM7812C and LM7815C.

Ripple Rejection

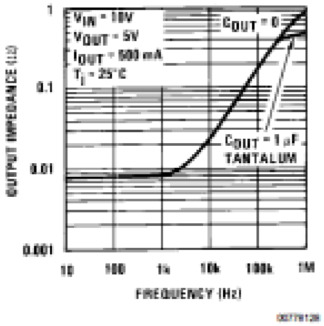


Ripple Rejection

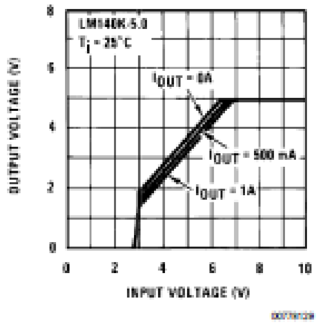


Typical Performance Characteristics (Continued)

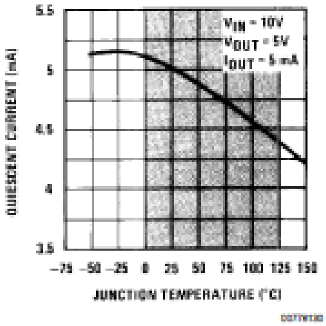
Output Impedance



Dropout Characteristics

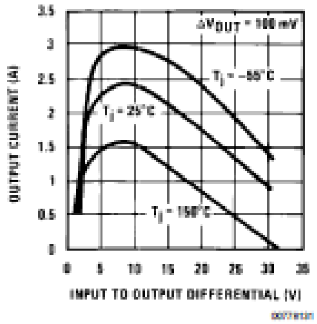


Quiescent Current

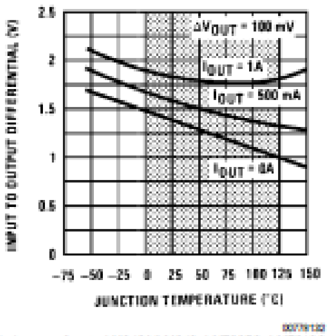


Note: Shaded area refers to LM340A/LM340, LM7805C, LM7812C and LM7815C.

Peak Output Current

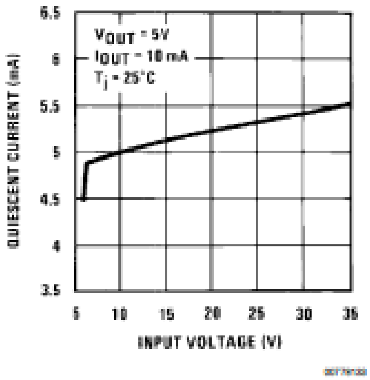


Dropout Voltage

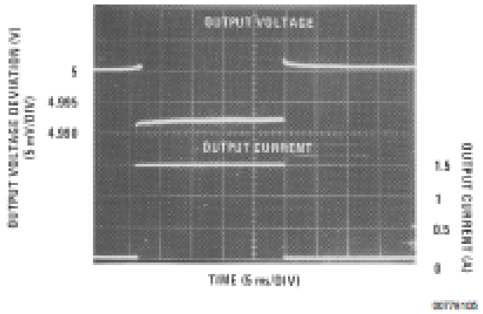


Note: Shaded area refers to LM340A/LM340, LM7805C, LM7812C and LM7815C.

Quiescent Current



Line Regulation
140AK-5.0, I_{OUT} = 1A, T_A = 25°C



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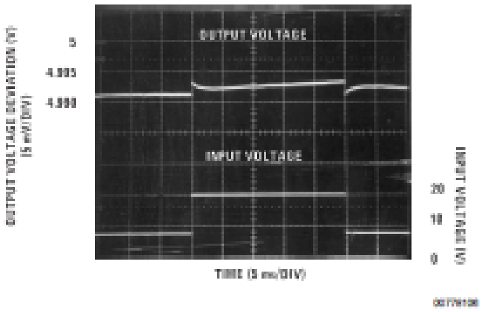
Line Regulation
140AK-5.0, V_{IN} = 10V, T_A = 25°C



