SMART HOMES - RF COMMUNICATIONS

Team 5

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CONTENTS

LIST OF FIGURES

LIST OF TABLES

ABSTRACT

In our day to day life every appliance electrical or non-electrical is to be controlled. For example, an electrical fan needs a regulatory system to control its speed or a switch to turn it on or off as required. In such circumstances, person may not be available to control the appliance or device manually. These types of problems can be solved using remote control technique where the user can perform controlling as well as switching operation using a remote controller.

Remote controller is a device which controls another device or a system based on the input given to it. It generates a signal in accordance to its input and transmits it to the receiver system or device for control.

In our project, “Smart Homes using RF Communications” we are controlling a set of electrical appliances from a reasonable distance by setting up a remote-control system using RF. Here we have used RF modules to make wireless remote. Using this remote, we can control the appliances within the range of 300 meters. This project has two sections, one is transmitter section and the other is receiver section. When we press any key in the remote, the transmitter section generates the corresponding RF signal and this signal is received by the receiver section, hence it switches the corresponding appliance. Having the ability to control various appliances inside or outside of your house wirelessly is a huge convenience and can make your life much easier and stress free.

CHAPTER-I

INTRODUCTION TO SMART HOMES

INTRODUCTION TO SMART HOMES

1.1 Introduction:

Smart homes is a 4-channel radio frequency remote controller operated system with ability to control various appliances inside or outside of our house wirelessly in a huge convenient manner and can make our life much easier and fun.

In this project a remote has been designed for switching ON/OFF the home appliances like television, fan, lights, etc. It gives a lot of comfort to the user since we can operate it by staying at one place. We can control any of the appliances by using this remote within the range of 400 feet. This project consists of two sections, transmitter (remote) and receiver section. Whenever we press the key in the remote it generates the corresponding RF signals, and these signals are received by the receiver unit. ASK transmitter and receiver is used as transmitter and receiver. HT12E, HT12D encoders and decoders are used in this electronic circuit.

This circuit utilizes the RF module (Tx/Rx) for making a wireless remote, which could be used to drive an output from a distant place. RF module, as the name suggests, uses radio frequency to send signals. These signals are transmitted at a particular frequency and a baud rate. A receiver can receive these signals only if it is configured for that frequency.

A four channel encoder/decoder pair has also been used in this system. The input signals, at the transmitter side, are taken through four switches while the outputs are monitored on a set of four LEDs corresponding to each input switch. The circuit can be used for designing Remote Appliance Control system. The outputs from the receiver can drive corresponding relays connected to any household appliance.

1.2 Organization of the Thesis:

This project gives a wide-range discussion on Application and Implementation of 4 channel radiofrequency remote control. In view of the proposed thesis work explanation of theoretical aspects and algorithms used in this work are presented as per the sequence described below.

Chapter 1 describes a brief review of the objectives and goals of the work.

Chapter 2 discusses the existing technologies and the study of various technologies in detail.

Chapter 3 Literature survey of the project and its basics.

Chapter 4 describes the Block diagram of the project and its description. The construction and description of various modules used for the application are described in detail.

Chapter 5 explains the working procedure of the project and the tools uses to develop the design.

Chapter 6 presents the results, overall conclusions of the study and proposes possible improvements and directions of future research work.

CHAPTER-II

OBJECTIVE & AIM

OBJECTIVE & AIM

2.1 Objective of the project:

It is very common in designing any of application to find out the cheap and high quality products that cost a little and work for a period of long time. In this project for designing of a remote control system, the most important factors to be achieved in the design are the cost and simplicity of the circuit. The cost will be minimized by choosing cheap circuit components, low cost RF component.

The main objective of this project is to develop a wireless remote controller system for house hold appliances. The aim of our effort is to create a remote controller device which has the capability of controlling electrical appliances in specified areas.

In this project we just have to Press button on a remote control and have the capability to control 4 different electrical appliances which we desire.

In this project we show that how we control electrical appliances with the help of WIRELESS REMOTE with Radio Frequency Module.

2.2 Background of the Project:

In our project, “Smart Homes – RF communication” we are controlling a set of electrical appliances from a reasonable distance by setting up a remote-control system using RF.

CHAPTER-III

LITERATURE SURVEY

LITERATURE SURVEY

3.1 Introduction:

This chapter basically deals with an introductory part of the project by reviewing some of the basic concepts in control.

3.2 Basic concepts:

This part will discuss basic concepts related to control system. It will cover an overview about remote control, infrared transmission.

3.2.1 Remote control:

A remote control is an electronics device component used to control which most commonly a used with television set, DVD player etc. Originally, is used for operating another device wirelessly from a short line-of-sight distance. Nowadays, Remote control has continually evolved and advanced to include motion sensor, Wi-Fi, Bluetooth connectivity, GPS to enable capabilities and voice control.

Usually, remote controls are operating throughout two ways: IR and radio signals. The remote controls used to issue commands from a distance to any other consumer electronics device.

Remote controls are usually small wireless handheld model while it is rarely come as wired object specially nowadays we can say that there is no more such remotes. The user just press with an array of buttons for adjusting different setting settings ex. change channel, increase volume.

Most of the electrical device has its own control bottom but the remote is used only for easier usage and more convertibility. At the same time most of the remote controls communicate with their electric device through an infrared signal while a few via radio signals.

However the first remote controller was using ultrasonic tones in 1973.

The remote controls its electric device trough specific code which must be different from any other device code because if so there will be wrong reading for the signal which is usually happen during using of radio wave.

3.3 Other Control Methods:

This part of this chapter delves into the other ideas that are used to get similar result to this research which is controlling an electrical device and will explore their significant Strength and weakness.

CHAPTER- IV

DESIGN IMPLEMENTATION

DESIGN IMPLEMENTATION

4.1 Radio frequencies:

Radio frequency is a term that refers to alternating current (AC) having characteristics such that, if the current is input to an antenna, an electromagnetic (EM) field will be generated and suitable for wireless broadcasting or communications. When a RF current is supplied to an antenna, it gives rise to an electromagnetic field that propagates through space. This field is called as RF field. RF communication works by creating electromagnetic waves at a source and being able to pick up those electromagnetic waves at a particular destination. These electromagnetic waves travel through the air at near the speed of light

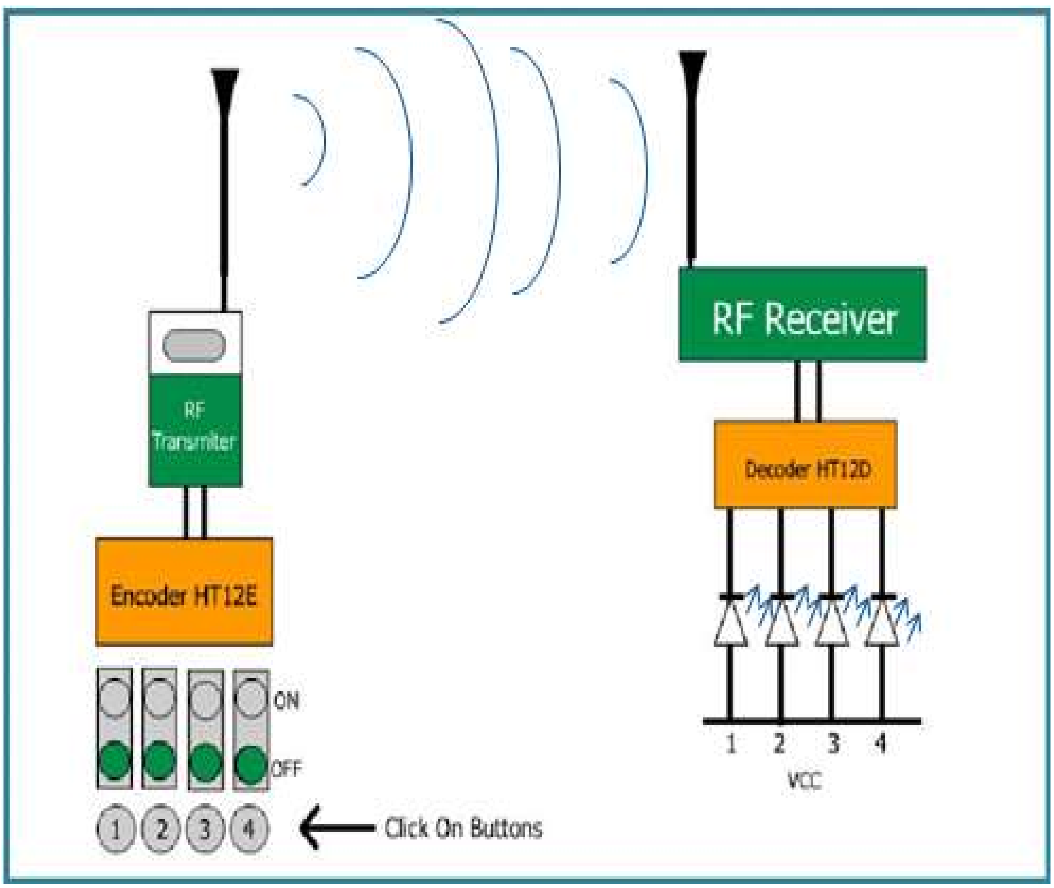


Fig 4.1: working of 4 channel RF remote controller

4.2 RF Remote Control block diagram:

This radio frequency (RF) transmission system employs Amplitude Shift Keying (ASK) with transmitter/receiver (Tx/Rx) pair operating at 434MHz. The transmitter module takes serial input and transmits these signals through RF. The transmitted signals are received by the receiver module placed away from the source of transmission. The system allows one way communication between two nodes, namely, transmission and reception. The RF module has been used in conjunction with a set of four channel encoder/decoder ICs. Here HT12E & HT12D have been used as encoder and decoder respectively. The encoder converts the parallel inputs (from the remote switches) into serial set of signals. These signals are serially transferred through RF to the reception point. The decoder is used after the RF receiver to decode the serial format and retrieve the original signals as outputs. These outputs can be observed on corresponding LEDs.

