A

PROJECT REPORT

on

IoT Based Home Automation System

Submitted in partial fulfilment of the requirements for the degree of

BACHELOR OF TECHNOLOGY

Session: - Jan-June 2022

Under Guidance of
Dr.Vivek Jain
Head Of Department
ECE & Techno India Njr Institute of Technology

Submitted by
Abhay Upadhyay (18ETCEC001)
Om Prakash
Kumawat(18ETCEC008)
VIII & ECE

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

TECHNO INDIA NJR INSTITUTE OF TECHNOLOGY, UDAIPUR-313001

MAY - 2022

Department of Electronics and Communication Engineering
Techno India NJR Institute of Technology, Udaipur-313001

Certificate

This is to certify that project work titled "IoT Based Home Automation System" by Om Prakash Kumawat was successfully carried out in the Department of Electronics and Communication Engineering, TINJRIT and the report is approved for submission in the partial fulfillment of the requirements for award of degree of Bachelor of Technology in Electronics and Communication. The work has been completed in all the respects during session 2018-2022.

Prof.Yogendra Singh Solanki
Assistant Professor
Dept. of E.C.E TINJRIT, Udaipur
Date : 28 May 2022

Dr.Vivek Jain
Head Of Departmemnt
Dept. of E.C.E TINJRIT, Udaipur
Date : 28 May 2022

Department of Electronics and Communication Engineering
Techno India NJR Institute of Technology, Udaipur-313001

Examiner Certificate

This is to certify that the following student

Om Prakash Kumawat

of final year B.Tech. (Electronics & Communication Engineering), was examined for the project work .

"IoT Based Home Automation System"

during the academic year 2018 – 2022 at Techno India NJR Institute of Technology, Udaipur

Remarks: Satisfactory

Date: 24-5-2022

Signature

(Internal Examiner)

Name :- Dr. Vivek Jain

Designation:- Associate Proff.

Department: - E.C.E.....

Organization:- ...TINRIT

Signature

(External Examiner)

Name :- Rajkumar Soni

Designation:- Asst. Prof.

Department: - ....E.E.....

Organization:- .....

CONTENTS

Preface

This project presents the overall design of Home Automation System (HAS) with low cost and wireless system. It specifically focuses on the development of an IOT based home automation system that is able to control various components via internet or be automatically programmed to operate from ambient conditions. In this project, we design the development of a firmware for smart control which can successfully be automated minimizing human interaction to preserve the integrity within whole electrical devices in the home. We used Arduino, a popular open source IOT platform, to execute the process of automation. Different components of the system will use different transmission mode that will be implemented to communicate the control of the devices by the user through Arduino to the actual appliance. The main control system implements wireless technology to provide remote access from smart phone.

In Chapter 1, we give an overview of the Internet Of Things,Features Of IoT,Advantages Of IoT,

Disadvantages of IoT,Application Ground Of IoT,IoT Technologies And protocols,IoT software.

Chapter 2 discusses the Design Process of devices. It is important

to understand the Arduino Module in order to correctly formulate the

problems. In addition, it is important for one to understand, what is doable

and what is not! Chapter 2 presents Bluetooth Module and Relay Module.

And Electrical Bulb & Wire.

Chapter 3 presents the status of Circuit Board, as well as, process

innovations on the Home Automation system its impact on physical design.

4. presents the status of code circuit in Arduino Uno.

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING
TECHNO INDIA NJR INSTITUTE OF TECHNOLOGY, UDAIPUR-313001

CHAPTER1

INTRODUCTION

1.1 IOT (INTERNET OF THINGS)

IOT as a term has evolved long way as a result of convergence of multiple technologies, machine learning, embedded systems and commodity sensors. IOT is a system of interconnected devices assigned a UIDS, enabling data transfer and control of devices over a network. It reduced the necessity of actual interaction in order to control a device. IOT is an advanced automation and analytics system which exploits networking, sensing, big data, and artificial intelligence technology to deliver complete systems for a product or service. These systems allow greater transparency, control, and performance when applied to any industry or system.

1.2 Features of IOT

1.1.1 Intelligence

IOT comes with the combination of algorithms and computation, software & hardware that makes it smart. Ambient intelligence in IOT enhances its capabilities which facilitate the things to respond in an intelligent way to a particular situation and supports them in carrying out specific tasks. In spite of all the popularity of smart technologies, intelligence in IOT is only concerned as a means of interaction between devices, while user and device interaction are achieved by standard input methods and graphical user interface

1.1.2 Connectivity

Connectivity empowers the Internet of Things by bringing together everyday objects. Connectivity of these objects is pivotal because simple object level interactions contribute towards collective intelligence in the IOT network. It enables network accessibility and compatibility in the things. With this connectivity, new market opportunities for the Internet of things can be created by the networking of smart things and applications

1.1.3 Dynamic Nature

The primary activity of Internet of Things is to collect data from its environment, this is achieved with the dynamic changes that take place around the devices. The state of these devices change dynamically, example sleeping and waking up, connected and/or disconnected as well as the context of devices including temperature, location and speed. In addition to the state of the device, the number of devices also changes dynamically with a person, place and time

1.1.4 Enormous Scale

The number of devices that need to be managed and that communicate with each other will be much larger than the devices connected to the current Internet. The management of data generated from these devices and their interpretation for application purposes becomes more critical. Gartner (2015) confirms the enormous scale of IOT in the

estimated report where it stated that 5.5 million new things will get connected every day and 6.4 billion connected things will be in use worldwide in 2016, which is up by 30 percent from 2015. The report also forecasts that the number of connected devices will reach 20.8 billion by 2020

1.1.5 Sensing

IOT wouldn't be possible without sensors that will detect or measure any changes in the environment to generate data that can report on their status or even interact with the environment. Sensing technologies provide the means to create capabilities that reflect a true awareness of the physical world and the people in it. The sensing information is simply the analog input from the physical world, but it can provide a rich understanding of our complex world

1.1.6 Heterogeneity

Heterogeneity in Internet of Things as one of the key characteristics. Devices in IOT are based on different hardware platforms and networks and can interact with other devices or service platforms through different networks. IOT architecture should support direct network connectivity between heterogeneous networks. The key design requirements for heterogeneous things and their environments in IOT are scalabilities, modularity, extensibility and interoperability.

1.1.7 Security

IOT devices are naturally vulnerable to security threats. As we gain efficiencies, novel experiences, and other benefits from the IOT, it would be a mistake to forget about security concerns associated with it. There is a high level of transparency and privacy issues with IOT. It is important to secure the endpoints, the networks, and the data that is transferred across all of it means creating a security paradigm.