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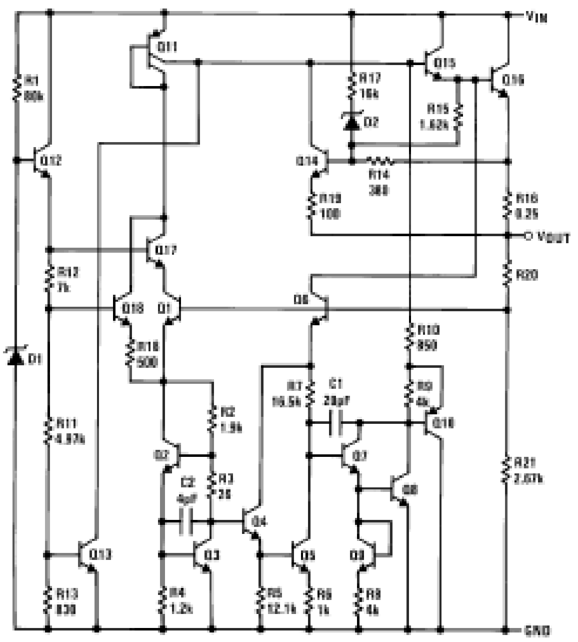
Equivalent Schematic



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Application Hints

The LM340/LM78XX series is designed with thermal protection, output short-circuit protection and output transistor safe area protection. However, as with *any* IC regulator, it becomes necessary to take precautions to assure that the regulator is not inadvertently damaged. The following describes possible misapplications and methods to prevent damage to the regulator.

Shorting the Regulator Input: When using large capacitors at the output of these regulators, a protection diode connected input to output (*Figure 1*) may be required if the input is shorted to ground. Without the protection diode, an input short will cause the input to rapidly approach ground potential, while the output remains near the initial V_{OUT} because of the stored charge in the large output capacitor. The capacitor will then discharge through a large internal input to output diode and parasitic transistors. If the energy released by the capacitor is large enough, this diode, low current metal and the regulator will be destroyed. The fast diode in *Figure 1* will shunt most of the capacitors discharge current around the regulator. Generally no protection diode is required for values of output capacitance ≤ 10 µF.

Raising the Output Voltage above the Input Voltage: Since the output of the device does not sink current, forcing the output high can cause damage to internal low current paths in a manner similar to that just described in the "Shorting the Regulator Input" section.

Application Hints (Continued)

Regulator Floating Ground (*Figure 2*): When the ground pin alone becomes disconnected, the output approaches the unregulated input, causing possible damage to other circuits connected to V_{OUT}. If ground is reconnected with power "ON", damage may also occur to the regulator. This fault is most likely to occur when plugging in regulators or modules with on card regulators into powered up sockets. Power should be turned off first, thermal limit ceases operating, or ground should be connected first if power must be left on.

Transient Voltages: If transients exceed the maximum rated input voltage of the device, or reach more than 0.8V below ground and have sufficient energy, they will damage the regulator. The solution is to use a large input capacitor, a series input breakdown diode, a choke, a transient suppressor or a combination of these.

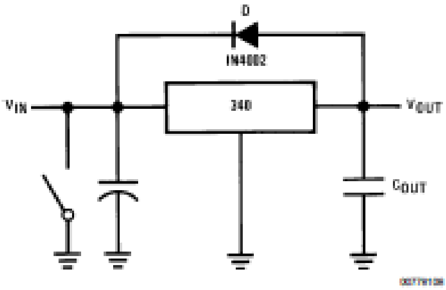


FIGURE 1. Input Short

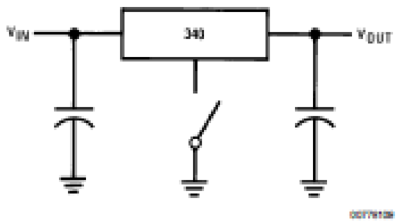


FIGURE 2. Regulator Floating Ground

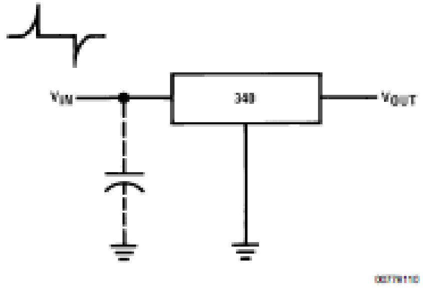


FIGURE 3. Transients

When a value for $\theta_{(H-A)}$ is found using the equation shown, a heatsink must be selected that has *a value that is less than or equal to this number.*

$\theta_{(H-A)}$ is specified numerically by the heatsink manufacturer in this catalog, or shown in a curve that plots temperature rise vs power dissipation for the heatsink.