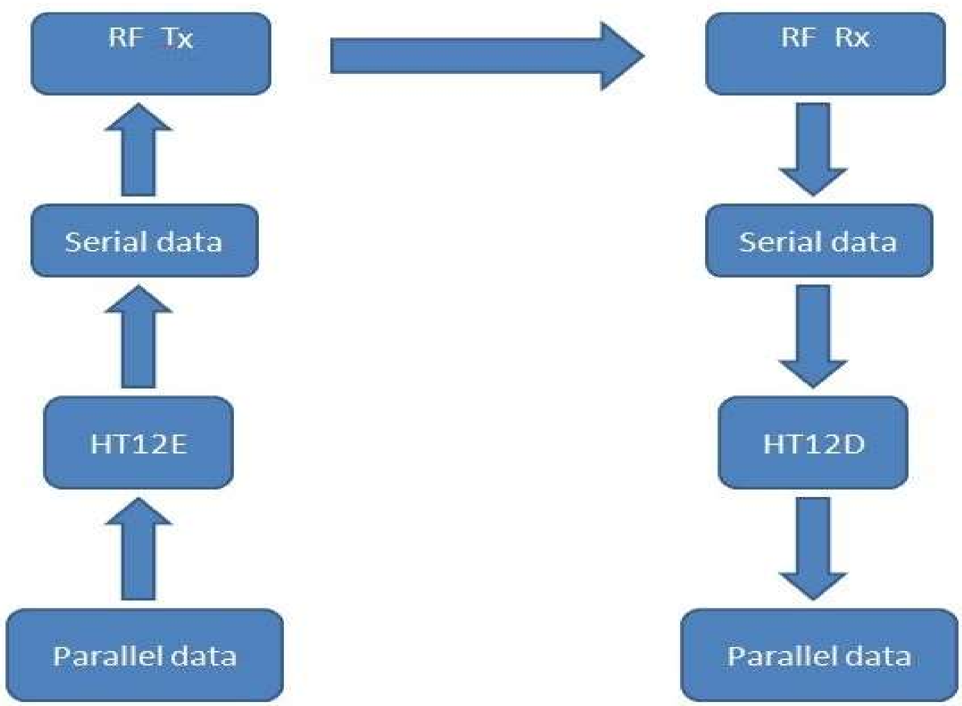


Fig 4.2: RF Remote Control block diagram

4.2.1 Remote Section:

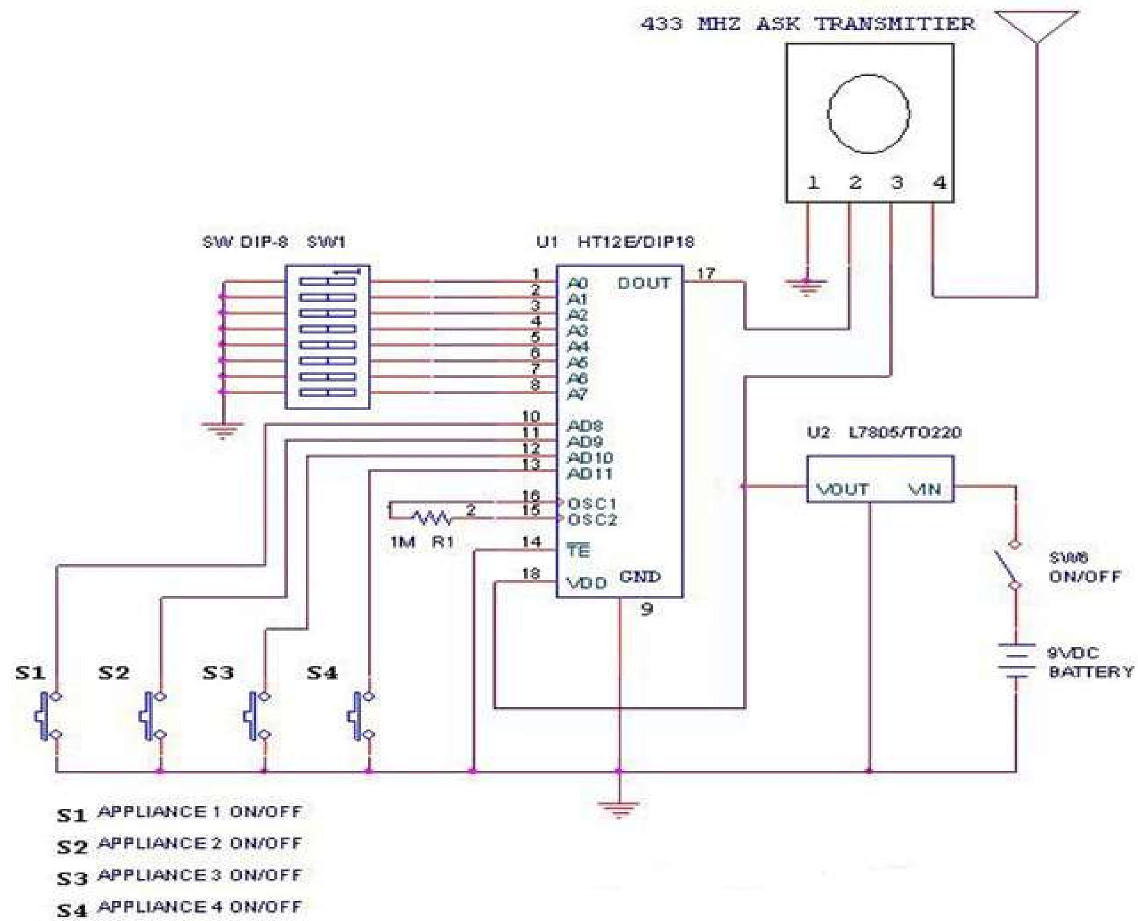


Fig 4.2.1: Remote section or transmitter

4.2.1.1 Remote description:

Remote section consist of an encoder (HT12E) and a ASK transmitter. The encoder generates 8 bit address and 4bit data. We can set the address by using the DIP switch connected in A0 to A7 (pin 1 to 8) encoder. If we set an address in the remote section, the same address will be required in the receiver section. So we will always set the same address in transmitter and receiver section. Whenever we press any key in the remote the encoder generates corresponding 4bit data and sends this data with 8bit address by using ASK transmitter.

The transmitting frequency is about 433MHz. The transmitter output is up to 8mW at 433.92 MHz with a range of approximately 400feet.

4.2.2 Receiver Section:

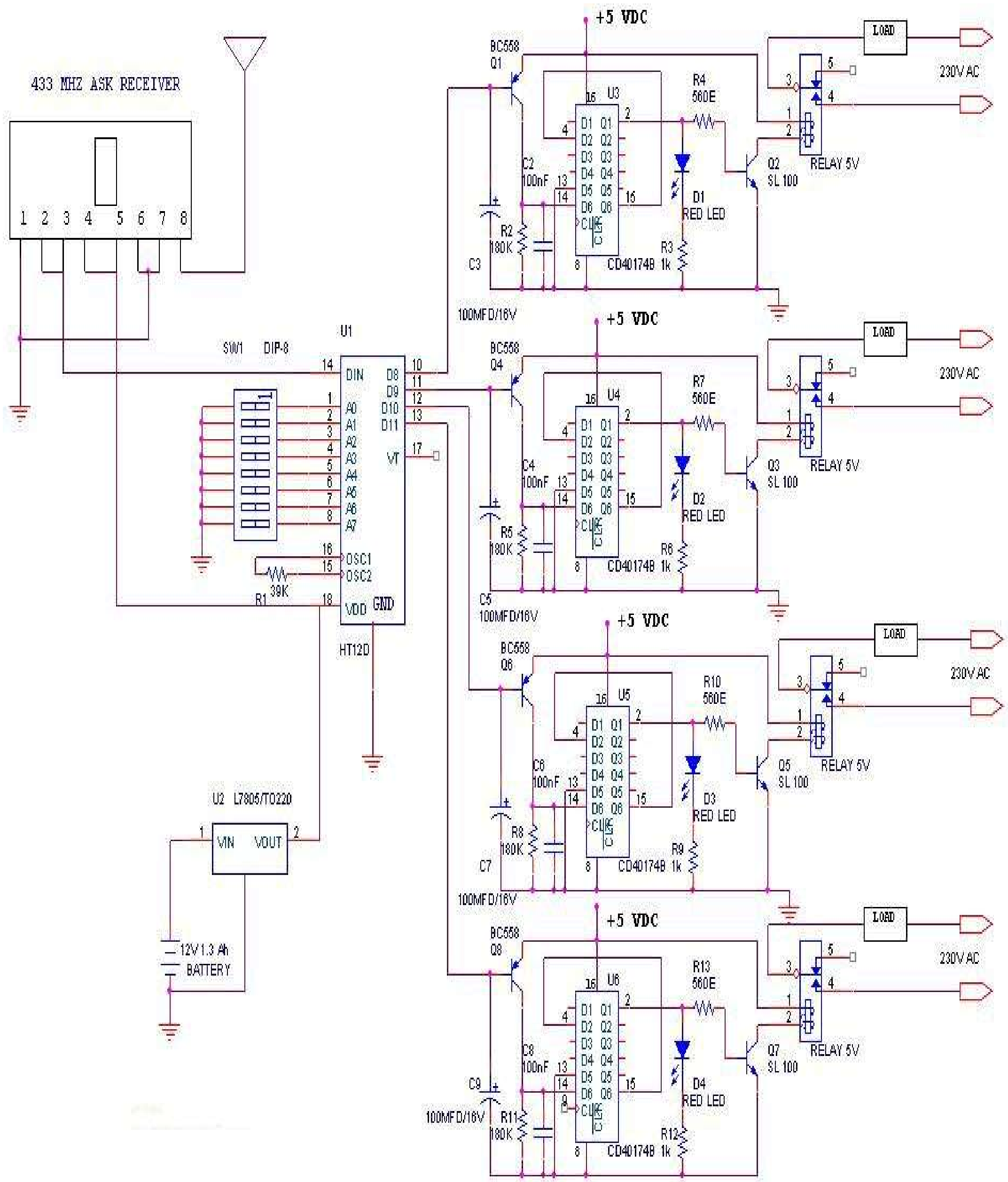


Fig 4.2.2: Receiver section

4.2.2.1 Receiver description:

At the reception part ASK receiver is kept as a receiver. The receiver also operates at 433.92MHz, and has a sensitivity of 3uV. The ASK receiver operates from 4.5 to 5.5 volts-DC, and has both linear and digital outputs. It receives the data from the transmitter. Then the decoder (HT12D) decodes the data and it will enable the corresponding output pins (pin 10, 11, 12, 13). Each output pins are connected to separate flip-flops.

A flip-flop or latch is a circuit that has two stable states and can be used to store state information. The circuit can be made to change state by signals applied to one or more control inputs and will have one or two outputs. The output of encoder will change the state of the flip-flop. So its output goes to set (high) from reset (low) state. This change makes a high signal in the output of the flip-flop. This output signal is not capable to drive a relay directly.