1.2 Advantages of IOT

1.2.1 Communication

IOT encourages the communication between devices, also famously known as Machine-to-Machine (M2M) communication. Because of this, the physical devices are able to stay connected and hence the total transparency is available with lesser inefficiencies and greater quality.

1.2.2 Automation and Control

Due to physical objects getting connected and controlled digitally and centrally with wireless infrastructure, there is a large amount of automation and control in the workings.

Without human intervention, the machines are able to communicate with each other leading to faster and timely output.

1.2.3 Information

It is obvious that having more information helps making better decisions. Whether it is mundane decisions as needing to know what to buy at the grocery store or if your company has enough widgets and supplies, knowledge is power and more knowledge is better.

1.2.4 Monitor

The second most obvious advantage of IOT is monitoring. Knowing the exact quantity of supplies or the air quality in your home, can further provide more information that could not have previously been collected easily. For instance, knowing that you are low on milk or printer ink could save you another trip to the store in the near future. Furthermore, monitoring the expiration of products can and will improve safety.

1.2.5 Time

As hinted in the previous examples, the amount of time saved because of IOT could be quite large. And in today's modern life, we all could use more time.

1.2.6 Money

The biggest advantage of IOT is saving money. If the price of the tagging and monitoring equipment is less than the amount of money saved, then the Internet of Things will be very widely adopted. IOT fundamentally proves to be very helpful to people in their daily routines by making the appliances communicate to each other in an effective manner thereby saving and conserving energy and cost. Allowing the data to be communicated and shared between devices and then translating it into our required way, it makes our systems efficient.

1.2.7 Automation of daily tasks leads to better monitoring of devices

The IOT allows you to automate and control the tasks that are done on a daily basis, avoiding human intervention. Machine-to-machine communication helps to maintain transparency in the processes. It also leads to uniformity in the tasks. It can also maintain the quality of service. We can also take necessary action in case of emergencies.

1.2.8 Efficient and Saves Time

The machine-to-machine interaction provides better efficiency, hence; accurate results can be obtained fast. This results in saving valuable time. Instead of repeating the same tasks every day, it enables people to do other creative jobs.

1.3 Disadvantages of IOT

1.3.1 Compatibility

Currently, there is no international standard of compatibility for the tagging and monitoring equipment. I believe this disadvantage is the most easy to overcome. The manufacturing companies of these equipment just need to agree to a standard, such as Bluetooth, USB, etc. This is nothing new or innovative needed.

1.3.2 Complexity

As with all complex systems, there are more opportunities of failure. With the Internet of Things, failures could sky rocket. For instance, let's say that both you and your spouse each get a message saying that your milk has expired, and both of you stop at a store on your way home, and you both purchase milk. As a result, you and your spouse have purchased twice the amount that you both need. Or maybe a bug in the software ends up automatically ordering a new ink cartridge for your printer each and every hour for a few days, or at least after each power failure, when you only need a single replacement.

1.3.3 Privacy/Security

With all of this IOT data being transmitted, the risk of losing privacy increases. For instance, how well encrypted will the data be kept and transmitted with? Do you want your neighbours or employers to know what medications that you are taking or your financial situation?

1.3.4 Safety

Imagine if a notorious hacker changes your prescription. Or if a store automatically ships you an equivalent product that you are allergic to, or a flavour that you do not like, or a product that is already expired. As a result, safety is ultimately in the hands of the consumer to verify any and all automation.

As all the household appliances, industrial machinery, public sector services like water supply and transport, and many other devices all are connected to the Internet, a lot of information is available on it. This information is prone to attack by hackers. It would be very disastrous if private and confidential information is accessed by unauthorized intruders.

1.3.5 Lesser Employment of Menial Staff

The unskilled workers and helpers may end up losing their jobs in the effect of automation of daily activities. This can lead to unemployment issues in the society. This is a problem with the advent of any technology and can be overcome with education. With daily activities getting automated, naturally, there will be fewer requirements of human

resources, primarily, workers and less educated staff. This may create Unemployment issue in the society.

1.4 Application Grounds of IOT

1.4.1 Wearables

Wearable technologies is a hallmark of IOT applications and is one of the earliest industries to have deployed IOT at its services. Fit Bits, heart rate monitors, smartwatches, glucose monitoring devices reflect the successful applications of IOT.

1.4.2 Smart homes

This area of application concerned to this particular project, so a detailed application is discussed further. Jarvis, an AI home automation employed by Mark Zuckerberg, is a remarkable example in this field of application.

1.4.3 Health care

IOT applications have turned reactive medical based system into proactive wellness based system. IOT focuses on creating systems rather than equipment. IOT creates a future of medicine and healthcare which exploits a highly integrated network of sophisticated medical devices. The integration of all elements provides more accuracy, more attention to detail, faster reactions to events, and constant improvement while reducing the typical overhead of medical research and organizations

1.4.4 Agriculture

A greenhouse farming technique enhances the yield of crops by controlling environmental parameters. However, manual handling results in production loss, energy loss, and labour cost, making the process less effective. A greenhouse with embedded devices not only makes it easier to be monitored but also, enables us to control the climate inside it. Sensors measure different parameters according to the plant requirement and send it to the cloud. It, then, processes the data and applies a control action.

1.4.5 Industrial Automation

For a higher return of investment this field requires both fast developments and quality of products. This vitality thus coined the term IIOT. This whole schematic is re-engineered by IOT applications. Following are the domains of IOT applications in industrial automation

□ Factory Digitalization □ Product flow Monitoring □ Inventory Management □ Safety and Security □ Quality Control □ Packaging optimization □ Logistics and Supply Chain Optimization

1.4.6 Government and Safety

IOT applied to government and safety allows improved law enforcement, defence, city planning, and economic management. The technology fills in the current gaps, corrects many current flaws, and expands the reach of these efforts. For example, IOT can help city planners have a clearer view of the impact of their design, and governments have a better idea of the local economy.

1.5 IOT Technologies and Protocols

Several communication protocols and technologies cater to and meet the specific functional requirements of IOT system.

1.5.1 Bluetooth

Bluetooth is a short range IOT communication protocol/technology that is profound in many consumer product markets and computing. It is expected to be key for wearable products in particular, again connecting to the IOT albeit probably via a smartphone in many cases. The new Bluetooth Low-Energy (BLE) – or Bluetooth Smart, as it is now branded – is a significant protocol for IOT applications. Importantly, while it offers a similar range to Bluetooth it has been designed to offer significantly reduced power consumption.

1.5.2 Zigbee

ZigBee is similar to Bluetooth and is majorly used in industrial settings. It has some significant advantages in complex systems offering low-power operation, high security, robustness and high and is well positioned to take advantage of wireless control and sensor networks in IOT applications. The latest version of ZigBee is the recently launched 3.0, which is essentially the unification of the various ZigBee wireless standards into a single standard.

