National Institute of Technology

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Design of a Controller for Simultaneous Control of Multiple Systems in Wireless Scenario

A thesis submitted in partial fulfillment of the requirements for the degree of

Bachelor of Technology in
Electronics & Communication Engineering

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Certificate

This is to certify that the thesis titled "***Design of a Controller for Simultaneous Control of Multiple Systems in Wireless Scenario"***, is submitted to National Institute of Technology, Rourkela by **Mr. Rakesh Swain**, Roll No**. 109EC0247** and **Mr. Soumya Ranjan Mohapatra**, Roll No. **109EC0287** for the award of the degree of Bachelor of Technology in Electronics & Communication Engineering, is a bona fide record of research work carried out by both under my supervision and guidance. To the best of my knowledge the matter embodied in the thesis has not been submitted to any other University/Institute for the award of any degree or diploma**.** In my opinion, the thesis is of standard required for the award of a Bachelor of Technology degree in Electronics & Communication Engineering.

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Abstract

Wireless technology is becoming an ever-emerging part of human life with new services and products being released every month. Thus wireless communications brings huge benefits to the user or users.The used Radio Frequency (RF) Module is basically an Advanced Virtual RISC (AVR) microcontroller based communication system. The RF Module used in our project contains two units transmitter and receiver. The transmitter module converts parallel data into serial by using HT12E encoder prior to wireless transmission. The encoded data get received by receiver and converts or decodes the serial data into parallel by using HT12D decoder. After converting the data into parallel form which is made use by AVR16A micro controller to generate instructions for operation of relays connected to two different bulbs.

CHAPTER-1

Introduction

1.1 What is wireless?

Wireless is a term used to describe telecommunications in which electromagnetic waves carry the signal over part or all of the communication medium. Some monitoring devices, such as intrusion alarms, uses acoustic waves at frequencies more than the range of human hearing; these are also sometimes classified as wireless.

Wireless technology is rapidly evolving and emerging, and thus is playing an increasing role in the lives of people all over the world. Additionally, ever larger numbers of people are relying on the technology directly or indirectly. (Thus it has been suggested that wireless is overused in some situations, creating a social disturbance.)

1.2 Examples of wireless devices

• ***Cellular phones and pagers*** -- provide connectivity for portable and mobile applications, that includes personal and business

• ***Global Positioning System (GPS)*** -- allows cars and trucks drivers, boats and ships captains, and pilots of aircraft to as
confirm their location anywhere on earth

• ***Cordless computer peripherals*** -- the cordless mouse is a common example; keyboards can also be linked to a computer via wireless

• ***Cordless telephone sets*** -- these are limited-range devices, that should not to be confused with cell phones

• ***Home-entertainment-system control boxes*** -- the VCR control and the TV channel control are the common examples; some hi-fi sound systems and FM broadcast Receivers also use this technology

• ***Remote garage-door openers*** –these devices are one of the oldest wireless devices in common use by consumers that operates at Radio frequencies

• ***Two-way radios*** -- this includes Amateur and Citizens Radio Service with business, marine, and military communications

• ***Baby monitors*** -- these devices are simplified radio transmitter/receiver units with very limited range

• ***Satellite television*** --that allows viewers in almost any location to select from hundreds of channels.

1.3 Main factor affecting any Wireless Module‟ s Performance

As with any wireless device, the performance of a wireless Module will depend on a number of parameters. For example, by increasing the transmitter power, a very large communication distance will be achieved. However, this will also result in a higher electrical power loss on the transmitter device, that will cause shorter operating life for battery powered devices. Again also, using a higher transmit power makes the system more prone to interference with other wireless devices, and that may in fact possibly cause the device to become illegal depending on the jurisdiction.

1.4 Typical applications/scope of Wireless RF Module

- Vehicle Monitoring
- Remote Control
- Telemetry
- Small-Range wireless network
- Wireless meter reading
- Access control systems
- Wireless home security systems
- Area paging
- Industrial data acquisition system
- Radio tags reading
- RF contact less smart cards

CHAPTER-2

GSM Module

2.1. Objective to study the peripheral

a. To understand the working of cellphone .
b. To interface the GSM modem with microcontroller.
c. To know and understand the AT commands and implement it in GSM modem.

2.2. Pre-requisites

a. Knowledge on UART.
b. Knowledge on microcontrollers.
c. Knowledge on C programming.

2.3. Part List

a. Microcontroller board.
b. GSM Modem.
c. USB to Serial converter.

2.4. Introduction of the device

a. Global System for Mobile communications (GSM) is a second-generation (2G) wireless technology which provides high-quality voice and circuit-switched data services in a wide variety of spectrum bands, including 850, 900, 1800 and 1900 MHz. GSM is a digital or "PCS" technology, and "GSM family of technologies" is often used as a catch-all term to refer to GPRS, EDGE and UMTS/HSDPA/HSUPA, which provide a very smooth, cost-efficient evolution to third generation (3G). This GSM is expected to account for up to 85% of next-generation customers worldwide, according to the UMTS Forum.

b. GSM is the most widely used wireless technology in the world available in more than 210 countries and territories worldwide and more than 1.6 billion customers globally [as of September 2005], which represents more than 75% of all wireless customers.

c. GSM allows multiple users to share a single radio channel through a technique called time division multiplexing (TDM), where a channel is divided into six time slots. And then each caller is assigned a specific time slot for transmission, thatallows multiple callers to share a single channel simultaneously without interfering with one another. So this design makes efficient use of spectrum and provides seven times more capacity than analog or "AMPS", which is a first-generation (1G) technology. This GSM also uses a technique called "frequency hopping" that decreases interference from outside sources and makes eavesdropping virtually impossible.

d. GSM is a technology which is the leading cell phone standard throughout the world. Back in 1982 it was recognized as a standard for digital wireless communications and was first adopted in Europe and then by Asia. But the first system was started online in 1991 and GSM was formerly known as Group Special Mobile but now it stands for Global System for Mobile communications But USA, however has not adopted GSM as a standard and so different carriers now use a lot of technologies as opposed to only GSM.

e. GSM uses digital technology and the methods of time division multiple access transmission. As seen in GSM, sound is digitally prearranged through a very special encoder, that imitates the distinctiveness of human speech and this method of transmission allows a competent statistics speed/information content ratio.

f. GSM is an open system and is a non propriety technology. But one of the great benefits of GSM is that it facilitates international roaming. Since it is adopted by more than 170 countries, where you have the facility of using your GSM cell phone in all these places without having to modify/change your number. This GSM satellite roaming has widened the scope of cellular services even to areas where standard terrestrial services are not at all possible.

g. GSM is a technology that is rapidly growing and constantly emerging with satellite, wireless and cordless systems offering greatly expanded services. All these services include multimedia data services, very high speed, along with inbuilt support for simultaneous use of these services and faultless incorporation with the Internet and wire line networks. This 3 GSM is already charted out and will make available services enhancing the already existing services like data, voice and text. GSM will provide video on demand and will help to decrease the gap between wireless and internet/computers.

h. GSM works on different frequency bands around the world. But in North America it uses a 1900 MHz frequency whereas in different parts of the world it uses either 900MHz or 1800 MHz. So as different frequencies are used in various places, your GSM handset should support various bands so that it can be used globally.

i. From the very beginning, this GSM has been developed with the need to give its customers utmost security in terms of secure communications and prevention of fraud, and providing call privacy. Today it is the world most secure public wireless standard for cellular phones.

2.5. Features of the device

a. Dual band EGSM module (EGSM 900/1800 MHz) designed for M2M and automotive applications.
b. Compliant with ETSI GSM Phase 2+ standard.
c. Class 4 (2W @ 900MHz).
d. Class 1 (1W @ 1800MHz).
e. Less than 3.5mA current is required during the idle mode.
f. Remote control by AT commands (according to standard used those are GSM 07.07 and GSM 07.05).
g. Standard RS-232 interface using 9 pin D connector provided with the device for communication.
h. Modem can be linked to a PC or a micro-controller based embedded system for sending SMS.
i. Data circuit asynchronous, transparent and non-transparent upto14400 bits/s and baud rate of 30-115,200 bits/s.

j. Coding schemes: CS1 to CS4.
k. Point to Point(MT/MO) and Cell Broadcast.
l. Latch type SIM holder (3V/5V SIM interface).