So we are using current driver, SL100 transistor act as the current driver. The appliance is connected to 230V AC through the relay and the appliance will start. The relay will be re-energized when the same switch is pressed in the remote. This is because we are pressing the same switch in the remote control. The output of the decoder again goes to high so this signal will again change the state of the flip-flop. So, the relay gets re-energized and the appliance goes to OFF state.

4.3 Hardware Components:

IC	HT12D	1
	CD 4017	4
	LM 7805	2
TRANSISTOR	BC 558	4
	SL 100	4
RESISTOR	180 K	4
	1 K	4
	560 E (Ω)	4
	39K	1
	1M	1
CAPACITOR	100nF	4
	100MFD/16V	4
LED	RED	4
DIP SWITCH		2
PUSH TO ON SWITCH		4
ASK TRANSMITER	433MHZ	1
ASK RECEIVER	433MHZ	1

Table 4.3: Hardware components

4.4 RF Section:

An RF (radio frequency) section is an electronic device used to transmit or receiving the radio signals between two devices. It is often desirable to communicate with another device wirelessly. This wireless communication may be accomplished through radio frequency (RF) communication. For much application the medium is RF since it does not require line of sight. RF communications incorporate a transmitter and a receiver section.

4.4.1 RF Transmitter:

Encoder IC (HT12E) receives parallel data in the form of address bits and control bits. The control signals from remote switches along with 8 address bits constitute a set of 12 parallel signals. The encoder HT12E encodes these parallel signals into serial bits.

Transmission is enabled by providing ground to pin14 which is active low. The control signals are given at pins 10-13 of HT12E. The serial data is fed to the RF transmitter through pin17 of HT12E.

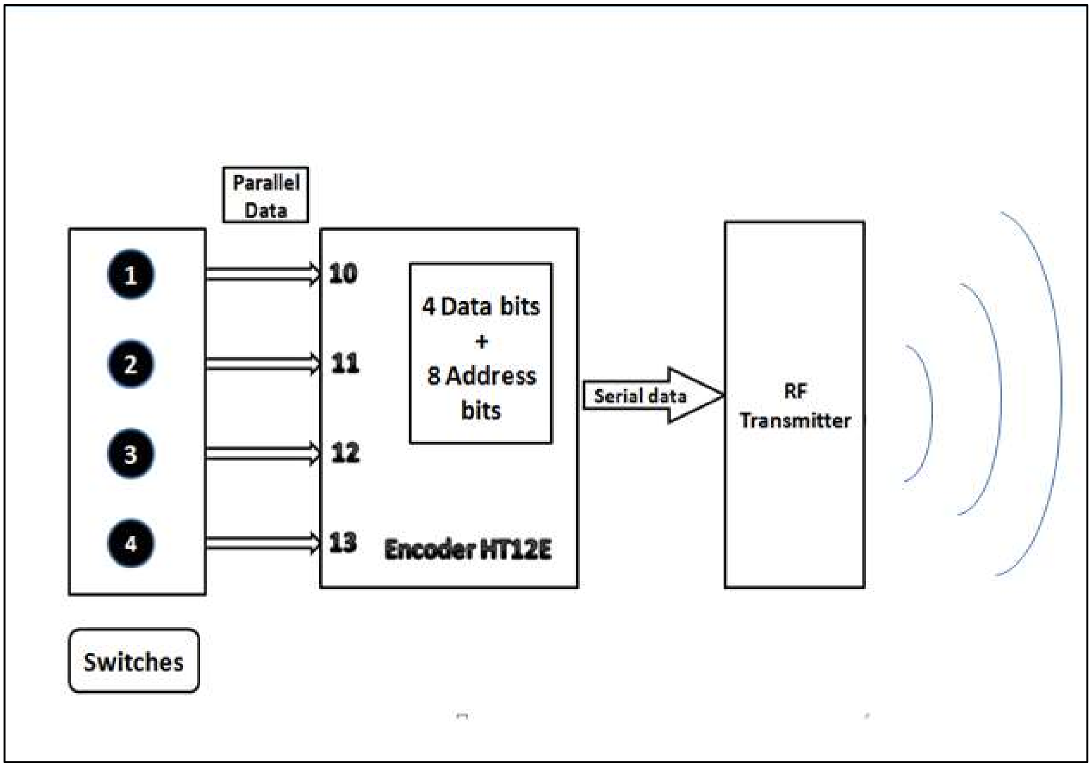


Fig 4.4.1: RF transmitter block diagram

An RF transmitter is capable of transmitting a radio wave and modulating that wave to carry data. RF transmitters are electronic devices that create continuously varying electric current, encode sine waves, and broadcast radio waves.

RF transmitters use oscillators to create sine waves, the simplest and smoothest form of continuously varying waves, which contain information such as audio and video. Modulators encode these sign waves and antennas broadcast them as radio signals. There are several ways to encode or modulate this information, including amplitude modulation (AM) and frequency modulation (FM). Radio techniques limit localized interference and noise. With direct sequence spread spectrum, signals are spread over a large band by multiplexing the signal with a code or signature that modulates each bit.

With frequency hopping spread spectrum, signals move through a narrow set of channels in a sequential, cyclical, and predetermined pattern. Selecting RF transmitters requires an understanding of modulation methods such as AM and FM. On-off key (OOK), the simplest form of modulation, consists of turning the signal on or off. Amplitude modulation (AM) causes the baseband signal to vary the amplitude or height of the carrier wave to create the desired information content. Frequency modulation (FM) causes the instantaneous frequency of a sine wave carrier to depart from the center frequency by an amount proportional to the instantaneous value of the modulating signal. Amplitude shift key (ASK) transmits data by varying the amplitude of the transmitted signal.

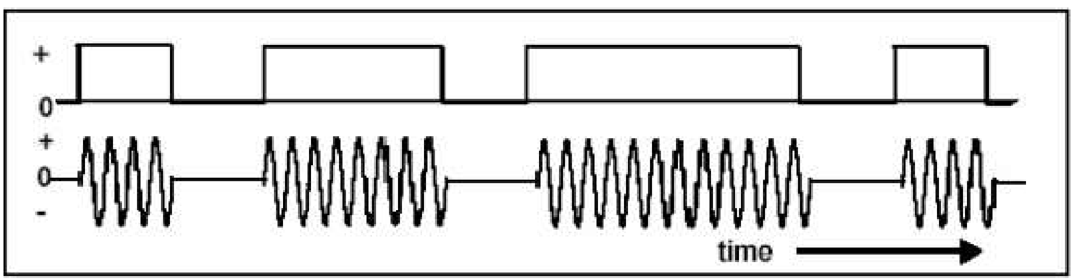


Fig 4.4.2: Amplitude shift keying (ASK)

Additional considerations when selecting RF transmitters include supply voltage, supply current, RF connectors, special features, and packaging. Some RF transmitters include visual or audible alarms or LED indicators that signal operating modes such as power on or reception. Other devices attach to coaxial cables or include a connector or port to which an antenna can be attached. Typically, RF transmitters that are rated for outdoor use feature a heavy-duty waterproof design. Devices with internal calibration and a frequency range switch are also available. RF transmitters are used in a variety of applications and industries.

Often, devices that are used with integrated circuits (ICs) incorporate surface mount technology (SMT), Through Hole Technology (THT), and flat pack.

In the telecommunications industry, RF transmitters are designed to fit in a metal rack that can be installed in a cabinet. RF transmitters are also used in radios and in electronic article surveillance systems (EAS) found in retail stores.

4.4.1.1 ASK Transmitter Module (ST-TX01-ASK (Saw Type))

General Description:

The ST-TX01-ASK is an ASK Hybrid transmitter module. ST-TX01-ASK are designed by the Saw Resonator, with an effective low cost, small size, and simple-to-use for designing.

Frequency Range	:	315/433.92 MHz
Supply Voltage	:	3~12V.
Output Power	:	4~16dBm.
Circuit shape	:	saw

Circuit:

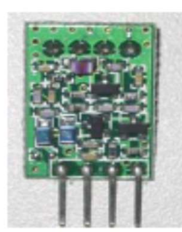


Fig 4.4.1.1: Circuit diagram of 434 MHz ASK TRANSMITTER

Pin diagram:

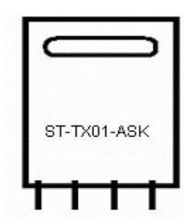


Fig: 4.4.1.2: pin diagram of ASK transmitter module

Pin description:

Pin Number	Function	Name
1	Ground (0V)	GND
2	Serial Data Input Pin	DATA
3	Supply Voltage (5V)	VCC
4	Antenna Output Pin	ANT

Table 4.4.1.1: pin description of ASK Transmitter module

Applications:

- Wireless security systems.
- Car Alarm systems.
- Remote controls.
- Sensor reporting.
- Automation systems.

4.4.2 RF Receiver:

RF receivers are electronic devices that separate radio signals from one another and convert specific signals into audio, video, or data formats. RF receivers use an antenna to receive transmitted radio signals and a tuner to separate a specific signal from all of the other signals that the antenna receives. Detectors or demodulators then extract information that was encoded before transmission. There are several ways to decode or demodulate this information, including amplitude modulation (AM) and frequency modulation (FM). Radio techniques limit localized interference and noise. With direct sequence spread spectrum, signals are spread over a large band by multiplexing the signal with a code or signature that modulates each bit.

With frequency hopping spread spectrum, signals move through a narrow set of channels in a sequential, cyclical, and predetermined pattern.

