CHAPTER 1

INTRODUCTION

Wireless operations permit services, such as long-range communications, that are impossible impractical to implement with the use of wires. The term is commonly used in the telecommunications industry to refer to telecommunications systems (e.g. radio transmitters and receivers, remote controls, etc.) which use some form of energy (e.g. radio waves, acoustic energy, etc.) to transfer information without the use of wires. Information is transferred in this manner over both short and long distances.

Pc to pc message communication is used for sending message using zigbee technology this is very useful in offices and organizations without connecting pc s to internet. This can be done by using zigbee technology we can communicate from one system to another pc easily and securely. User can send the messages from PC and transmits using ZigBee wireless technology and another module at the microcontroller receives the data and displays on screen. This process continues for every new message we send to it.Here we also do the wireless intercommunication between two modules using zigbee.where two trans receiver modules are used for performing a data communication between them and at the trans receiver end a particular prerecorded voice will be heard corresponding to the data received. This can be implemented in many areas such as monitoring and assisting disabled or old who can not communicate properly and in educational institutions etc.

1.1 Motivation

In order to solve the above specified problems this project was designed . In this project, we look back at the history of wireless intercom systems and see what we have learned about wireless communications in the process. The original “wireless intercom” consisted of two-way radios and a headset. The advantages were the technology was readily available and it was relatively inexpensive to use. Two ways worked well for some applications, such as pre-show setup and post-show teardown where they are still used today in much the same way they were 30 years ago. Two-ways (now often called HTs or Handie-Talkies) have higher operating power which affords substantially increased operating range of over a mile or more in some cases. This range can be increased to cover an entire city by the use of repeater stations located at the top of centrally located buildings. This helps in communication between two pc s offline.

1.2 Objective

The main objective this project is to use Zigbee for communication so that the pc s need not be connected to the internet. So that the cost for internet connection is eliminated and this is an one time investment and do not require much maintance .Here the data is secured. The wireless intercom project aims at supporting disabled and also helps in easy communication in many institutions. Because of its energy autonomy and low cost, the system has the potential to be brought by common men easily.

1.3 Description of Project

In recent times in offices, communication between employees is essential. This project aims at helping in the communication between one pc to another using a pair of 2.4 GHz transceiver modules (Zigbee).When ever employees want to communicate through message the either need a GSM module or connect the pc s to internet .So in order to solve these above problem the above project was designed .This project helps in generating a chat module that helps in communicating between two pc s without connecting pc s to internet. They are used for bidirectional real time chat communication from one PC to another wirelessly using hyper terminal. When ever a dumb and disabled person wants to communicate he just press the button corresponding to the thing that he wants to communicate and the same can be used in institutions for conveying anything required. This project also helps in wireless intercommunication between a pair of trans receivers. In this project based on the data received by the receiver for transmitter a prerecorded audio will be played.

1.4 Methodology

Wireless communication between two pc s is done using Zigbee that is connected to both pc s using USB to RS232 cable. A pair of transceiver modules are connected to the PCs using a DB9 (De-Sub) connector and through serial data cord using RS232 protocol communication between the module and the PC. An on-board dedicated ac to dc power supply is used at both ends to power the units. Here input to the P89V51RD2 are microcontroller is given by the press of key in the keypad which is 4x4 keypad used on transmitter side and 1x4 on the receiver side. When ever the key is pressed the row and the column of the key pressed is scanned .This scanned key is then imputed to the microcontroller through i/o port .then based on the key pressed this microcontroller will send the information to lcd through i/o port that acts as output port to display the name based on the key pressed. This same information about the key pressed is given to the zigbee through Tx pin. This will transmit the data to the receiver module .one the data is received by the zigbee of the receiver .This data is send to microcontroller which in turn connected to lcd and APR kit will signal the APR to play the audio corresponding to the data of key pressed that is received. Based on this data the lcd also displays the corresponding message. Now at the receiver in response to the received data a particular key is pressed then the same above action that takes place at the transmitter repeats at the receiver.

1.5 Organization of Project report

Chapter 1 gives a brief introduction about wireless communication between to pc's using zigbee module including wireless intercom. It also specifies the motivation, Objective, Description and methodology of the project.

Chapter 2 specifies the literature survey of wireless communication technology.

Chapter 3 includes the development of proposed method. This includes project arrangement, working, memory organization, Different ports and timers of the microcontroller. It defines the USB to RS232 converter cable's system requirement, features and installation procedure.

Chapter 4 contains requirement analysis of the project which specifies about the power supply, zigbee, LCD display, APR kit and their features.

Chapter 5 shows the results and discussions using keil development tool. That contains algorithms and results of the project. Finally project is concluded based on the applications, advantages and future scope of the project.

CHAPTER 2

LITERATURE SURVEY

2.1 IEEE 802.15.4: a wireless communication technology

Wireless communication have been attracting increasing interest for supporting a new generation of ubiquitous computing systems with great potential for many applications such as surveillance, environmental monitoring, health care monitoring or home automation. However, the communication paradigms in WSNs differ from the ones associated to traditional wireless networks, triggering the need for new communication protocols. In this context, the IEEE 802.15.4 protocol presents some potentially interesting features for supporting large-scale ubiquitous computing applications, namely power-efficiency, timeliness and scalability. Nevertheless, when addressing applications with (soft/hard) timing requirements some inherent paradoxes emerge, such as power-efficiency versus timeliness. Consequently, there is the need of engineering solutions for an efficient deployment of IEEE 802.15.4 in such scenarios. In this paper, we present some of the most important results on the IEEE 802.15.4 protocol that have been achieved within the context of wireless sensor networks. The paper outlines the most relevant characteristics of the IEEE 802.15.4 protocol and presents the most important research challenges regarding time-sensitive WSN-based applications. Then, it presents some timing performance analysis that unveils some directions for resolving the previously mentioned paradoxes[1].

2.2 Overview of the IEEE 802.15.4 protocol

The deployment of IEEE 802.15.4 WPANs in the presence IEEE 802.11b WLANs (IEEE 802.11 Specification 1999) triggers some inherent problems since they both operate in the 2.4 GHz frequency band. Coexistence between both technologies has become an important issue after the proposal of the IEEE 802.15.4 standard and has been subject of recent research works. In (Hewitt and Gutierrez 2003), the authors analyzed the impact of an IEEE 802.15.4 network composed of several clusters on an IEEE 802.11b station communicating with a WLAN access point. An expression of the probability of an IEEE 802.11b packet collision due to the interference with IEEE 802.15.4 has been proposed[2]. The authors conclude that the IEEE 802.15.4 network has little to no impact on the performance of IEEE 802.11b, unless the IEEE 802.11b station is very close to an IEEE 802.15.4 cluster with high activity level. A later work in (Shin *et al.* 2005) analyzed the packet error rate of IEEE 802.15.4 WPANs under the interference of IEEE 802.11b WLAN and proposed some coexistence criteria for both standards[3]. The results of this work show that the interference caused by the IEEE 802.11b WLAN does not affect the performance of an IEEE 802.15.4 WPAN if the distance between the IEEE 802.15.4 nodes and the IEEE 802.11b WLAN is larger than 8 m. Moreover, if the frequency offset is larger than 7 MHz, the interference of IEEE 802.11b has negligible effect on the performance of the IEEE 802.15.4. Another experimental work by Crossbow Tech[4].(Crossbow Tech. 2005) considered a set of three experiments using the MICAz motes, which implement the physical layer of the IEEE 802.15.4 and the Stargate single board computer compliant with IEEE 802.11b[5]. The first experiment run with no WiFi interference and the other experiments run under IEEE 802.11 interference with two different power levels (standard level and 23 dBm)[6]. The packet delivery rate was analysed. The experiment shows that high power transmissions of IEEE 802.11b packet reduce the packet delivery rate up to 80% for 23 dBm Wifi cards. In general, these results state that the coexistence of both IEEE 802.15.4 and IEEE 802.11b networks is generally possible with an acceptable performance, when nodes are not in a close proximity of each other and channels are adequately selected to prevent overlapping.

2.3 Network Planning

Network planning has been extensively studied in the context of different wireless networks, including cellular networks, IEEE 802.16 WiMAX, and sensor networks [7]. Network planning is usually formulated as device deployment optimization problems, aiming at maximizing the network capacity [8] or minimizing the cost of device deployment and/or network operation [9]. According to the methodologies to solve the optimization problem, these works can be further classified into two types, i.e., continuous and discrete cases. In the continuous case, it is assumed that there is no physical constraints and wireless network devices can be deployed at any location of the network region . Such problems can be solved by using some optimization algorithms like direct search and quasi-Newton methods. However, in reality, wireless devices usually can only be placed at some candidate locations due to the physical constraints. Such problems can be formulated as the discrete cases of device deployment problems.The discrete problems are normally modeled as a mixed integer optimization problem to find out the optimal placement of devices in a given region, such that all the users in the region can be served by the deployed network devices. In [10] are lay node placement problem is investigated with the physical constraints of sensor nodes. In how to place the minimal number of APs is studied under the physical and protocol interference models; and it is found that the underlying interference models have a significant effect on the AP placement problem. In [11], the optimization of base stations' number and locations is investigated in order to minimize the energy consumption of a cellular network, considering a practical case of non-uniform user distributions.

There have been limited works on network planning in sustainable wireless networks, which mainly focus on how to minimize the cost and network outage, i.e., some green wireless devices do not have sufficient energy to support normal operation or data transmission. The possibility and advantages of deploying a sustainable energy powered wireless system are reported in [11]. It is shown that solar or wind powered APs provide a cost-effective solution in wireless local area networks (WLANs),especially for APs installed in off-gridlocations. In[12],thetraditional AP placement problem is revisited with sustainable power supplies. Their work focuses onplacing a minimal number of green energy powered APs on a set of candidate locations to ensure that the harvested energy is sustainable to servewireless users and fulfill their QoS requirement. The minimum-cost placement of solar-powered data collection BSs is considered in [12]. BSs are placed in a wireless sensor network, such that the outage-free operation of the sensor nodes can be obtained. In [13], authors jointly consider allocating transmitting power and deploying the green APs based on the harvested energy. In this work, a closed form power allocation scheme and an AP placement metric are proposed, and their theoretical analysis shows a dramatically improvement on overall throughput by using the proposed scheme.

2.4 Energy Modeling

One of the effective methods to prolong the battery life is to enhance the energy efficiency by designing an accurate analytic energy model [14].A model which integrates typical WSNs transmission and reception modules with realistic battery models is proposed. Based on the battery models, they propose two battery power-conserving schemes for two M-ary orthogonal modulations. Authors focus on designing time division multiple access medium access control protocols for healthcare applications in wireless body-area monitoring networks. They find that the proposed schemes can extend the lifetime of sensor nodes for the wireless body-area monitoring networks based on the theoretical and simulations.

The first addressed issue in many works related to green energy is sustainable wireless sensor networks with renewable energy [15]. Authors show that such kind of prototype scan achieve near-perpetual operation of a sensor node.In WLAN meshnetworks,the solar/windpowered AP is believed to be a more efficient method to save energy than energy efficient schemes in traditional AP,especially when the traditional power supply is not available. Different from traditional energyresources, we need to consider the inherently dynamic characteristics in both energy charging and discharging processes. Therefore, it is essential to characterize the variations in the analytical model of energy conditions. In [16], authors design a framework to model there maining power of sensornodes with and without greenenergy, and then the expression of network lifetime can be derived based on the energy model. In [16], the transmission policies for rechargeable nodes are considered to maximize the short term throughput, which refers to the amount of data transmitted in a finite time horizon.

Based on the renewable energy model with discrete packets of energy arrivals, their proposed algorithm can successfully generate the optimal transmissionpolicy, which can achieve the maximum short-term throughput and the minimum transmission completion time. In [17], the sustainable wireless rechargeable sensor network is proposed with mobile chargers charging multiple sensors from candidate locations.After that, an optimization model is developed to minimize the selected number of locations based on the energy recharging requirement of the sensors. Other works, such as mainly focus on the battery capacity and solar panel size of the BSs or APs, with an objective to mitigate the network outage by using the minimal cost of energy according to the recorded historical solar insolation traces.

2.5 ResourceAllocation

Resource allocation is one of the most crucial methods to enhance the resource utilization of wireless networks [18]. Many works have been studied in various aspectsofresourceallocation, which include traffic scheduling and routing, optimal power management energy efficient communication and cooperation and adaptive sleep control of mobile device etc. Resource allocation in infrastructure network can be formulated as an optimization problem such that the network performance, e.g. maximizing network throughput and maximizing network lifetime, etc., with fixed yet limited energy resource in traditional wireless networks is maximized, under various constraints including network connectivity, throughput, energy consumption and etc. The energy in these works is normally considered as a limited resource,thus these works generally target at maximizing the energy efficiency.

In sustainable wireless networks, the energy is sustainable in the long term yet dynamic in the short term, which may lead to intermittent energy supply in wireless networkinfrastructuredevices[19].Moreover,since the green wireless devices highly depend on their locations,which leads to uneven distribution of charging capabilities.

Thus,in order to balance the harvested energy and traffic demand,we should concern these characteristics and challenges of sustainable wireless networks. Sofar,only a few works on resource management in wireless networks with green energy focuson maximizing the network sustainability,and most existing works aim at mitigating the node outage or minimizing the cost. In [20], the work focuses on solar panel sizing problem of the BS orAPs based on the historical solar insolation traces, such that the network outage can be mitigated and the cost can be minimized. In [21], the problem of traffic scheduling for infrastructure of vehicular wireless networks is formulated into a mixed integer linear program with minimizing energy consumption as objective. In [22], authors propose a framework by jointly considering integrated admission control and routing under the multi-hop radio networks powered by green energy. Then,routing algorithms are proposed to improve network performance by using available energy. In [23], statistical power saving mechanism is proposed under solar-powered WLAN mesh networks. To balance the energy consumption with energy charging capability for each node, a control algorithm is developed to match the future load conditions and solar insolation for maintaining outage-free operations of the node.

Wireless Communications Principles and Practice, Second Edition is the definitive modern text for wireless communications technology and system design[24]. Building on his classic first edition, Theodore S. Rappaport covers the fundamental issues impacting all wireless networks and reviews virtually every important new wireless standard and technological development, offering especially comprehensive coverage of the 3G systems and wireless local area networks (WLANs) that will transform communications in the coming years.RS-232 stands for Recommend Standard number 232 and C is the latest revision of the standard. The serial ports on most computers use a subset of the RS-232C standard. The full RS-232C standard specifies a 25-pin "D" connector of which 22 pins are used. Most of these pins are not needed for normal PC communications, and indeed, most new PCs are equipped with male D type connectors having only 9 pins.Electronic data communications between elements will generally fall into two broad categories: single-ended and differential. RS232 (single-ended) was introduced in 1962, and despite rumors for its early demise, has remained widely used through the industry[25].

CHAPTER 3

DEVELOPMENT OF PROPOSED METHOD

3.1 Project Description

The central part of the project is the microcontroller. Here we are using the 8051 based Philips P89V51RD2 microcontroller. The P89V51RD2 are 80C51 microcontrollers with 64kB flash and 1024 B of data RAM. A key feature of the P89V51RD2 is its X2 mode option. The design engineer can choose to run the application with the conventional 80C51 clock rate (12 clocks per machine cycle) or select the X2 mode (six clocks per machine cycle) to achieve twice the throughput at the same clock frequency. The flash program memory supports both parallel programming and in serial ISP. Parallel programming mode offers gang-programming at high speed, reducing programming costs and time to market. ISP allows a device to be reprogrammed in the end product under software control. The capability to field/update the application firmware makes a wide range of applications possible.

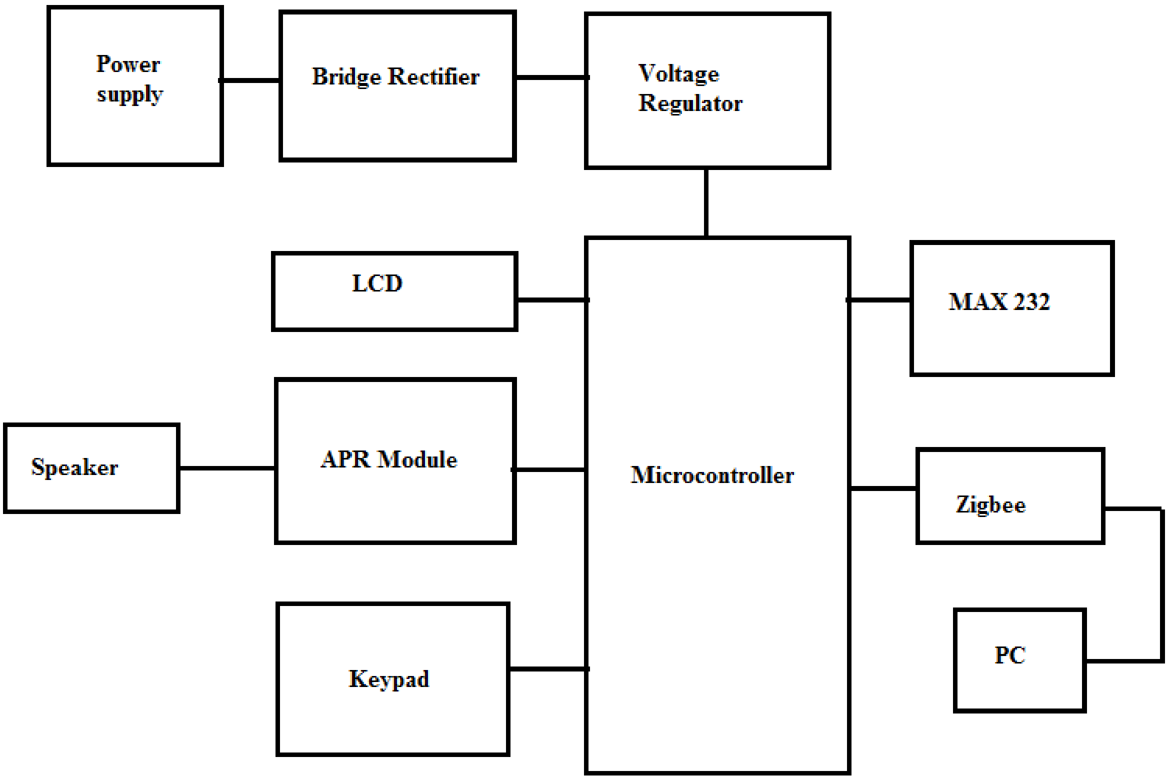

Figure 3.1 Block Diagram of Trans receiver Module.