2.6. Operation of the device with flow chart

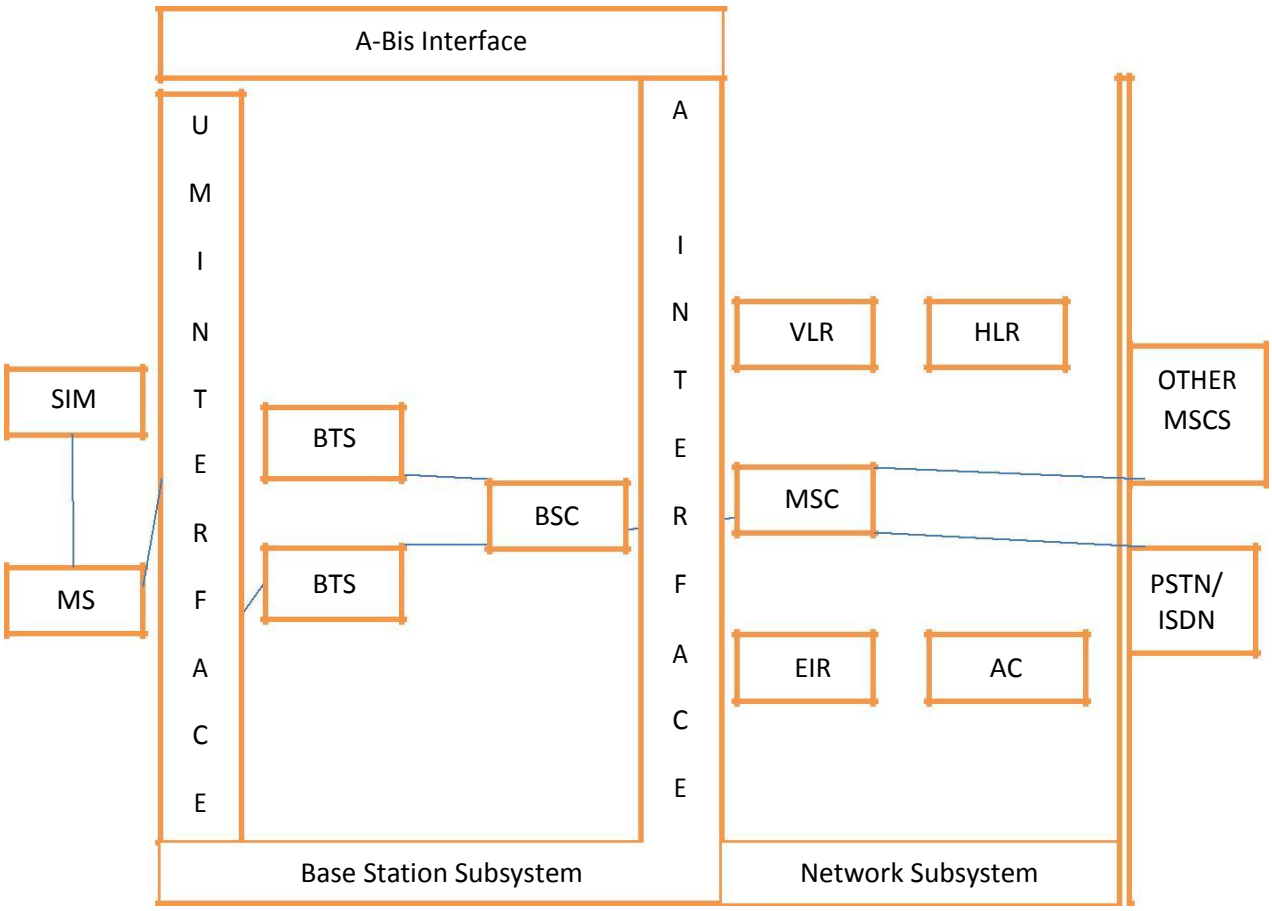

Figure 2.1 Skeleton Structure of GSM Modem

SIM -Subscriber Identity Module
MS -Mobile Station
BTS -Base Transceiver Station
BSC -Base Station Controller
MSC -Mobile services Switching Center
VLR -Visitor Location Register
HLR- Home Location Register
VLR -Visitor Location Register
EIR -Equipment Identity Register
AC -Authentication Center
PSTN -Public Switched Telecomm Network
ISDN -Integrated Services Digital Network

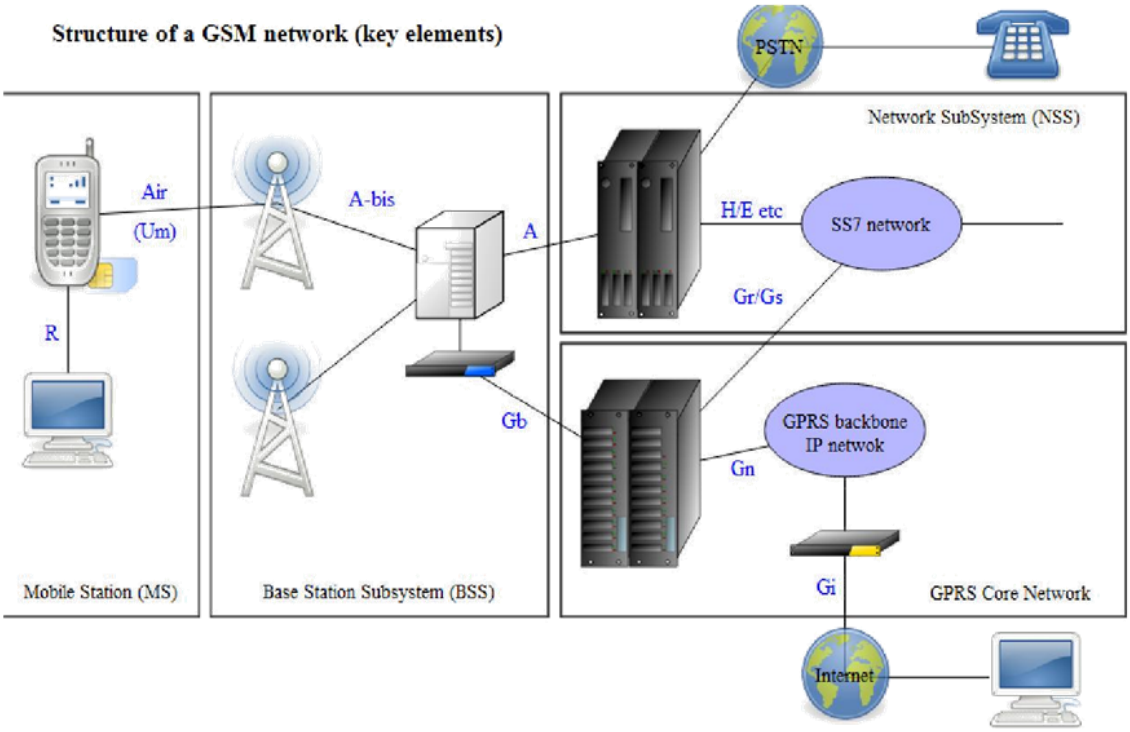

Figure 2.2 Structure of a GSM network

The figure shows the layout of a generic GSM network. The GSM network has be divided into three broad parts. In the left part includes the Mobile Station is carried by the subscriber, then the Base Station Subsystem controls the radio link with the Mobile Station. And finally the Network Subsystem, the main part of which is known as the Mobile services Switching Center, does the work of switching of calls between the mobile and other fixed or mobile network users, along with management of mobile services, such as authentication. But not shown is the Operations and Maintenance center, that oversees the proper operation and setup of the network. This Mobile Station and the Base Station Subsystem communicate across the Um interface, also known as the air interface or radio link and the Base Station Subsystem communicates with the Mobile service Switching Center across the A interface.

2.7. Modes of operation

There are 2 ways of sending and receiving SMS messages: by text mode and by PDU (protocol description unit) mode. The text mode (unavailable on phones) is just an encoding of the bit stream represented by the PDU mode. The alphabets may differ and there are various encoding alternatives when displaying an SMS message. The most common options are "PCCP437", "PCDN", "8859-1", "IRA" and "GSM". These are all set by the at-command AT+CSCS, when you read the message in a computer application. If you read the message on your phone, then a phone will choose a proper encoding. Thus the application capable of reading incoming SMS messages, can thus use text mode or PDU mode. So if text mode is used, the application is bound to (or limited by) the set of preset encoding options. But in some cases, that's just not good enough whereas if PDU mode is used, any encoding can be implemented.

2.8. Required Calculation or Commands to operate the device

AT COMMANDS		
Sl.no	Commands	Usage
1.	AT	To test the connection with GSM modem
2.	ATD	To call to number 999999999
3.	ATDL	Dial the last outgoing number
4.	ATH	Hangup the call
5.	ATA	Answer a call
6.	ATE	Enable echo
7.	ATO	Switch from command mode to data mode
8.	ATP	Perform pulse dialing
9.	ATS0	Set Auto Answer
10.	ATI	Prompt manufacture identification
11.	AT+CRC	Set incoming call type
12.	AT+CLVL	Set call volume
13.	AT+CLIP	Set caller ID presentation
14.	AT+ZSETMUTE	Mute control
15.	AT+CIMI	Inquire international ID
16.	AT+CGMR	Obtain product version
17.	AT+ECHO	Remove ECHO
18.	AT+CLCK	Function lock
19.	AT+CCFC	Set call forwarding number and condition
20.	AT+CCWA	Call waiting control
21.	AT+CHLD	Call hold and multiple session
22.	AT+CPWD	Change password
23.	AT+CSCA	Set SMS center number
24.	AT+CNMA	Confirm SMS
25.	AT+CMGF	Set SMS mode
26.	AT+CNMI	Set SMS indicator format
27.	AT+CMGR	View SMS
28.	AT+CSMS	Select SMS service
29.	AT+CMGD	Delete a message
30.	AT+CMGL	Message List
31.	AT+CPBS	Select Phonebook
32.	AT+CPBR	Read Phone Book
33.	AT+CPBW	Write phonebook
34.	AT+CPBF	Find Phonebook