1.5.3 Z-Wave

Z-Wave is a low-power RF communications IOT technology that primarily design for home automation for products such as lamp controllers and sensors among many other devices. A ZWave uses a simpler protocol than some others, which can enable faster and simpler development, but the only maker of chips is Sigma Designs compared to multiple sources for other wireless technologies such as ZigBee and others.

1.5.4 Wi-Fi

Wi-Fi connectivity is one of the most popular IOT communication protocol, often an obvious choice for many developers, especially given the availability of Wi-Fi within the home environment within LANs. There is a wide existing infrastructure as well as offering fast data transfer and the ability to handle high quantities of data. Currently, the most

common Wi-Fi standard used in homes and many businesses is 802.11n, which offers range of hundreds of megabit per second, which is fine for file transfers but may be too power-consuming for many IOT applications.

1.6 IOT software

IOT software addresses its key areas of networking and action through platforms, embedded systems, partner systems, and middleware. These individual and master applications are responsible for data collection, device integration, real-time analytics, and application and process extension within the IOT network. They exploit integration with critical business systems (e.g., ordering systems, robotics, scheduling, and more) in the execution of related tasks.

1.6.1 Data Collection

This software manages sensing, measurements, light data filtering, light data security, and aggregation of data. It uses certain protocols to aid sensors in connecting with real-time, machineto-machine networks. Then it collects data from multiple devices and distributes it in accordance with settings. It also works in reverse by distributing data over devices. The system eventually transmits all collected data to a central server.

1.6.2 Device Integration

Software supporting integration binds (dependent relationships) all system devices to create the body of the IOT system. It ensures the necessary cooperation and stable networking between devices. These applications are the defining software technology of the IOT network because without them, it is not an IOT system. They manage the various applications, protocols, and limitations of each device to allow communication.

1.6.3 Real-Time Analytics

These applications take data or input from various devices and convert it into feasible actions or clear patterns for human analysis. They analyse information based on various settings and designs in order to perform automation-related tasks or provide the data required by industry.

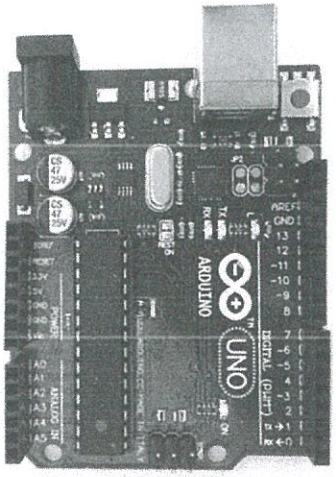
1.6.4 Application and Process Extension

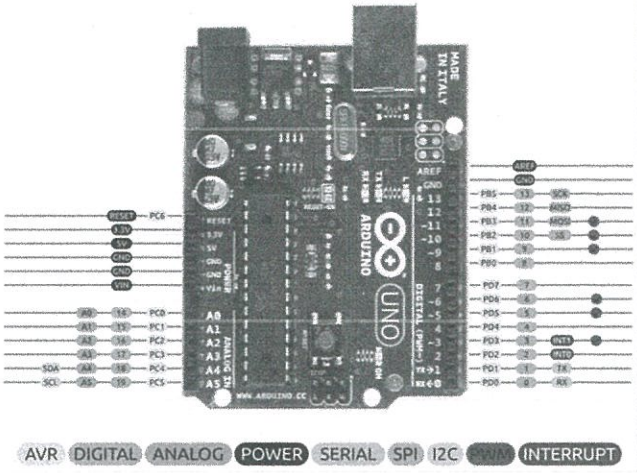
These applications extend the reach of existing systems and software to allow a wider, more effective system. They integrate predefined devices for specific purposes such as allowing certain mobile devices or engineering instruments access. It supports improved productivity and more accurate data collection.

Chapter 2

Electronic Component

2.1 Defination and Properties of Arduino UNO





2014 by Bouni
Photo by Arduino.cc

Arduino Uno is a popular microcontroller development board based on 8-bit ATmega328P microcontroller. Along with ATmega328P MCU IC, it consists other components such as crystal oscillator, serial communication, voltage regulator, etc. to support the microcontroller.

Arduino Uno Pinout Configuration

Pin Category	Pin Name	Details
Power	Vin, 3.3V, 5V, GND	Vin: Input voltage to Arduino when using an external power source. 5V: Regulated power supply used to power microcontroller and other components on the board. 3.3V: 3.3V supply generated by on-board voltage regulator. Maximum current draw is 50mA. GND: ground pins.
Reset	Reset	Resets the microcontroller.
Analog Pins	A0 – A5	Used to provide analog input in the range of 0-5V

Input/Output Pins	Digital Pins 0 - 13	Can be used as input or output pins.
Serial	0(Rx), 1(Tx)	Used to receive and transmit TTL serial data.
External Interrupts	2, 3	To trigger an interrupt.
PWM	3, 5, 6, 9, 11	Provides 8-bit PWM output.
SPI	10 (SS), 11 (MOSI), 12 (MISO) and 13 (SCK)	Used for SPI communication.
Inbuilt LED	13	To turn on the inbuilt LED.
TWI	A4 (SDA), A5 (SCA)	Used for TWI communication.
AREF	AREF	To provide reference voltage for input voltage.

-

Arduino Uno Technical Specifications

Microcontroller	ATmega328P – 8 bit AVR family microcontroller
Operating Voltage	5V
Recommended Input Voltage	7-12V
Input Voltage Limits	6-20V
Analog Input Pins	6 (A0 – A5)
Digital I/O Pins	14 (Out of which 6 provide PWM output)
DC Current on I/O Pins	40 mA

DC Current on 3.3V Pin	50 mA
Flash Memory	32 KB (0.5 KB is used for Bootloader)
SRAM	2 KB
EEPROM	1 KB
Frequency (Clock Speed)	16 MHz

Note: Complete technical information can be found in the **Arduino UNO Datasheet**, linked at the bottom of this page.

Other Arduino Boards

Arduino Nano, Arduino Pro Mini, Arduino Mega, Arduino Due, Arduino MKR1000 Wi-Fi Board, Arduino Leonardo

Overview

Arduino Uno is a microcontroller board based on 8-bit ATmega328P microcontroller. Along with ATmega328P, it consists other components such as crystal oscillator, serial communication, voltage regulator, etc. to support the microcontroller. Arduino Uno has 14 digital input/output pins (out of which 6 can be used as PWM outputs), 6 analog input pins, a USB connection, A Power barrel jack, an ICSP header and a reset button.