Here the this microcontroller is connected to other modules and components as shown in the block diagram figure 3.1.The 4x4 keypad is connected to microcontroller through the

Port 1 of microcontroller that provide input to the microcontroller.A LED display is connected to the microcontroller by the port2 of microcontroller that acts as an output port to microcontroller.Now the APR module is provided with an supply voltage of 12v.The microcontroller is provided with the input supply of 5v.A speaker is connected to the output pin of APR module.The input supply of Zigbee is given to the 5v.the transmitter pin of Zigbee is connected to the pin 1 of port 3 and the receiver pin of the zigbee is connected to the pin 0 of the port 3 that acts as an input and output to the zigbee and the microcontroller.Pin 2 and pin 3 of port 3 are connected to the M1 and M2 pin of the APR module at the transmitter side.At the receiver end the Port 2 is connected to the LCD display.port 1 of the microcontroller is connected to the input port of APR module say M0 to M7.At the receiver side we are using 1x4 key pad with two switches SW0 and SW1 is connected to the interrupt pins of microcontroller that is pin 2 and pin 3 of port 3 of microcontroller.At the receiver side The input supply of Zigbee is given to the 5v.the transmitter pin of Zigbee is connected to the pin 1 of port 3 and the receiver pin of the zigbee is connected to the pin 0 of the port 3 that acts as an input and output to the zigbee.For wireless communication between two pc we connect the two pc s to their corresponding zigbee using the USB to Rs32 converter cable.

3.2 Working Operation

A power supply of 12v AC is given to the microcontroller as it requires only 5v dc supply this 12v ac is rectified to convert it into DC .the voltage regulator regulates the voltage from 12v to 5v.this is given as power supply to the microcontroller. The MAX232 is an integrated circuit that converts signals From an RS-232serial port to signals suitable for use in TTL compatible digital logic circuits. The MAX232 is a dual driver/receiver and typically converts the RX, TX, CTS and RTS signals .When a MAX232 IC receives a TTL level to convert, it changes a TTL Logic 0 to between +3 and +15V, and changes TTL Logic 1 to between -3 to -15V, and vice versa for converting from RS232 to TTL.

The P89V51RD2 are 80C51 microcontrollers with 16/32/64 kB flash and1024 B of data RAM.A key feature of the P89V51RD2 is its X2 mode option. The design engineer can choose to run the application with the conventional 80C51 clock rate (12 clocks per machine cycle) or select the X2 mode (six clocks per machine cycle) to achieve twice the throughput at the same clock frequency. Here input to microcontroller is given by the press of key in the keypad which is 4x4 keypad used on transmitter side and 1x4 on the receiver side. When ever the key is pressed the row and the column of the key pressed is scanned .This scanned key is then imputed to the microcontroller through i/o port .then based on the key pressed this microcontroller will send the information to lcd through i/o port that acts as output port to display the name based on the key pressed. This same information about the key pressed is given to the zigbee through Tx pin. This will transmit the data to the receiver module .one the data is received by the zigbee of the receiver .This data is send to microcontroller which in turn connected to lcd and APR kit will signal the APR to play the audio corresponding to the data of key pressed that is received. Based on this data the lcd also displays the corresponding message. Now at the receiver in response to the received data a particular key is pressed then the same above action that takes place at the transmitter repeats at the receiver as well.

The audio at ARP can be recorded and played this way. We can use 8 channels(M0 TO M7) each channel having 1.3minutes recording length. Onboard MIC will automatically be used for recording. supply voltage:12v AC/DC. Switch on the board power LED(LD1)will on and the put the jumper in the board JP1(REC) Section. While in record mode select J5 (M0-M7) to select a channel to record the message. Let us assume we want to record message in channel M0,Connect M0 to GND(IN Board J3-VCC,GND). Now Whatever we Speak will be captured by MIC and recorded, status LED(LD2)Will on in record mode indicating that chip is currently recording. Once duration is full the LED(LD2)Will off means that segment is full. Now you can disconnect the GND Connection from M0,if before the duration is this connection is removed, then that many seconds are recorded and rest duration is kept empty. To Playback recorder message Connect the speaker to the board J4 Speaker section. Now let us check what we recorded. Remove jumper from the JP1(REC)section now connect the MO(J5) to GND(J3) Section, status LED (LD2) will ON till the recorded sound play in the speaker. This procedure same for the remaining channels also.To use with Microcontroller Better Do Voice Recording can be done Manually To play back connect Controller I/Os to M0 to M7 When Output Goes Low For particular Pin Recorded message will played[5].

There are a pair of trans receiver modules that are placed at two different locations. In second case whenever we want wirelessly communicate between two Pc s then we use USB to RS232 convertor cable that is connected between Pc and the Zigbee .Then we have a driver installed in the pc using which there is a message passing between two pc s is done. The USB to Serial converter making the use of legacy peripherals and communication between PC and RS-232 devices easily. It’s simple low cost-effective solution ideal for various communication and automation applications. Full compliance with USB specification 1.1 and compatible with USB v2.0 ports. Supports the standard RS-232 Serial (com) interface and automatic handshaking mode. The USB to Serial converter connects RS-232 serial devices to your USB providing a bridge connection with a DB-9 female serial port connector on the end and USB port plug connector on the other side. The default settings for RS-232 communication are set to 9600 baud, 8 bits, no parity, and no software handshaking. Only the Transmit (TX), Receive (RX), and Ground signals are used. The Request to Send (RTS) and Clear to Send (CTS) signals are tied together at the board level so that devices requiring the CTS signal will always be enabled to send data. This works because the device will set its own RTS signal high, so connecting these two signals will ensure that CTS will be held high as long as the device is connected. If an attached device requires settings different from the board default, this can be changed in the software with the exception that this board does not accommodate devices that require handshaking beyond the CTS signal.

3.3 Memory Organization

The device has separate address spaces for program and data memory.

3.3.1 Flash program memory

There are two internal flash memory blocks in the device. Block 0 has 64 k bytes and contains the user's code. Block 1 contains the Philips-provided ISP/IAP routines and may be enabled such that it overlays the first 8 k bytes of the user code memory. The 64 kB Block 0 is organized as 512 sectors, each sector consists of 128 bytes[Appendix I]. Access to the IAP routines may be enabled by clearing the BSEL bit in the FCF register. However, caution must be taken when dynamically changing the BSEL bit .Since this will cause different physical memory to be mapped to the logical program address space, the user must avoid clearing the BSEL bit when executing user code within the address range 0000H to 1FFFH[3].

3.3.2 Data RAM memory

The data RAM has 1024 bytes of internal memory. The device can also address up to 64 kB for external data memory.

3.3.3 Expanded data RAM addressing

The P89V51RD2 has 1 kB of RAM. See Figure 3.2 "Internal and external data memory

structure." The device has four sections of internal data memory:

1. The lower 128 bytes of RAM (00H to 7FH) are directly and indirectly addressable.

2. The higher 128 bytes of RAM (80H to FFH) are indirectly addressable.

3. The special function registers (80H to FFH) are directly addressable only.

4. The expanded RAM of 768 bytes (00H to 2FFH) is indirectly addressable by the move external instruction (MOVX) and clearing the EXTRAM bit.

Since the upper 128 bytes occupy the same addresses as the SFRs, the RAM must be accessed indirectly. The RAM and SFRs space are physically separate even though they have the same addresses.

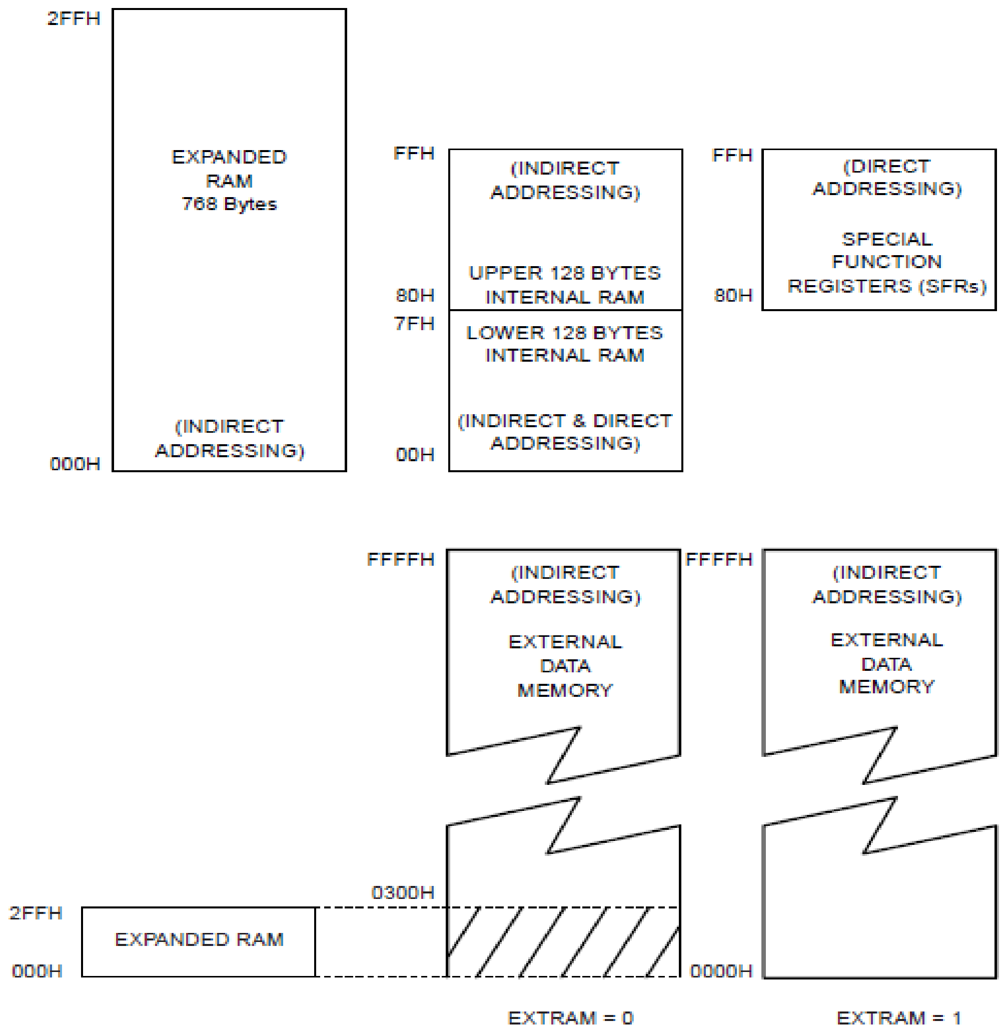

Figure 3.2 Internal and external data memory structure.

3.3.4 Dual data pointers

The device has two 16-bit data pointers. The DPTR Select (DPS) bit in AUXR1 determines which of the two data pointers is accessed. When DPS = 0, DPTR0 is selected; when DPS = 1, DPTR1 is selected. Quickly switching between the two data pointers can be accomplished by a single INC instruction on AUXR1 as seen in Figure 3.3.

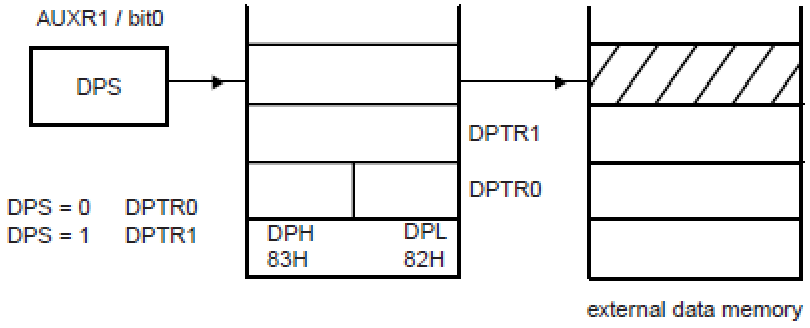

Figure 3.3 Dual data pointers

3.4 Ports

Following are the different types of ports in P89V51RD2 microcontroller.

PORT 0

PORT0 is an 8-bit open drain bi-directional I/O PORT. As output PORT, each pin can sink eight TTL inputs. When are written to PORT0 pins, the pins can be used as high impedance inputs.PORT0 can also be configured to be the multiplexed low-order address/data bus during accesses to external program and data memory. In this mode, P0 has internal pull-ups. PORT0 also receives the code bytes during Flash programming and outputs the code bytes during program verification. External pull-ups are required during program verification.

PORT 1

PORT1 is an 8-bit bi-directional I/O port with internal pull-ups. The PORT1 output buffers can sink/source four TTL inputs. When logic 1s are written to PORT1 pins, they are pulled high by the internal pull-ups and can be used as inputs. As inputs, PORT1 pins that are externally being pulled low will source current because of the internal pull-ups. PORT1 also receives the lower order address bytes during flash programming and verification. In addition, P1.0 and P1.1 can be configured to be the timer/counter 2 external count input (P1.0/T2) and the timer/counter 2 trigger input (P1.1/T2EX).

PORT 2

PORT2 can also be used as an 8-bit bi-directional I/O PORT with internal pull-ups. The PORT2 output buffers can sink/source four TTL inputs. When ones are written to PORT2 pins, they are pulled high the internal pull-ups and can be used as inputs. As inputs, PORT2 pins that are externally being pulled low will source current because of the internal pull-ups.The alternate use of PORT 2 is to supply a high order address byte in conjunction with the PORT0 low order byte to address external memory. It uses strong internal pull-ups when emitting ones.It also receives the higher order address bytes and some control signals during flash programming and verification.

PORT 3

PORT3 is an 8-bit bi-directional I/O PORT with internal pull-ups The PORT3 output buffers can sink/source four TTL inputs. When ones are written to PORT3 pins, they are pulled high by the internal pull-ups and can be used as inputs. As inputs, PORT3 pins that are externally being pulled low will source current because of the pull-ups. PORT3 also serves the functions of various special features of the AT89C51, as shown below

P3.0	RXD	(serial input port)
P3.1	TXD	(serial output port)
P3.2	INT0	(external interrupt 0)
P3.3	INT1	(external interrupt 1)
P3.4	T0	(timer 0 external input)
P3.5	T1	(timer 1 external input)
P3.6	WR	(external data memory writes strobe)
P3.7	RD	(external data memory read strobe)

3.5 Timers

The two 16-bit Timer/counter registers: Timer 0 and Timer 1 can be configured to operate either as timers or event counters. In the ‘Timer’ function, the register is incremented every machine cycle. Thus, one can think of it as counting machine cycles. Since a machine cycle consists of six oscillator periods, the count rate is 1¤6 of the oscillator frequency. In the ‘Counter’ function, the register is incremented in response to a 1-to-0 transition at its corresponding external input pin, T0 or T1. In this function, the external input is sampled once every machine cycle. When the samples show a high in one cycle and a low in the next cycle, the count is incremented. The new count value appears in the register in the machine cycle following the one in which the transition was detected. Since it takes two machine cycles (12 oscillator periods) for 1-to-0 transition to be recognized, the maximum count rate is 1/12 of the oscillator frequency. There are no restrictions on the duty cycle of the external input signal, but to ensure that a given level is sampled at least once before it changes, it should be held for at least one full machine cycle. In addition to the 'Timer' or 'Counter' selection, Timer 0 and Timer 1 have four operating modes from which to select.

The 'Timer' or 'Counter' function is selected by control bits C/T in the Special Function Register TMOD. These two Timer/counters have four operating modes, which are selected by bit-pairs (M1, M0) in TMOD. Modes 0, 1, and 2 are the same for both Timers/counters. Mode 3 is different. The four operating modes are described in the following text.

3.5.1 Mode 0

Putting either Timer into Mode 0 makes it look like an 8048 Timer, which is an 8-bitCounter with a fixed divide-by-32 prescaler. Figure 3.4 shows Mode 0 operation. In this mode, the Timer register is configured as a 13-bit register. As the count rolls over from all 1s to all 0s, it sets the Timer interrupt flag TFn. The count input is enabled to the Timer when TRn = 1 and either GATE = 0 or INTn = 1. (Setting GATE = 1 allows the Timer to be controlled by external input INTn, to facilitate pulse width measurements). TRn is a control bit in the Special Function Register TCON . The GATE bit is in the TMOD register. The 13-bit register consists of all 8 bits of THn and the lower 5 bits of TLn.

The upper 3 bits of TLn are indeterminate and should be ignored. Setting the run flag (TRn) does not clear the registers. Mode 0 operation is the same for Timer 0 and Timer 1 . There are two different GATE bits, one for Timer 1 (TMOD.7) and one for Timer 0 (TMOD.3) mode 0 operation is as shown in figure 3.4.

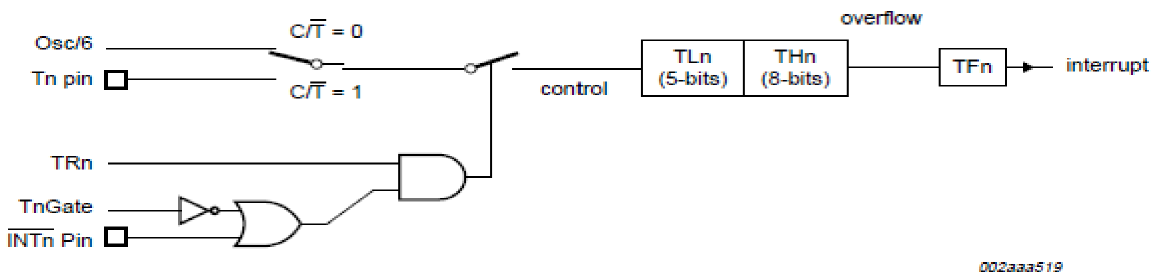

Figure 3.4. Timer/Counter 0 or 1 in Mode 0 (13-bit counter).

3.5.2 Mode 1

Mode 1 is the same as Mode 0, except that all 16 bits of the timer register (THn and TLn) are used. Seen in Figure 3.5.