Table 2.1 AT Commands

2.9. Interfacing of the device with Micro Controller

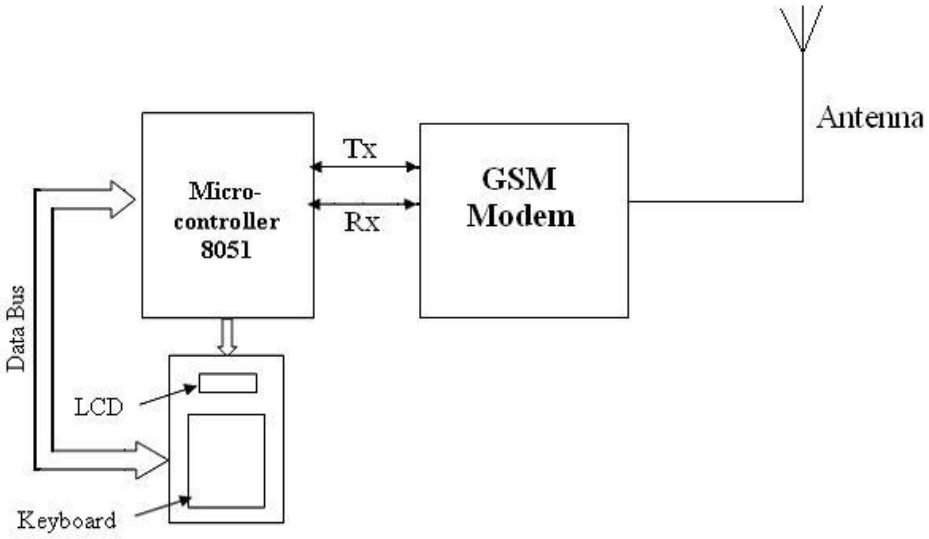

Figure 2.3 Interfacing of the device with microcontroller

This project is based on the 8051 Microcontroller, in which we can transmit/receive SMS(Short Message Service).GSM stands for Global System for Mobile communication. In this we have used GSM e Modem. SIM Card is inserted in Modem to store the transmitted/received data. Antenna is used to transmit/receive the data. In the field of Microcontroller, serial communication is an important concept since saving of port pin is much concerned so we have also used serial communication method to transmit/receive the SMS. Phonebook facility is also done in this project and using LCD or Keyboard interfacing card we can read/write the phonebook which is stored inside the SIM Card.

This project is basically carried out to explain the serial communication method. The project consists of GSM Modem, Antenna, Power Cable, EPB (Educational Practice Board) Microcontroller kit, LCD/Keyboard interface kit, Serial Cable, power Supply etc. In this project, we have provided two modes viz. (i) Transmit mode and (ii) Receive mode which can be used respectively to transmit some data and to receive some data.

After dumping the code in the microcontroller the serial communication cable between computer and microcontroller is removed and the connection is made between gsm modem and microcontroller through

2.10. Application of the device

a. Pre-stored messaging.
b. Remote home appliance control.
c. Industrial warning system.
d. Automatic Meter Reading (AMR).
e. Fleet/Traffic Management (with optional GPS integration).
f. Security Systems.
g. Remote Data logging and reporting.
h. Low cost router.
i. Remote monitoring of Vending machines.

2.11. Advantages and Disadvantages of the device

GSM's advantages can be divided into two main categories: user benefits and operator benefits.

Key user benefits include:

a. **Coverage:** GSM is the most widely available wireless technology in the world, available in more than 210 countries and territories worldwide. As a result, GSM customers have constant access to high-quality voice and enhanced services (e.g. text messaging) in their home region and while traveling. Extensive coverage is particularly attractive to businesspeople who want to be accessible with their current mobile device and phone number while traveling throughout the Americas and the rest of the world.
b. **Selection:** With more than 1.6 billion customers in the world, or more than 75% of the world‟ s wireless customers, GSM is the logical selection. In the Americas alone, GSM‟ s growth rate has increased each year. This market size requires large volumes of handsets, which translate into a wide selection of devices with a variety of features and prices. Low-cost devices make GSM-based data networks, such as GPRS, attractive to third-party service providers who offer such services (e.g. telemetry).
c. **Voice Quality:** GSM provides clear voice calls. Although data is an increasingly popular wireless application, voice will continue to be the primary reason that people use wireless technology.
d. **Flexibility:** Thanks to a unique, innovative feature called the Subscriber Identity Module (SIM) card, customers can easily switch GSM devices – such as buying a new phone or adding a GSM/GPRS PC Card modem – without the hassle of configuring the new device or losing personalized subscription services (e.g. messaging). In addition, the SIM card makes it simple for users to change GSM operators and keep the same phone, and the SIM card flexibility makes GSM-based data networks, such as GPRS, attractive to various data applications (e.g. telemetry).
e. **Innovative Services:** GSM pioneered many of the world‟ s most popular services. A prime example is Short Message Service (SMS), which supports text messages and content such as ringtones. Just as important, GSM‟ s roaming abilities let users access their favorite services while traveling.

The key operator benefits include:

f. **Economies of scale:** GSM is the most widely used wireless technology in the world, available in more than 210 countries and territories worldwide. More than one billion customers in the Americas, Asia and Europe, or more than 75% of the world‟ s wireless customers, use GSM. This market size requires high volumes of handsets and infrastructure, that attract vendors and application developers while reducing costs.So with this lower overhead, GSM operators can in turn price their services more competitively.

g. **Coverage:** GSM is available in more than 210 countries and territories worldwide. As a result, GSM operators can emphasize that customers have constant access to high-quality voice and enhanced services at home and while traveling. Extensive coverage is particularly attractive to the businessperson, a high-revenue generating customer, who wants their current mobile device and phone number to be accessible while traveling throughout the Americas and the rest of the world.

h. **Flexibility:** GSM infrastructure and devices are available for the most popular spectrum bands, including 850 and 1900 MHz, which gives operators multiple deployment options to fit their spectrum requirements and market needs. The GSM community‟ s close attention to standards also ensures interoperability between infrastructure and devices from multiple manufacturers, which provides operators with more than one equipment selection options.

i. **Efficiency:** GSM makes efficient use of spectrum and provides seven times more capacity than analog or “AMPS”, which is a first-generation (1G) technology. EDGE, along with enhancements such as Adaptive Multi-rate Codec (AMR), provide an additional increase of nearly three times the number of simultaneous voice calls as basic GSM.

j. **Upgradeability:** GSM is the first step for a cost-effective and flexible migration to 3G. In each next step leverages the former step, and gives backward compatibility, assuring that investments and customers are maintained during the migration. These standards behind GSM‟ s upgradeability and interoperability are supported and coordinated by key international organizations like the Third Generation Partnership Project (3GPP) and 3G Americas.

CHAPTER-3

Zigbee Module

3.1. Objective to study the peripheral

a. To understand the study of RF module communication.
b. To interface the ZigBee module with the microcontroller.
c. To know and understand the data transfer between two ZigBeemodule.

3.2. Pre-requisites

a. Knowledge on Uart.
b. Knowledge on microcontrollers.
c. Knowledge on C programming.

3.3. Part List

a. .Microcontroller board.
b. ZigBee Module.
c. USB to Serial converter.

3.4. Introduction of the device

Zigbee modules are designed for low to medium transmit power and for high reliability wireless networks. These modules require minimal power and provide reliable delivery of data between devices and the interfaces provided with the module help to directly fit into many industrial applications. These modules operate within the standards ISM 2.4-2.4835 GHz frequency band with IEEE standard 802.15.4 baseband.

3.5. Types of the device

1. ZigBee coordinator (ZC): The most capable device, this Zigbee coordinator builds the root of the network tree and might bridge to other networks. But there is exactly one ZigBee coordinator in every network since it is the device that started the network originally. However, it stores information about the network which includes acting as the Trust Center and repository for security keys.

2. ZigBee Router (ZR): Along with running an application function, the other function a router can act is as an intermediate router,that passes on data from other devices.

3. ZigBee End Device (ZED):It just contains enough functionality to talk to the parent node (either the coordinator or a router); that cannot relay data from other devices. Hence this relationship allows the node to be asleep a significant amount of the time thereby giving long battery life. Well a ZED requires the least amount of memory, and so can be less expensive to manufacture than a ZR or ZC.

3.6. Features of the device

1. Range - Indoor/Urban: up to 300 mts.
2. Range - Outdoor line of sight: up to 50kms with directional antenna.
3. Transmit Power: up to 1 watt / 30 dBm nominal.
4. Receiver Sensitivity: up to –107 dBm.

5. RF data rate: 250 kbps.
6. AT Command Modes for configuring Module Parameters
7. Direct sequence spread spectrum technology.
8.Analog to digital conversion and digital I/O line support.

