

**BUILDING ENVIRONMENT CONTROL WITH WIRELESS
SENSOR AND ACTUATOR NETWORKS CENTRALIZED VS.
DISTRIBUTED**

A PROJECT REPORT

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*DEDICATED TO
OUR PARENTS*

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ACRONYMS & ABBREVIATIONS

LCD	-	Liquid Crystal Display
UART	-	Universal Asynchronous Receiver and Transmitter
CMOS	-	Complementary Metal Oxide Semiconductor
ASK	-	Amplitude Shift keying
TX/RX	-	Transmitter / Receiver
RISC	-	Reduced Instruction Set Computer
TTL	-	Transistor Transistor Logic
ALE	-	Address Latch Enable
PC	-	Program Counter
DPTR	-	Data Pointer
IE	-	Interrupt Enable
PIC	-	Peripheral Interface Controller
EEPROM	-	Electrically Erasable Programmable Read Only Memory
OST	-	Oscillator Start-up Timer
WDT	-	Watch Dog Timer
ICSP	-	In Circuit Serial Programming
SSP	-	Synchronous Serial Port.

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ABSTRACT

This project considers joined problems of control and communication in wireless sensor and actuator networks (WSANs) for building environment control systems. In traditional control systems, centralized control and distributed control are two major approaches. However, little work has been done in comparing the two approaches in joined problems of control and communication, particularly in WSANs serving as components of control loops. In this paper, we develop a centralized control (CC) scheme in which control decisions are made based on global information, and a distributed control (DC) scheme which enables distributed actuators to make control decisions locally. We also develop methods that enable wireless communications among system devices compatible with the control strategies, and propose a method for reducing packet loss rate. We compare the two schemes using simulations in many aspects. Simulation results show that the DC can achieve comparable control performance of the CC, while the DC is more robust against packet loss and has lower computational complexity than the CC. Furthermore, the DC has shorter actuation latency than the CC under certain conditions.

CHAPTER 1
INTRODUCTION

1.1. NEED OF OUR PROJECT

BUILDING environment control systems are used for controlling the environment of buildings, such as temperature, humidity, and illumination, by means of heating, air-conditioning, ventilating, lighting, and so forth. There are some available commercial products based on wired communication techniques for setting up such systems. However, researches have not been well done in wireless sensor and actuator networks (WSANs), which have the benefits of energy efficiency and easy deployment. We propose a three-tier design (from the bottom to the top) for such a WSAN.

- 1) NETWORK TIER:*** It provides networking services to a controller, if any, actuators, and sensors with wireless communication protocols such as medium access control (MAC), routing, time synchronization, security, etc.
- 2) CONTROL TIER:*** It is a closed control loop comprised of the controller, if any, actuators, physical environment as plant, and sensors as transmitters. It is responsible for gathering sensor measurements and actuator states, estimating network states, making control decisions, and coordinating the actuators. Its operations are supported by the *Network tier* while the control objective is specified by the *User interface*. Compared with wired communication networks, wireless networks have high packet loss rates and larger delays. Therefore, information at control decision unit(s) is unreliable and incomplete. This becomes a top challenge and should be seriously treated at this tier.
- 3) USER INTERFACE:*** This tier defines control objectives and interacts with network users.

1.2 OBJECTIVE OF OUR PROJECT

We focus on the first two tiers and propose two distinct schemes, a CENTRALIZED CONTROL (CC) SCHEME and A DISTRIBUTED CONTROL (DC) SCHEME.