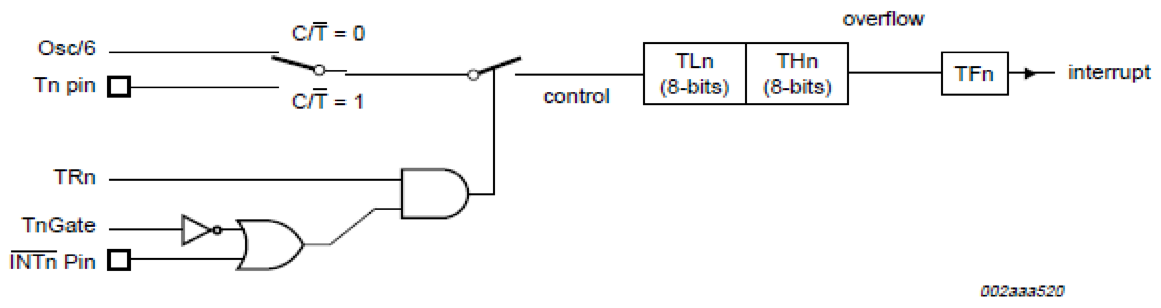

Figure 3.5 Timer/Counter 0 or 1 in Mode 1 (16-bit counter).

3.5.3 Mode 2

Mode 2 configures the Timer register as an 8-bit Counter (TLn) with automatic reload, as shown in Figure 3.6. Overflow from TLn not only sets TFn, but also reloads TLn with the contents of THn, which must be preset by software. The reload leaves TRn unchanged. Mode 2 operation is the same for Timer 0 and Timer 1.

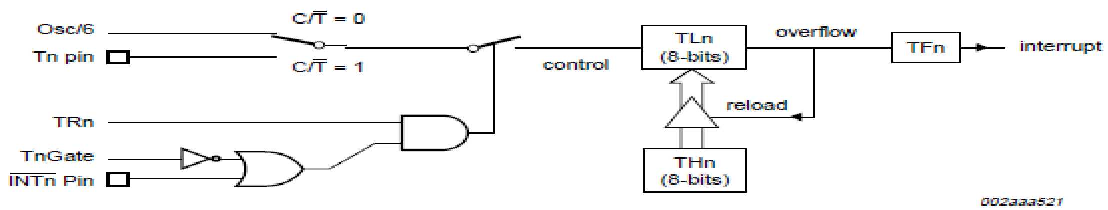

Figure 3.6. Timer/Counter 0 or 1 in Mode 2 (8-bit auto-reload).

3.5.4 Mode 3

When timer 1 is in Mode 3 it is stopped (holds its count) as shown in figure 3.7. The effect is the same as setting TR1 = 0. Timer 0 in Mode 3 establishes TL0 and TH0 as two separate 8-bit counters. The logic for Mode 3 and Timer 0 is shown in Figure 3.7. TL0 uses the Timer 0 control bits: T0C/T, T0GATE, TR0, INT0, and TF0. TH0 is locked into a timer function (counting machine cycles) and takes over the use of TR1 and TF1 from Timer 1. Thus, TH0 now controls the ‘Timer 1’ interrupt. Mode 3 is provided for applications that require an extra 8-bit timer. With Timer 0 in Mode 3, the P89V51RD2 can look like it has an additional Timer. When Timer 0 is in Mode 3, Timer 1 can be turned on and off by switching it into and out of its own Mode 3. It can still be used by the serial port as a baud rate generator, or in any application not requiring an interrupt.

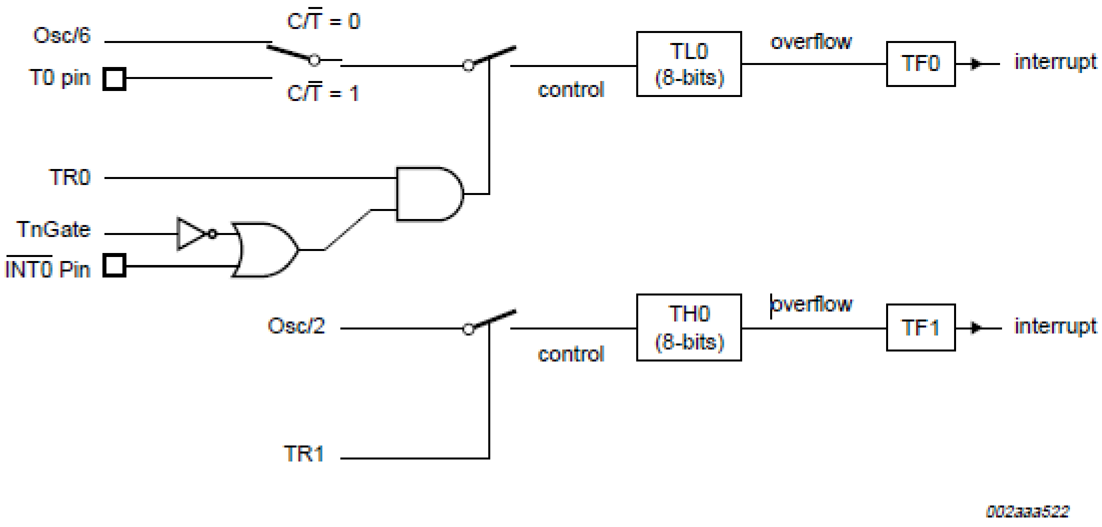

Figure 3.7. Timer/Counter 0 Mode 3 (two 8-bit counters).

3.6 USB to RS232 converter

The USB to Serial converter making the use of legacy peripherals and communication between PC and RS-232 devices easily. It's simple low cost-effective solution ideal for various communication and automation applications. Full compliance with USB specification 1.1 and compatible with USB v2.0 ports. Supports the standard RS-232 Serial (com) interface and automatic handshaking mode. The USB to Serial converter connects RS-232 serial devices to your USB providing a bridge connection with a DB-9 female serial port connector on the end and USB port plug connector on the other side as shown in figure 3.8. The USB-RS232 converter board components:

- "READY" device ready LED.
- USB port connect
- DB9 female serial port connector.

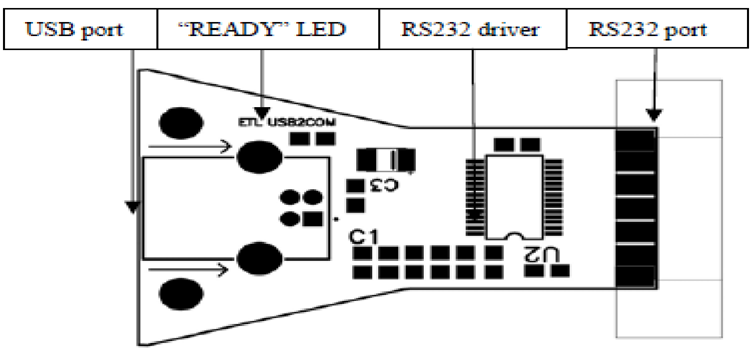

Figure 3.8. USB - RS232 board layout

3.6.1. Device Overview and Features

The USB-RS232 converter interface consists of the Tx (transmit), Rx (receive) data signals and the RTS, CTS, DSR, DTR, DCD, RI control signals. The UART supports RTS/CTS, DSR/DTR, and XOn/ X-Off handshaking. If the Virtual COM Port drivers are used, the data format and baud rate are set during serial port configuration on the PC[4].

- 576 Byte receive buffer, 640 byte transmit buffer
- Data bits: 5, 6, 7, 8
- Stop bits: 1, 1.5* 2
- Parity types: None, Even, Odd, Mark, Space
- Baud rates: 9600, 14400, 19200, 38400, 56000, 115200 (7 / 8 data bits)

***** - 5 data bits only

3.6.2 System Requirements

- IBM Compatible Desktop/Laptop PC with free USB port
- 8X speed CD/DVD ROM
- RAM - 32 Mb or higher
- MB free disk space
- Display : color SVGA display
- Power supply : no external power supply required (powered from USB)
- Operating system : Windows 2000/Windows XP/Windows Vista/Windows 7.

3.7 Installation USB to RS232 of converter

This section will guide you through the Virtual COM port driver installation process and help to verify installation process step by step.

3.7.1. Hardware interface

Please, follow the step-by-step installation procedure listed below:

Hardware interface:

1. Connect one end of the USB cable to a USB port on the PC
2. Connect the other end of the USB cable to the USB connector on the USB-RS232 converter
3. Connect the DB-9 connector to the target serial device as shown in figure 3.9.

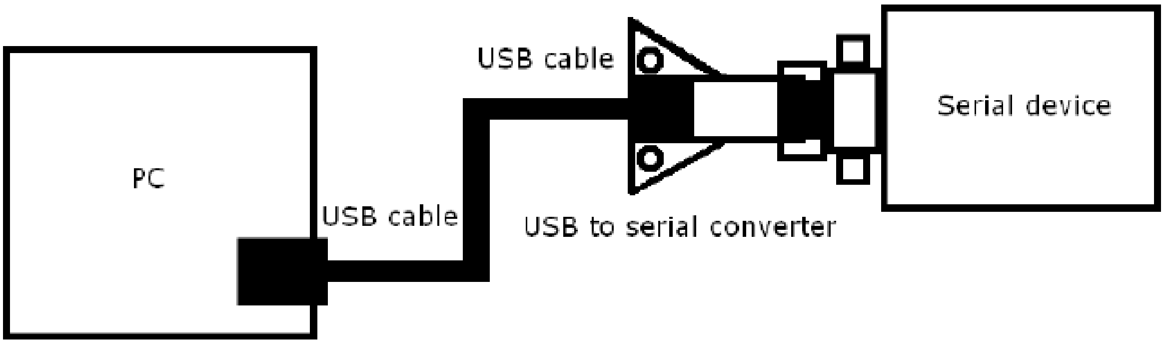

Figure 3.9 hardware setup of USB to RS232 of converter

3.7.2. Virtual COM port driver installation

1. Turn On your PC. Wait until “READY” led become red, from now device ready to use

2. Then you should see window “Found New Hardware Wizard” on your Desktop as shown in Figure 3.10

Figure 3.10 “Found New Hardware Wizard” dialog

3. Click “Cancel”.

4. Insert CD labeled: “USB SERIAL VCP DRIVER SETUP” into your CD/DVD drive.

5. Run “USB2COM_DriverSetup.exe”.

6. Follow to the wizard.

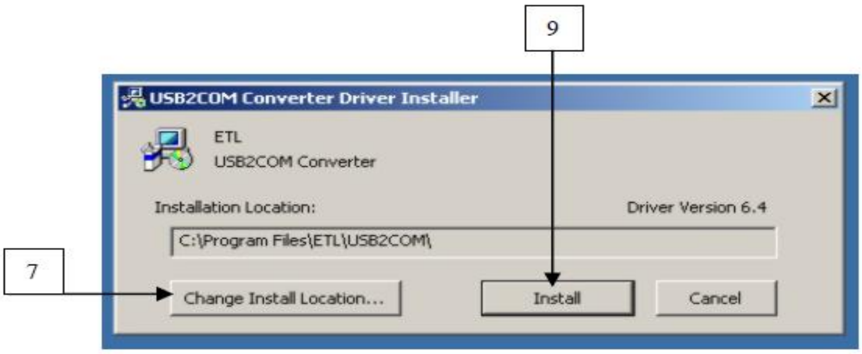

Figure 3.11. Driver installer dialog.

7. Click “Change Install Location…” button shown in figure 3.11.

8. Select new installation directory among exiting directories under your hard drive or create new by clicking “Make New Folder” button.

9. Or click “Install” button to continue default driver installation.

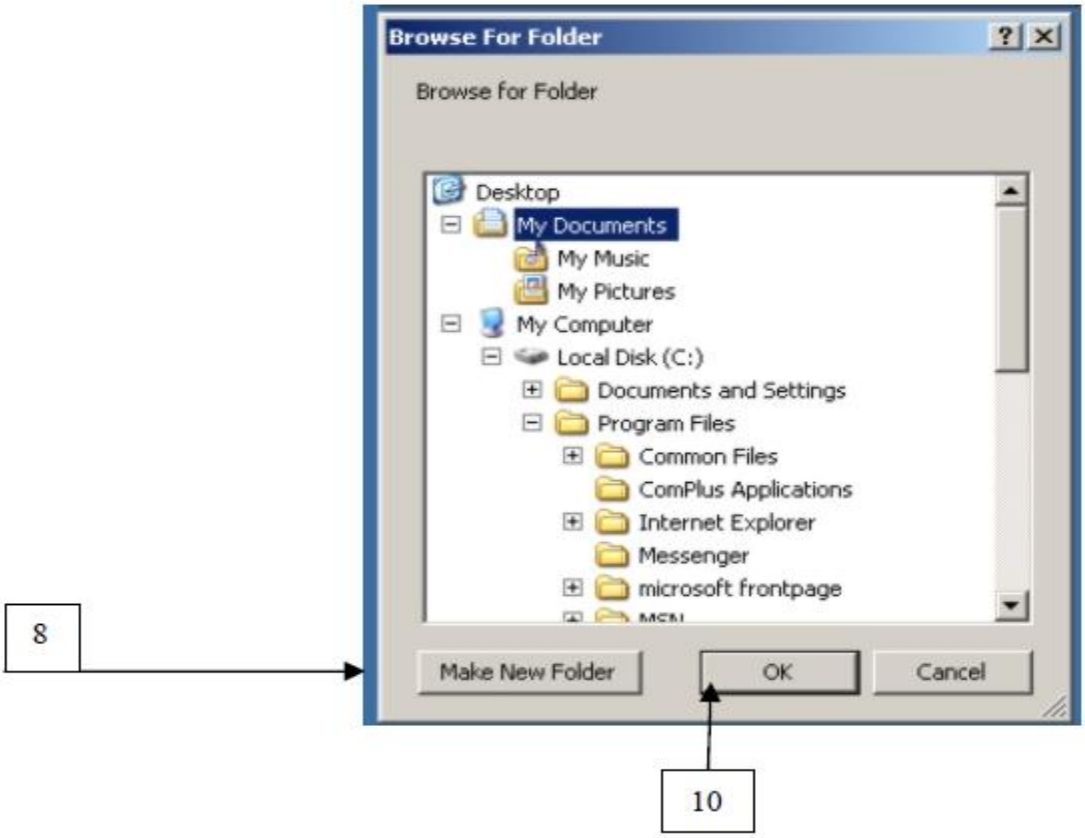

Figure 3.12 “Browse For Folder” dialog.

10. Click “OK”

11. Once installation procedure is successfully completed you should see message window: “Installation completed successfully” as shown in Figure 3.12. Click “OK” and “USB2COM Converter Driver Installer” will be automatically closed as shown in figure 3.13.

Figure 3.13. Installation completed.

12. After finish steps you’ll see “pop-up bubble” message of the Task bar as shown in Figure 3.14.

Figure 3.14. Found New Hardware system message

Be patient for few seconds until new one “pop-up bubble” confirmation message will appear as seen in figure 3.15.

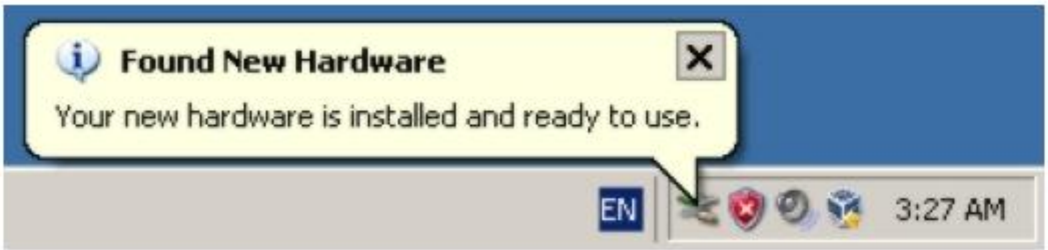

Figure 3.15. New hardware is ready to use.

3.7.3 Virtual COM port driver installation check

Follow to the verification steps:

1. Click “My computer” icon on your Desktop or click menu “Start” -> select “Properties” from pop-up menu.

2. Select “Hardware” tab of “System properties” dialog.

3. Click “Device manager” button.

4. Expand tree of “Device manager”.

5. Expand branch named “Ports (COM & LPT)”

6. In case of successful installation you’ll see node named “Silicon Labs CP210x USB to UART

Bridge (COM3)” that is seen in figure 3.16.

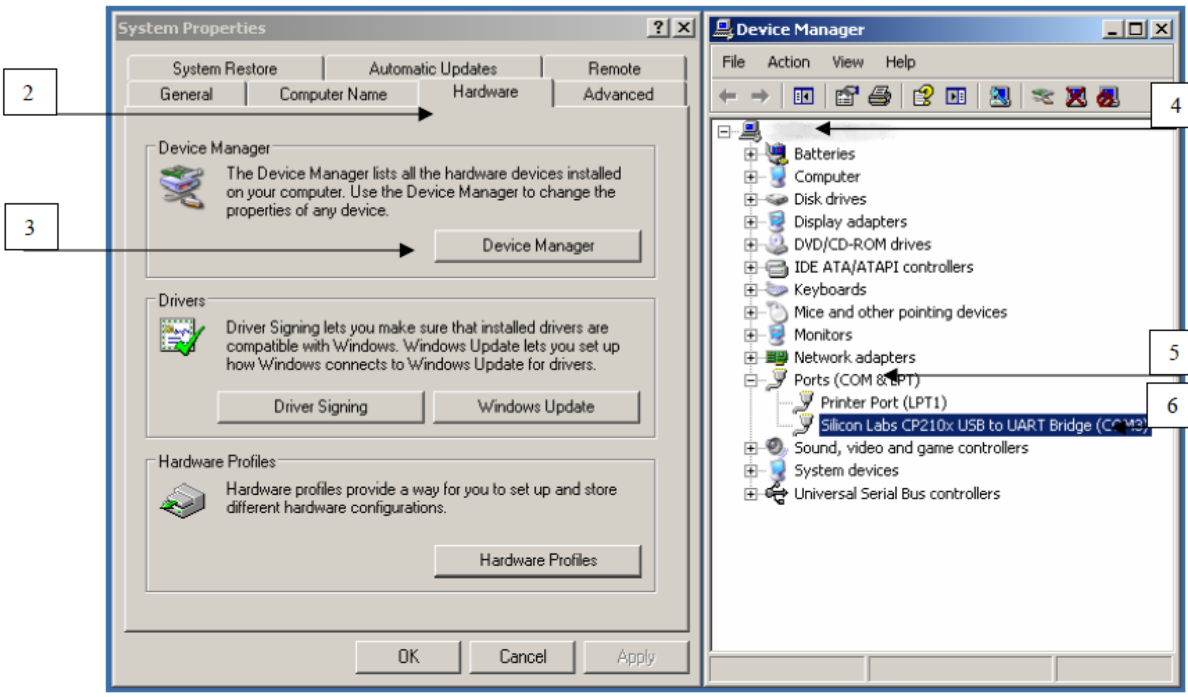

Figure 3.16. Virtual COM port in Device Manager.