HEATSINKING TO-263 AND SOT-223 PACKAGE PARTS

Both the TO-263 ("S") and SOT-223 ("MP") packages use a copper plane on the PCB and the PCB itself as a heatsink. To optimize the heat sinking ability of the plane and PCB, solder the tab of the plane.

shows for the TO-263 the measured values of $\theta_{(J-A)}$ for different copper area sizes using a typical PCB with 1 ounce copper *and no solder mask over the copper area used for heatsinking.*

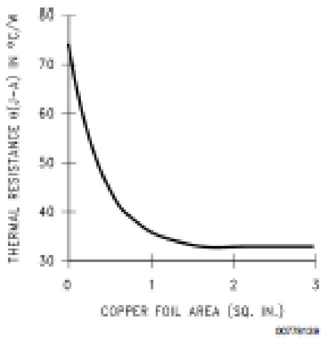


FIGURE 4. $\theta_{(J-A)}$ vs Copper (1 ounce) Area for the TO-263 Package

As shown in the figure, increasing the copper area beyond 1 square inch produces very little improvement. It should also be observed that the minimum value of $\theta_{(J-A)}$ for the TO-263 package mounted to a PCB is 32°C/W.

As a design aid, *Figure 5* shows the maximum allowable power dissipation compared to ambient temperature for the TO-263 device (assuming $\theta_{(J-A)}$ is 35°C/W and the maximum junction temperature is 125°C).

Application Hints (Continued)

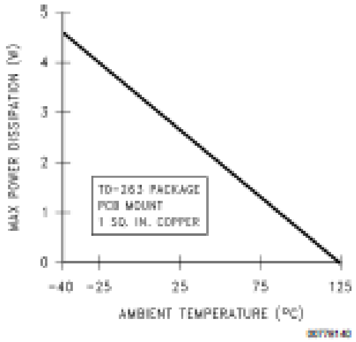


FIGURE 5. Maximum Power Dissipation vs T_{AMB} for the TO-263 Package

Figures 6, 7 show the information for the SOT-223 package. *Figure 6* assumes a $\theta_{(J-A)}$ of 74°C/W for 1 ounce copper and 51°C/W for 2 ounce copper and a maximum junction temperature of 125°C.

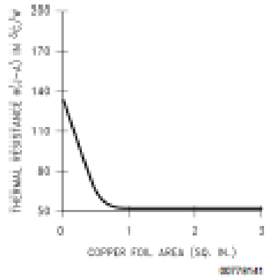
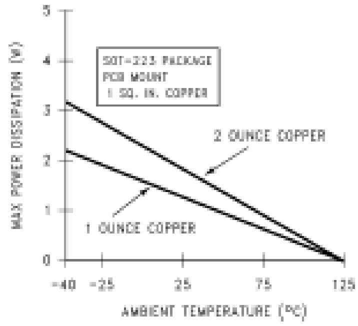


FIGURE 6. $\theta_{(J-A)}$ vs Copper (2 ounce) Area for the SOT-223 Package

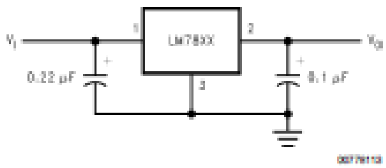


Please see AN-1028 for power enhancement techniques to be used with the SOT-223 package.

FIGURE 7. Maximum Power Dissipation vs T_{AMB} for the SOT-223 Package

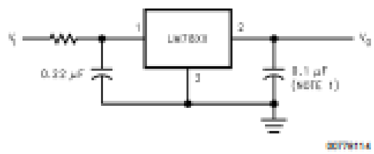
Typical Applications

Fixed Output Regulator

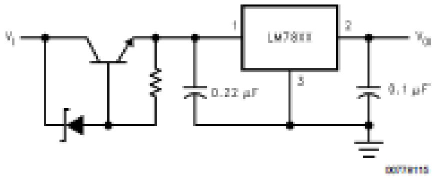


Note: Bypass capacitors are recommended for optimum stability and transient response, and should be located as close as possible to the regulator.