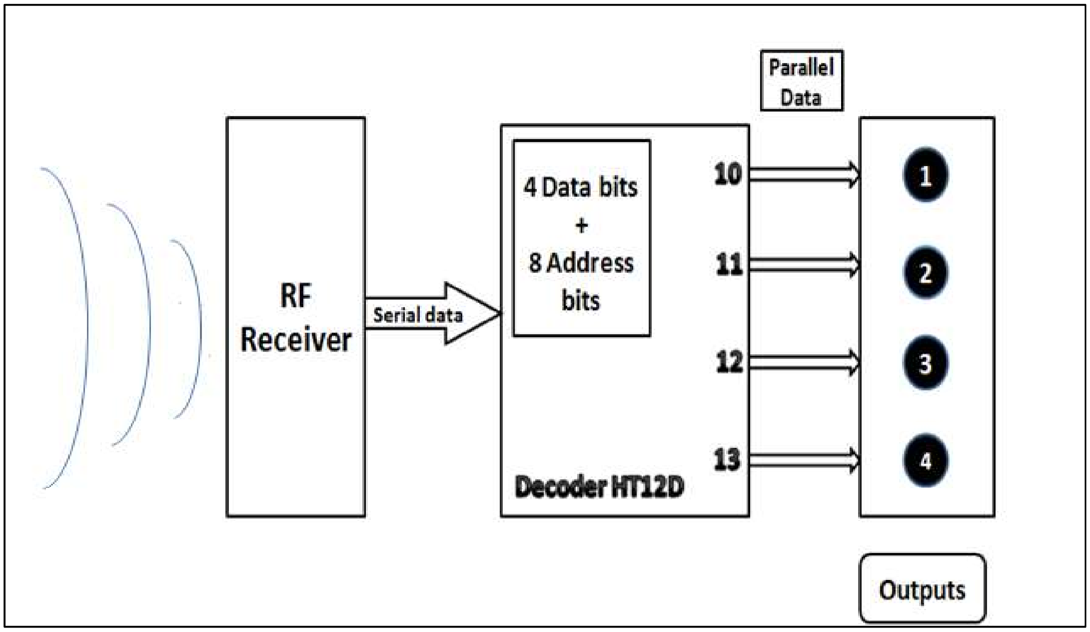


Fig 4.4.2: Receiver section

Upon receiving serial data from encoder IC (HT12E), transmits it wirelessly to the RF receiver. The receiver, upon receiving these signals, sends them to the decoder IC (HT12D) through pin2. The serial data is received at the data pin (DIN, pin14) of HT12D. The decoder then retrieves the original parallel format from the received serial data. When no signal is received at data pin of HT12D, it remains in standby mode and consumes very less current (less than 1µA) for a voltage of 5V. When signal is received by receiver, it is given to DIN pin (pin14) of HT12D.

On reception of signal, oscillator of HT12D gets activated. IC HT12D then decodes the serial data and checks the address bits three times. If these bits match with the local address pins (pins 1-8) of HT12D, then it puts the data bits on its data pins (pins 10-13) and makes the VT pin high. An LED is connected to VT pin (pin17) of the decoder. This LED works as an indicator to indicate a valid transmission. The corresponding output is thus generated at the data pins of decoder IC. A signal is sent by lowering any or all the pins 10-13 of HT12E and corresponding signal is received at receiver's end (at HT12D).

Address bits are configured by using the first 8 pins of both encoder and decoder ICs. To send a particular signal, address bits must be same at encoder and decoder ICs. By configuring the address bits properly, a single RF transmitter can also be used to control different RF receivers of same frequency.

To summarize, on each transmission, 12 bits of data is transmitted consisting of 8 address bits and 4 data bits. The signal is received at receiver's end which is then fed into decoder IC. If address bits get matched, decoder converts it into parallel data and the corresponding data bits get lowered which could be then used to drive the LEDs. The outputs from this system can either be used in negative logic or NOT gates (like 74LS04) can be incorporated at data pins.

4.4.2.1 Receiver description:

The RX04 is a low-power ASK Receiver IC which is fully compatible with the Mitel KESRX01 IC and is suitable for use in a variety of low power radio applications including remote keyless entry. The RX04 is based on a single-conversion, super-heterodyne receiver architecture and incorporates an entire phase-locked loop (PLL) for precise local oscillator generation. RF receivers vary in terms of performance specifications such as sensitivity, digital sampling rate, measurement resolution, operating frequency, and communication interface.

Functional description:

Fig 4.4.2.1: 434 MHz ASK RECEIVER

PIN DIAGRAM:

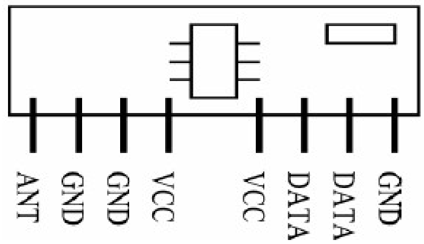


Fig 4.4.2.2: RF RECEIVER MODULE PIN DIAGRAM

Pin description:

Pin Number	Function	Name
1	Ground (0V)	GND
2	Serial Data Output Pin	DATA
3	Linear Output Pin; Not Connected	NC
4	Supply Voltage (5V)	VCC
5	Supply Voltage (5V)	VCC
6	Ground (0V)	GND
7	Ground (0V)	GND
8	Antenna Input Pin	ANT

Table 4.4.2.1: Receiver pin description

Applications:

- Car security system
- Wireless security systems
- Sensor reporting
- automation system
- Remote Keyless entry

Features:

- Low power consumption.
- Easy for application.
- On-Chip VCO with integrated PLL using crystal oscillator reference.
- Integrated IF and data filters.
- Operation temperature range: -10°C～＋60°C.
- Operation voltage: 5 Volts.
- Available frequency at: 315/434 MHz

4.5 ENCODER and DECODER Sections:

The Encoders are the devices which are used to encode the data where the Decoder is the device which is quite opposite to the Encoder. The Encoder used in the project are HT12E and Decoder is HT 12D.

4.5.1 HT12E as RF encoder, HT12D as RF decoder:

The radio frequency spectrum is filled with noise and other signals, especially those frequencies where unlicensed transmitter operation under FCC part 15 rules is allowed. When using a wireless remote control system it is desirable to have a way of filtering out or ignoring those unwanted signals to prevent false data from being received.

A simple way to accomplish this is to use an encoder IC at the transmitter and a decoder IC at the receiver. The encoder generates serial codes that are automatically sent three times and must be received at least twice before data is accepted as valid by the decoder circuit and the information is being decoded using decoder circuitry.

4.5.1.1 HT12E ENCODER:

Fig 4.5.1.1: HT12E Encoder

HT12E is an encoder integrated circuit of 2^{12} series of encoders. They are paired with 2^{12} series of decoders for use in remote control system applications. It is mainly used in interfacing RF and infrared circuits. The chosen pair of encoder/decoder should have same number of addresses and data format.

Simply put, HT12E converts the parallel inputs into serial output. It encodes the 12 bit parallel data into serial for transmission through an RF transmitter.

These 12 bits are divided into 8 address bits and 4 data bits.HT12E has a transmission enable pin which is active low. When a trigger signal is received on TE pin, the programmed addresses/data are transmitted together with the header bits via an RF or an infrared transmission medium. HT12E begins a 4-word transmission cycle upon receipt of a transmission enable. This cycle is repeated as long as TE is kept low. As soon as TE returns to high, the encoder output completes its final cycle and then stops.

Applications:

- Burglar alarm system
- Smoke and fire alarm system
- Garage door controllers
- Car door controllers
- Car alarm system
- Security system
- Cordless telephones
- Other remote control systems

Pin Diagram:

Fig 4.5.1.1.1: Pin Diagram

Pin Description:

Pin Number	Function	Name
1	8 BIT ADDRESS PINS FOR INPUT	A0
2		A1
3		A2
4		A3
5		A4
6		A5
7		A6
8		A7
9	GROUND (0V)	GROUND
10	4 BIT DATA/ADDRESS PINS FOR INPUT	D0
11		D1
12		D2
13		D3
14	TRANSMISSION ENABLE (ACTIVE LOW)	TE
15	OSCILLATOR OUTPUT	OSC 2
16	OSCILLATOR INPUT	OSC 1
17	VALID TRANSMISSION, ACTIVE HIGH	VT
18	SUPPLY VOLTAGE; 5V (2.4 – 12V)	Vcc

Table 4.5.1.1: Encoder pin description

Features:

- Operating voltage
- 2.4V~5V for the HT12A
- 2.4V~12V for the HT12E
- Low power and high noise immunity CMOS
- Low standby current: 0.1mA (type.) at VDD=5V
- HT12A with a 38kHz carrier for infrared transmission medium

4.5.1.2 HT12D DECODER:

Fig 4.5.1.2: HT12D Decoder

HT12D IC comes from HOLTEK Company. HT12D is a decoder integrated circuit that belongs to 2^{12} series of decoders. This series of decoders are mainly used for remote control system applications, like burglar alarm, car door controller, security system etc. It is mainly provided to interface RF and infrared circuits. They are paired with 2^{12} series of encoders. The chosen pair of encoder/decoder should have same number of addresses and data format.

In simple terms, HT12D converts the serial input into parallel outputs. It decodes the serial addresses and data received by, say, an RF receiver, into parallel data and sends them to output data pins. The serial input data is compared with the local addresses three times continuously. The input data code is decoded when no error or unmatched codes are found. A valid transmission in indicated by a high signal at VT pin.

Pin Diagram:

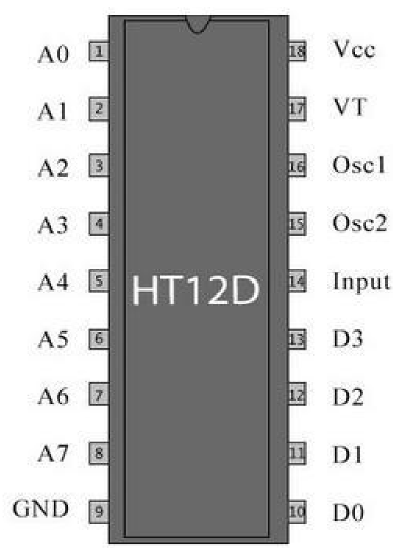


Fig 4.5.1.3: pin diagram

Pin Description:

Pin Number	Function	Name
1	8 BIT ADDRESS PINS FOR INPUT	A0
2		A1
3		A2
4		A3
5		A4
6		A5
7		A6
8		A7
9	GROUND (0V)	GROUND
10	4 BIT DATA/ADDRESS PINS FOR OUTPUT	D0
11		D1
12		D2
13		D3
14	SERIAL DATA INPUT	INPUT
15	OSCILLATOR OUTPUT	OSC 2
16	OSCILLATOR INPUT	OSC 1
17	VALID TRANSMISSION, ACTIVE HIGH	VT
18	SUPPLY VOLTAGE; 5V (2.4 – 12V)	Vcc

Table 4.5.1.2: HT12D Decoder pin description

Applications:

- Burglar alarm system
- Smoke and fire alarm system
- Garage door controllers
- Car door controllers
- Car alarm system
- Security system
- Cordless telephones, Other remote control systems

Features:

- Operating voltage: 2.4V~12V
- Low power and high noise immunity CMOS technology
- Low standby current
- Capable of decoding 12 bits of information
- Binary address setting
- Received codes are checked 3 times
- Address/Data number combination
- HT12D: 8 address bits and 4 data bits
- HT12F: 12 address bits only
- Built-in oscillator needs only 5% resistor
- Valid transmission indicator
- Easy interface with an RF or an infrared transmission medium
- Minimal external components
- Pair with HOLTEk 2^{12}series of encoders
- 18-pin DIP, 20-pin SOP package

RF MODULES (434MHz):

The RF module, as the name suggests, operates at Radio Frequency. The corresponding frequency range varies between 30 kHz & 300 GHz. In this RF system, the digital data is represented as variations in the amplitude of carrier wave. This kind of modulation is known as Amplitude Shift Keying (ASK).