3.7.4. Port Configuration

Users can re-configure default Virtual COM port settings (such as baud rate, data bits etc.) according to target application requirements. Default Virtual COM port configuration:

- Baud rate : 9600
- Data bits : 8

- Parity : none
- Stop bits : 1
- Flow control : none
- Port number : 3

Once when you decided to change default settings follow to the next steps as seen in figure 3.16 and figure 3.17.:

1. Click "My computer" icon on your Desktop or click menu "Start" -> select "Properties" from

pop-up menu .

2. Select "Hardware" tab of "System properties" dialog .
3. Click "Device manager" button .
4. Expand tree of "Device manager".
5. Click node named "Silicon Labs CP210x USB to UART Bridge (COM3)".
6. Select "Properties" from pop-up menu.

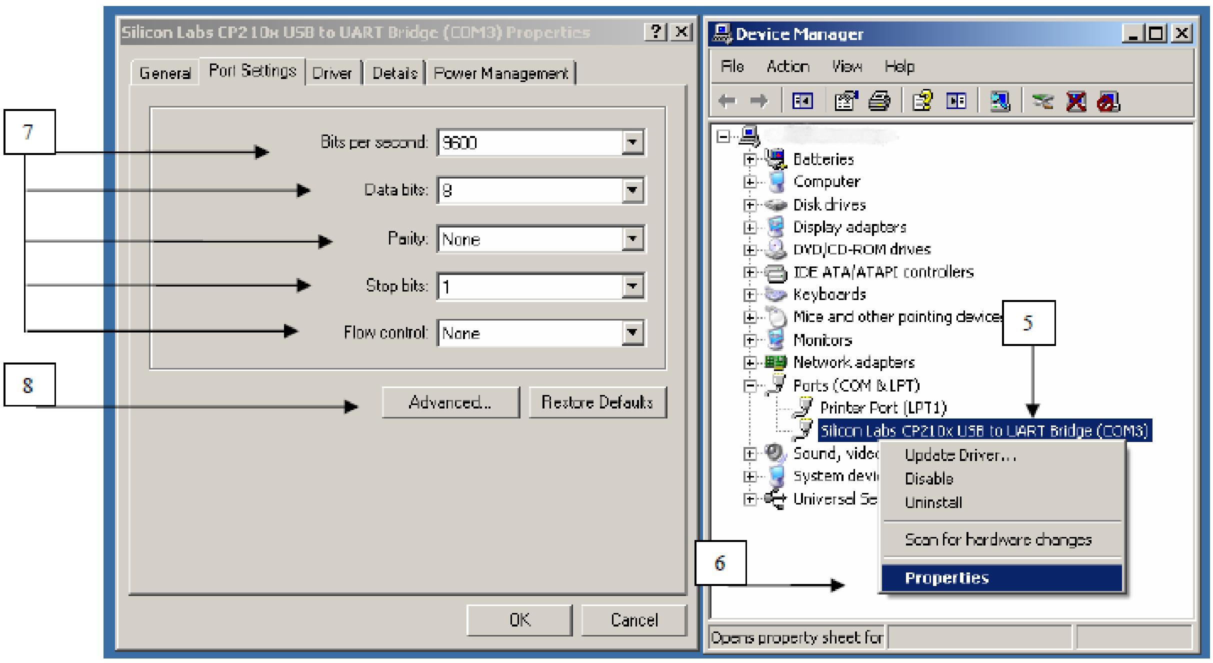

Figure 3.17. Virtual COM port properties dialog.

7. Use dropdown combo boxes to change port settings.
8. Click "Advanced" button then you should see one more window.
9. Select port number (available ports numbers 256) from the dropdown combo box labeled "COM Port Number" as shown in figure 3.17.

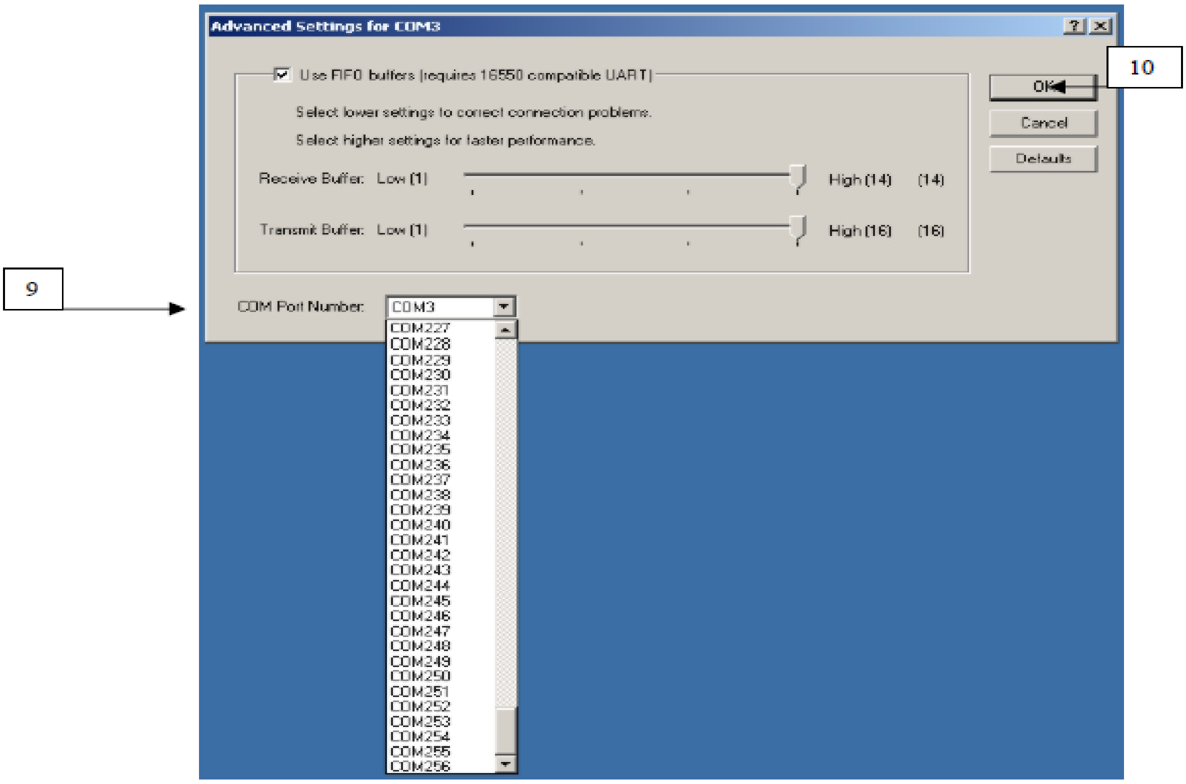

Figure 3.18. Changing Virtual COM port number.

10. Click “OK”.

11. Follow back to the Virtual COM port properties dialog .

12. Click “OK” to save settings changes as shown in figure 3.18.Figure 3.19.3.20 and 3.21 give information about PCB of USB to Rs232 converter.

Figure 3.19. PCB top/bottom side.

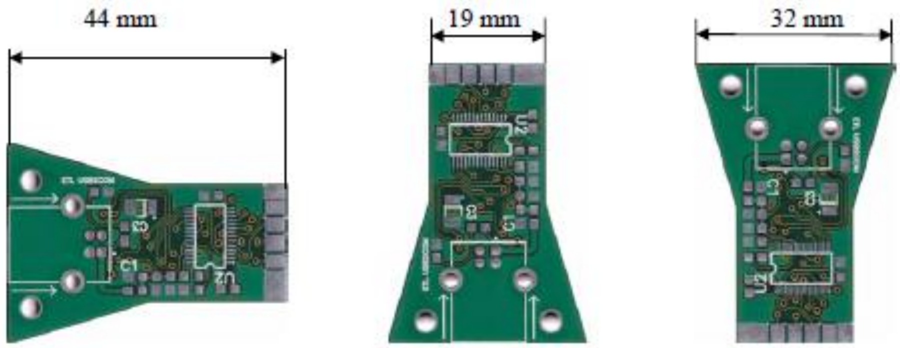

Figure 3.20 PCB dimensions.

Figure 3.21 USB port connector and DB-9 port connector M/F Types

Table 3.1. USB specification pins.

Series A/B pin	Conductor	Cable Wire
1	VBUS (Vcc + 5V)	RED
2	D -	WHITE
3	D +	GREEN
4	GND	BLACK
Shell****	Shield	DRAIN WIRE

CHAPTER 4

REQUIREMENT ANALYSIS

4.1 Power Supply

Power supply is a reference to a source of electrical power. A device or system that supplies electrically or other types of energy to an output load or a group of loads is called power supply unit or PSU. This power supply section is required to convert AC signal to DC signal and also reduce the amplitude of the signal. The available voltage signal from the mains is 230V/50Hz which is an AC voltage, but the required is DC voltage (no frequency) with the amplitude of +5V and +12V for various applications. In this section Transformer, Bridge rectifier, are connected serially and voltage regulators for +5V and +12V (7805 and 7812) via a capacitor (1000µF) which are connected in parallel as shown in the circuit diagram below. Each voltage regulator output is again is connected to the capacitors of values (0.1µF, 470µF) are connected in parallel through which the corresponding output (+5V or +12V) are taken into consideration as shown in figure 4.1.

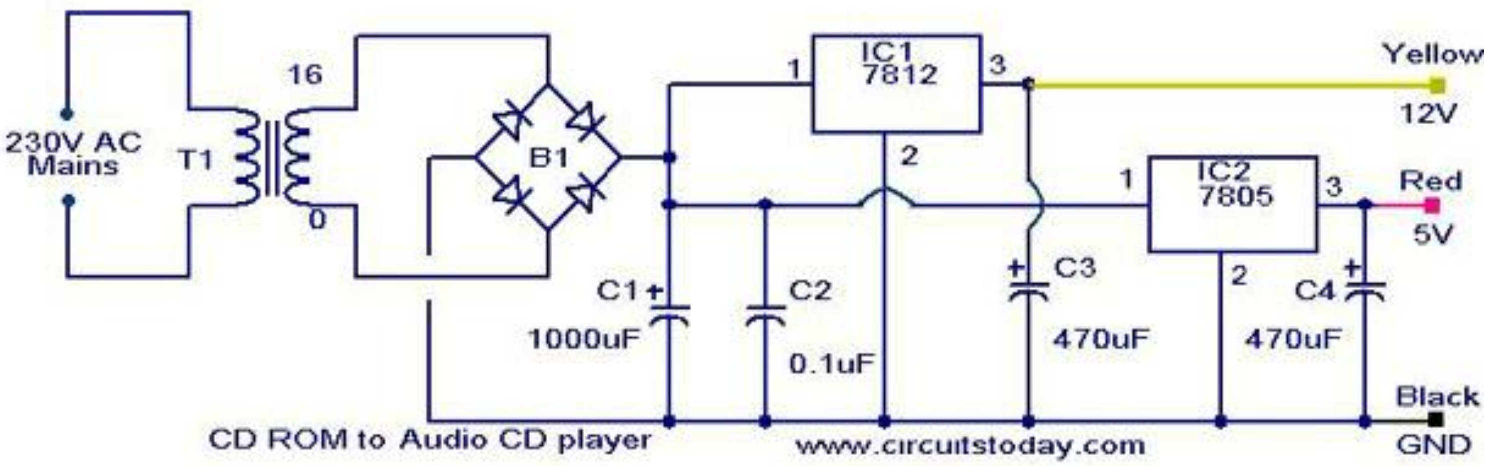

Figure 4.1 Circuit with Transformer and Bridge rectifier

4.1.1 Transformer

A transformer is a device that transfers electrical energy from one circuit to another through inductively coupled electrical conductors. A changing current in the first circuit (the primary) creates a changing magnetic field; in turn, this magnetic field induces a changing voltage in the second circuit (the secondary). By adding a load to the secondary circuit, one can make current flow in the transformer, thus transferring energy from one circuit to the other. The secondary induced voltage Vs, of an ideal transformer, is scaled from the primary Vp by a factor equal to the ratio of the number of turns of wire in their respective windings:

$$\frac{Vs}{Vp} = \frac{Ns}{Np}$$

Basic principle of transformer

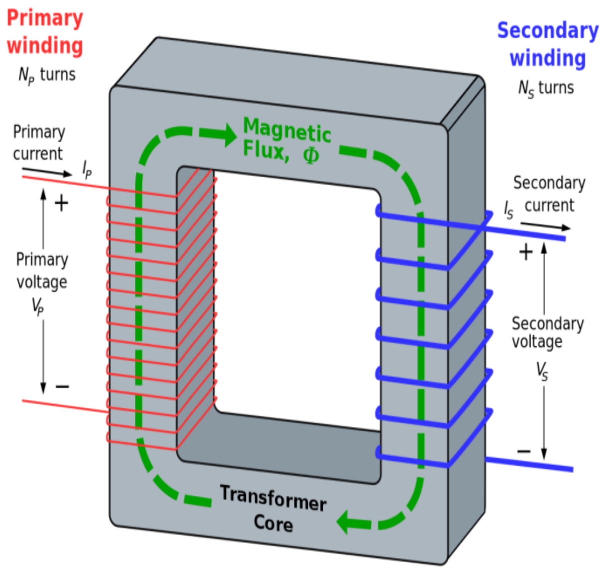

Figure 4.2 An ideal step –down transformer showing magnetic flux in the core

The transformer is based on two principles: firstly, that an electric energy current can produce a magnetic field (electromagnetism) and secondly that a changing magnetic field within a coil of wire induces a voltage across the ends of the coil (electromagnetic induction). By changing the current in the primary coil, it changes the strength of its magnetic field; since the changing magnetic field extends into the secondary coil, a voltage is induced across the secondary. A current passing through the primary coil creates a magnetic field as shown in figure 4.2. The primary and secondary coils are wrapped around a core of very high magnetic permeability, such as iron; this ensures that most of the magnetic field lines produced by the primary current are within the iron and pass through the secondary coil as well as the primary coil.

4.1.2 Bridge Rectifier

A bridge rectifier is an arrangement of four diodes in a bridge configuration that provides the same polarity of output for either polarity of input. When used in its most common application, for conversion of an alternating_current (AC) input into a direct current (DC) output, it is known as a bridge rectifier. A bridge rectifier provides full-wave rectification from a two-wire AC input, resulting in lower cost and weight as compared to a center-tapped transformer design, but has two diode drops rather than one, thus exhibiting reduced efficiency over a center tapped design for the same output voltage. The essential feature of a bridge rectifier is that the polarity of the output is the same regardless of the polarity at the input.

Basic Operation of Bridge rectifier

When the input connected at the left corner of the diamond is positive with respect to the one connected at the right hand corner, current flows to the right along the upper path to the output, and returns to the input supply via the lower one as shown in figure 4.3.

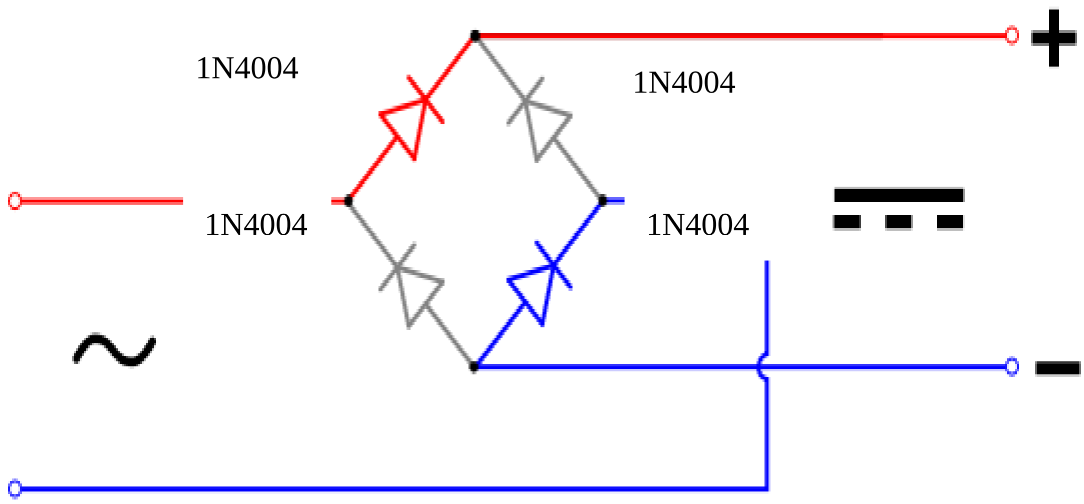

Figure 4.3 Bridge rectifier operation 1

When the right hand corner is positive relative to the left hand corner, current flows along the upper path and returns to the supply via the lower path as shown in figure 4.4.

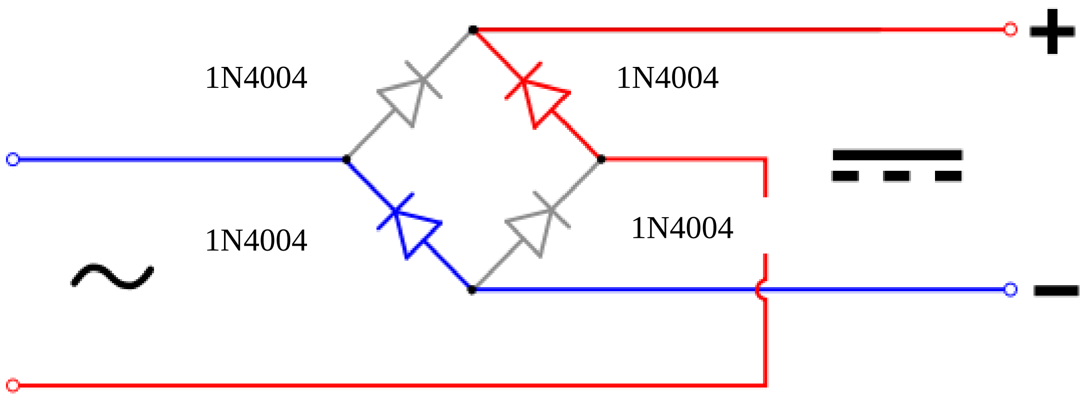

Figure 4.4 Bridge rectifier operation 2

In each case, the upper right output remains positive and lower right output negative. Since this is true whether the input is AC or DC, this circuit not only produces a DC output from an AC input, it can also provide what is sometimes called "reverse polarity protection". That is, it permits normal functioning of DC-powered equipment when batteries have been installed backwards, or when the leads (wires) from a DC power source have been reversed, and protects the equipment from potential damage caused by reverse polarity as shown in figure 4.5.