3.7. Structure of the device with block diagram(Architecture)

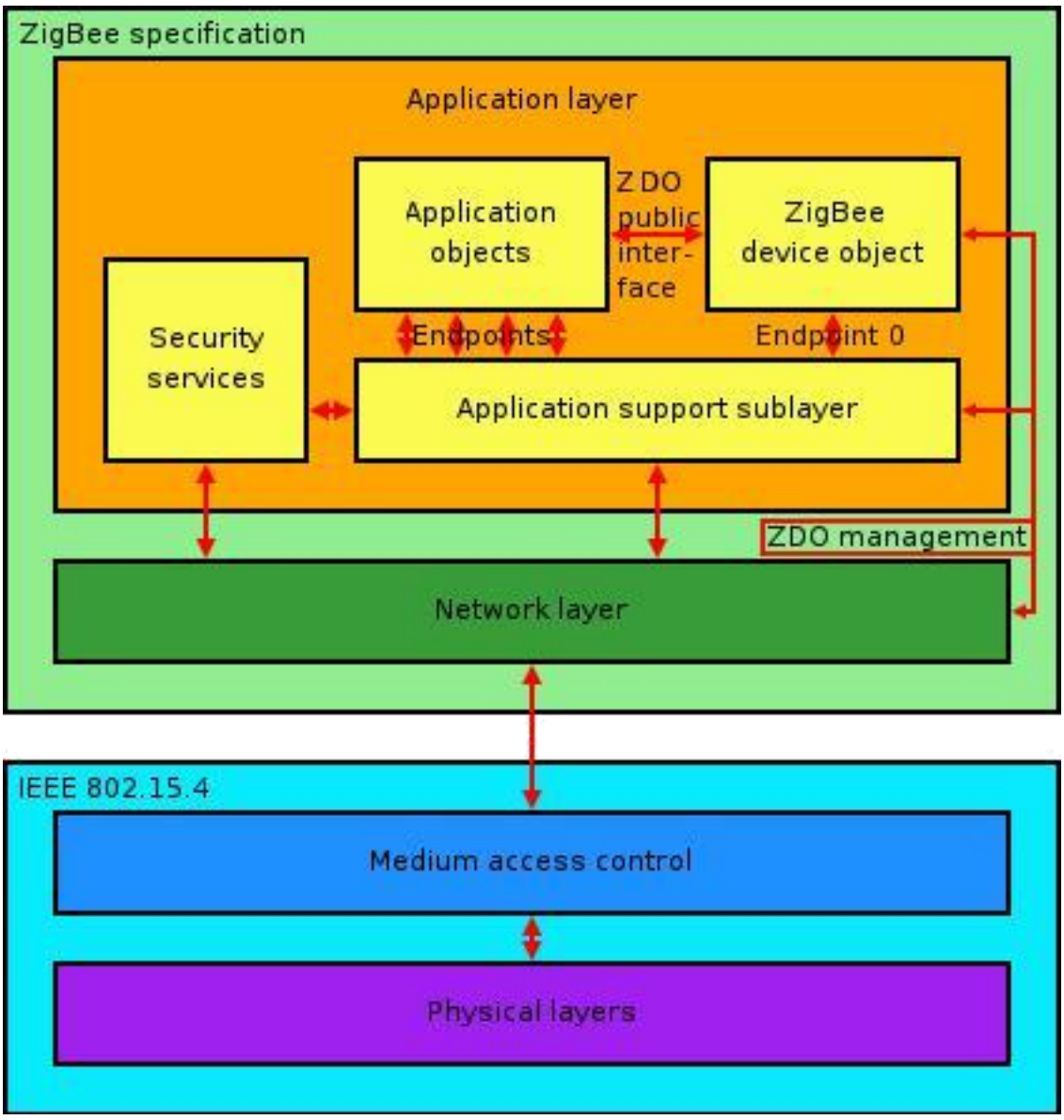

Figure 3.1 Block Diagram of Zigbee

Network Layer

The main functions of a network layer are to enable the correct use of the MAC sub layer and provide a suitable interface for use by the next upper layer, which is named as the application layer. So its capabilities and structure are those typically associated to such network layers, that includes routing.

On the one hand, the data entity creates and manages network layer data units from the payload of the application layer and also performs routing according to the current topology. On the other hand, there is the layer control which is used to handle configuration of new devices and at the same time establish new networks: it can determine whether a neighbouring device belongs to the network and discovers new neighbours and routers. Now the control can also detect the presence of a receiver, that allows direct communication and MAC synchronization.

The routing protocol used by the Network layer is AODV. So in order to find the destination device, the AODV broadcasts out a route request to all of its neighbours. The neighbours and then broadcast the request to their neighbours, etc. for the time till the destination is reached. And once the destination is reached, the protocol sends its route reply via unicast transmission following the lowest cost path back to the source. Now once the source receives the reply, it will then update its routing table for the destination address with the next hop in the path and the path cost.

Application layer

The application layer is the highest-level layer defined by the specification and thus is the effective interface of the ZigBee system to its end users and this layer comprises the majority of components that are added by the ZigBee specification: both ZDO and its management procedures, together with application objects defined by the manufacturer, are thus considered part of this layer.

3.8. Modes of Operation

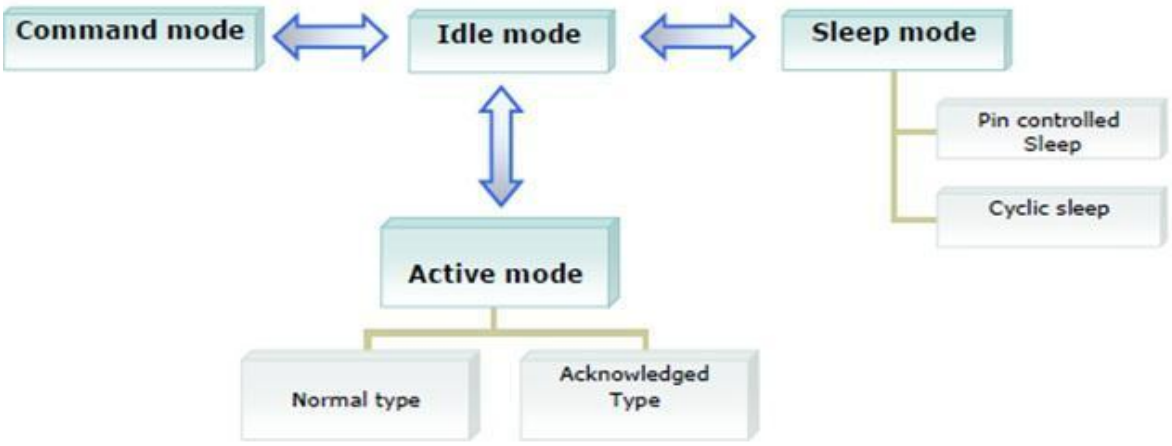

Figure 3.2 Modes of Operation

3.8.1. Idle Mode

1. Active Mode Transmit- When it receives an RF Packet or serial data present in Buffer.
2. Sleep Mode -When sleep mode condition is met.
3. Command Mode - When command sequence is received.

3.8.2. Active Mode

Data Transmission

ZigBee receives the data from host through the serial port.Now the next step before transmitting the data on air is packetization and This part includes adding a communication header, etc.The output power of the module can be configured through „Output Power" parameter depending upon the range of application. The output power ranges from 0 to 0x0F.

Data Reception

Once a data packet is retrieved from air.ZigBee module extracts the contents and pushes out to serial port according to the serial parameters configured. The signal strength of the received packet can be seen through RSSI parameter through „ATPRS" command

Communication Types

It communicates in multiple types

i.Normal Type

ii.Acknowledge Type

3.8.3. Sleep Mode

Sleep Mode enables the RF module to enter the state of low-power consumption when not in use