How to use Arduino Board

The 14 digital input/output pins can be used as input or output pins by using pinMode(), digitalRead() and digitalWrite() functions in arduino programming. Each pin operate at 5V and can provide or receive a maximum of 40mA current, and has an internal pull-up resistor of 20-50 KOhms which are disconnected by default. Out of these 14 pins, some pins have specific functions as listed below:

- **Serial Pins 0 (Rx) and 1 (Tx):** Rx and Tx pins are used to receive and transmit TTL serial data. They are connected with the corresponding ATmega328P USB to TTL serial chip.
- **External Interrupt Pins 2 and 3:** These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value.
- **PWM Pins 3, 5, 6, 9 and 11:** These pins provide an 8-bit PWM output by using analogWrite() function.
- **SPI Pins 10 (SS), 11 (MOSI), 12 (MISO) and 13 (SCK):** These pins are used for SPI communication.

- **In-built LED Pin 13:** This pin is connected with an built-in LED, when pin 13 is HIGH – LED is on and when pin 13 is LOW, its off.

Along with 14 Digital pins, there are 6 analog input pins, each of which provide 10 bits of resolution, i.e. 1024 different values. They measure from 0 to 5 volts but this limit can be increased by using AREF pin with analog Reference() function.

- Analog pin 4 (SDA) and pin 5 (SCA) also used for TWI communication using Wire library.

Arduino Uno has a couple of other pins as explained below:

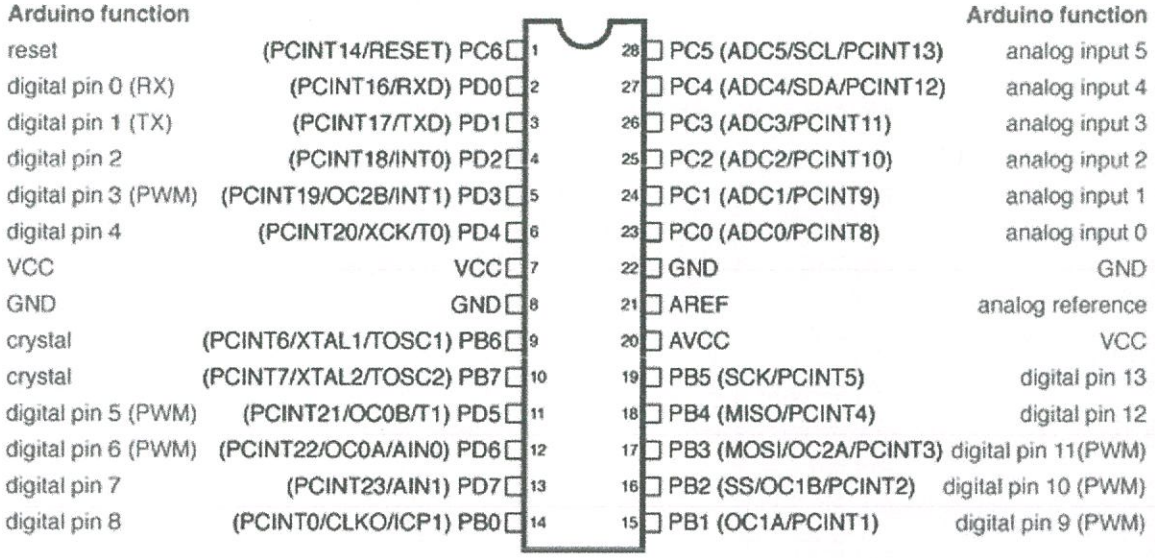
- **AREF:** Used to provide reference voltage for analog inputs with analogReference() function.
- **Reset Pin:** Making this pin LOW, resets the microcontroller.

Communication

Arduino can be used to communicate with a computer, another Arduino board or other microcontrollers. The ATmega328P microcontroller provides UART TTL (5V) serial communication which can be done using digital pin 0 (Rx) and digital pin 1 (Tx). An ATmega16U2 on the board channels this serial communication over USB and appears as a virtual com port to software on the computer. The ATmega16U2 firmware uses the standard USB COM drivers, and no external driver is needed. However, on Windows, a .inf file is required. The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the Arduino board. There are two RX and TX LEDs on the arduino board which will flash when data is being transmitted via the USB-to-serial chip and USB connection to the computer (not for serial communication on pins 0 and 1). A SoftwareSerial library allows for serial communication on any of the Uno's digital pins. The ATmega328P also supports I2C (TWI) and SPI communication. The Arduino software includes a Wire library to simplify use of the I2C bus.

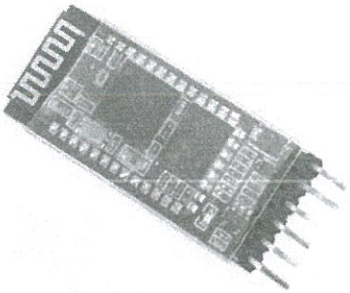
Arduino Uno to ATmega328 Pin Mapping

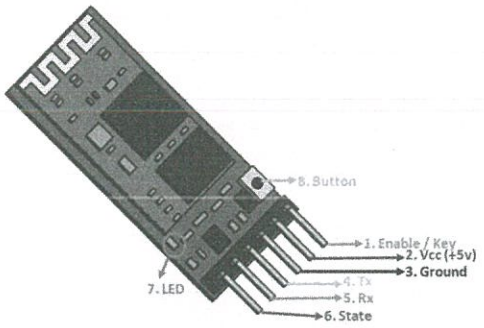
When ATmega328 chip is used in place of Arduino Uno, or vice versa, the image below shows the pin mapping between the two



Digital Pins 11,12 & 13 are used by the ICSP header for MOSI, MISO, SCK connections (Atmega168 pins 17,18 & 19). Avoid low-impedance loads on these pins when using the ICSP header.

2.2 Explain HC-05 Bluetooth Module.





The **HC-05** is a popular bluetooth module which can add two-way (full-duplex) wireless functionality to your projects.