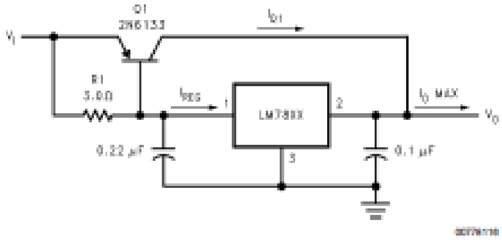
High Input Voltage Circuits



Typical Applications (Continued)



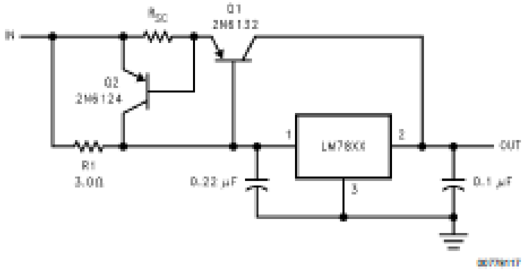
High Current Voltage Regulator



$$\beta(Q1) \geq \frac{I_{O\,Max}}{I_{REG\,Max}}$$

$$R1 = \frac{0.9}{I_{REG}} = \frac{\beta(Q1)\,V_{BE(Q1)}}{I_{REG\,Max}\,(\beta + 1) - I_{O\,Max}}$$

High Output Current, Short Circuit Protected

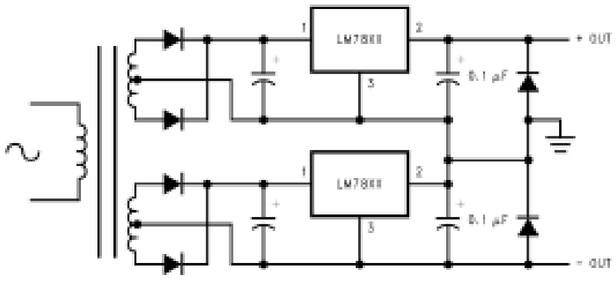


$$R_{SC} = \frac{0.8}{I_{SC}}$$

$$R1 = \frac{\beta V_{BE(Q1)}}{I_{REG\,Max}\,(\beta + 1) - I_{O\,Max}}$$

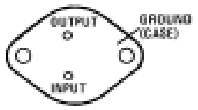
Typical Applications (Continued)

Positive and Negative Regulator



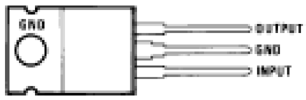
Connection Diagrams and Ordering Information

TO-3 Metal Can Package (K)



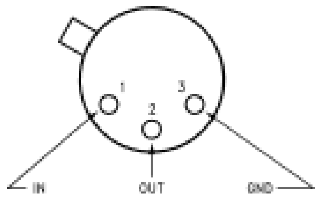
Bottom View
Steel Package Order Numbers:
LM140K-5.0 LM140K-12 LM140K-15
LM340K-12 LM340K-15
LM340K-5.0
See Package Number K02A
LM140K-5.0/883 LM140K-12/883 LM140K-15/883
See Package Number K02C

TO-220 Power Package (T)



Top View
Plastic Package Order Numbers:
LM340AT-5.0 LM340T-5.0
LM340T-12 LM340T-15
LM7805CT LM7812CT
LM7815CT LM7808CT
See Package Number T03B

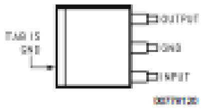
TO-39 Metal Can Package (H)



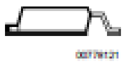
Top View
Metal Can Order Numbers†:
LM140H-5.0/883 LM140H-6.0/883
LM140H-8.0/883 LM140H-12/883
LM140H-15/883 LM140H-24/883
See Package Number H03A

Connection Diagrams and Ordering Information (Continued)

TO-263 Surface-Mount Package (S)



Top View



Side View

Surface-Mount Package Order Numbers:

LM340S-5.0 LM340S-12

See Package Number TS3B

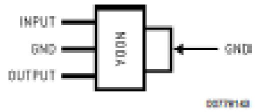
3-Lead SOT-223

(Front View)