3.9. Interfacing of the device with micro-controller

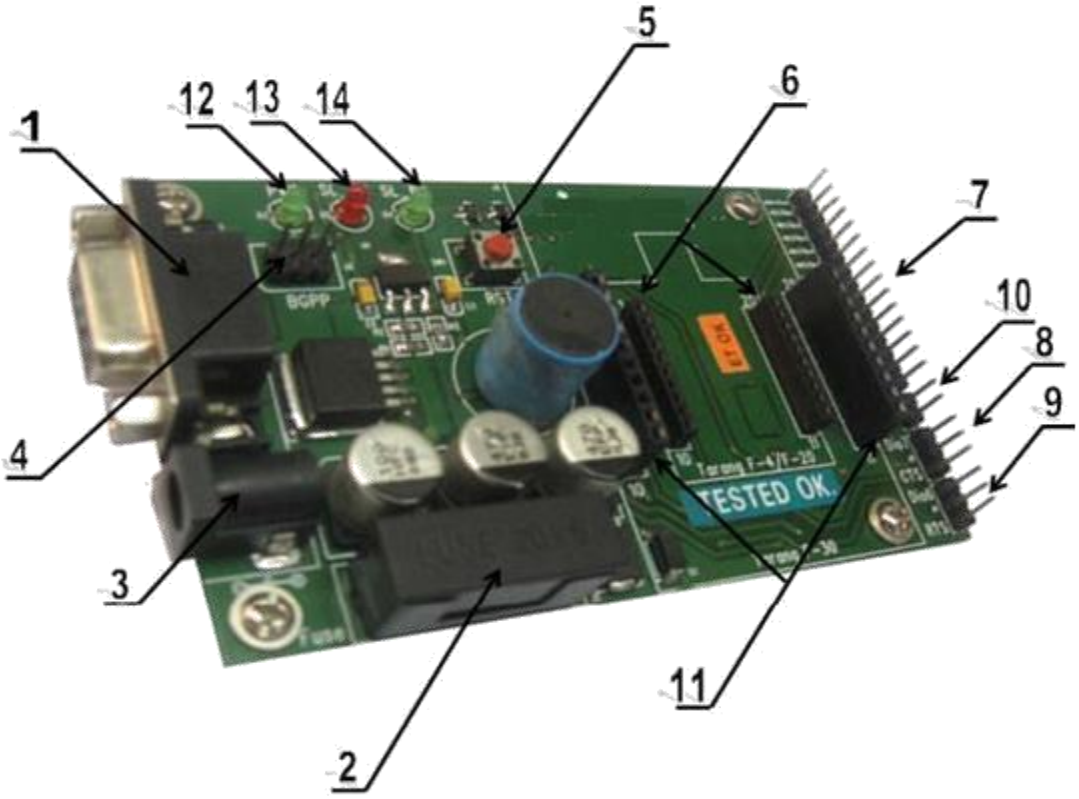

Figure 3.3 ZigBee Interface Board

Interface Board connector details:

1. DB9 Female (P1)
2. Fuse 1A
3. Power Jack Female (J4)
4. Programming Port (BGPP)
5. Reset Switch (RST)
6. Zigbee Module Interface (J1)
7. ADC/ Digital I/O lines (J6.1 to J6.15)
8. CTS/DIO7Selector Pins (J8)
9. RTS/DIO6 Selector Pins (J9)
10. ADC Reference Voltage (J7)
11. Zigbee Module Interface (J5)
12. Power LED (PWR)
13. Serial Transmit LED (SL_TX)
14. Serial Receive LED (SL_RX)

Zigbee Module can be interfaced with a micro controller or a PC using serial port with the help of an appropriate level conversion.

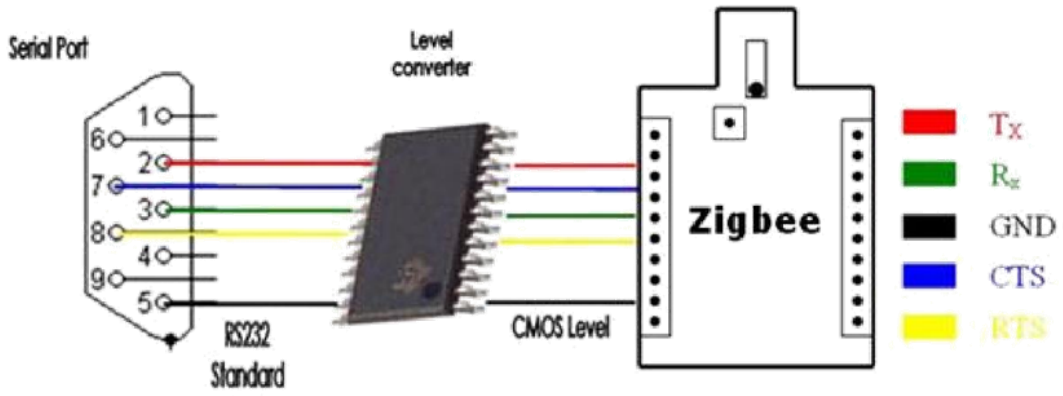

Figure 1.4 Interfacing of Serial port with Zigbee

Module supports serial data with,

- Flow Control : Hardware, None
- Parity : None, Even, Odd
- Baud Rates : 1200, 2400, 4800, 9600, 38400, 57600
- Data Bits : 8

To establish a successful serial communication with this module, the serial parameters that are required to be configured properly in the module and host side.
Both the module , PC settings are viewed and set using AT command set through popular terminal applications like “HyperTerminal”.

3.10. Required Commands to operate the device

Step	Description	Command
1	Enter into the command mode	+++
2	Set the Zigbee in default configuration mode	ATGRD
3	Set the communication channel	ATNCH0
4	Set the Baud-rate	ATSBD3
5	Set the source address	ATNMY1
6	Set the destination address	ATNDA2
7	Save the parameter to memory	ATGWR
8	Exit from the command mode	ATGEX
9	Start sending data via serial communication	HELLO WORLD

Table 3.1 Commands to operate Zigbee Module

3.11. Application of the device

1. Monitors sensors automation control.
2. Toys and games.
3. Home automation.
4. Used in TV VCR DVD/CD remote.(consumer electronics).
5. ZigBee Smart Energy .
6. ZigBee telecommunication.
7. ZigBee health care.

3.12. Advantages of ZigBee

1. Chip-vendor independence
2. Rapid innovation
3. Extremely Low cost
4. Open standards enable markets
5. Easy to deploy
6. Excellent performance in environments with low signal-to-noise ratio
7. Appropriate range of operation (30 - 100 meters)
8. Appropriate and reliable data transfer, bit rate : 250kbps at 2.4 GHz
9. Very low power consumption
10. Secure data transfer
11. Zigbee protocol needs less than 64 kb of ROM and 2-32 kb of RAM
12. Zigbee can be implemented with any type of microcontroller

CHAPTER-4

RF Module

4.1. Objectives to study the peripherals

a. To understand the working of radio transmission.
b. To interface the RF module with micro controller.

4.2. Pre-requisites

a. Knowledge on Uart.
b. Knowledge on microcontrollers.
c. Knowledge on C programming.

4.3. Part List

a. Microcontroller board.
b. RF Module.
c. USB to Serial converter.

4.4. Introduction of the device

An **RF Module** (Radio Frequency Module) is a usually a small electronic circuit which is used to transmit and/or receive radio signals on a number of carrier frequencies. RF Modules are widely used in electronic design owing to the difficulty and complexity of designing radio circuitry.This good electronic radio design is very complex only because of the sensitivity of radio circuits and the accuracy of components and layouts that are required to achieve operation on a specific frequency. Mostly the design engineers design a circuit for an application which requires radio communication and then "drop in" a radio module rather than working on a discrete design, saving both time and money on development. RF Modules are most often used in medium and low volume products for consumer applications such as garage wireless alarm systems, industrial remote controls, smart sensor applications as well as wireless home automation systems. They have also replaced older infra-red radio communication designs because they have the advantage of not requiring line-of-sight operation and Several carrier frequencies that are commonly used in commercially-available RF modules but including frequencies such as 433.92MHz, 315MHz, 868MHz and 915MHz. All these frequencies are used because of national and international regulations governing the use of radio for communication.

4.5. Types of the device

This RF module is used for various types and shapes and sizes of small electronic sub assembly circuit board and It can also be applied to modules across a large

variation of functionality and capability and The standard well known types of module are as follows:

a. Transmitter module
b. Intelligent transmitter module
c. Receiver module
d. Intelligent receiver module
e. Transceiver module
f. Intelligent transceiver module

4.6. Working of Rf module

This radio frequency (RF) transmission system employs Amplitude Shift Keying (ASK) with transmitter/receiver (Tx/Rx) pair which operates at 434 MHz. The transmitter module that takes serial input and transmits these signals through RF and The transmitted signals are being received by the receiver module placed away from the source of transmission.

The system allows one way communication between two nodes that are known as transmission and reception. This RF module has been used in conjunction with a set of four channel encoder/decoder ICs and here HT12E & HT12D have been used as encoder and decoder respectively and The encoder converts the parallel inputs into serial set of signals and These signals are serially transferred through RF to the reception point and The decoder is used after the RF receiver to decode the serial format and then retrieve the original signals as outputs and These outputs can be observed on corresponding LEDs.