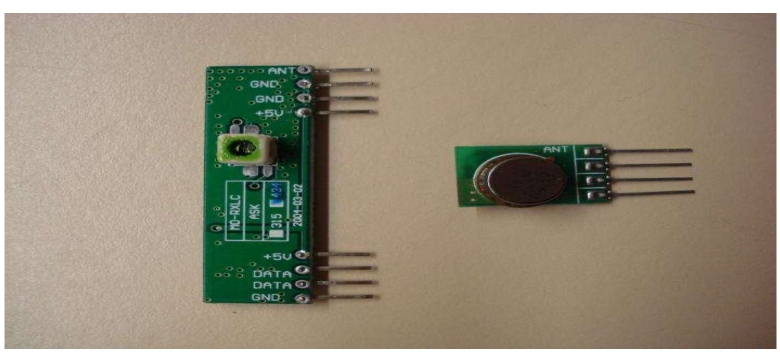


Fig 4.5.1.4: RF modules

Transmission through RF is better than IR (infrared) because of many reasons. Firstly, signals through RF can travel through larger distances making it suitable for long range applications. Also, while IR mostly operates in line-of-sight mode, RF signals can travel even when there is an obstruction between transmitter & receiver. Next, RF transmission is more strong and reliable than IR transmission. RF communication uses a specific frequency unlike IR signals which are affected by other IR emitting sources.

This RF module comprises of an RF Transmitter and an RF Receiver. The transmitter/receiver (Tx/Rx) pair operates at a frequency of 434 MHz An RF transmitter receives serial data and transmits it wirelessly through RF through its antenna connected at pin4. The transmission occurs at the rate of 1Kbps - 10Kbps.The transmitted data is received by an RF receiver operating at the same frequency as that of the transmitter.

The RF module is often used along with a pair of encoder/decoder. The encoder is used for encoding parallel data for transmission feed while reception is decoded by a decoder. HT12E-HT12D, HT640-HT648, etc. are some commonly used encoder/decoder pair ICs.

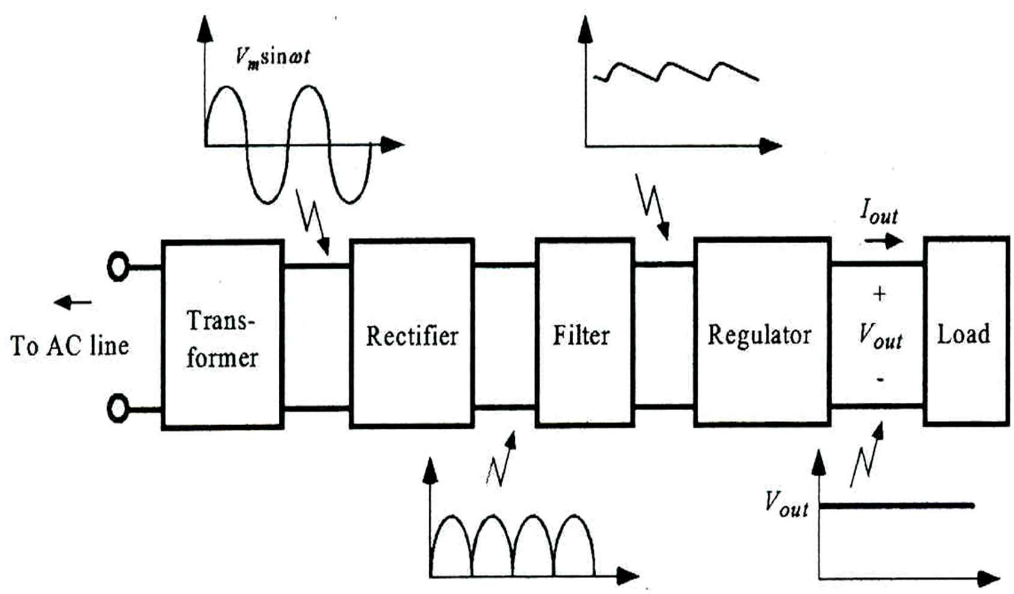
CHAPTER- V
HARDWARE IMPLEMENTATION

HARDWARE IMPLEMENTATION

5.1 Power supply:

The power supplies are designed to convert high voltage AC mains electricity to a suitable low voltage supply for electronic circuits and other devices. A power supply can by broken down into a series of blocks, each of which performs a particular function. The input to the circuit is applied from the regulated power supply. The A.C input i.e., 230V from the mains supply is step down by the transformer to 12V and is fed to a rectifier. The output obtained from the rectifier is a pulsating D.C voltage. So, in order to get a pure D.C voltage, the output voltage from the rectifier is fed to a filter to remove any A.C components present even after rectification. Now, this voltage is given to a voltage regulator to obtain a pure constant dc voltage

A D.C power supply which maintains the output voltage constant irrespective of an A.C mains fluctuations or load variations is known as "Regulated D.C Power Supply". For example a 5V regulated power supply system as shown below.



Components of a typical linear power supply

Fig 5.1: linear power supply

5.2 Transformer:

A transformer is an electrical device which is used to convert electrical power from one electrical circuit to another without change in frequency. Transformers convert AC electricity from one voltage to another with little loss of power. Usually, DC voltages are required to operate various electronic equipment and these voltages are 5V, 9V or 12V. But these voltages cannot be obtained directly. Thus, the A.C input available at the mains supply i.e., 230V is to be brought down to the required voltage level. This is done by a transformer. Step-up transformers increase in output voltage, step-down transformers decrease in output voltage. Thus, a step down transformer is employed to decrease the voltage to a required level. Transformers work only with AC and this is one of the reasons why mains electricity is AC. Most power supplies use a step-down transformer to reduce the dangerously high mains voltage to a safer low voltage.

Fig 5.2: Electrical transformer

The input coil is called the primary and the output coil is called the secondary. There is no electrical connection between the two coils; instead they are linked by an alternating magnetic field created in the soft-iron core of the transformer. The two lines in the middle of the circuit symbol represent the core.

Transformers waste very little power so the power out is (almost) equal to the power in. Note that as voltage is stepped down current is stepped up.

The ratio of the number of turns on each coil, called the turn's ratio, determines the ratio of the voltages. A step-down transformer has a large number of turns on its primary (input) coil which is connected to the high voltage mains supply, and a small number of turns on its secondary (output) coil to give a low output voltage.

- Turns ratio = $V_p/V_S = N_p/N_S$
- Power Out = Power In
- V_S X I_S = V_P X I_P
- Vp = primary (input) voltage.
- Np = Number of turns on primary coil.
- Ip = primary (input) current

5.3 Rectifier:

The output from the transformer is fed to the rectifier. It converts A.C. into pulsating D.C. The process of conversion a.c to d.c is called "rectification".

5.3.1 Types of rectifiers:

- Half wave Rectifier
- Full wave rectifier

1. Centre tap full wave rectifier.
2. Bridge type full wave rectifier or Bridge rectifier

Comparison of rectifier circuits:

Parameter	Type of Rectifier		
	Half wave	**Full wave**	**Bridge**
Number of diodes	1	2	4
PIV of diodes	Vm	2Vm	Vm
D.C output voltage	Vm/ π	2Vm/ π	2Vm/ π
Vdc, at no-load	0.318Vm	0.636Vm	0.636Vm
Ripple factor	1.21	0.482	0.482
Ripple Frequency	F	2f	2f
Rectification Efficiency	0.406	0.812	0.812
Transformer Utilization Factor(TUF)	0.287	0.693	0.812
RMS voltage Vrms	Vm/2	Vm/√2	Vm/√2

Table 5.3.1: comparison of rectifier circuits

Full-wave Rectifier:

From the above comparison we came to know that full wave bridge rectifier as more advantages than the other two rectifiers. So, in our project we are using full wave bridge rectifier circuit.

Bridge Rectifier:

A bridge rectifier makes use of four diodes in a bridge arrangement to achieve full-wave rectification. This is a widely used configuration, both with individual diodes wired as shown and with single component bridges where the diode bridge is wired internally.

A bridge rectifier makes use of four diodes in a bridge arrangement as shown in fig(a) to achieve full-wave rectification. Diodes D1,D2,D3 and D4 with resistor in the middle. This is a widely used configuration, both with individual diodes wired as shown and with single component bridges where the diode bridge is wired internally.

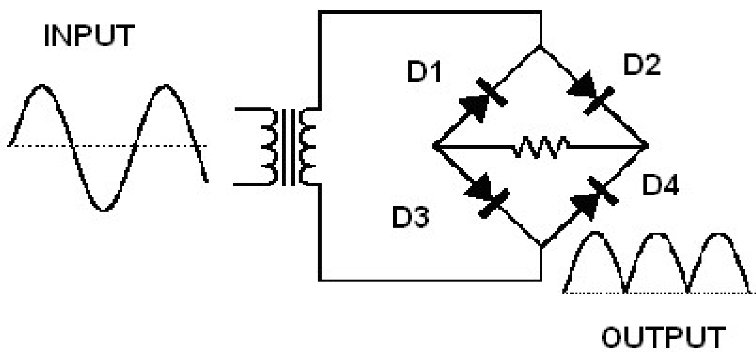


Fig 5.3.1.2: bridge rectifier

Operation:

During positive half cycle of secondary, the diodes D2 and D3 are in forward biased while D1 and D4 are in reverse biased as shown in the fig(b). The current flow direction is shown in the fig (b) with dotted arrows.