HC-05 Pinout Configuration

Pin Number	Pin Name	Description
1	Enable / Key	This pin is used to toggle between Data Mode (set low) and AT command mode (set high). By default it is in Data mode
2	Vcc	Powers the module. Connect to +5V Supply voltage
3	Ground	Ground pin of module, connect to system ground.
4	TX – Transmitter	Transmits Serial Data. Everything received via Bluetooth will be given out by this pin as serial data.
5	RX – Receiver	Receive Serial Data. Every serial data given to this pin will be broadcasted via Bluetooth
6	State	The state pin is connected to on board LED, it can be used as a feedback to check if Bluetooth is working properly.
7	LED	Indicates the status of Module Blink once in 2 sec: Module has entered Command Mode Repeated Blinking: Waiting for connection in Data Mode Blink twice in 1 sec: Connection successful in Data Mode
8	Button	Used to control the Key/Enable pin to toggle between Data and command Mode

HC-05 Default Settings

Default Bluetooth Name: "HC-05"

Default Password: 1234 or 0000

Default Communication: Slave

Default Mode: Data Mode

Data Mode Baud Rate: 9600, 8, N, 1

Command Mode Baud Rate: 38400, 8, N, 1

Default firmware: LINVOR

-

HC-05 Technical Specifications

- Serial Bluetooth module for Arduino and other microcontrollers
- Operating Voltage: 4V to 6V (Typically +5V)
- Operating Current: 30mA
- Range: <100m
- Works with Serial communication (USART) and TTL compatible
- Follows IEEE 802.15.1 standardized protocol
- Uses Frequency-Hopping Spread spectrum (FHSS)
- Can operate in Master, Slave or Master/Slave mode
- Can be easily interfaced with Laptop or Mobile phones with Bluetooth
- Supported baud rate: 9600,19200,38400,57600,115200,230400,460800.

-

HC-05 Equivalent Bluetooth Module

HC-02

-

Other Bluetooth Modules

HC-04, HC-06, HM-11, ESP32, CSR8645

-

Where to use HC-05 Bluetooth module

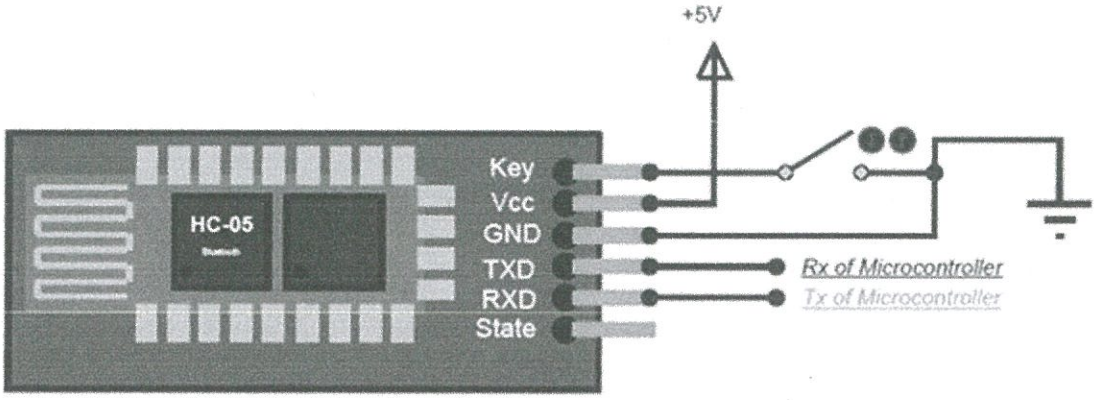
The **HC-05** is a popular module which can add two-way (full-duplex) wireless functionality to your projects. You can use this module to communicate between two microcontrollers like Arduino or communicate with any device with Bluetooth functionality like a Phone or Laptop. There are many android applications that are already available which makes this process a lot easier. The module communicates with the help of USART at 9600 baud rate hence it is easy to interface with any microcontroller that supports USART. We can also configure the default values of the module by using the command mode. So if you looking for a Wireless module that could transfer data from your computer or mobile phone to microcontroller or vice versa then this module might be the right choice for you. However do not expect this module to transfer multimedia like photos or songs; you might have to look into the CSR8645 module for that.

-

How to Use the HC-05 Bluetooth module

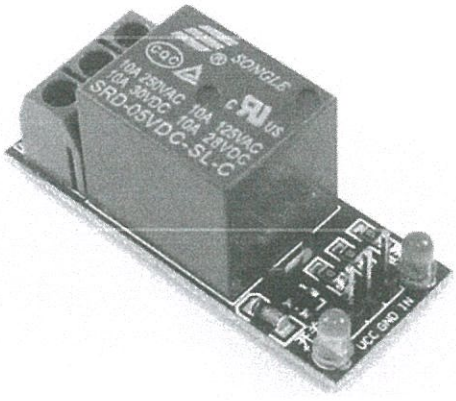
The **HC-05** has two operating modes, one is the Data mode in which it can send and receive data from other Bluetooth devices and the other is the AT Command mode where the default device settings can be changed. We can operate the device in either of these two modes by using the key pin as explained in the pin description.

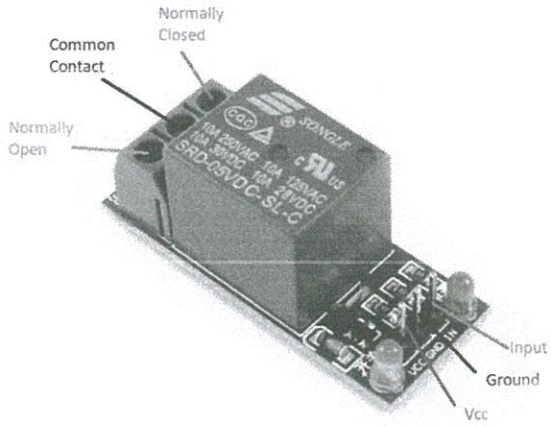
It is very easy to pair the HC-05 module with microcontrollers because it operates using the Serial Port Protocol (SPP). Simply power the module with +5V and connect the Rx pin of the module to the Tx of MCU and Tx pin of module to Rx of MCU as shown in the figure below



During power up the key pin can be grounded to enter into Command mode, if left free it will by default enter into the data mode. As soon as the module is powered you should be able to discover the Bluetooth device as "HC-05" then connect with it using the default password 1234 and start communicating with it. The name password and other default parameters can be changed by entering into the

2.4 Relay Module





Relay is an electromechanical device that uses an electric current to open or close the contacts of a switch. The single-channel relay module is much more than just a plain relay, it comprises of components that make switching and connection easier and act as indicators to show if the module is powered and if the relay is active or not.

Single-Channel Relay Module Pin Description

Pin Number	Pin Name	Description
1	Relay Trigger	Input to activate the relay
2	Ground	0V reference
3	VCC	Supply input for powering the relay coil
4	Normally Open	Normally open terminal of the relay
5	Common	Common terminal of the relay
6	Normally Closed	Normally closed contact of the relay

Single-Channel Relay Module Specifications

- Supply voltage – 3.75V to 6V
- Quiescent current: 2mA
- Current when the relay is active: ~70mA
- Relay maximum contact voltage – 250VAC or 30VDC
- Relay maximum current – 10A

Alternate Relay Modules

Dual-channel relay module, four-channel relay module, 8-channel relay module.