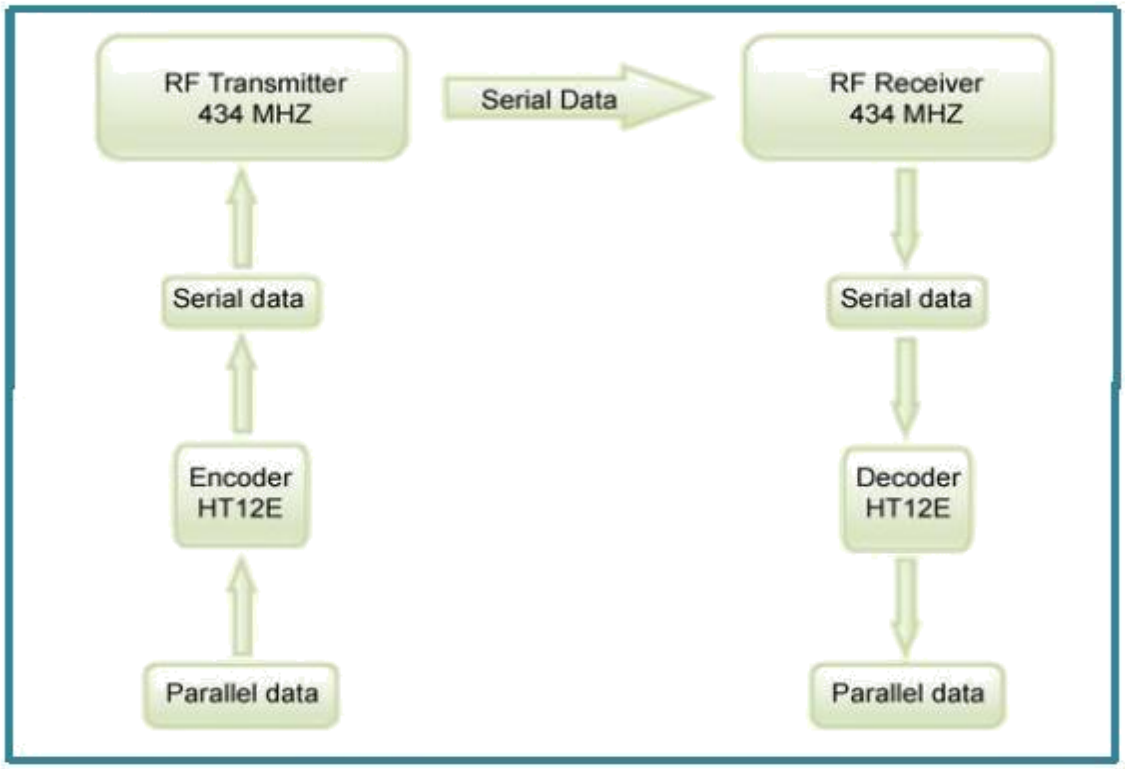

Figure 4.1 Block Diagram of RF Module

Encoder IC (HT12E) receives parallel data in the form of address bits and control bits and The control signals from remote switches along with 8 address bits constitute a set of 12 parallel signals. This encoder HT12E encodes all these parallel signals into serial bits then Transmission is enabled by providing ground to pin14 which is active low thus The control signals are given at pins 10-13 of HT12E and The serial data is fed to the RF transmitter through pin17 of HT12E.

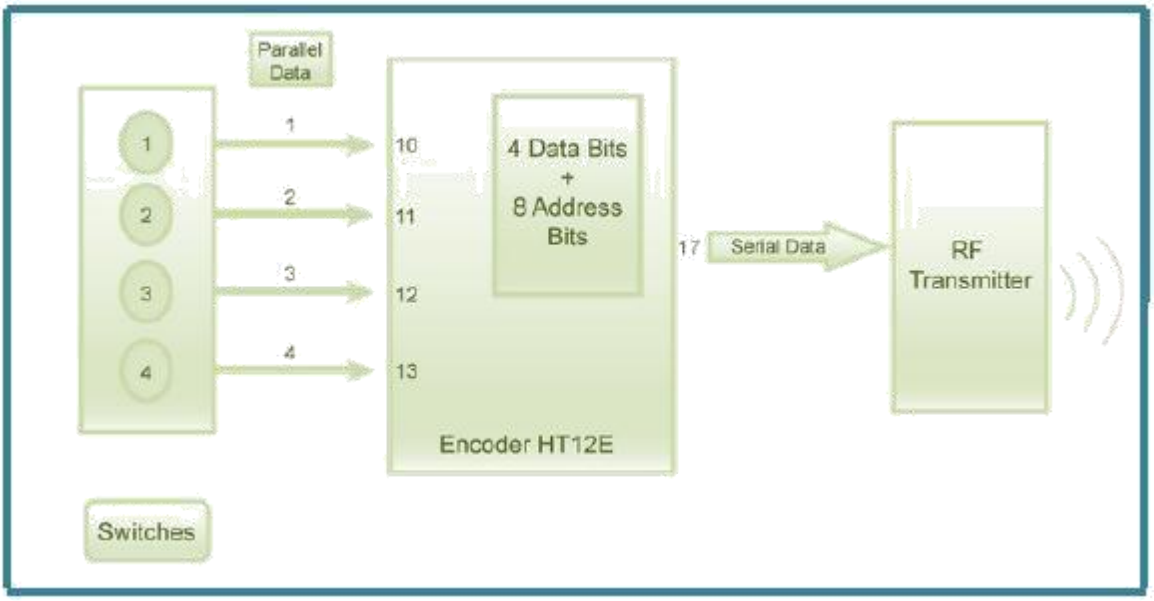

Figure 4.2 Block diagram of transmission

Transmitter, upon receiving serial data from encoder IC (HT12E), transmits it wirelessly to the RF receiver and The receiver, upon receiving these signals, sends them to the decoder IC (HT12D) through pin2 and 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.

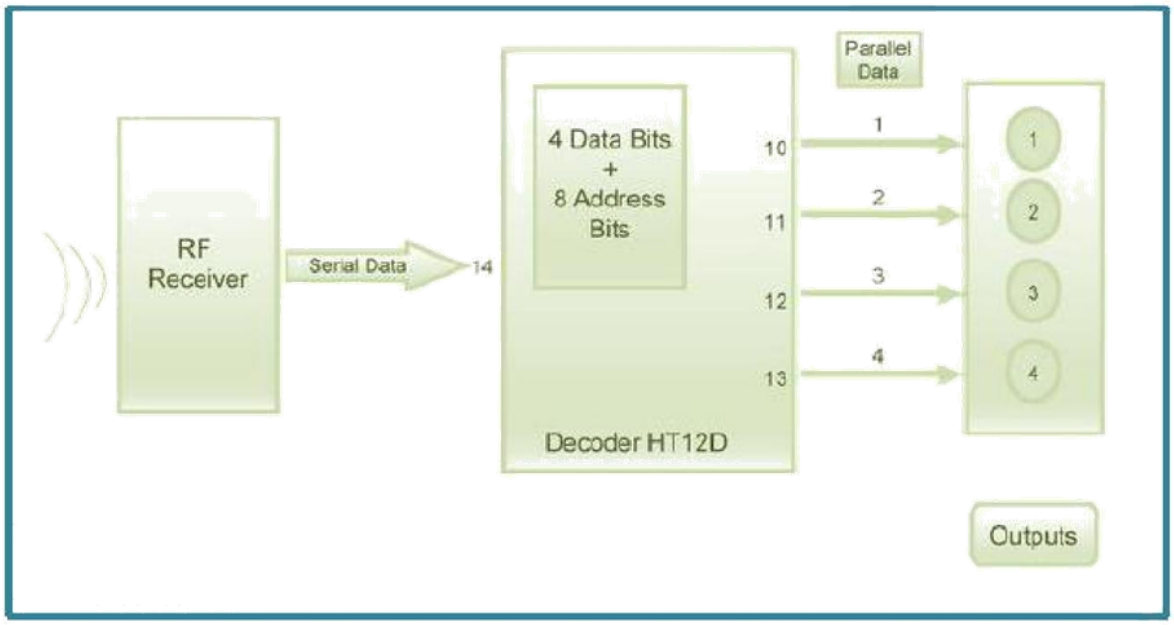

Figure 4.3 Block Diagram of Reception

When no signal is received at data pin of HT12D, that remains in standby mode , consumes very less current (less than 1μA) for a voltage of 5V and When signals are received by receiver and it is given to DIN pin (pin14) of HT12D. So on reception of signal, oscillator of HT12D gets activated. IC HT12D then decodes those serial data then checks these address bits 3 times. If the bits coincides with these local address pins (pins 1-8) of HT12D, then it stores the data bit on its data pins (pins 10-13) and makes the VT pin high. An LED is connected to VT pin (pin17) of that decoder. The LED behaves as a sign to indicate a valid transmission and corresponding output is produced at the data pins of decoder IC. Any signal is directed by lowering one or all the pins 10-13 of HT12E and the corresponding signal is received at receiver‟ s end (at HT12D). Address bits are then configured by using the by using the first 8 pins of both encoder and decoder ICs. Send a particular signal and address bits must be same at encoder and decoder ICs. By configuring the address bits and a single RF transmitter can also be used to control various RF receivers of same frequency.

To summarize, on each transmission, twelve bits of data is transmitted consisting of 8 address bits and 4 data bits. Signal is received at receiver‟ s end which is then fed into decoder IC. Address bits get matched and decoder converts it into parallel data and the corresponding data bits get lowered that could be then used to drive the LEDs. Outputs of the above system can either be used in negative logic or NOT gates (like 74LS04) can be incorporated at data pins.

4.7 Components used with their working and description

4.7.1 HT12D DECODER

Figure 4.4 HT12D Decoder

HT12D IC comes from HolTek Company and HT12D is a decoder integrated circuit that belongs to 212 series of decoders and this series of decoders are mainly used for remote control system applications, like burglar alarm, security system, car door controller etc. It is mainly provided to interface RF and infrared circuits. These are paired with 212 series of encoders and the chosen pair of encoder or decoder should have same number of addresses and data format and so in simple terms and decoder HT12D converts the serial data input into parallel outputs and it decodes the serial addresses and data received by an RF receiver into parallel data and sends them to output data pins. Then the serially inputed data is compared with the local addresses three times repeatedly. The input data code is decoded when no error or unmatched codes are found. A valid transmission indicates by a high signal at VT pin. HT12D is capable of decoding 12 bits, out of them 8 are address bits and 4 are data bits. The data of 4 bit latch type output pins that remain unchanged until new is received.