Order Number LM340MP-5.0

Package Marked N00A

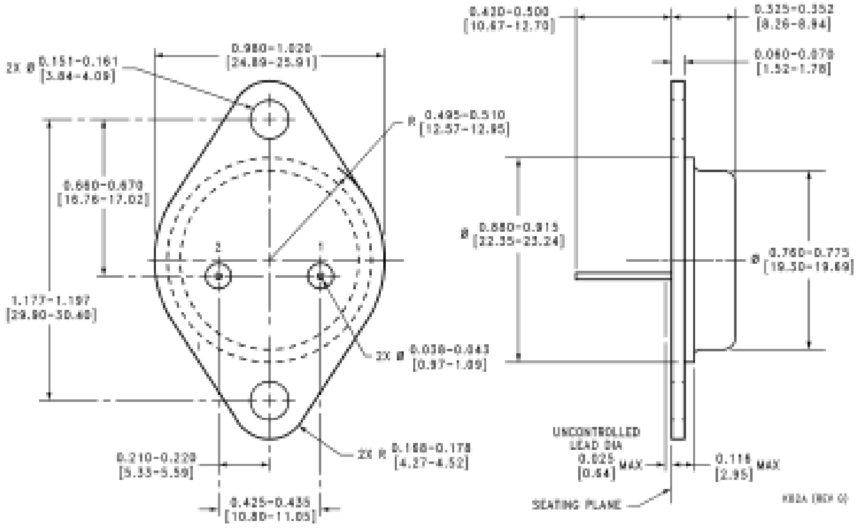
See Package Number MA04A



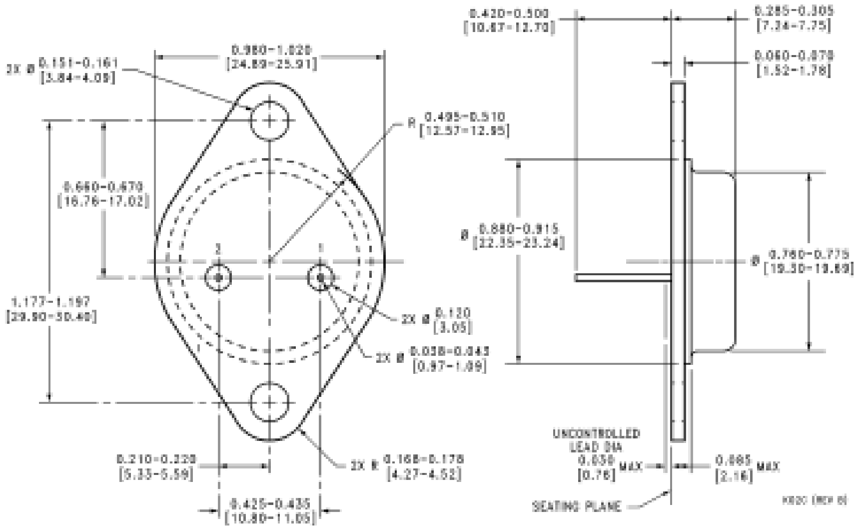
†The specifications for the LM140H/883 devices are not contained in this datasheet. If specifications for these devices are required, contact the National Semiconductor Sales Office/Distributors.

Physical Dimensions inches (millimeters)

unless otherwise noted

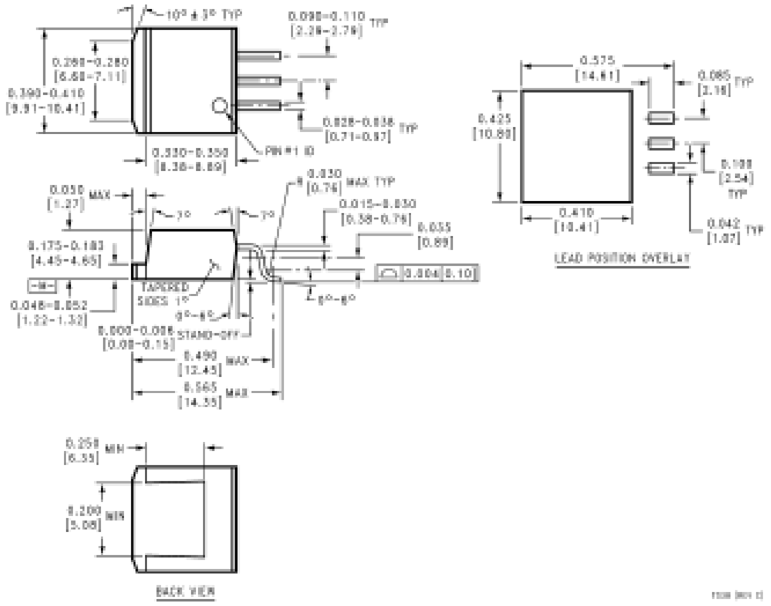


TO-3 Metal Can Package (K)
Order Number LM140K-5.0, LM340K-5.0, LM140K-12, LM340K-12, LM140K-15, LM340K-15, LM7805CK, LM7808CK, LM7815CK or LM7824CK
NS Package Number K02A