Alternate Switching Modules

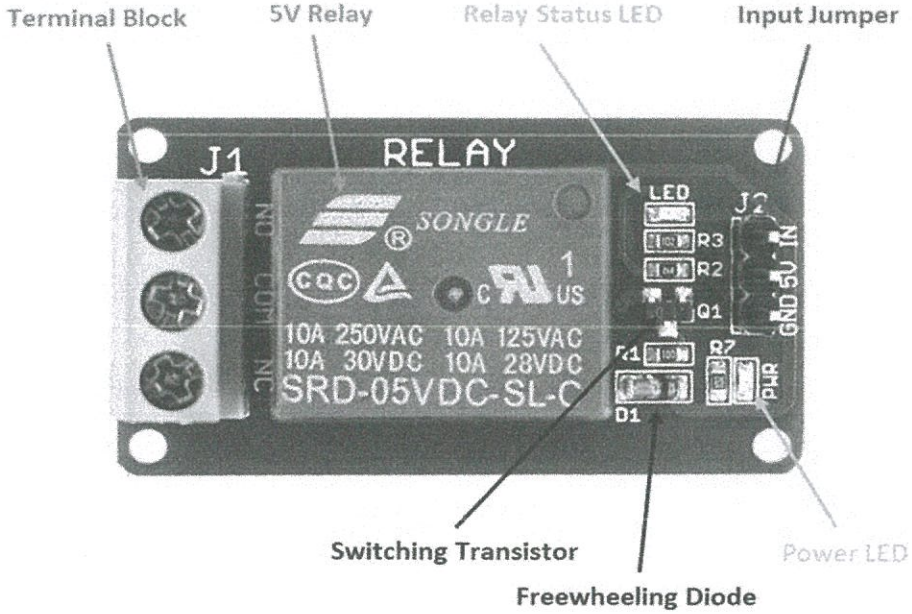
Solid State Relay Module, TRIAC, SCR

Components Present on a 5V Single Channel Relay Module

The following are the major components present on a relay module; we will get into the details later in this article.

5V Relay, Transistor, Diode, LEDs, Resistors, Male Header pins, 3-pin screw-type terminal connector, etc.

Understanding 5V Single-Channel Relay Module



The single-channel relay module is much more than just a plain relay, it contains components that make switching and connection easier and act as indicators to show if the module is powered and if the relay is active.

First is the screw terminal block. This is the part of the module that is in contact with mains so a reliable connection is needed. Adding screw terminals makes it easier to connect thick mains cables, which might be difficult to solder directly. The three connections on the terminal block are connected to the normally open, normally closed, and common terminals of the relay.

The second is the relay itself, which, in this case, is a blue plastic case. Lots of information can be gleaned from the markings on the relay itself. The part number of the relay on the bottom says "05VDC", which means that the relay coil is activated at 5V minimum – any voltage lower than this will not be able to reliably close the contacts of the relay. There are also voltage and current markings, which represent the maximum voltage and current, the relay can switch. For example, the top left marking says "10A 250VAC", which means the relay can switch a maximum load of 10A when connected to a 250V mains circuit. The bottom left rating says "10A 30VDC", meaning the relay can switch a maximum current of 10A DC before the contacts get damaged.

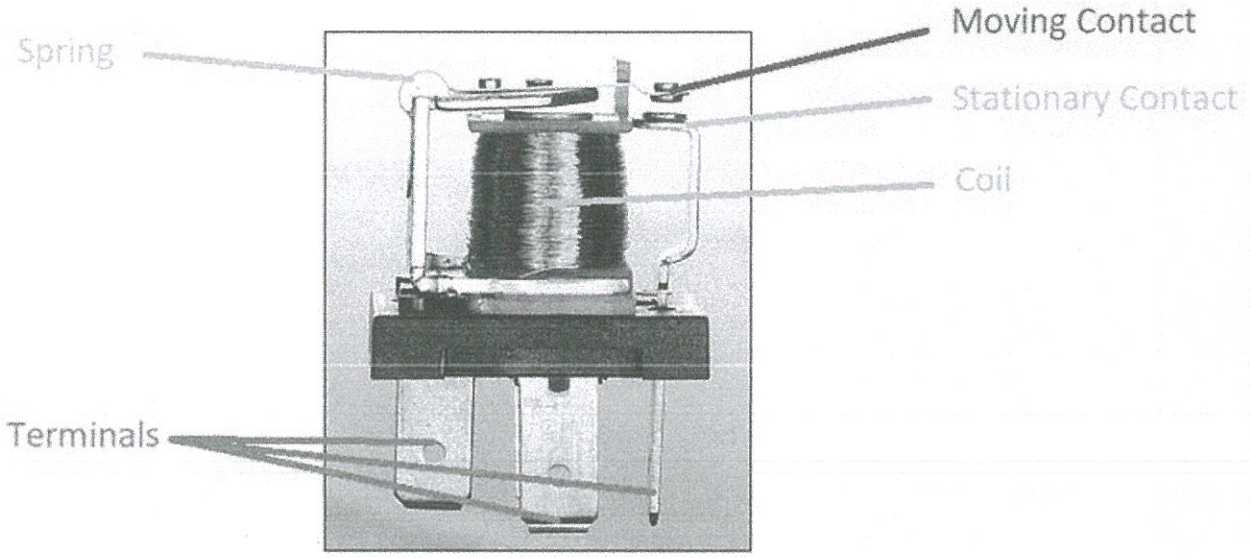
The 'relay status LED' turns on whenever the relay is active and provides an indication of current flowing through the relay coil.

The input jumper is used to supply power to the relay coil and LEDs. The jumper also has the input pin, which when pulled high activates the relay.

The switching transistor takes an input that cannot supply enough current to directly drive the relay coil and amplifies it using the supply voltage to drive the relay coil. This way, the input can be driven from a microcontroller or sensor output. The freewheeling diode prevents voltage spikes when the relay is switched off.

The power LED is connected to V_{cc} and turns on whenever the module is powered.

How Does A Relay Work?