Pin Diagram

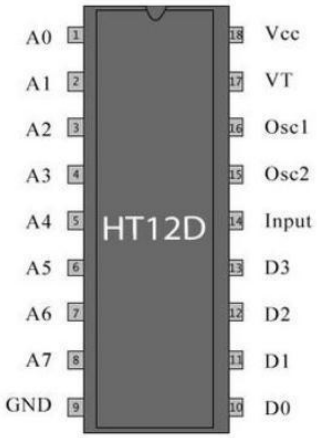

Figure 4.4 Pin diagram of HT12D Decoder

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	OSC2
16	OSCILLATOR INPUT	OSC1
17	VALID TRANSMISSION,ACTIVE HIGH	VT
18	SUPPLY VOLTAGE; 5V(2.4-12V)	Vcc

Table 4.1 Pin Description of HT12D Decoder

4.7.2 HT12E ENCODER

HT12E is an encoder integrated circuit of 212 series of encoders. It is paired with 212 series of decoders for use in remote control system applications. It used in interfacing RF and infrared circuits. The chosen pair of encoder or decoder should have same number of addresses and data format.HT12E converts the parallel inputs into serial output which encodes the 12 bit parallel data into serial for transmission through an RF transmitter. These 12 bits , which are divided into 8 address bits and four data bits and HT12E has a transmission enable pin which is active low. Trigger signal is received on TE pin and the programmed addresses or data are transmitted together with the header bits via an RF or an infrared transmission medium. finishes HT12E begins a 4-word

transmission cycle upon receipt of a transmission enable. Cycle repeats as long as TE is kept low. As soon as TE turns to high, the encoder output its final cycle and then stops.

Pin Diagram

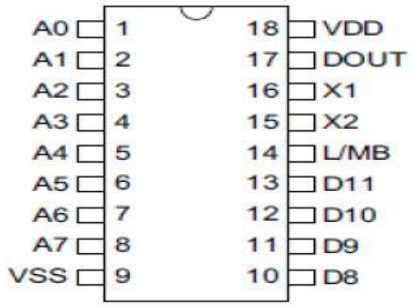

Figure 4.6 Pin diagram of HT12E Encoder

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		D0
11		D1
12		D2
13		D3
14	TRANSMISSION ENABLE(ACTIVE LOW)	TE
15	OSCILLATOR OUTPUT	OSC2
16	OSCILLATOR INPUT	OSC1
17	VALID TRANSMISSION,ACTIVE HIGH	VT
18	SUPPLY VOLTAGE; 5V(2.4-12V)	Vcc

Table 4.2 Pin Description of HT12E Encoder

4.7.3 RF MODULES (434MHz)

The RF module operates at Radio Frequency. This corresponding frequency range varies in between 30 kHz & 300 GHz. In RF system the digital data is represented as variations in the amplitude of carrier wave. Such modulation is known as Amplitude Shift Keying . Transmission by RF is better than IR (infrared) because of various reasons. Signals through RF can travel through larger distances making it suitable for long range applications. Also, IR operates in line-of-sight mode, RF signals travel when there is an obstruction between transmitter and receiver. RF transmission is strong and reliable than IR transmission. A RF communication uses a certain frequency unlike IR signals which are affected by other IR emitting sources. This **RF module** comprise of a **RF Transmitter** and an **RF Receiver**. The transmitter/receiver (Tx/Rx) pair operates at a frequency of **434 MHz**. A RF transmitter receive serial data and transmits it wirelessly through RF through its antenna is connected at pin4. Transmission takes place at the rate of 1Kbps - 10Kbps.The transmitted data is received by an RF receiver operating at the same frequency like the transmitter.