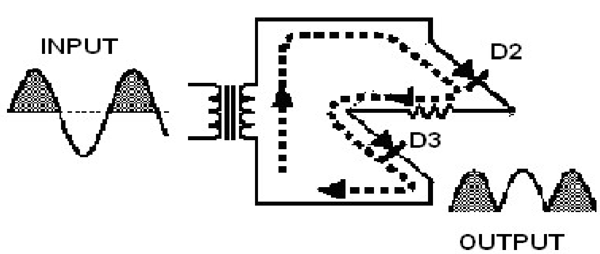


Fig 5.3.1.3: positive half cycle of bridge rectifier

During negative half cycle of secondary voltage, the diodes D1 and D4 are in forward biased while D2 and D3 are in reverse biased as shown in the fig(c).

The current flow direction is shown in the fig (c) with dotted arrows.

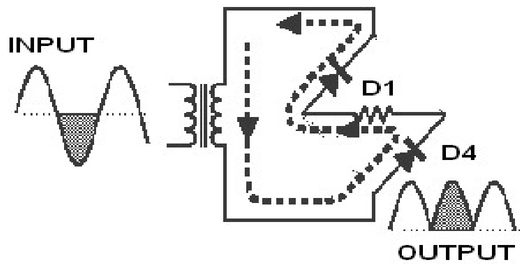


Fig 5.3.1.4: Negative half cycle of bridge rectifier

5.4 Filter:

A Filter is a device which removes the a.c component of rectifier output but allows the d.c component to reach the load. Capacitive filter is used in this project. It removes the ripples from the output of rectifier and smoothens the D.C. Output received from this filter is constant until the mains voltage and load is maintained constant. However, if either of the two is varied, D.C. voltage received at this point changes. Therefore a regulator is applied at the output stage.

Capacitor Filter:

We have seen that the ripple content in the rectified output of half wave rectifier is 121% or that of full-wave or bridge rectifier or bridge rectifier is 48% such high percentages of ripples is not acceptable for most of the applications. Ripples can be removed by one of the following methods of filtering.

(a) A capacitor, in parallel to the load, provides an easier by –pass for the ripples voltage though it due to low impedance. At ripple frequency and leave the d.c.to appears the load.

(b) An inductor, in series with the load, prevents the passage of the ripple current (due to high impedance at ripple frequency) while allowing the d.c (due to low resistance to d.c).

(c) Various combinations of capacitor and inductor, such as L-section filter π section filter, multiple section filter etc. which make use of both the properties mentioned in (a) and (b) above. Two cases of capacitor filter, one applied on half wave rectifier and another with full wave rectifier.

Filtering is performed by a large value electrolytic capacitor connected across the DC supply to act as a reservoir, supplying current to the output when the varying DC voltage from the rectifier is falling. The capacitor charges quickly near the peak of the varying DC, and then discharges as it supplies current to the output.

Filtering significantly increases the average DC voltage to almost the peak value (1.4 × RMS value).

To calculate the value of capacitor(C),

$$C = \frac{1}{4}*\sqrt{3}*f*r*Rl$$

Where,

f = supply frequency.

r = ripple factor.

Rl = load resistance.

Note:

In our circuit we are using 1000µF. Hence large value of capacitor is placed to reduce ripples and to improve the DC component.

5.5 Regulator:

As the name itself implies, it regulates the input applied to it. A voltage regulator is an electrical regulator designed to automatically maintain a constant voltage level. Voltage regulator ICs is available with fixed (typically 5, 12 and 15V) or variable output voltages. The maximum current they can pass also rates them. Negative voltage regulators are available, mainly for use in dual supplies. Most regulators include some automatic protection from excessive current ('overload protection') and overheating ('thermal protection').

Many of the fixed voltage regulator ICs have 3 leads and look like power transistors, such as the 7805 +5V 1A regulator shown on the right.

The LM7805 is simple to use. You simply connect the positive lead of your unregulated DC power supply (anything from 9VDC to 24VDC) to the Input pin, connect the negative lead to the Common pin and then when you turn on the power, you get a 5 volt supply from the output pin.

Fig 5.5: A Three Terminal Voltage Regulator

78XX:

The Bay Linear LM78XX is integrated linear positive regulator with three terminals. The LM78XX offer several fixed output voltages making them useful in wide range of applications. When used as a zener diode/resistor combination replacement, the LM78XX usually results in an effective output impedance improvement of two orders of magnitude, lower quiescent current. The LM78XX is available in the TO-252, TO-220 & TO-263packages.

Features:

- Output Current of 1.5A
- Output Voltage Tolerance of 5%
- Internal thermal overload protection
- Internal Short-Circuit Limited
- No External Component
- Output Voltage 5.0V, 6V, 8V, 9V, 10V,12V, 15V, 18V, 24V
- Offer in plastic TO-252, TO-220 & TO-263
- Direct Replacement for LM78XX

5.6 RELAY:

Relays can be used for switching as well as protection application. A relay is used to switch a circuit such that current through it can be diverted from present circuit to another. This switching operation can be performed either manually or automatically. Manual operation for switching a relay is performed through push buttons and other conventional switches.

Protective relays are used to ensure the smooth operation of any power system such that they isolate the particular circuit or generate the alarm whenever parameters like voltage or current exceeds their limits. Therefore the principal function of the relay is to make or break the circuit in switching and protection applications. A variety class of relays is found in several applications. This article gives you a brief idea on the electromechanical relay and also different types of relays.

Single Pole Double Throw SPDT relay is quite useful in certain applications because of its internal configuration. It has one common terminal and 2 contacts in 2 different configurations: one can be Normally Closed and the other one is opened or it can be Normally Open and the other one closed. So basically you can see the SPDT relay as a way of switching between 2 circuits: when there is no voltage applied to the coil one circuit “receives” current, the other one doesn’t and when the coil gets energized the opposite is happening.

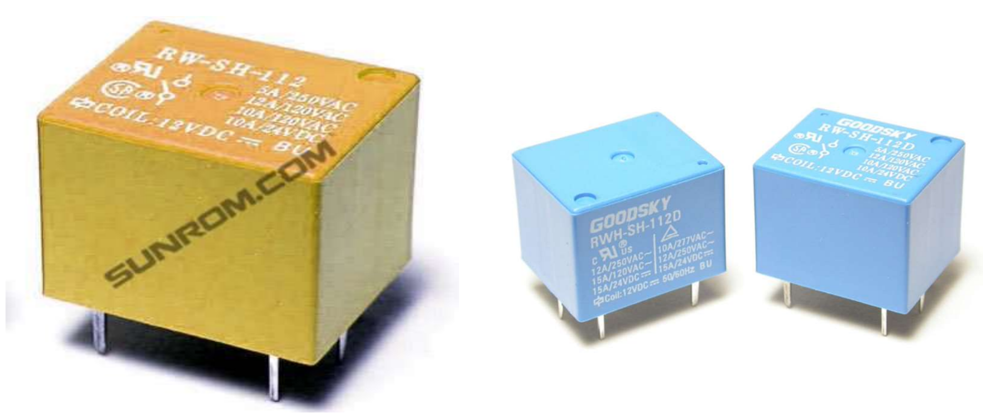


Fig 5.6: relay

Relay Operation:

We have given attracted type electromagnetic type relay. In any type of electromechanical relay of the relay, the major components are coil, armature and contacts. A piece of wire is wound around a magnetic core so it forms an electromagnet. When the supply is given to this coil, it becomes energized and produces an electromagnetic field.

An armature is a movable part and its main function is to open or close the contacts. It is attached with a spring so that under normal working condition this armature comes back to its original position. And the contacts are the conducting parts which connects the load and source circuits.

Under De-energized Condition:

When the power is not supplied to the relay coil, there is no magnetic flux production and hence the armature is in stationary position. Therefore, both the contacts are remains untouched and there exists a small air gap between these contacts. In other words, NC and COM contacts are get in touch with each other when the coil is de-energized.

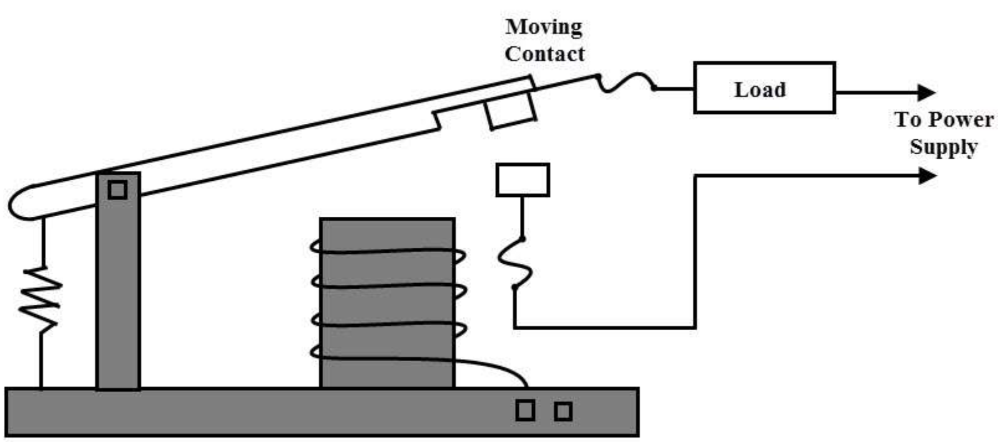


Fig 5.6.1: De-energized condition

Under Energized Condition:

If the coil is supplied by the source, the coil of the relay gets energized and produces a magnetic flux proportional to the current flowing through it. This magnetic field causes to attract the armature towards the electromagnet and hence both moving and fixed contacts are come closer to each other as shown in figure. In case of NO, NC and COM terminals (not shown in figure), both NO and COM terminals are get contact when the relay get energized while NC contact remains floating.