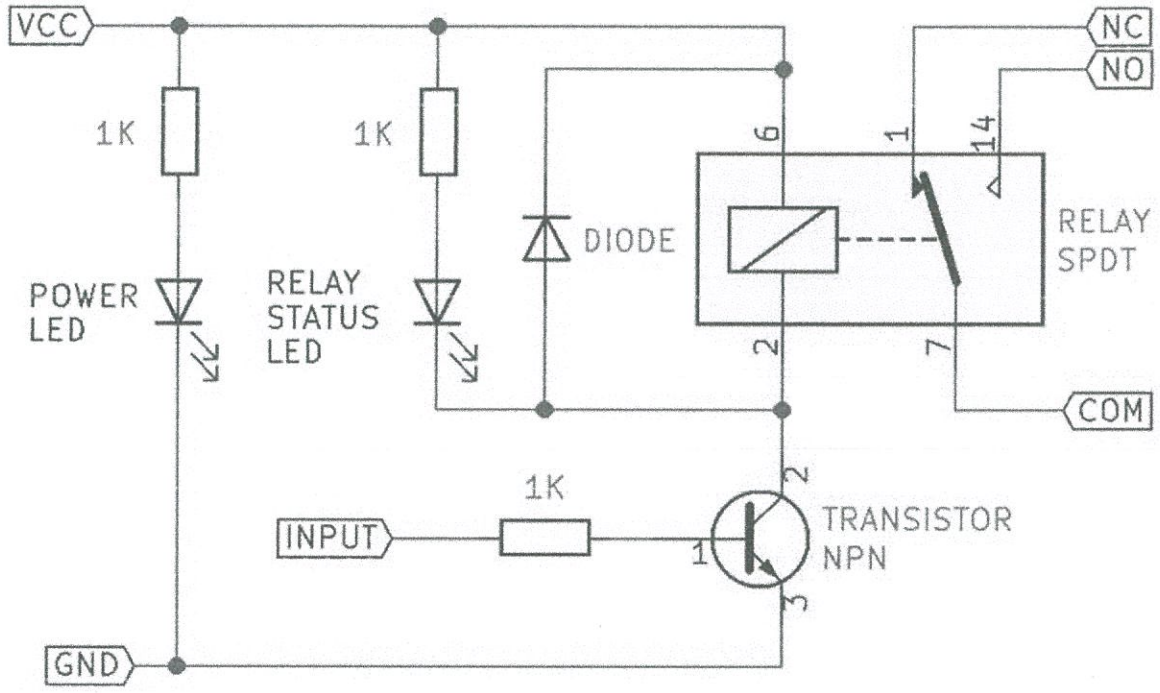


The relay uses an electric current to open or close the contacts of a switch. This is usually done using the help of a coil that attracts the contacts of a switch and pulls them together when activated, and a spring pushes them apart when the coil is not energized.

There are two advantages of this system – First, the current required to activate the relay is much smaller than the current that relay contacts are capable of switching, and second, the coil and the contacts are galvanically isolated, meaning there is no electrical connection between them. This means that the relay can be used to switch mains current through an isolated low voltage digital system like a microcontroller.

Internal Circuit Diagram for Single Channel Relay Module

The circuit on the PCB is quite simple.



Relay Module Basic Schematic

The extra components apart from the relay are there since it would not be possible to drive the relay directly from the pins of a microcontroller. digital logic or a sensor. This is because although the coil consumes much less current than the currents it can switch, it still needs relatively significant current – low power relays consume around 50mA while higher power relays consume around 500mA. The coil is also an inductive load, so when the coil is switched off, a large flyback voltage is developed which can damage the device turning it on and off. For this reason, a flyback diode is added anti-parallel to the relay coil to clamp the flyback voltage.

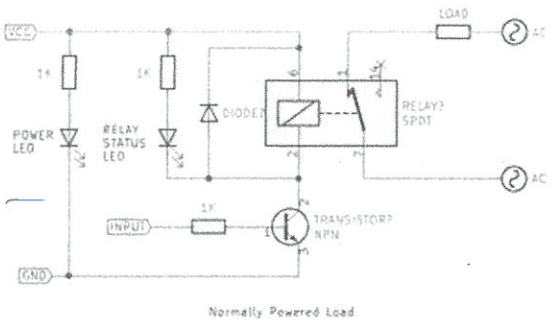
-

LEDs can be added to this basic circuit to act as indicators, and sometimes even optical isolation is added to the input to further improve the isolation.

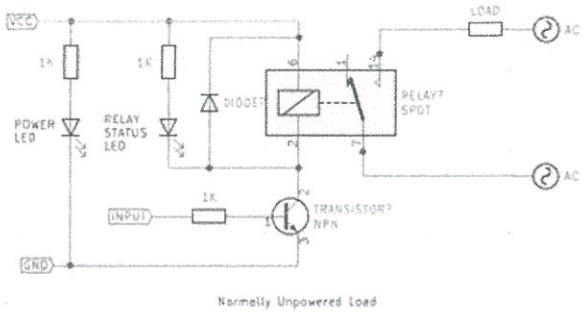
-

How to use Single-Channel Relay Module

Relay modules like this one are commonly used to drive mains loads from a microcontroller like the Arduino or a sensor. In cases like this, the common circuit diagram would be as follows.



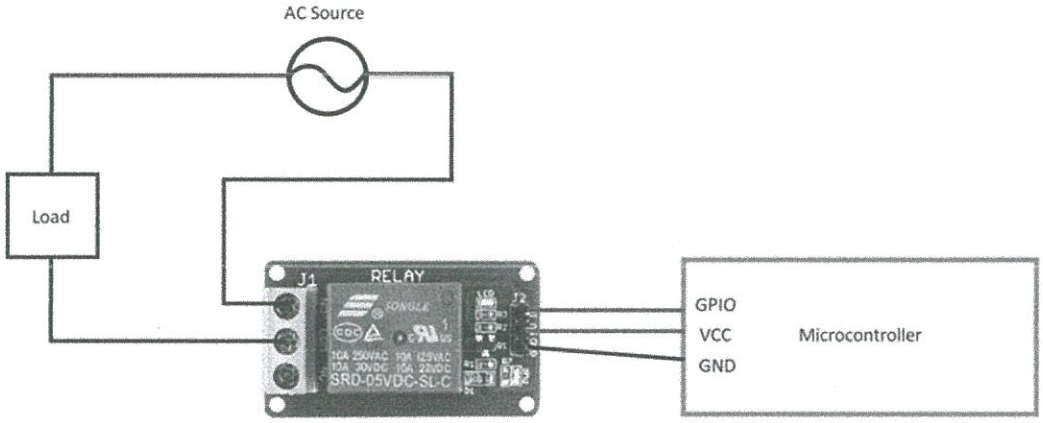
Normally Powered Load



Normally Unpowered Load

For simple on/off applications, the relay can be connected as shown above. One terminal of mains is connected to common, and the other is connected to NO or NC depending on whether the load should be connected/disconnected when the relay is active.

Check out the image below to see how the relay module is connected to a microcontroller and mains source and load.



The mains wiring is screwed to the terminal block, and the microcontroller can be connected using jumper cables.

Single-Channel Relay Module Basic Trouble Shooting

If the relay does not switch on, i.e. no audible clicking sound is heard:

- The contacts might be stuck - Check by physically shaking the relay, if a light clicking sound is not heard, then tap the relay hard, in most cases, this should 'unstick' both the contacts.
- If the contacts do click when the relay is shaken, then the transistor or the flyback diode might be damaged and must be replaced.