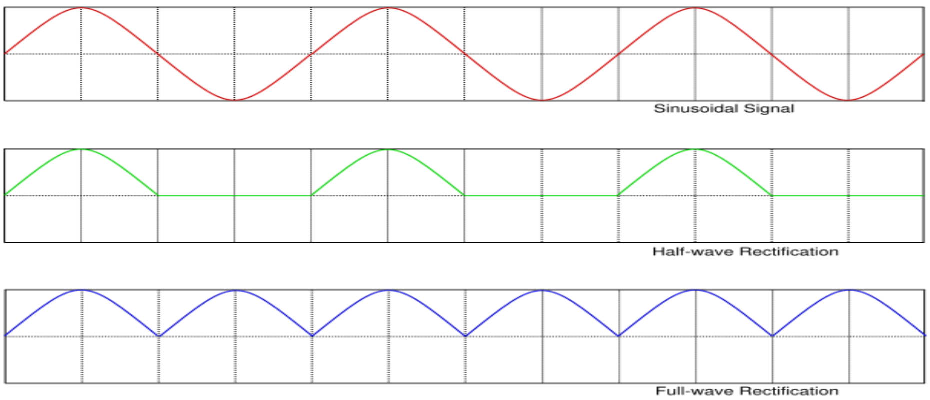

Figure 4.5 Waveforms of rectifiers

4.1.3 Voltage Regulator

The voltage regulator is an electrical regulator designed to automatically maintain a constant voltage level. The 78xx (also known as LM78xx) series of devices is a family of self-contained fixed linear voltage regulator integrated circuits. The 78xx family is a very popular choice for many electronic circuits which require a regulated power supply, due to their ease of use and relative cheapness. When specifying individual ICs within this family, the xx is replaced with a two-digit number, which indicates the output voltage the particular device is designed to provide (for example, the 7805 has a 5V output, while the 7812 produces 12V). The 78xx line is a positive voltage regulator, meaning that they are designed to produce a voltage that is positive relative to the common ground as shown in figure 4.6. 78xx ICs have three terminals and typically support an input voltage which can be anywhere from a couple of volts over the intended output voltage, up to a maximum of 35 or 40 volts, and can typically provide up to 1 or 1.5 amps of current.

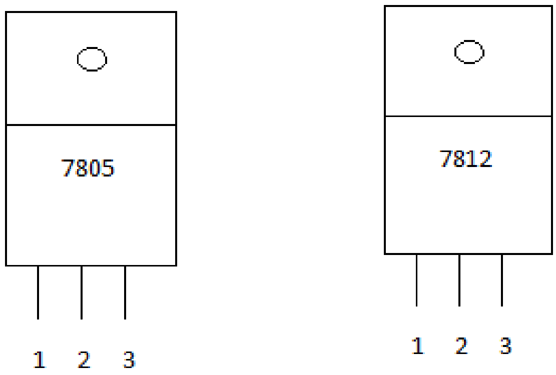

Figure 4.6 Pin out of the 78xx regulator ICs.

1. Unregulated voltage in
2. Ground
3. Regulated voltage out

4.2 Zigbee

zigbee is a latest evolved technology with the commonly effort of Zigbee alliance and IEEE 802.5.11 based on the demand of low power, low data transfer rate, low cost, low complexity wireless network technology. Zigbee is ordinarily used in wireless sensor network and control systems which connect and communicate among thousands of tiny sensors, these sensors require very small amount of energy to send data from one sensor to another sensor through radio waves in a relay way, and communication efficiency is very high. Zigbee is a standard that defines a set of communications protocol for low data rate short range wireless networking. Zigbee based wireless devices operate in 868 MHz, 915 MHz, and 2.5 GHz frequency bands. Zigbee is a kind of short distance, low power, low data transfer rate, low cost, low complexity wireless network technology. Zigbee connect and communicate among thousands of sensors. The maximum data rate is 250k bit per second. Zigbee is targeted mainly for battery powered applications.

The ZigBee specifications is as follows:

- It is intended to be simpler protocol.
- It is cheaper than other WPANs, such as Bluetooth. It is a radio-frequency (RF) application with a low data rate which require, secure networking and long battery life

In the market most wireless standards are available with fast data rate. Speed and power consumption have direct relationship. The zigbee wireless networking standards fit into the market that is simply not filled by the other wireless technologies. While other wireless protocols add more and more features, zigbee aims for a tiny stack that fits on 8-bit micro controller. ZigBee nodes are used for tying an entire network, control, for security home or factory together, convenience and safety. For a huge number of controls and sensors nodes can be incorporated and for automation applications this nodes are built into big infrastructures like home automation, industrial automation, remote metering, medical equipment, automotives, security systems, temperature control systems, patient monitoring, lighting and, asset tracking systems.The comparison between most common wireless technologies is listed in below table according to its wireless standard, power consumption, data rate, range of covering and memory requirement. The In the context of sensor network which require only small data rate and low power consumption all the wireless protocol seems to be infeasible except Zigbee. Zigbee is ideal for low power consumption and low data rate required network sensor networks as shown in table 4.1.

Table 4.1 comparision between Zigbee,bluetooth and WiFi

	Zigbee	Bluetooth	WiFi
Standard	802.15.4	802.15.1	802.11b
Memory Requirements	4-32KB	250KB+	1MB+
Battery life	Years	Days	Hours
Nodes per master	65,000+	7	32
Data rate	250Kb/s	1Mb/s	11Mb/s
Range	300m	10m	100m

A **wireless sensor network** (WSN) is the collection of the autonomous sensors which are spatially distributed for the purpose of monitoring physical or environmental condition, such as temperature, sound, vibration, humidity, pressure, motion etc. Initially the wireless sensor network was developed for the application of military such as battlefield surveillance to increase the security and make reliable operation. The wired technology is so much cumbersome in this task and not feasible as well. In present days WSN used in many industrial and civilian application areas, including industrial process monitoring and control, machine health monitoring, environment and habitat monitoring, healthcare applications, home automation, and traffic control.

In the network there is one or more sensors node and in the node it is equipped with a radio transceiver or other wireless communication device, a small microcontroller, and an energy source usually a battery voltage since it requires a small amount of energy to operate. As a radio transceiver for low data rate and low power consumption application zigbee wireless protocol is used. And most of the sensor network they operate in low data rate and try to consume minimum power so that a pair of battery operates a single year for reliability of its application. Sensor nodes are in different size. The sizes vary from that of a shoebox down to the size of a grain of dust. Size and cost constraints on sensor nodes result in corresponding constraints on resources such as energy, memory, computational speed and bandwidth. A sensor network normally works a s wireless ad-hoc network that means each sensor follow a multi-hop routing algorithm where node forwards relays data packets to a base station.

4.2.1 Sensor node

Sensor nodes gather the information about its surrounding according to its particular application. It processes the raw information and can communicate with other nodes in the network. The typical block diagram of the sensor node is presented below in figure 4.7. As in the block diagram the main components of the sensor nodes are listed below

Controller

As the name suggest controller is the controls the overall operation of the node. It includes processing of data, controlling the functionality of other different component that is used in the sensor node. There are various types of controller for this purpose but the most common used controller is Microcontroller unit of different series. Other alternative controllers are desktop microprocessor, digital signal processors ASICs, and FPGAs. A microcontroller gain popularity in the embedded system sensor node due to its low cost, flexibility to connect to other devices, ease of programming and low power consumption.

Other general purpose microprocessors are not considered for this purpose due to the higher power consumption than microcontroller since wireless sensor network totally based on the power saving mechanism. A general purpose microprocessor generally has higher power consumption than a microcontroller; therefore it is often not considered a suitable choice for a sensor node. In the broadband wireless communication system, digital signal processor may be implemented but in the case of wireless sensor network the communication process is so much simpler, easy process of modulation and the signal processing tasks of actual sensing of data is less complicated. Therefore it is not seen more advantages of DSP to the wireless sensor node. In the other hand FGPAs can utilized for this processing by reprogramming and reconfiguring it according to our need, but the time consumption and effort is more than requirement.

Transceiver

Sensor node often operates to the ISM band which is a free radio, spectrum allocation and global availability However apart from radio frequency for transmission other media includes optical communication (Laser) and Infrared. Now talking about these options laser is the line-of-sight communication with the less energy requirement and it is more sensitive towards the atmospheric environment. Though the infrared communication does not need any antenna for communication like laser but it has limited broadcasting capacity. So that, the relevant fit for WSN applications is Radio frequency based communication with more flexibility. WSN generally tend to operate in license-free communication frequencies: 173, 433, 868, and 915 MHz; and 2.4 MHz. The device which contains both the function of transmitter and receiver is known as the transceivers. Transceivers often lack unique identifiers. The different operational stage of the transceivers is transmitting, receive, idle, and sleep.The most of transceivers operating in idle mode consume same amount of power as in the receive mode. Thus, for the power consumption process it is better to completely off the transceiver, not allowing it to idle mode when it is not transmitting or receiving data.

Transceiver consumes more power when changing the state from sleep mode to transmit mode in order to transmit the packet of data.

External memory

Generally there are two types of memory; User memory and Program memory. User memory is used to store application related or personal data and program memory contain space for programming the device and identification data of the device. Microcontroller contain on chip memory itself. Flash memories are most relevant from the view of energy perspective as well there cost is relatively low and storage capacity is high. Off-chip RAM is used according to the application requirement. Memory requirement is totally application dependent.

Power source

The power is required for sensor node for sensing, communicating and data processing. Sensor node needs relatively low power so that Power requirement is fulfilled either the use of batteries or capacitors. Batteries with rechargeable or non-rechargeable option are the main source of power supply for sensor nodes. They are also classified according to electrochemical material used for the electrodes such as NiCd (nickel-cadmium), NiZn (nickel-zinc), NimHh (nickel-metal hydride), and lithium-ion. Current sensors are able to renew their energy from solar sources, temperature differences, or vibration. Two power saving policies used are Dynamic power management (DPM) and Dynamic voltage Scaling.(DVS). DPM conserves power by shutting down parts of the sensor node which are not currently used or active. A DVS scheme varies the power levels within the sensor node depending on the non-deterministic workload. By varying the voltage along with the frequency, it is possible to obtain quadratic reduction in power consumption.

Sensors

A sensor; is a physical which is used for measuring a physical condition which produce a measurable response according to the change in physical condition like temperature , pressure or humidity and converts it into a signal which can be read by an observer or by an instrument. Sensors measure physical data of the parameter to be monitored. The initially generated signal by the sensor is continual analog in signal the nature which should be digitized by an Analog to Digital converter (ADC) for further processing by the controller. For the proper design consideration in terms of size, power consumption and speed and to increase intelligence in the system a sensor node should be small in size, consume extremely low energy, operate in high volumetric densities, be autonomous and operate unattended, and be adaptive to the environment. So that wireless sensor nodes are typically very small electronic devices, they can only be equipped with a limited power source of less than 0.5-2 ampere-hour and 1.2-3.7 volts.

The sensors are divided into further three categories they are listed below

- Passive sensors
- Omni-directional sensors
- Passive narrow beam sensors

Passive sensors are self powered sensors which sense the data without actually manipulating the environment by active probing. External power is needed only for the amplification of the analog signal. An active sensor requires continuous energy from the power source to operate and it actively examines the environment, for example, a sonar or radar sensor.Narrow-beam sensors have a well-defined notion of direction of measurement, similar to a camera. Omni-directional sensors have no notion of direction involved in their measurements. For the theoretical work on the WSN network, passive and Omni-directional sensors are used. For each sensors node certain area of coverage will be determined at which it can fully monitor that area. The power is required during the different work on the sensor node; signal sampling and conversion of physical signals to electrical ones, signal conditioning, and analog-to-digital conversion.

4.2.2 Why is it called Zigbee?

It has been suggested that the name evokes the haphazard paths that bees follow as they harvest pollen, similar to the way packets would move through a mesh network. Using communication system, whereby the bee dances in a zigzag pattern, the worker also able to share information such as the location, distance, And direction of a newly discovered food source to her fellow colony members. Instinctively implementing the ZigBee Principle, bees around the world actively sustain productive itchiness and promote future generations of Colony members.

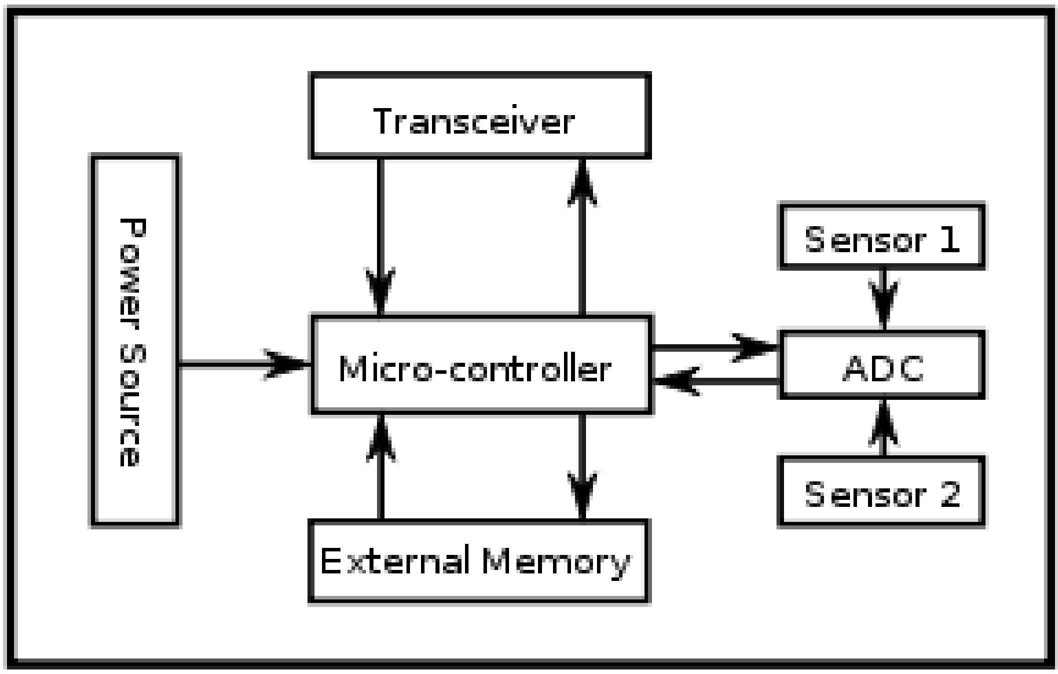

Figure 4.7 Typical block diagram of the sensor node

4.2.3 Wires versus wireless

Wireless is inherently unreliable. Does this sound strange coming from a proponent of Zigbee? It's true. There are so many factors that affect wireless; RF noise coming from machinery, changes in the physical environment, even the vagaries of the atmosphere. In the 2.4 GHz spectrum, which is the ISM band used by Zigbee, there is even more interference. Water, people, concrete, metal, foliage can all change the wireless characteristics, causing packet delivery to fail. Now granted, zigbee, with its mesh networking and per hop and end to end retries and acknowledgments, turns what is an essentially unreliable medium into a very reliable network, but zigbee is not the only solution to network devices. A wired network doesn't have any of the above problems. But wires do have problems of their own. Wires have connectors, and connectors get broken over time, especially if they are plugged in frequently. The wires themselves get caught on things and get cut. A wireless system can test and inspect the washing machines, dryers and refrigerators coming down the line without any of the drawbacks of wires.

4.2.4 Zigbee Specifications

1. IEEE 802.15.4 with OQPS and DSSS
2. CSMA – CA
3. 16 bit CRC'S

4. Acknowledgement at each hop
5. Mesh networking to find reliable route
6. End to end acknowledgement to verify data made it to the destination.

4.2.5 Zigbee benefits

Characteristics that are highly beneficial and they are as follows.Zigbee is highly reliable:Wireless communication is inherently unreliable. Prove this to yourself by walking around with your cell phones, then step into an elevator. Anyone who has used the cell phone has experienced dropped calls or poor reception. It’s all because radio waves are just that: waves. They run into interference pattern, can be blocked by the metal, water or a lot of concrete and vary depend on many complex factors including antenna design, power amplification and even weather condition.

1 Low Cost

The typical Zigbee radio is extremely cost-effective. This pricing to simplify the devices for economic explanation and for extending wireless networking.

2 Range and Obstruction Issues Avoidance:

As input devices and repeaters the Zigbee routers doubles to create a form of mesh networks. A clear path to the data’s destination from the blocked node the transmission is dynamically routed to a router if two or more network points are cannot communicate as designed. This happens automatically, so even when a link fails unexpectedly in the networks the communication continues. When the distance between the remote node and base station outpace the device range the use of low-cost routers can also be elongate the network’s effective reach, an intermediate node can relay transmission, dispensing the need for the isolated repeaters.

3 Multi-Source Products

Zigbee provides customers in open standard, with the ability to choose among vendors. In Zigbee Alliance working groups define that the interoperability profiles is to which Zigbee certified devices must adhere, and with any other Zigbee certified radio minding to the same profile the assured radio will interoperate, promoting compatibility and the associated competition that acquiesce the end users to select the best device for each and every network node, regardless of manufacturer.

4 Low Power Consumption

The Zigbee radios operate at 1 m WRF power, and it can sleep when not involved in transmission. More practical than ever as this also makes battery powered radio, in addition wireless devices are free to be placed to eliminating data cable runs without power cable runs.

5 Zigbee is low data rate

In order to achieve low cost and low power, and considering the applications space and markets Zigbee is aiming for, the Zigbee alliance decided to keep the protocol designed for a low data rate environment.

6 Zigbee is highly secure

For securing the network, Zigbee uses the national institute of standard and technology (nist) advanced encryption standard (aes). This standard is a block cipher that encrypts and decrypts packets in manner that is very difficult to crack. Its one of the best known and well-respected standards. The reason it was adopted by zigbee was for the following key reasons:

- It’s an international recognized and trusted standard.
- It’s free of patent infringements
- It’s implementable on an 8 bit processor.