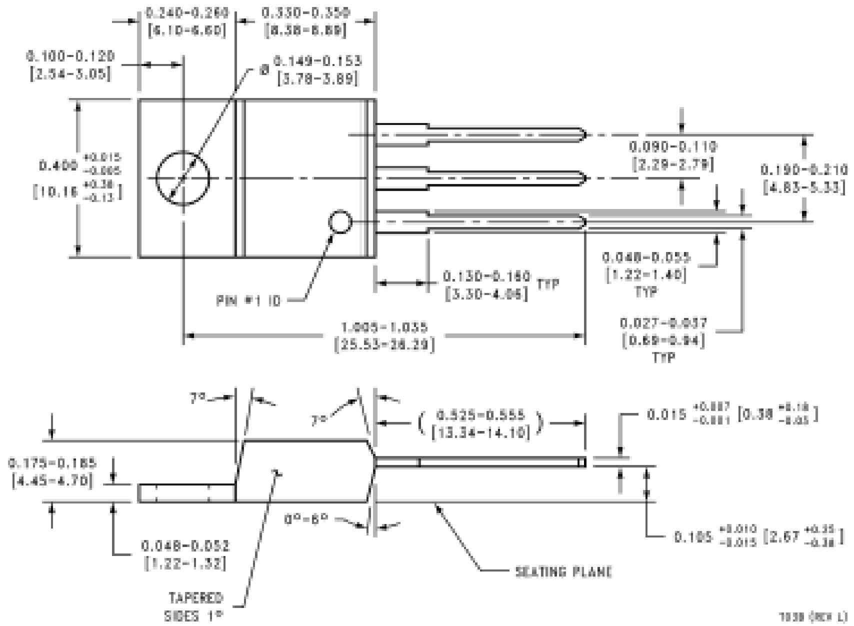
TO-3 Metal Can Package (K)
Mil-Aero Products
Order Number LM140K-5.0/883, LM140K-12/883, or LM140K-15/883
NS Package Number K02C

Physical Dimensions inches (millimeters) unless otherwise noted (Continued)



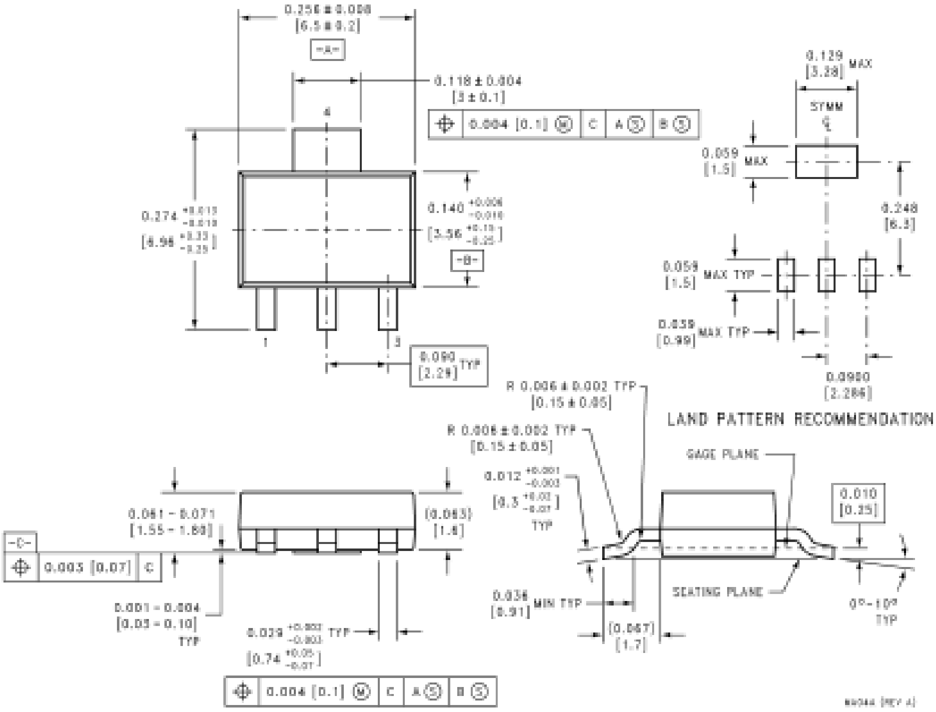
TO-263 Surface-Mount Package (S)
Order Number LM340S-5.0 or LM340S-12
NS Package Number TS3B