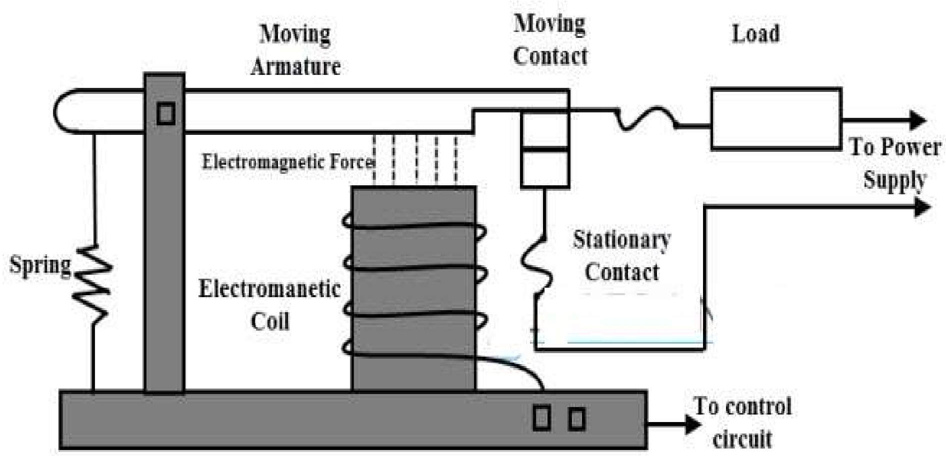


Fig 5.6.2: Energized condition

Relays are used to protect the electrical system and to minimize the damage to the equipment connected in the system due to over currents/voltages. The relay is used for the purpose of protection of the equipment connected with it. These are used to control the high voltage circuit with low voltage signal in applications audio amplifiers and some types of modems. These are used to control a high current circuit by a low current signal in the applications like starter solenoid in automobile. These can detect and isolate the faults that occurred in power transmission and distribution system. Typical application areas of the relays include. These SPDT relays covers switching capacity of 10A in spite of miniature size for PCB Mount.

Contact Rating:

- 12A at 120VAC
- 10A at 120VAC
- 10A at 24VDC

Coil Resistance:

- 400ohm 12VDC

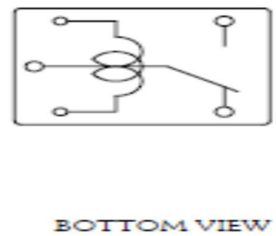


fig: SPDT Relay

Life expectancy:

Mechanical 10,000,000 operations at no load and electrical 100,000 at rated load.

Driving a Relay:

A relay allows for switching a high power circuit with a low power circuit. So to make a relay operate, we have to energize the coil by passing a current through it. Therefore a driving circuit is necessary which nothing but a control circuitry of the relay.

A relay driving circuit operates or drives the relay in order to perform switching function appropriately in a given circuit. Majorly there are two types of driving circuits for driving a relay namely AC relay driver circuit and DC relay driver circuit. There are numerous ways to operate a DC relay using different types of control devices ranging from simple transistor devices to high end integrated type devices.

Driver ICs:

Alternative to the transistor and timer based driver circuits; relay driver ICs can drive multiple devices. These drives are ICs are of different types such as bipolar transistor driven ICs, Darlington pair driven ICs, MOSFET bridge type ICs, etc with various channel configuration like 8 channel, 16 channel, and so on. These ICs are allows to connect more than one relay coils in order to perform the switching application.

Some of the popular relay driver ICs used in controlling the electronic equipments includes UL2803, ULN2003, TLC5940, etc. We used ULN2003 driver as the IC so we will discuss about it in below.

ULN2003A Driver:

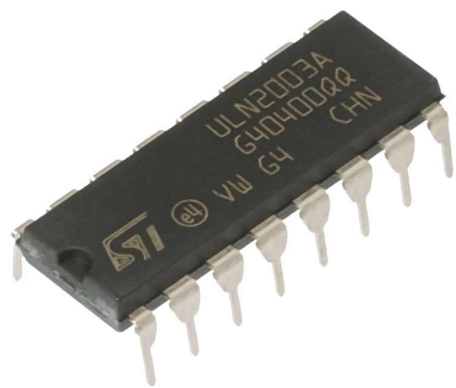


Fig 5.6.3: ULN2003 relay driver

The ULN2003A devices are high-voltage, high-current Darlington transistor arrays. Each consists of seven NPN Darlington pairs that feature high-voltage outputs with common-cathode clamp diodes for switching inductive loads.

Internal circuit and pin diagram:

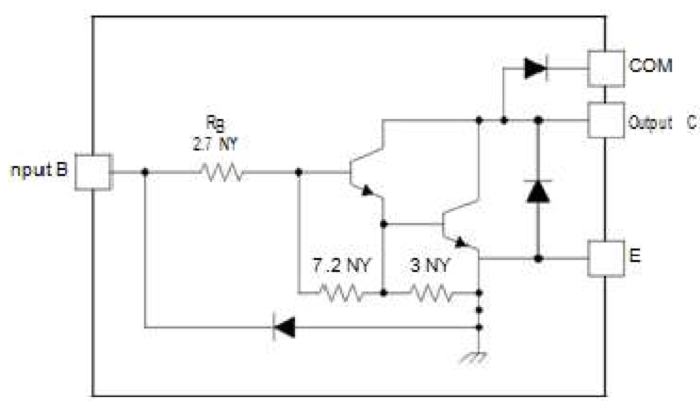


Fig 5.6.3.1: ULN2003A internal circuit

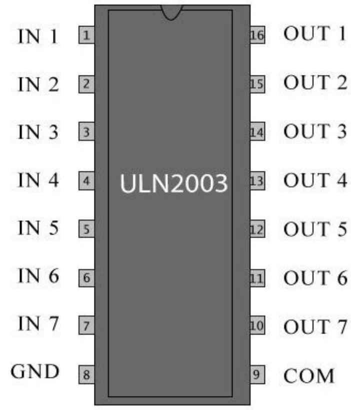


Fig 5.6.3.2:ULN2003A Pin diagram

Main Feature:

1. RW Series Relay covers switching capacity by 10A is spite of miniature size to comply with user's wide selection.
2. RWH is approved C-UL & TÜV safety standard.
3. The employment of suitable plastic materials is applied under high temperature condition and various chemical solutions.
4. Complete protective construction is designed form dust and soldering flux. If required, plastic sealed type is available for washing procedure.
5. 12A at 120VAC for RW & 12A at 240VAC for RWH are UL approved.

Applications:

- Lighting control systems
- Telecommunication
- Industrial process controllers
- Traffic control
- Motor drives control
- Protection systems of electrical power system
- Computer interfaces
- Automotive
- Home appliances

5.7 LIGHT EMITING DIODES:

It is a semiconductor diode having radioactive recombination. It requires a definite amount of energy to generate an electron-hole pair. The same energy is released when an electron recombines with a hole. This released energy may result in the emission of photon and such a recombination. Hear the amount of energy released when the electro reverts from the conduction band to the valence band appears in the form of radiation. Alternatively the released energy may result in a series of phonons causing lattice vibration. Finally the released energy may be transferred to another electron. The recombination radiation may be lie in the infra-red and visible light spectrum. In forward is peaked around the band gap energy and the phenomenon is called injection luminescence.

In a junction biased in the avalanche break down region, there results a spectrum of photons carrying much higher energies. Almost White light then gets emitted from micro-plasma breakdown region in silicon junction. Diodes having radioactive recombination are termed as Light Emitting Diode, abbreviated as LEDs.

In gallium arsenide diode, recombination is predominantly a radiation recombination and the probability of this radioactive recombination far exceeds that in either germanium or silicon. Hence Ga As LED has much higher efficiency in terms of Photons emitted per carrier. The internal efficiency of Ga As LED may be very close to 100% but because of high index of refraction, only a small fraction of the internal radiation can usually come out of the device surface.

In spite of this low efficiency of actually radiated light, these LEDs are efficiency used as light emitters in visual display units and in optically coupled circuits, the efficiency of light generation increases with the increase of injected current and with decreases in temperature. The light so generated is concentrated near the junction since most of the charge carriers are obtained within one diffusion length of the diode junction.

The following are the merits of LEDs over conventional incandescent and other types of lamps

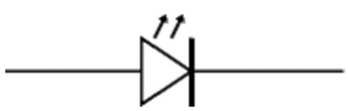
1. Low working voltages and currents
2. Less power consumption
3. Very fast action
4. Emission of monochromatic light
5. small size and weight
6. No effect of mechanical vibrations
7. Extremely long life

Typical LED uses a forward voltage of about 2V and current of 5 to 10mA.

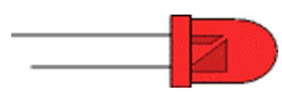
GaAs LED produces infra-red light while red, green and orange lights are produced by gallium arsenide phosphide (GaAs) and gallium phosphide(Gap) .

Light Emitting Diodes (LEDs):

Circuit symbol :



Example:

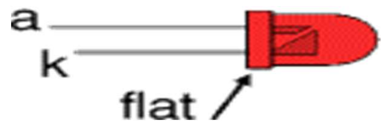


Function:

LEDs emit light when an electric current passes through them.

Connecting and soldering:

LEDs must be connected the correct way around the diagram may be labeled **a** for anode and **k** for cathode!). The cathode is the short lead and there may be a slight flat on the body of round LEDs. If you can see inside the LED the cathode is the larger electrode.



LEDs can be damaged by heat when soldering, but the risk is small unless you are very slow. No special precautions are needed for soldering most LED.

Testing an LED:

Never connect an LED directly to a battery or power supply! It will be destroyed almost instantly because too much current will pass through and burn it out. LEDs must have a resistor in series to limit the current to a safe value, for quick testing purposes a 1kΩ resistor is suitable for most LEDs if your supply voltage is 12V or less. Remember to connect the LED the correct way round.

Colours of LEDs:

LEDs are available in red, orange, amber, yellow, green, blue and white. Blue and white LEDs are much more expensive than the other colors. The color of an LED is determined by the semiconductor material, not by the coloring of the 'package' (the plastic body). LEDs of all colors are available in uncolored packages which may be diffused (milky) or clear (often described as 'water clear'). The colored packages are also available as diffused (the standard (type) or transparent.

Tri-color LEDs:

The most popular type of tri-color LED has a red and a green LED combined in one package with three leads. They are called tri-color because mixed red and green light appears to be yellow and this is produced when both the red and green LEDs are on.

The diagram shows the construction of a tri-color LED. Note the different lengths of the three leads. The centre lead (k) is the common cathode for both LEDs, the outer leads (a1 and a2) are the anodes to the

LEDs allowing each one to be lit separately, or both together to give the third color.