Zigbee provides both encryption, which means that packets cannot be understand by listening nodes that are not aware of the key, and authentication. Which means a malicious node cannot inject false packets into the network and expect the zigbee nodes to do anything with them other than throw them away? Zigbee has been very careful to ensure the security solution.

4.2.6 Components used in ZIGBEE MODULE

1. Zigbee module
2. Transistor - LM117-3.3
3. Capacitors – 10uf – 2no
4. Power supply – 5v

4.3 LCD display

LCD stands for liquid crystal display. They come in many sizes 8x1 , 8x2 , 10x2 ,16x1 , 16x2 , 16x4 , 20x2 , 20x4 ,24x2 , 30x2 , 32x2 , 40x2 etc. A liquid-crystal display is a flat panel display, electronic visual display, or video display that uses the light modulating properties of liquid crystals. Liquid crystals do not emit light directly. LCDs are available to display arbitrary images or fixed images which can be displayed or hidden, such as present words, digits, and 7-segment displays as in a digital clock as shown in figure 4.8,4.9 and 4.10

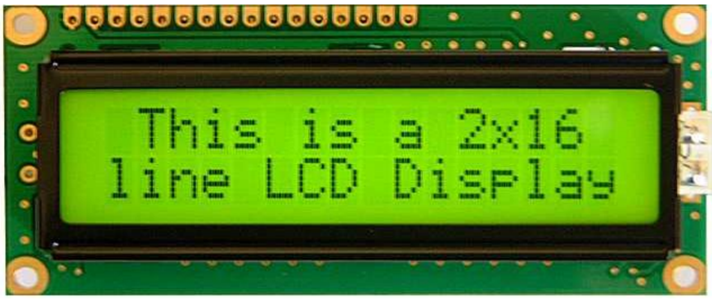

Figure 4.8 LCD Display

Table 4.2 Pin Description of LCD

Pin	Symbol	Function
1	Vss	Power supply(gnd)
2	Vdd	Power supply(+5v)
3	Vo	Contrast adjust
4	RS	Instruction/data register select
5	R/W	Data bus line
6	E	Enable signal
7-14	DB0-DB7	Data bus line
15	A	Power supply for LED B/L(+)
16	K	Power supply for LED B/L(-)

Most LCDs with 1 controller has 14 Pins and LCDs with 2 controller has 16 Pins (two pins are extra in both for back-light LED connections)

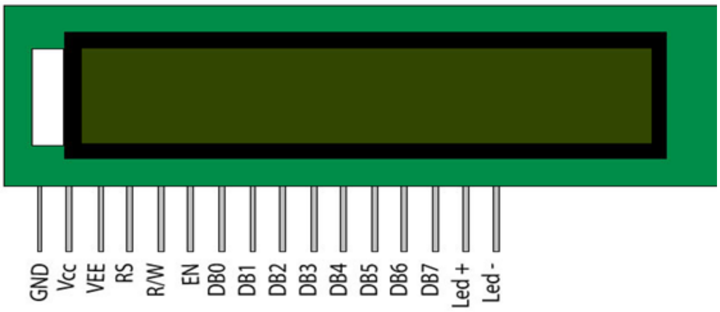

Figure 4.9 Pin Diagram of LCD Display

1. V0 (Set Lcd contrast)

The best way to Set LCD contrast is to use potentiometer. The output of the potentiometer is connected to this pin. Rotate the potentiometer knob forward and backward to adjust the lcd contrast

2. RS (Register select)

There are two registers in every lcd.

1. Command Register

2. Data Register

3. Command Register

When we send commands to lcd these commands go to Command register and are processed there.

4. Data Register

When we send Data to lcd it goes to data register and is processed there.

When RS=1 Data Register is selected.

When RS=0 Command Register is Selected.

5. RW(Read / Write)

When RW=1 We want to read data from lcd.

When RW=0 We want to write to lcd.

6. **EN (Enable signal)**

When you select the register (Command and Data) and set RW(read - write) now its time to execute the instruction. By instruction the 8-bit data or 8-bit command present on Data lines of lcd. This requires an extra voltage push to execute the instruction and EN (enable) signal is used for this purpose. Usually we make it en=0 and when we want to execute the instruction we make it high en=1 for some milliseconds. After this we again make it ground en=0[2] table 4.2 and 4.3 show the pin description.

Interfacing LCD with Arduino

Table 4. 3 Interfacing LCD pins

LCD pin	Arduino pin
1	Gnd
2	5V
3	10kΩ
4	12
5	Gnd
6	11
7	NC
8	NC
9	NC
10	NC
11	2
12	3
13	4
14	5
15	5V
16	Gnd

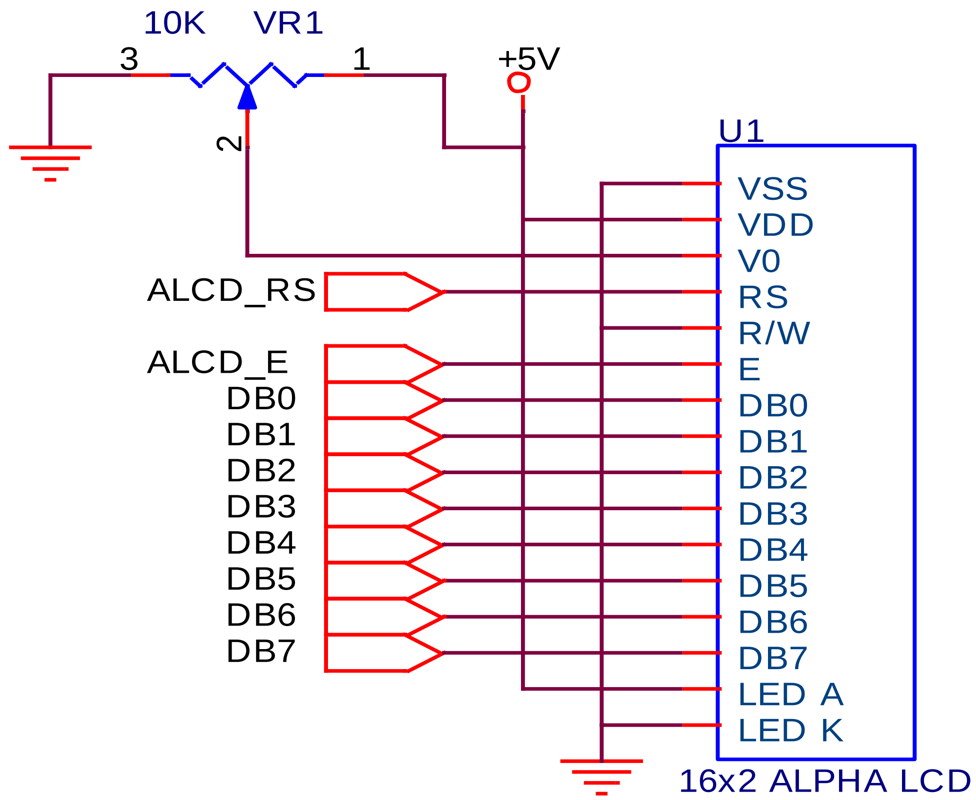

Figure 4.10 lcd connected to microcontroller

4.4 MAX232

Max232 is compatible with RS-232 standard and consists of dual transceiver. Each receiver converts TIA/EIA-232-E levels into 5V TTL/COMS levels. Each driver converts TTL/COMS levels into TIA/EIA-232-E levels. The MAX232 is characterized for operation from -40̊ C to +85̊ C for all packages. MAX232 is purposed for application in high-performance information/processing systems and control devices of wide application.

4.4.1 Features

- Input voltage levels are compatible with standard CMOS levels.
- Output voltages levels are compatible with EIA/TIA-232-E levels.
- Single Supply Voltage: 5V.
- Low input Current: 0.1µA at TA=25̊ C.
- Output Current: 24mA.
- Latching current not less than 450mA at TA= 25̊ C.

- The transmitter outputs and receiver inputs are protected to +/-15kV Air ESD as shown in figure 4.11 and table 4.4.

4.4.2 Pin Configuration of MAX232

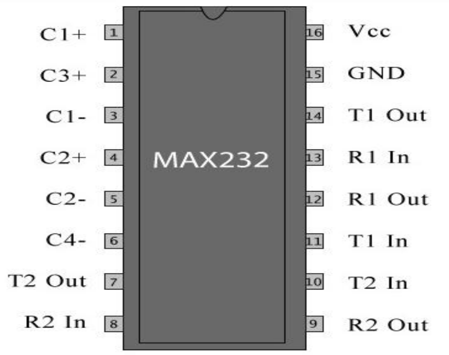

Figure 4.11 Pin description of MAX 232

4.4.3 Pin Description of MAX232

Table 4.4 Pin Description of MAX232

No.	Name	Function
1	C1+	Positive lead of C1 capacitor
2	V+	Positive charge pump output for storage capacitor only
3	C1-	Negative lead of C1 capacitor
4	C2+	Positive lead of C2 capacitor
5	C2-	Negative lead of C2 capacitor
6	V-	Negative charge pump output for storage capacitor only
7	T2OUT	RS232 line data output (to remote RS232 system)
8	R2IN	RS232 line data input (from remote RS232 system)
9	R2OUT	Logic data output (to UART)
10	T2IN	Logic data input (from UART)
11	T1IN	Logic data input (from UART)
12	R1OUT	Logic data output (to UART)
13	R1IN	RS232 line data input (from remote RS232 system)
14	T1OUT	RS232 line data output (to remote RS232 system)
15	GND	Ground
16	VCC	Supply Voltage, Connect to external 5V power supply

4.5 APR Kit

APR stands for Audio play record.It is a module that is ured for recording a perticuler audio on 8 channels provided on the kit using the MIC given on the kit.This module has the following features.

4.5.1 Features

1.Total 11 minutes of recording time each channel(M0 to M7) having 1.3minutes of recording time.
2.Single chip, high quality voice recording and playback solution.
3.User friendly and easy to use operation.
4.Non-Volatile flash memory technology, no battery backup required.
5.Audio output to drive a speaker or audio out for public address system.
6.Can record voice with the help of on-board microphone

4.5.2 How to Record your Voice

1.we can use 8channels(M0 TO M7)each channel having 1.3minutes recording length.
2.Onboard MIC will automatically be used for recording.
3.supply voltage:12v AC/DC.
4.switch on the board power LED(LD1)will on.
5.Put the jumper in the board JP1(REC)Section.
6.while in record mode select J5(M0-M7) to select a channel to record the message.
7.Let us assume we want to record message in channel M0,Connect M0 to GND(IN Board J3 VCC,GND).
8. NOW Whatever we Speak will be captured by MIC and recorded,status LED(LD2) Will on in record mode indicating that chip is currently recording.once duration is full the LED(LD2)Will
off means that segment is full.now you can disconnect the GND Connection from M0,if before the duration is this connection is removed,then that many seconds are recorded and rest duration is kept empty.

4.5.3 Playback recorder message

1.Connect the speaker to the board J4 Speaker section.
2.NOW let us check what we recorded.remove jumper from JP1(REC)section

now connect the MO(J5)to GND(J3)Section, status LED(LD2) will ON till the recorded sound play in the speaker.

"This procedure same for the remaining channels also"

4.5.4 Use with Microcontroller

Voice Recording can be done Manually.To play back connect Controller I/Os to M0 to M7.When Output Goes Low For particular Pin Recorded message will play as shown in the figure 4.12.

Figure 4.12 Audio playback board using APR33A3 IC for 8channels of recording

CHAPTER 5

RESULTS AND DISCUSSION

5.1 Algorithm and Result

Step1: Take input from 4*4 input keyboard from transmitter.

Step2: Display the name in the LCD screen and play the pre-recorded audio.

Step3: Take the input from the 4*4 keyboard at the receiver.

Step4: Display the input give at the receiver on the transmitter LCD.

Step5: play the pre-recorded audio in the speaker.

Step6: check the transmitter keypad again for the input again.

Step7: If the modules are connected to PC's that the input from the transmitter window and display it on the receiver window of the PC.

Step8: Check for the reply at receiver end and if there is any reply from the user display it on the transmitter screen.

Steps involved in obtaining results:

1.At the transmitter to send in order to inform the receiver a necessary key is pressed as figure 5.1.

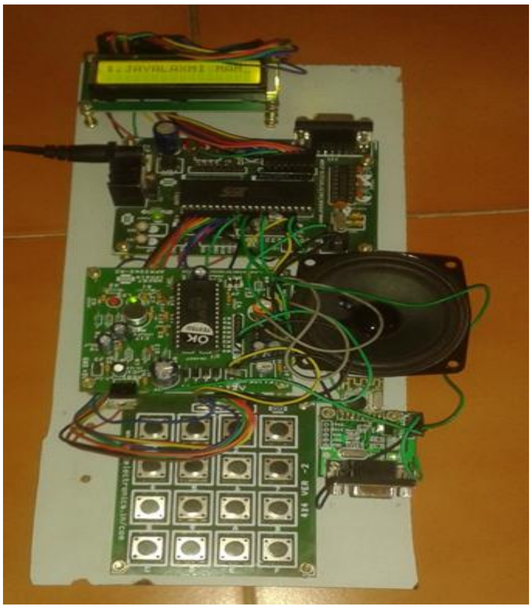

Figure 5.1 Input at the transmitter

2. . Here input to microcontroller is given by the press of key in the keypad which is 4x4 keypad used on transmitter side and 1x4 on the receiver side. When ever the key is pressed the row and the column of the key pressed is scanned.

3. This same information about the key pressed is given to the zigbee through Tx pin. This will transmit the data to the receiver module as shown in figure 5.2.

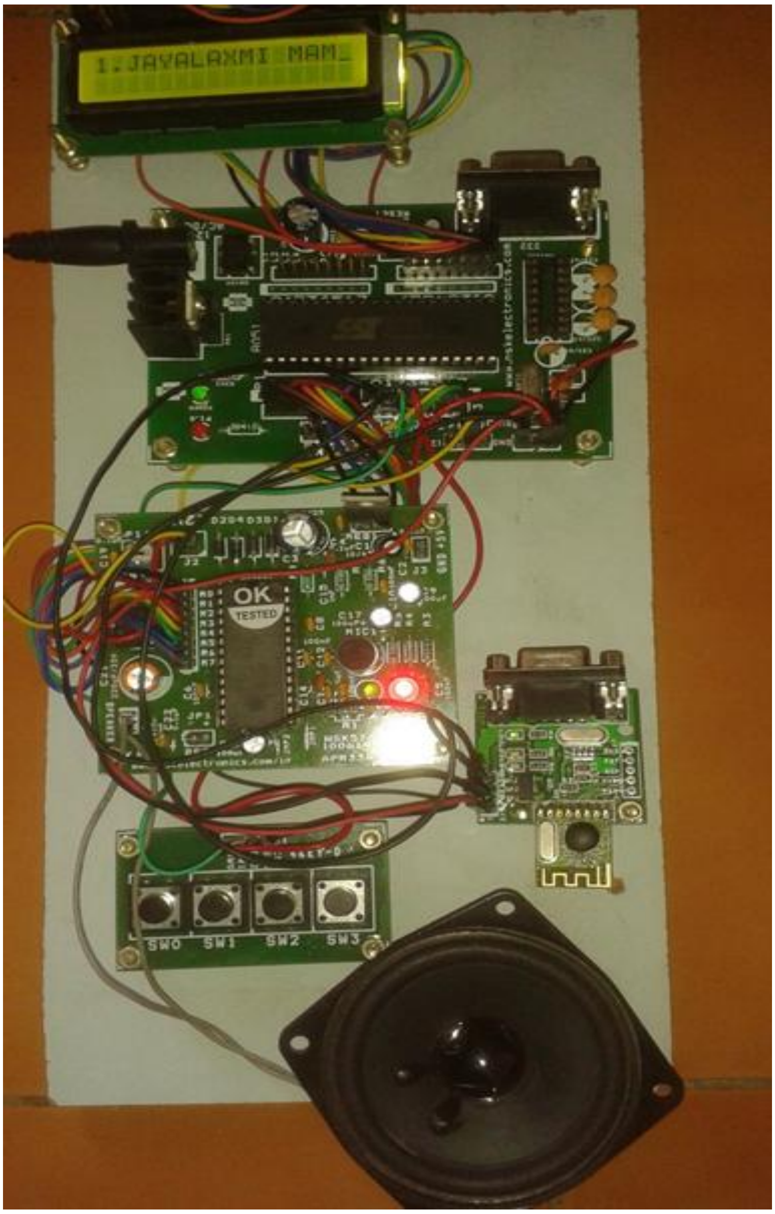

Figure 5.2 output received at the receiver

4. This data is send to microcontroller which in turn connected to lcd and APR kit will signal the APR to play the audio corresponding to the data of key pressed that is received.

5. Now at the receiver in response to the received data a particular key is pressed then the same above action that takes place at the transmitter repeats at the receiveras shown in figure 5.3.

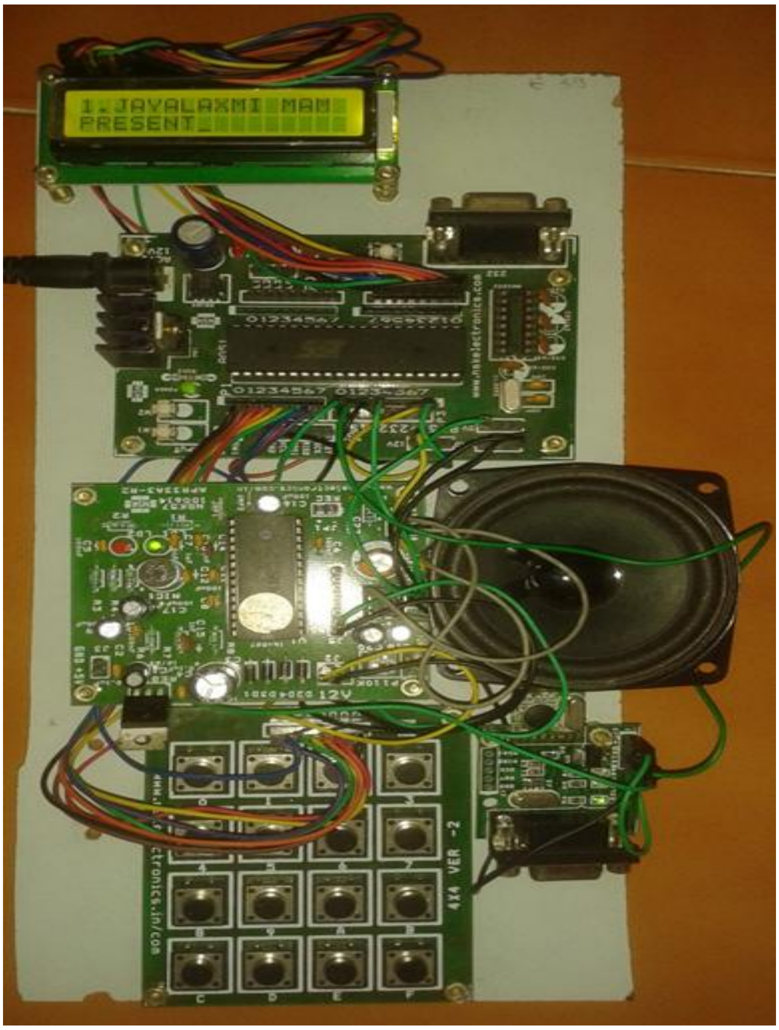

Figure 5.3 Output at transmitter after the reply from receiver

6. Now Whatever we Speak will be captured by MIC and recorded, status LED(LD2)Will on in record mode indicating that chip is currently recording.