Physical Dimensions inches (millimeters) unless otherwise noted (Continued)



TO-220 Power Package (T)
Order Number LM340AT/LM340T-5.0, LM340AT/LM340T-12, LM340AT/LM340T-15, LM7805CT, LM7812CT, LM7815CT, LM7808CT, LM7808CT, LM7818CT or LM7824CT
NS Package Number T03B

Physical Dimensions inches (millimeters) unless otherwise noted (Continued)



3-Lead SOT-223 Package
Order Part Number LM340MP-5.0
NS Package Number MA04A

LIFE SUPPORT POLICY

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2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

National Semiconductor Corporation
Americas
Email: support@nsc.com

www.national.com

National Semiconductor Europe
Fax: +49 (0) 180-530 85 86
Email: europe.support@nsc.com
Deutsch Tel: +49 (0) 69 9508 6208
English Tel: +44 (0) 870 24 0 2171
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National Semiconductor Asia Pacific Customer Response Group
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Fax: 65-2504466
Email: ap.support@nsc.com

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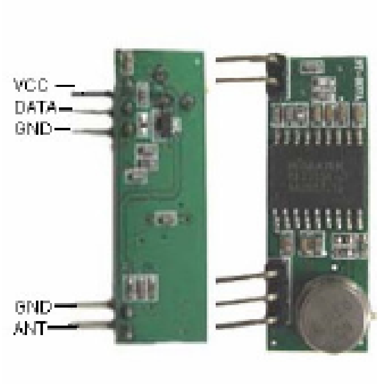
Data sheet for transmitter and receiver

Receiving module> Receiving Module without decoding:



Product Detail

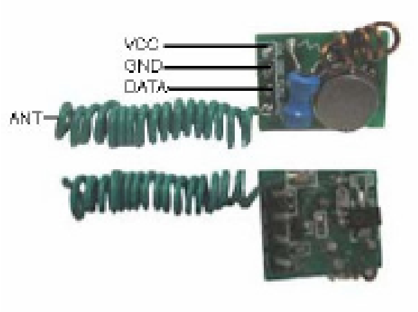
NT-R07A is adopting RF integrated circuit made in Taiwan with super heterodyne working mode and SAW resonance. Its features are stability and strong ability of anti-jamming. It is widely used at some spot of industrial control that has high requirement.

1. Applicable field:

a. Receiving for various digital signal at low velocity;
b. Industrial remote control, remote measurement and remote sensing;
c. Anti-theft alarm signal receiving and various remote controls for home-appliances.

2. Technical Specifications:

Working voltage	5.0VDC + 0.5V	Working current	≤5.5mA (5.0VDC)
Working Principle	Single chip superregeneration receiving	Working method	OOK/ASK
Working frequency	315MHz-433.92MHz,customized frequency is available	Bandwidth	2MHz (315MHz, having result from testing at lowing the sensitivity 3dBm
Sensitivity	Excel-100dBm (50Ω)	Transmitting velocity	<9.6Kbps (at 315MHz and -95dBm)
Output signal	TTL electric level signal entire transmission	Aerial length	24cm (315MHz, 18cm (433.92MHz)



Product Detail
Description: This transmitting module is adopting advanced RF technology and production techniques with sound wave resonance gadget (SAW) component for stabilizing frequency, high quality components, and having the features of small size, easy installation and simple operation. Additionally, this module has be modulated by advanced instruments, passed serious QC and processed by electricity-loaded high temperature aging.

Applicable field:

1. Transmission for the signals from anti-theft alarm and various digital signal of low velocity;
2. Industrial remote control, remote measurement and remote sensing;
3. The remote controls for various home appliances and intellectual toys.

Technical Specifications:

Working voltage	3V-12V	Working current	max≤95mA (12V), min≤2mA(3V)
Resonance mode	Sound wave resonance (SAW)	Modulation mode	OOK/ASK
Working frequency	315MHz-433.92MHz Customized frequency is available	Frequency error	+150kHz (max)
Transmission power	50mW (315MHz at 12V)	Velocity	≤10Kbps
Self-owned codes	negative		