Single-Channel Relay Module Applications

- Mains switching
- High current switching

Chapter 3

Board Circuitry

3.1 Board Circuitry

Aim : Advancement in technology has brought lot's of change in today's world. So, in this tutorial we are going to learn about home automation using Arduino, Relay and Bluetooth Module. Here, we have automated our four room appliances namely AC, Bulb, Heater, Fan.

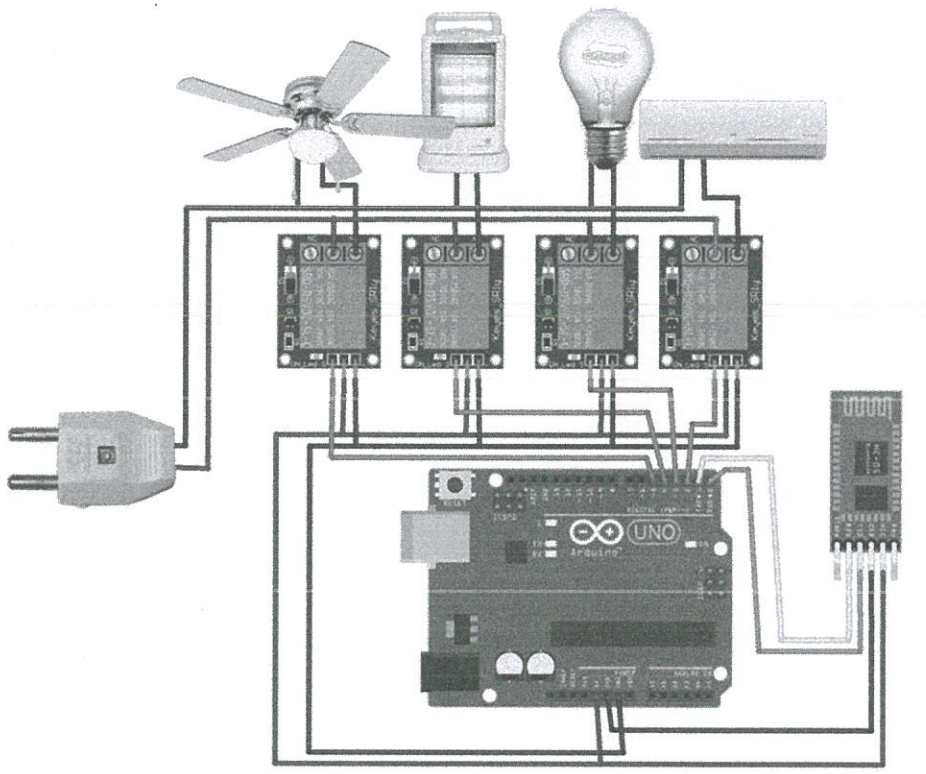
Let's get started with the today's tutorial.

Components Required:

1. Arduino UNO X 1
2. 5 Volt Relay Module X 4
3. HC-05 Bluetooth Module X 1
4. Any four home appliances according to your desire

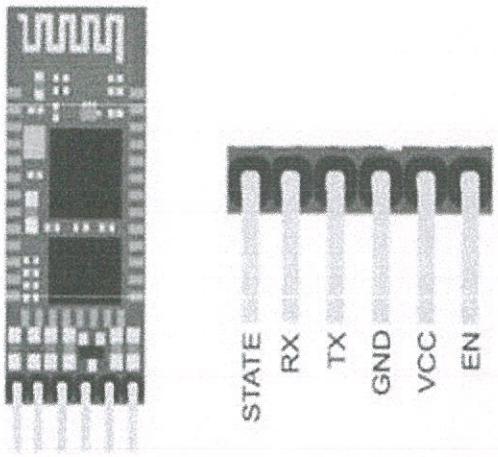
Circuit Diagram:

(NOTE: First upload the code to the Arduino board and then only do the given below circuit in order to avoid the short circuit from the previously uploaded code.)



www.roboticsinsighto.com

About HC-05 Bluetooth Module:



It is a small portable device that is used to be connected in the Arduino board so that it can communicate with mobile or smartphone.

It has 6 pins, among which we are concerned with only 4 pins;

- PIN 2 (RXD for receiving information from smartphone through Bluetooth medium)
- PIN 3 (TXD for transmitting information from smartphone through Bluetooth medium)
- PIN 4 (GND for grounding or zero potential point)
- PIN 5 (VCC for supply of 5 Volt in order to power up HC-05)

The TXD pin of Arduino is connected to RXD pin HC-05 and the RXD pin of Arduino is connected to TXD pin of HC-05.

Here, TXD = 1 in Arduino means transmission of information from Arduino to HC-05.
And, RXD=0 in HC-05 means receiving information from from Arduino to HC-05.

Also, TXD = 1 in HC-05 means transmission of information from HC-05 to Arduino.
And, RXD=0 in Arduino means receiving information from from HC05 to Arduino.

Chapter 4

Code Circuit

4.1 Code Circuitry

Coding:
Copy and pest the given below code to the Arduino IDE board and compile it.

```
long int ac=2;
long int bulb=3;
long int heater=4;
long int fan=5;
char x;
void setup()
{
pinMode(ac,OUTPUT);
pinMode(bulb,OUTPUT);
pinMode(heater,OUTPUT);
pinMode(fan,OUTPUT);
digitalWrite(ac,LOW);
digitalWrite(bulb,LOW);
digitalWrite(heater,LOW);
digitalWrite(fan,LOW);
Serial.begin(9600);
}
void loop()
{
  if(Serial.available()>0)
  {
  x=Serial.read();
  }
  if(x=='a')
  digitalWrite(ac,HIGH);
  if (x=='b')
  digitalWrite(ac,LOW);
  if (x=='c')
  digitalWrite(bulb,HIGH);
  if(x=='d')
  digitalWrite(bulb,LOW);
  if(x=='e')
  digitalWrite(heater,HIGH);
  if(x=='f')
  digitalWrite(heater,LOW);
  if(x=='g')
  digitalWrite(fan,HIGH);
  if(x=='h')
  digitalWrite(fan,LOW);
}
```

Application Instillation:
From the given below link install the app from google play store to your smartphone and connect it as given below process:

https://play.google.com/store/apps/details?id=com.bluetoothcontroller

1. Turn on your smartphone Bluetooth
2. Install and open the app
3. Click on connect to bluetooth
4. Click on HC-05
5. It will ask code, put code '1234' if it doesn't work then put '0000' if this step doesn't work here then goto step 1 and try connect manually with same codes and then follow from step 2.
6. Press OK or Connect and now you are done

In this way you can make your own home automated system using Arduino, Relay and Bluetooth Module(HC-05).