7. There are a pair of trans receiver modules that are placed at two different locations. In second case whenever we want wirelessly communicate between two Pc s then we use USB to RS232 convertor cable that is connected between Pc and the Zigbee .Then we have a driver installed in the pc using which there is a message passing between two pc s is done.

8. The USB to Serial converter making the use of legacy peripherals and communication between PC and RS-232 devices easily.

9. The USB to Serial converter connects RS-232 serial devices to your USB providing a bridge connection with a DB-9 female serial port connector on the end and USB port plug

connector on the other side. The default settings for RS-232 communication are set to 9600 baud, 8 bits, no parity, and no software handshaking. Only the Transmit (TX), Receive (RX), and Ground signals are used.

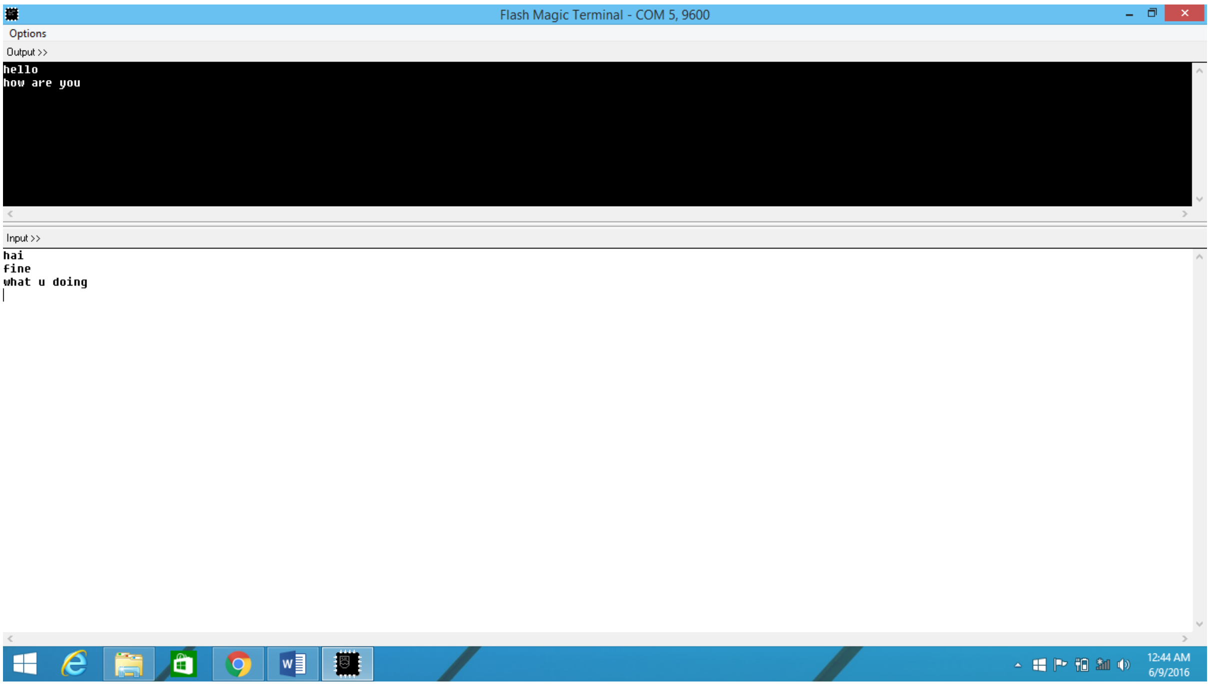

Figure 5.4 input seen on transmitter pc

10. The Request to Send (RTS) and Clear to Send (CTS) signals are tied together at the board level so that devices requiring the CTS signal will always be enabled to send data.

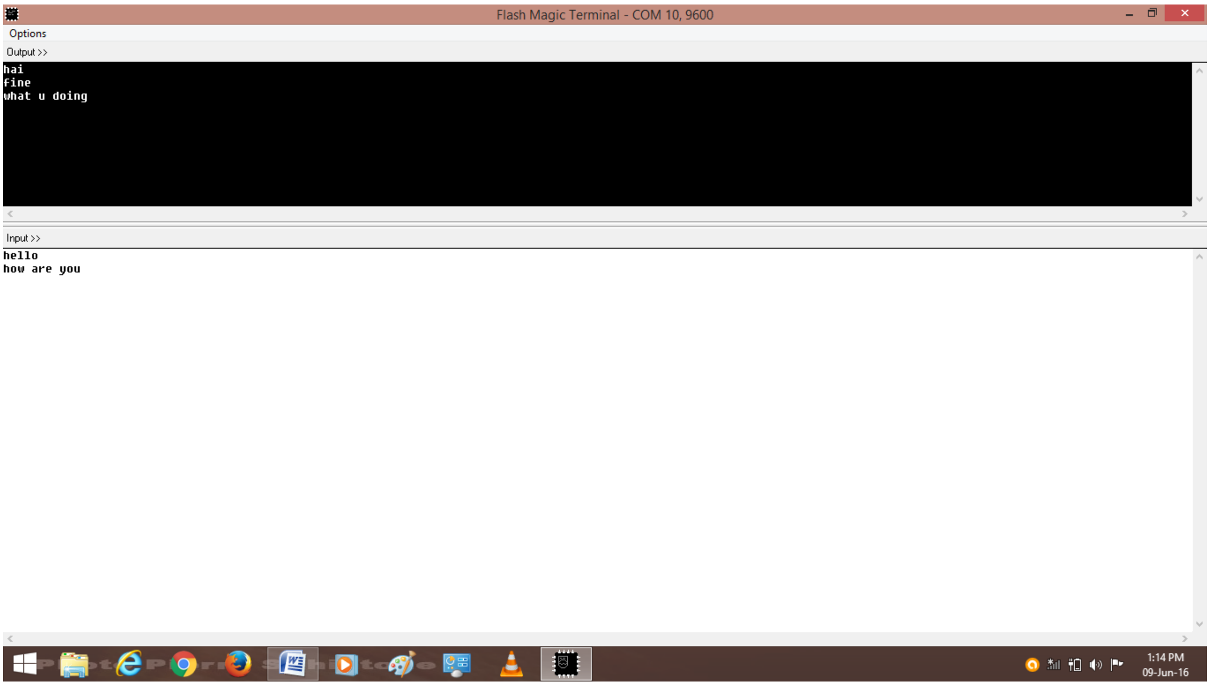

Figure 5.5 output at the receiver pc

11. If an attached device requires settings different from the board default, this can be changed in the software with the exception that this board does not accommodate devices that require handshaking beyond the CTS signal.

5.2 KEIL Development Tool

Keil software provides the ease of writing the code in either C or ASSEMBLY. U-VISION 2, the new IDE from Keil Software combines Project management, Source Code Editing and Program Debugging in one powerful environment. It acts as a CROSS-COMPILER.

5.2.1 How to Create a New Project

1. Select the Project from the menu bar.
2. Select New Project.
3. Give the File Name. A project with extension of .uv2 will be created as shown in figure 5.6.

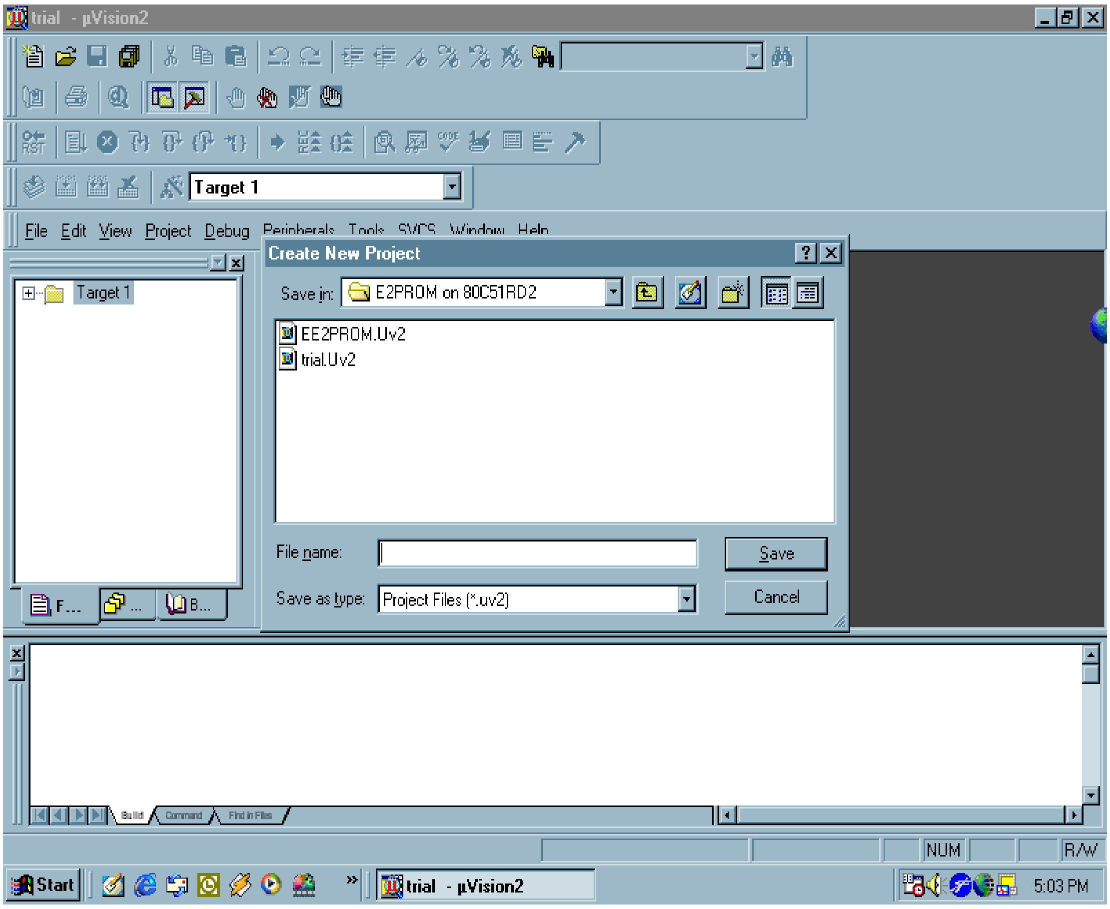

Figure 5.6 A project window with extension of .uv2

5.2.2 Selecting the Device

1. After giving the file name the device list windows opens.
4. Select the respective company's microcontroller IC that is going to be implemented in hardware as shown in figure 5.7.

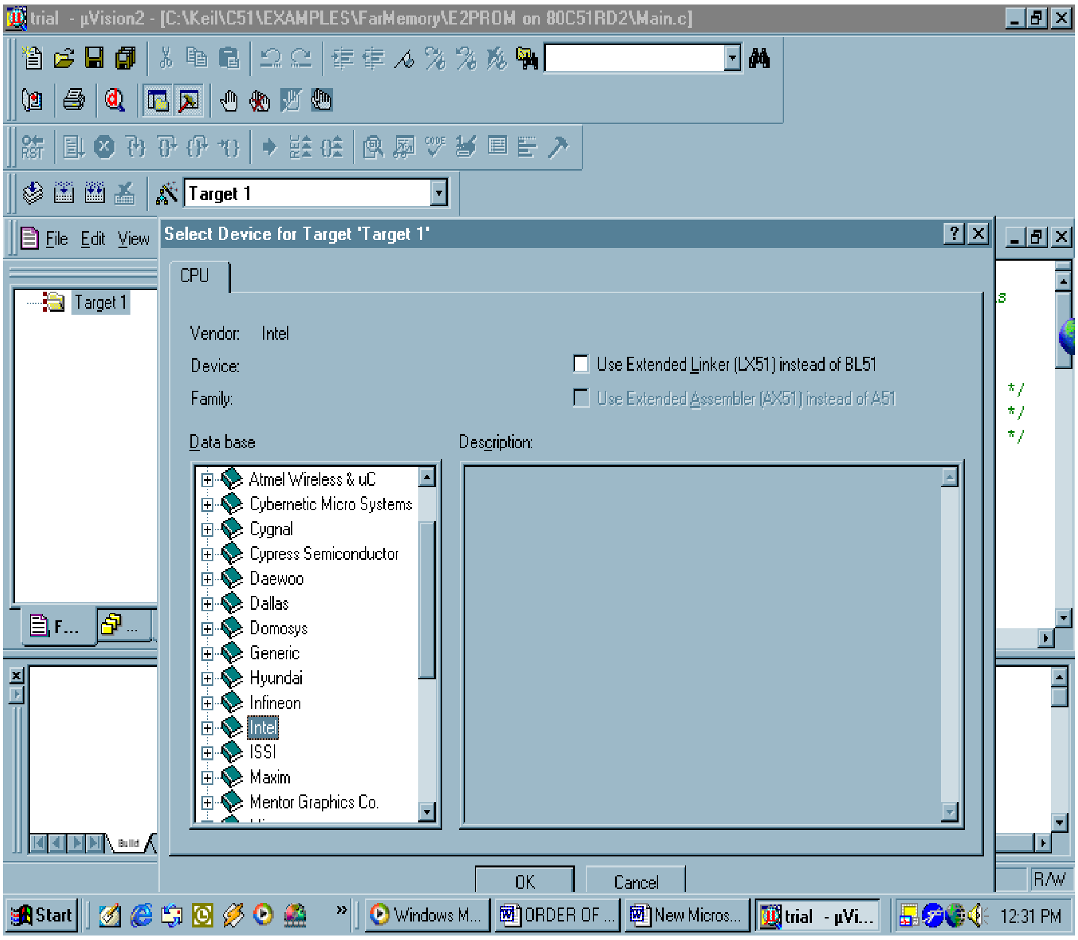

Figure 5.7 Selecting the Device

2. From the drop down arrow, we get a list of all the chips from that particular manufacturer. Choose the appropriate one.
3. Now the target is ready.
4. The data sheets and user manuals are automatically added.

5.2.3 Configuring the essentials

1. Right Click on Target to view the options for Target 1.
2. The Target tab enables to give the Starting address and size of RAM and ROM. We also have to specify the frequency of the crystal used which in our case is 11.0592Hz.

3. The Output tab has the option to create the HEX file. Confirm the check box given beside it.
4. The A166 and C51 tabs show the compiler options as shown in figure 5.8.

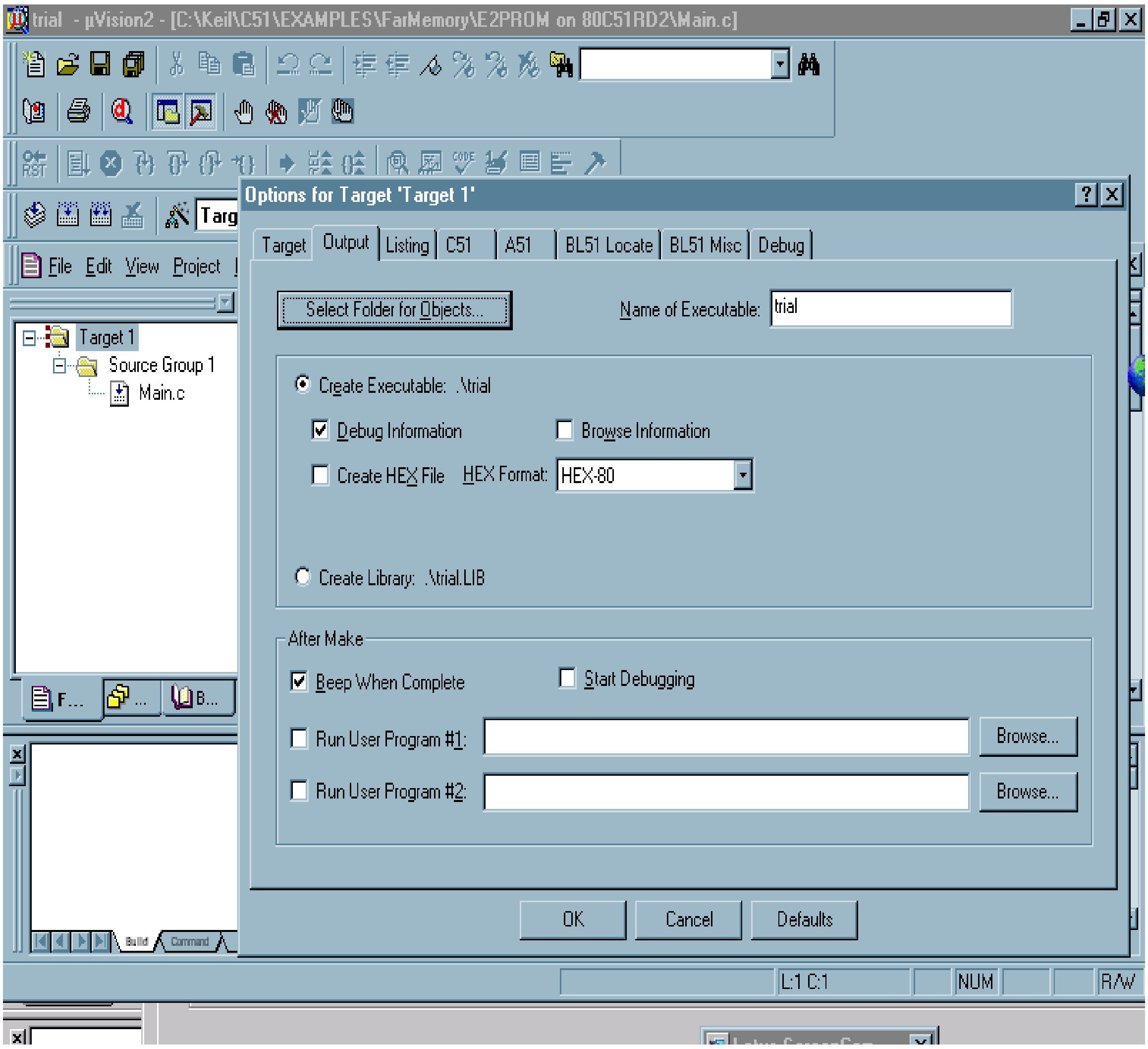

Figure 5.8 Configuring the essentials

5.2.4 Addition of files in Source group

1. After the Target is created the source group is added to it.
2. Select the file menu and choose the ‘New’ option in it to get a page. Save the same with a .a51 or .asm extension. These assembler files are the ones recognized by the compiler.
5. Right click on source group and select add files to include the program. Select the assembler files created earlier and confirm the action. The selected files appear in the left-hand side project window as shown in figure 5.9.