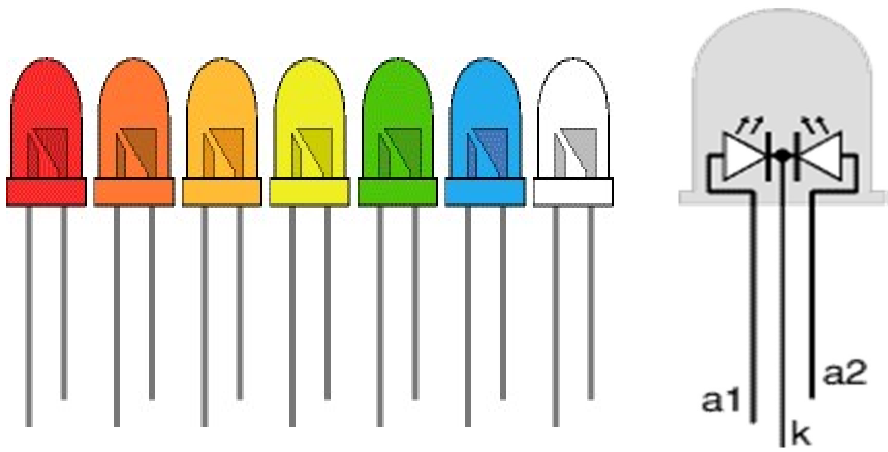


Fig 5.7: Colors of LED

Bi-color LEDs:

A bi- color LED has two LEDs wired in 'inverse parallel' (one forwards, one backwards) combined in one package with two leads. Only one of the LEDs can be lit at one time and they are less useful than the tri-color LEDs described above.

Sizes, Shapes and Viewing angles of LEDs:

LEDs are available in a wide variety of sizes and shapes. The 'standard' LED has a round cross-section of 5mm diameter and this is probably the best type for general use, but 3mm round LEDs are also popular.

Round cross-section LEDs are frequently used and they are very easy to install on boxes by drilling a hole of the LED diameter, adding a spot of glue will help to hold the LED if necessary. LED clips are also available to secure LEDs in holes. Other cross-section shapes include square, rectangular and triangular. As well as a variety of colors, sizes and shapes, LEDs also vary in their viewing angle. This tells you how much the beam of light spreads out. Standard LEDs have a viewing angle of 60° but others have a narrow beam of 30° or less.

Connecting LEDs in series:

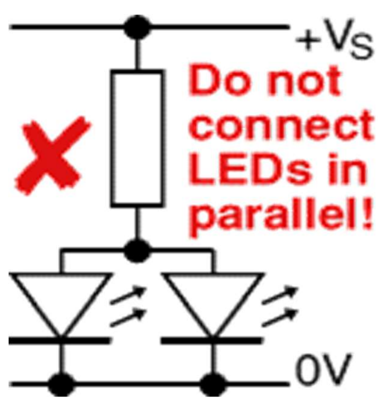
If you wish to have several LEDs on at the same time it may be possible to connect them in series. This prolongs battery life by lighting several LEDs with the same current as just one LED.
All the LEDs connected in series pass the same current so it is best if they are all the same type.

The power supply must have sufficient voltage to provide about 2V for each LED plus at least another 2V for the resistor. To work out a value for the resistor you must add up all the LED voltages and use this for V_L.

Avoid connecting LEDs in parallel:

Connecting several LEDs in parallel with just one resistor shared between them is generally not a good idea. If the LEDs require slightly different voltages only the lowest voltage LED will light and it may be destroyed by the larger current flowing through it.

Although identical LEDs can be successfully connected in parallel with one resistor this rarely offers any useful benefit because resistors are very cheap and the current used is the same as connecting the LEDs individually.



warning

5.8 Antenna:

An antenna (plural antennae or antennas) or aerial is an electrical device which converts electric power into radio waves, and vice versa. It is usually used with a radio transmitter or radio receiver.

In transmission, a radio transmitter supplies an electric current oscillating at radio frequency (i.e. a high frequency alternating current (AC)) to the antenna's terminals, and the antenna radiates the energy from the current as electromagnetic waves (radio waves). In reception, an antenna intercepts some of the power of an electromagnetic wave in order to produce a tiny voltage at its terminals, that is applied to a receiver to be amplified. Antennas are essential components of all equipment that uses radio.

They are used in systems such as radio broadcasting, broadcast television, two-way radio, communications receivers, radar, cell phones, and satellite communications, as well as other devices such as garage door openers, wireless microphones, Bluetooth-enabled devices, wireless computer networks, baby monitors, and RFID tags on merchandise.

Typically an antenna consists of an arrangement of metallic conductors(elements),electrically connected(often through a transmission line) to the receive or transmitter. An oscillating current of electrons forced through the antenna by a transmitter will create an oscillating magnetic field around the antenna elements,

While the charge of the electrons also creates an oscillating electric field along the elements. These time-varying fields radiate away from the antenna into space as a moving transverse electromagnetic field wave. Conversely, during reception, the oscillating electric and magnetic fields of an incoming radio wave exert force on the electrons in the antenna elements, causing them to move back and forth, creating oscillating currents in the antenna.

5.8.1 Helical antenna:

A helical antenna is an antenna consisting of a conducting wire wound in the form of a helix. In most cases, helical antennas are mounted over a ground plane. The feed line is connected between the bottom of the helix and the ground plane.

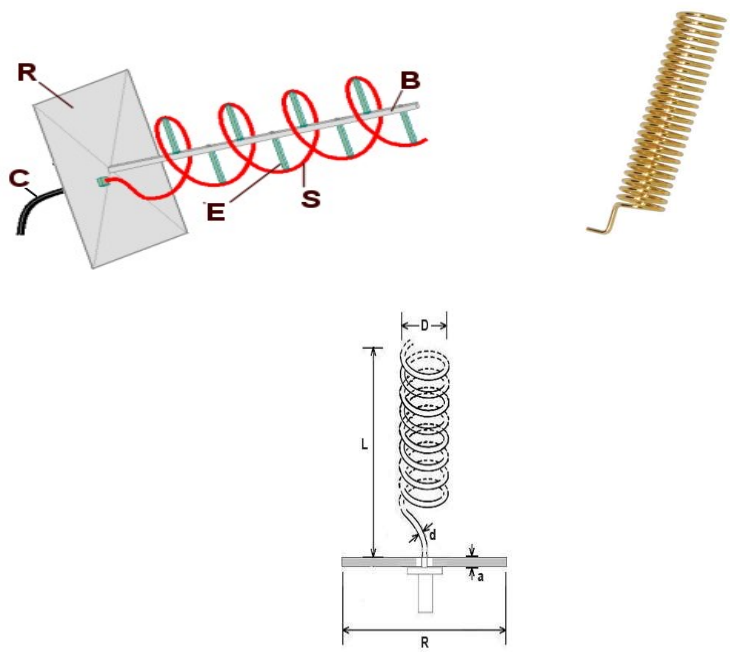


Fig 5.8.1: Helical antennas

CHAPTER VI

APPLICATIONS & ADVANTAGES, DISADVANTAGES

APPLICATIONS & ADVANTAGES, DISADVANTAGES

6.1 APPLICATIONS:

- Home appliances
- Bells, Security System
- Garage Door and Car Door Controllers
- Other Remote Control System
- Wireless security systems
- Car Alarm systems
- Remote controls.
- Sensor reporting

6.2 Advantages & Disadvantages:

Advantages:

- It is absolutely free from ambient light interference and provides long control range without the use of any focusing lens.
- The Antenna used is small size with long range.
- It doesn't need line of sight.
- No need of micro controllers.

Disadvantages:

- The received addresses from the encoder must match the decoders for the Valid Transmission.

CHAPTER VII

RESULT & CONCLUSION

RESULT & CONCLUSION

7.1 Result:

Assembling the circuit on the PCB is completed. The device is working properly and it is ready for application.

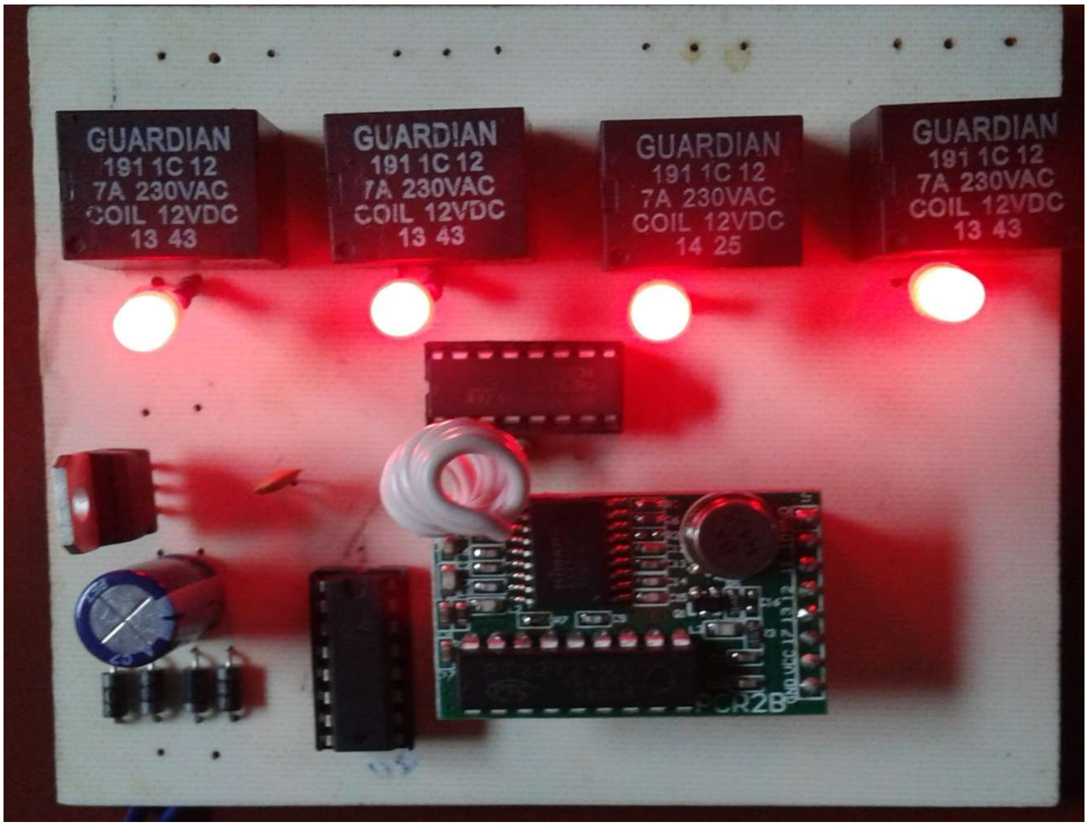


Fig 7.1: Hardware kit of SMART HOMES - RF

7.2 Conclusion:

- The design is durable, sturdy which is built with an available compact IC's and RF module.
- From any place around the house any four appliances can be controlled without requirement of line of sight.
- Multiple devices can be controlled using different receiver with different addressing modes using single remote.

CHAPTER VIII
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BIBLIOGRAPHY

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