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

Pin Diagram

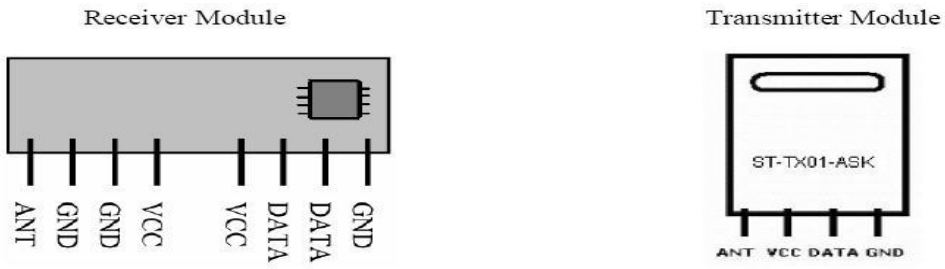

Figure 4.7 Transmitter and Receiver Module

Pin Description

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

Transmitter Module

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

Receiver Module

Table 4.3 Pin Description of Transmitter and Receiver Module

Circuit Diagram

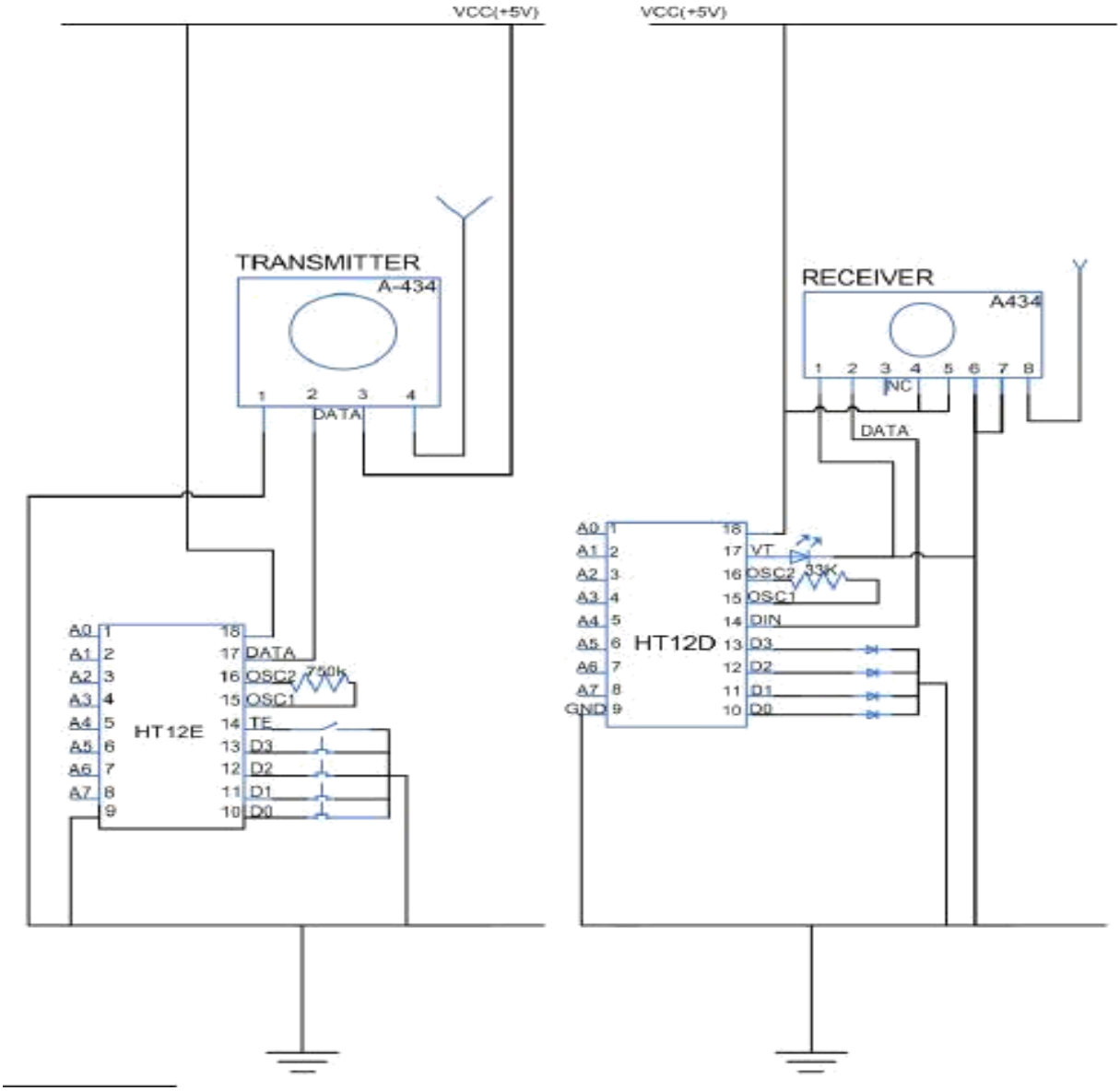

Figure 4.8 Circuit Diagram

4.9 Interfacing of the device with micro controller

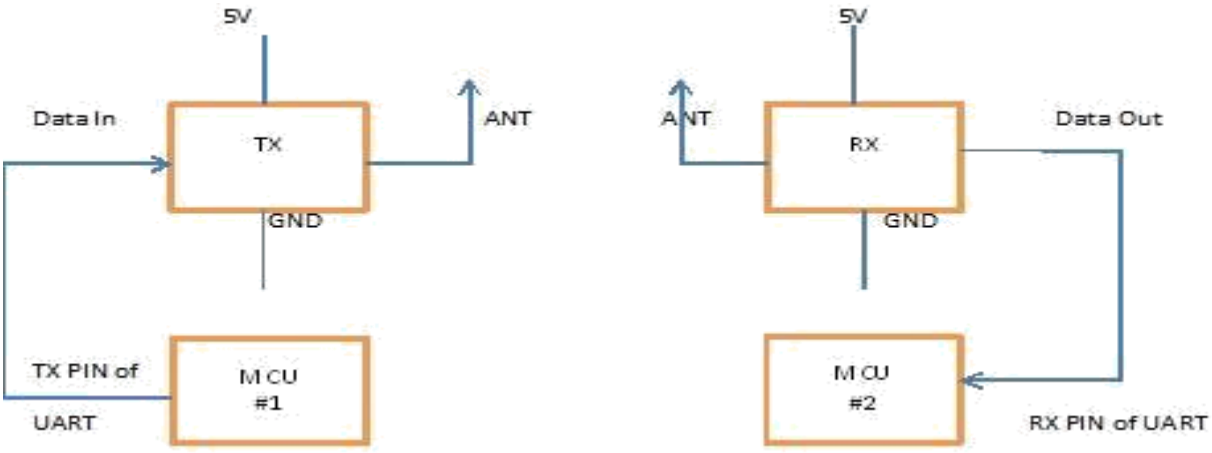

Figure 4.9 Interfacing of the device with micro-controller

When the TX unit is switched off or not transmit data, then the **"data out**" of RX will be oscillating high and low and as this is connected to RX of MCU's UART, the MCU#2 will receive garbage data ,and when TX unit will send some data, MCU#2 will be receiving data. So MCU #2 is always receiving data when MCU#1 is not sending anything and there must be a mechanism to distinguish real data with garbage data.

4.10 Application of the device

1. With its low bill of Material the RF Module is a single chip solution for active RF ID and Point of sale applications.
2. In Industrial automation there is an ever-increasing need to monitor and analyze the status or wear and tear of sensors and machines. Using of low power wireless connectivity of the RF Module is a vey low cost high reliability method of getting access to this data.
3. With the extremely high integration of the RF Module, its sensitivity and high output power can be used to make a single chip long range solutions for remote meter reading.
4. Controlling the environment inside buildings can be done at a low installation cost and without wires running across buildings - all facilitated by the integration and ease use of the RF Module.
5. Frequency hopping and short time on air increases security in applications using RF module. Remote Keyless Entry systems the low voltage operation, low current ,and internal voltage regulator operation of the RF Module increases the battery life time.

4.11 Sending and receiving data.

The steps created for this simple mechanism are shown below.

- We first begin transmission by sending character 'A'
- We again send one more 'A'
- Then we send the actual data.
- Now we send the **inverse** of data. All 0's are converted to 1 and vice-versa.
- We end the packet by sending 'Z'

In this way we create a simple packet based transmission with error detection. In the RX side of MCU our program follows the algorithm given below.

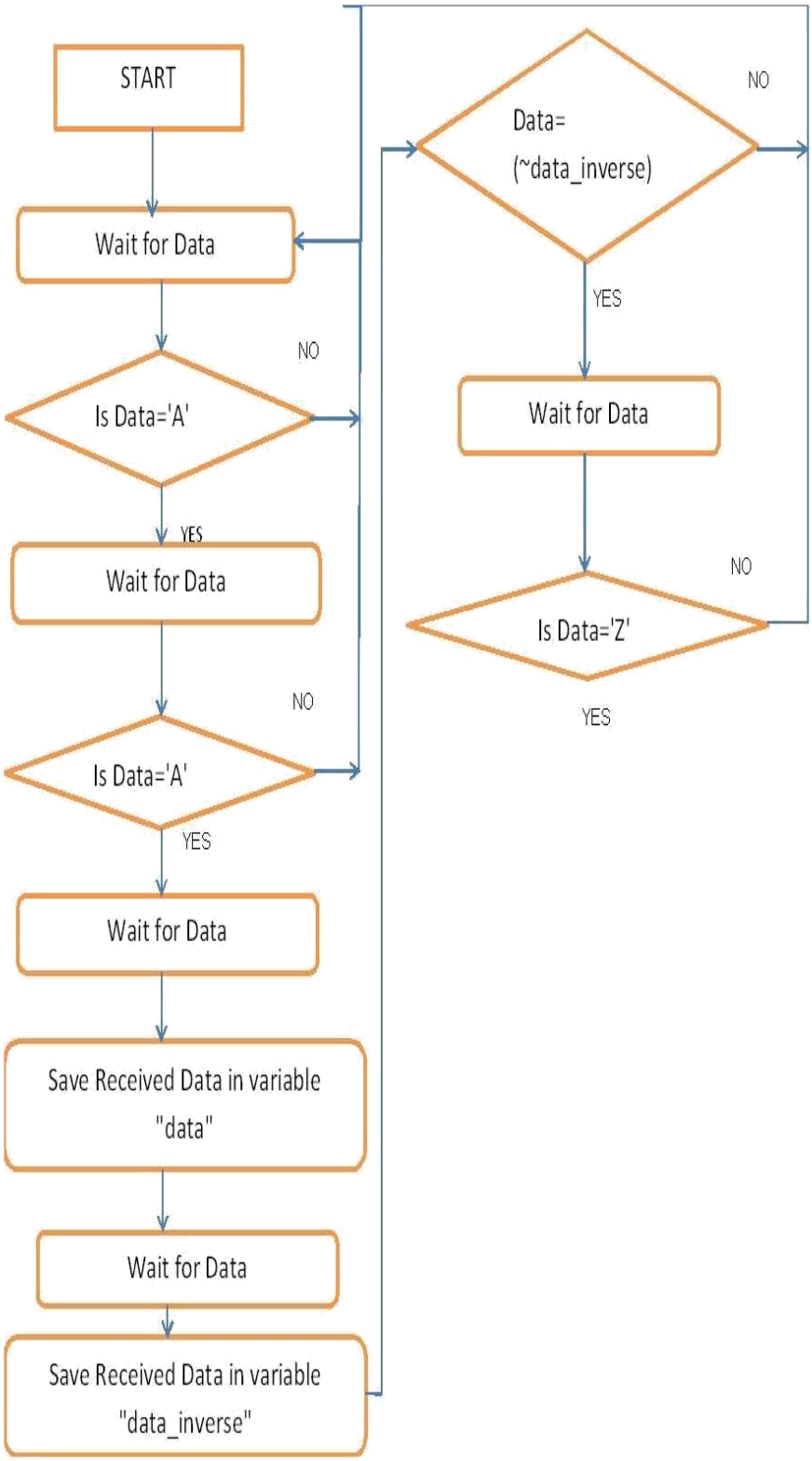

FIG 4.10 Flow Chart for Sending and Receiving data

CHAPTER-5

Conclusion and Scope for Future work

As, we know the second thing after the applications of any project which concerns the most to any electronics student is the future of that project by any means, off course. So, here in following chapter we are going to add some of the possible futuristic insights of wireless RFmodule.

This project can be used for -

a.Identifying Objects Using RF Transmitters And Receivers and Retrieving Data Using GSM

To provide a system for monitoring as well as locating objects using Radio Frequency (RF) transmitters and receivers, and enquiring on the objects using mobile phones which represents a real world object. This is a RF transmitters that are tagged to the objects of daily use and have the capability of transmitting signals and a receiver that detects the transmission of the object tagged and stores its corresponding location in the database that is created specifically for information maintenance of the marked objects. Mobile phones are used to enquire the location of that tagged object by sending a message to the Subscriber Identity Module (SIM) connected to a Global System for Mobile Communications or GSM modem. This GSM modem fetches the location and any other relevant information from the database and encapsulates this received information into a message which is sent back to the mobile phone that has requested the information.

b. Two Channels RF Remote Control

How many times do we need some remote control to handle some electric device? Many times, of course. There are lot of remote controls for ex infrared, RF, SMS ,etc. The small range remote controls are of two types, Infrared and RF (Radio Frequency).

One of the weak points of Infrared is that the signal cannot pass the walls. Therefore, if we want to control the garage door then we can use this RF remote control. The circuit (transmitter and receiver) uses few components ordinary and simple. It's easy to be built because we don't have to tune-up any coil or variable capacitor.

c. Weather Monitoring System

Well, this might be considered as a complex project to work with RF.RF Module systems could be used for Weather Monitoring applications. So in Weather Monitoring application we have to put a transmitter having some kind of sensors (like Temp. Sensors, Heat sensors).Installed on it , can be placed at any free place. Transmitter will then send current updates of weather to the receiver which is placed at the ground floor of the house using RF Communication. This RF system becomes the live updating system for a command house hold applications. We can also add some kind of Warning bor LCD display messages for weather notifications. This definitely could be considered as one of the most innovative projects with RF Module today.

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