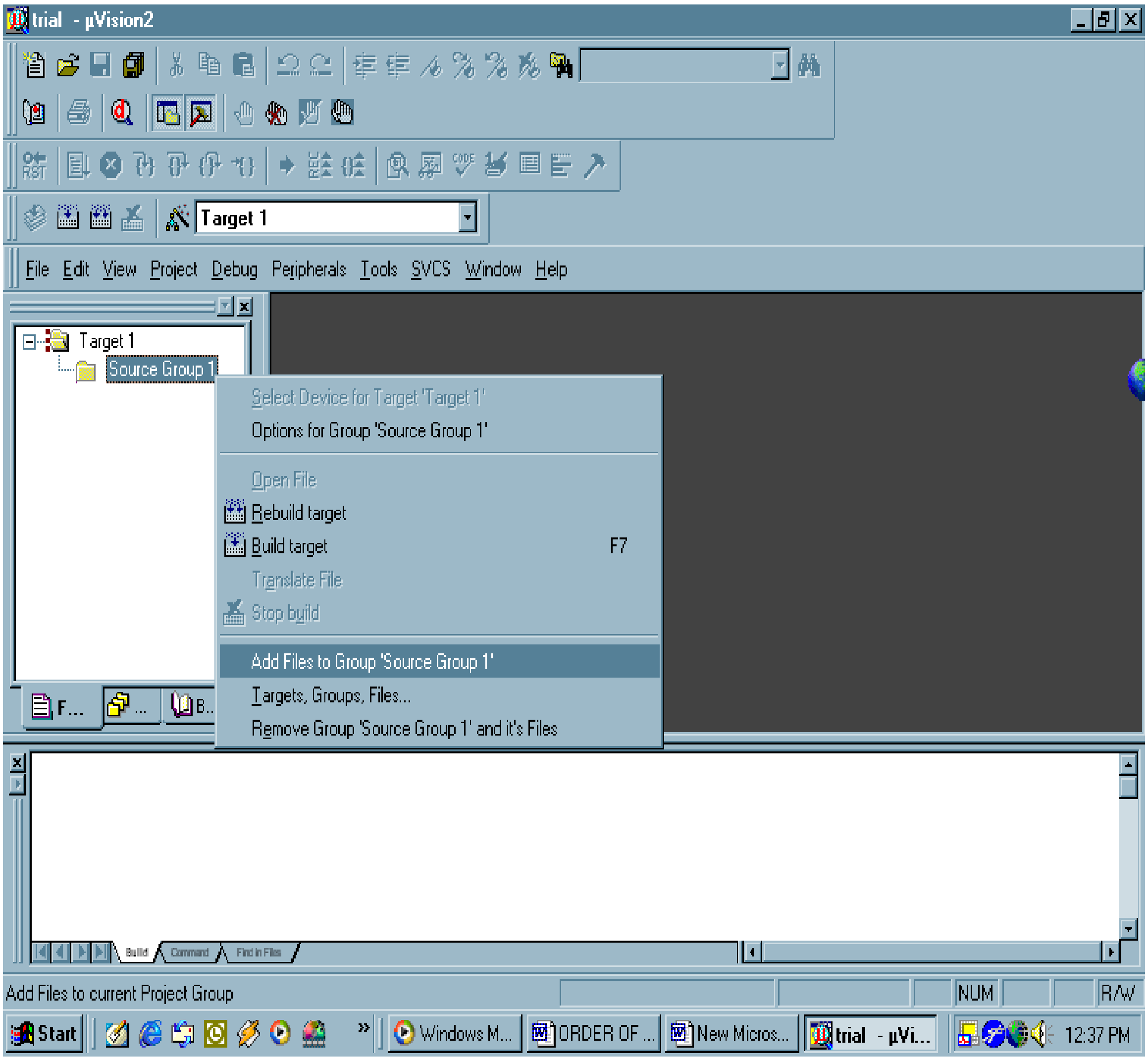

Figure 5.9 Addition of files in Source group

3. These files will contain your actual program in assembly or in embedded C language
4. An option for source group includes the compilers C51 and A51 paths.

5.2.5 Running the program

1. Any number of sub programs can be added to source group.
2. To run the program right click on it and select Build Target. When you
6. Build an application with syntax errors, µVision2 will display errors and warning messages in the Output Window – Build page. A double click on a message line opens the source file on the correct location in a µVision2 editor window as shown in figure 5.10.

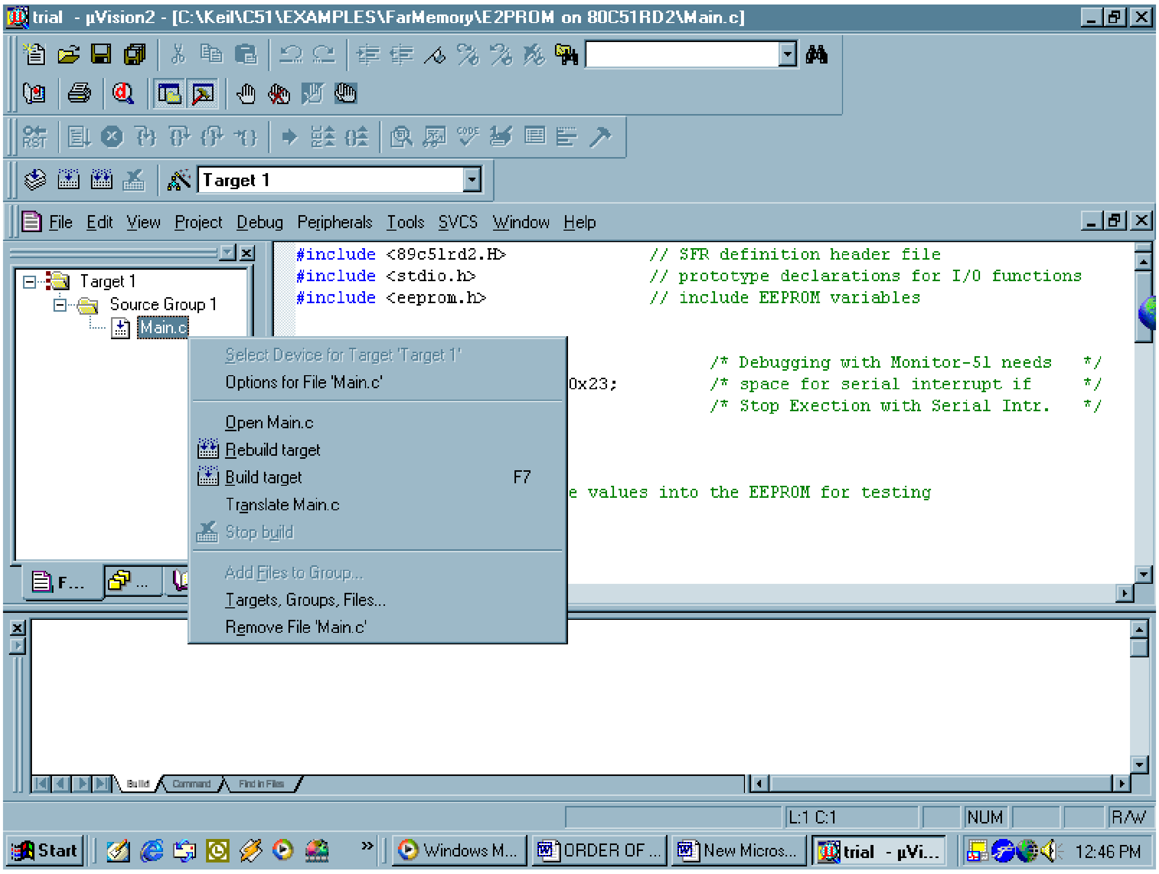

Figure 5.10. Running the Program

3. Then select rebuild all the target files too. With the Rebuild Target Command, all source files are translated, regardless of modifications.

4. After the target is built, debugging is done.

5. After all the debugging the file is built again which creates a hex file. This hex file is then used to download to the microcontroller using a programmer kit.

5.2.6. Target Program Execution & Debugging

µVision2 lets execute your application program in several different ways:

- With the Debug Toolbar buttons and the "Debug Menu and Debug Commands".
- With the Run till Cursor line command in the local menu. The local menu opens with a right mouse click on the code line in the Editor or Disassembly window.
- In the Output Window – Command page you can use the Go, Ostep, Pstep, and Tstep command. The Watch window lets you to view and modify program variables and

lists the current function call nesting. The contents of the Watch Window are automatically updated whenever program execution stops. You can enable View Periodic Window Update to update variable values while a target program is running. The Locals page shows all local function variables of the current function. The Watch pages display user-specify program variables. You add variables in three different ways:

- Select the text <enter here> with a mouse click and wait a second. Another mouse click enters edit mode that allows you to add variables. In the same way you can modify variable values.
- In an editor window open the context menu with a right mouse click and use Add to Watch Window. µVision2 automatically selects the variable name under the cursor position, alternatively you may mark an expression before using that command.
- In the Output Window – Command page you can use the Watch Set command to enter variable names.

To remove a variable, click on the line and press the Delete key. The current function call nesting is shown in the Call Stack page. Double clicking on a line shows the invocation an editor window.

CONCLUSION AND FUTURE SCOPES

This project designed for wireless data transfer from one pc to another pc using ZigBee.It mainly aims at providing the communication between two pc s offline that is without the use of any data connection. So that it is economical and one time investment. As wireless mode of communication is being used the problems associated with wired communication is solved. Using a wireless remote system means no wire for thieves to steal. Unlike much of the equipment on the market, Remote Control Technology's wireless remote equipment has long-range communication capabilities — up to 5 miles. Wire and conduit are expensive and high maintenance. Typical wear-and-tear, digging, rodent damage, theft, etc., are all examples of problems that can damage wire. RCT's wireless remote systems put an end to these drawbacks of wired technology. Wireless remote switching systems eliminate the costly, labor-intensive process of trenching and laying wire. RCT wireless remote equipment has proven to be highly compatible with standard equipment used in most industries, as well as offering unparalleled reliability in use with programmable logic controllers (PLCs), various switches and relays, etc.

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APPENDIX I

Features

- 80C51 CPU with 5V operating voltage from 0 to 40 MHz
- 64 kB of on-chip flash user code memory with ISP and IAP.
- SPI and enhanced UART.
- Four 8-bit I/O ports with three high-current port 1 pins.
- Three 16-bit timers/counters.
- Programmable watchdog timer.
- Eight interrupt sources with four priority levels.
- Second DPTR register
- Low EMI mode (ALE inhibit)
- TTL- and CMOS-compatible logic levels
- Brownout detection
- Low power modes
    - Power-down mode with external interrupt wake-up
    - Idle mode

Pin configuration

Symbol	Pin			Type	Description
	DIP40	TQFP44	PLCC44		
P0.0 to P0.7	39-32	37-30	43-36	I/O	**Port 0:** Port 0 is an 8-bit open drain bi-directional I/O port. Port 0 pins that have '1's written to them float, and in this state can be used as high-impedance inputs. Port 0 is also the multiplexed low-order address and data bus during accesses to external code and data memory. In this application, it uses strong internal pull-ups when transitioning to '1's. Port 0 also receives the code bytes during the external host mode programming, and outputs the code bytes during the external host mode verification. External pull-ups are required during program verification or as a general purpose I/O port.
P1.0 to P1.7	1-8	40-44, 1-3	2-9	I/O with internal pull-up	**Port 1:** Port 1 is an 8-bit bi-directional I/O port with internal pull-ups. The Port 1 pins are pulled high by the internal pull-ups when '1's are written to them and can be used as inputs in this state. As inputs, Port 1 pins that are externally pulled LOW will source current (I_{IL}) because of the internal pull-ups. P1.5, P1.6, P1.7 have high current drive of 16 mA. Port 1 also receives the low-order address bytes during the external host mode programming and verification.
P1.0	1	40	2	I/O	**T2:** External count input to Timer/Counter 2 or Clock-out from Timer/Counter 2
P1.1	2	41	3	I	**T2EX**: Timer/Counter 2 capture/reload trigger and direction control
P1.2	3	42	4	I	**ECI**: External clock input. This signal is the external clock input for the PCA.
P1.3	4	43	5	I/O	**CEX0**: Capture/compare external I/O for PCA Module 0. Each capture/compare module connects to a Port 1 pin for external I/O. When not used by the PCA, this pin can handle standard I/O.
P1.4	5	44	6	I/O	**$\overline{\text{SS}}$**: Slave port select input for SPI **CEX1**: Capture/compare external I/O for PCA Module 1
P1.5	6	1	7	I/O	**MOSI**: Master Output Slave Input for SPI **CEX2**: Capture/compare external I/O for PCA Module 2
P1.6	7	2	8	I/O	**MISO**: Master Input Slave Output for SPI **CEX3**: Capture/compare external I/O for PCA Module 3
P1.7	8	3	9	I/O	**SCK**: Master Output Slave Input for SPI **CEX4**: Capture/compare external I/O for PCA Module 4

Symbol	Pin			Type	Description
	DIP40	TQFP44	PLCC44		
P2.0 to P2.7	21-28	18-25	24-31	I/O with internal pull-up	**Port 2**: Port 2 is an 8-bit bi-directional I/O port with internal pull-ups. Port 2 pins are pulled HIGH by the internal pull-ups when '1's are written to them and can be used as inputs in this state. As inputs, Port 2 pins that are externally pulled LOW will source current (I_{IL}) because of the internal pull-ups. Port 2 sends the high-order address byte during fetches from external program memory and during accesses to external Data Memory that use 16-bit address (MOVX@DPTR). In this application, it uses strong internal pull-ups when transitioning to '1's. Port 2 also receives some control signals and a partial of high-order address bits during the external host mode programming and verification.
P3.0 to P3.7	10-17	5, 7-13	11, 13-19	I/O with internal pull-up	**Port 3**: Port 3 is an 8-bit bidirectional I/O port with internal pull-ups. Port 3 pins are pulled HIGH by the internal pull-ups when '1's are written to them and can be used as inputs in this state. As inputs, Port 3 pins that are externally pulled LOW will source current (I_{IL}) because of the internal pull-ups. Port 3 also receives some control signals and a partial of high-order address bits during the external host mode programming and verification.
P3.0	10	5	11	I	**RXD**: serial input port
P3.1	11	7	13	O	**TXD**: serial output port
P3.2	12	8	14	I	**$\overline{\text{INT0}}$**: external interrupt 0 input
P3.3	13	9	15	I	**$\overline{\text{INT1}}$**: external interrupt 1 input
P3.4	14	10	16	I	**T0**: external count input to Timer/Counter 0
P3.5	15	11	17	I	**T1**: external count input to Timer/Counter 1
P3.6	16	12	18	O	**$\overline{\text{WR}}$**: external data memory write strobe
P3.7	17	13	19	O	**$\overline{\text{RD}}$**: external data memory read strobe
$\overline{\text{PSEN}}$	29	26	32	I/O	**Program Store Enable**: $\overline{\text{PSEN}}$ is the read strobe for external program memory. When the device is executing from internal program memory, $\overline{\text{PSEN}}$ is inactive (HIGH). When the device is executing code from external program memory, $\overline{\text{PSEN}}$ is activated twice each machine cycle, except that two $\overline{\text{PSEN}}$ activations are skipped during each access to external data memory. A forced HIGH-to-LOW input transition on the $\overline{\text{PSEN}}$ pin while the RST input is continually held HIGH for more than 10 machine cycles will cause the device to enter external host mode programming.
RST	9	4	10	I	**Reset**: While the oscillator is running, a HIGH logic state on this pin for two machine cycles will reset the device. If the $\overline{\text{PSEN}}$ pin is driven by a HIGH-to-LOW input transition while the RST input pin is held HIGH, the device will enter the external host mode, otherwise the device will enter the normal operation mode.

Symbol	Pin			Type	Description
	DIP40	TQFP44	PLCC44		
$\overline{EA}$	31	29	35	I	**External Access Enable**: $\overline{EA}$ must be connected to V_{SS} in order to enable the device to fetch code from the external program memory. $\overline{EA}$ must be strapped to V_{DD} for internal program execution. However, Security lock level 4 will disable $\overline{EA}$, and program execution is only possible from internal program memory. The $\overline{EA}$ pin can tolerate a high voltage of 12 V.
ALE/ $\overline{PROG}$	30	27	33	I/O	**Address Latch Enable:** ALE is the output signal for latching the low byte of the address during an access to external memory. This pin is also the programming pulse input ($\overline{PROG}$) for flash programming. Normally the ALE[1] is emitted at a constant rate of $\frac{1}{6}$ the crystal frequency[2] and can be used for external timing and clocking. One ALE pulse is skipped during each access to external data memory. However, if AO is set to '1', ALE is disabled.
NC	-	6, 17, 28, 39	1, 12, 23, 34	I/O	**No Connect**
XTAL1	19	15	21	I	**Crystal 1**: Input to the inverting oscillator amplifier and input to the internal clock generator circuits.
XTAL2	18	14	20	O	**Crystal 2:** Output from the inverting oscillator amplifier.
V_{DD}	40	38	44	I	**Power supply**
V_{SS}	20	16	22	I	**Ground**