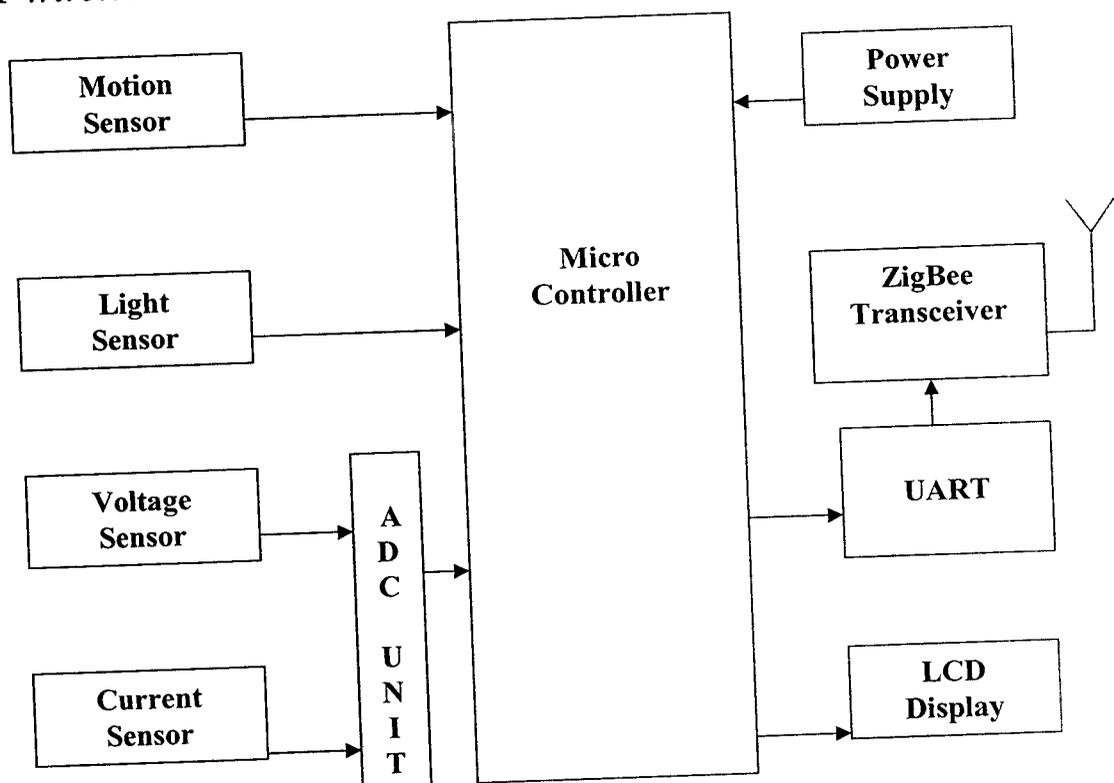
- ✓ In the CC, there is a centralized controller that gathers packets from sensors and actuators, makes control decisions based on all the received information, and dispatches commands to coordinate actuators.
- ✓ In the DC, based on local information, control decisions are made locally by each actuator.

CHAPTER 2
METHODOLOGY

BUILDING ENVIRONMENT CONTROL SYSTEMS:

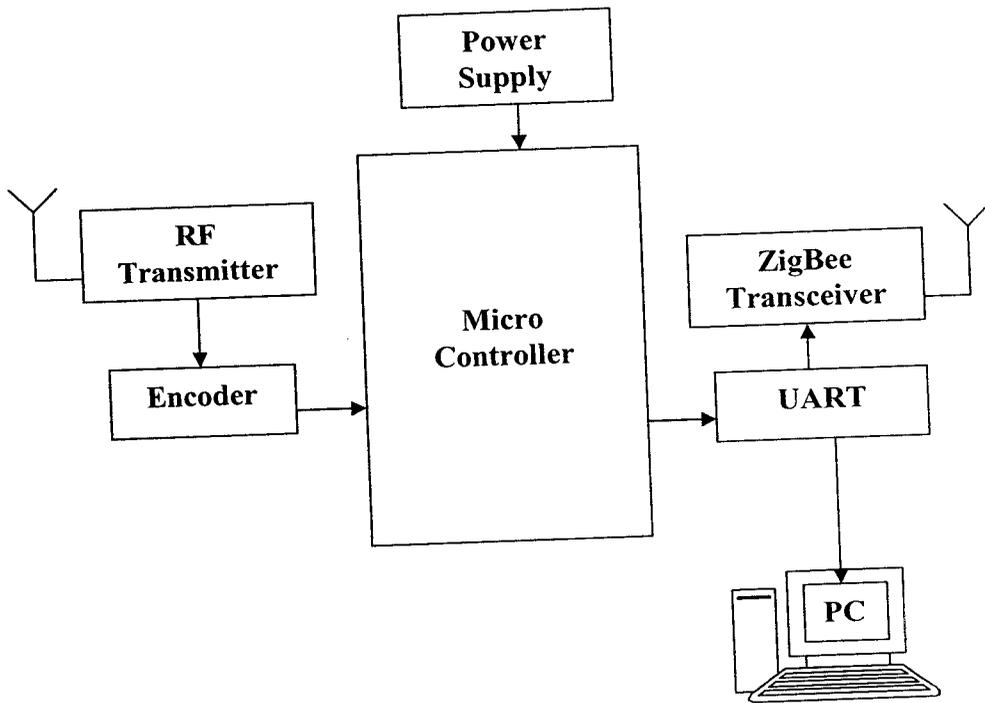
Block Diagrams:

2.1 Wireless Sensor Networks:



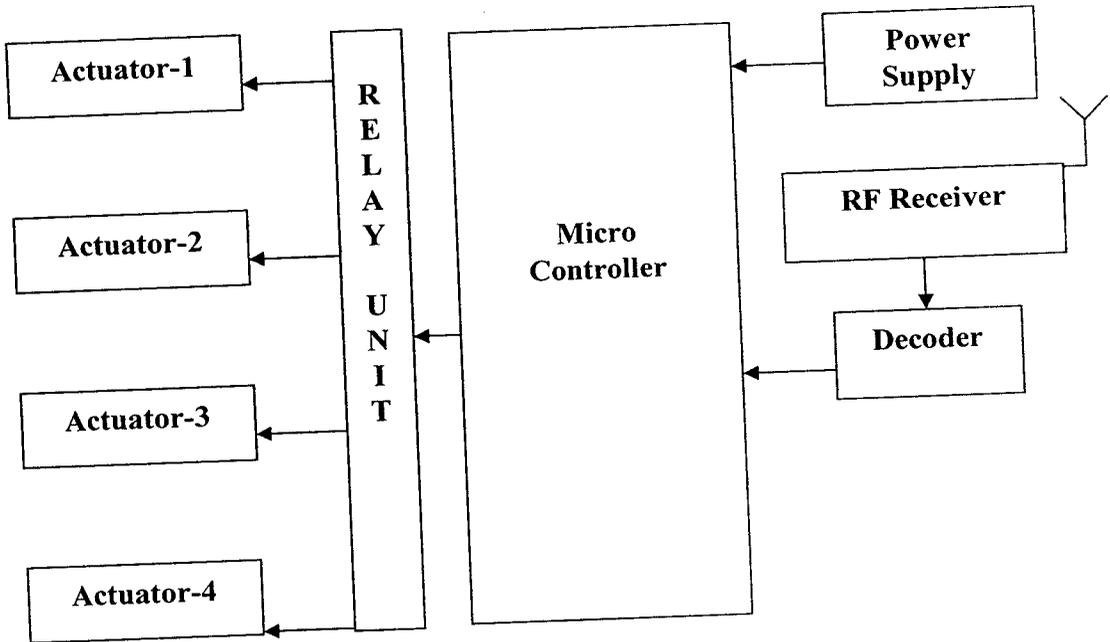
The motion sensor used here is an IR sensor. It is used to detect the entry & exit of a person in a room. The light sensor used is LDR. It is used to detect the day and Night time so that energy (like light) can be saved during night time. ZIGBEE transceiver is used to get information from various sensors in different rooms. The current sensor used is a power transformer.

2.2 Centralized vs. Distributed:



RF transmitter is used to transmit signals from short distances to microcontroller. The encoder is used to encode signals from RF transmitter. The UART is used to connect PC and the microcontroller.

2.3 Actuator Networks:



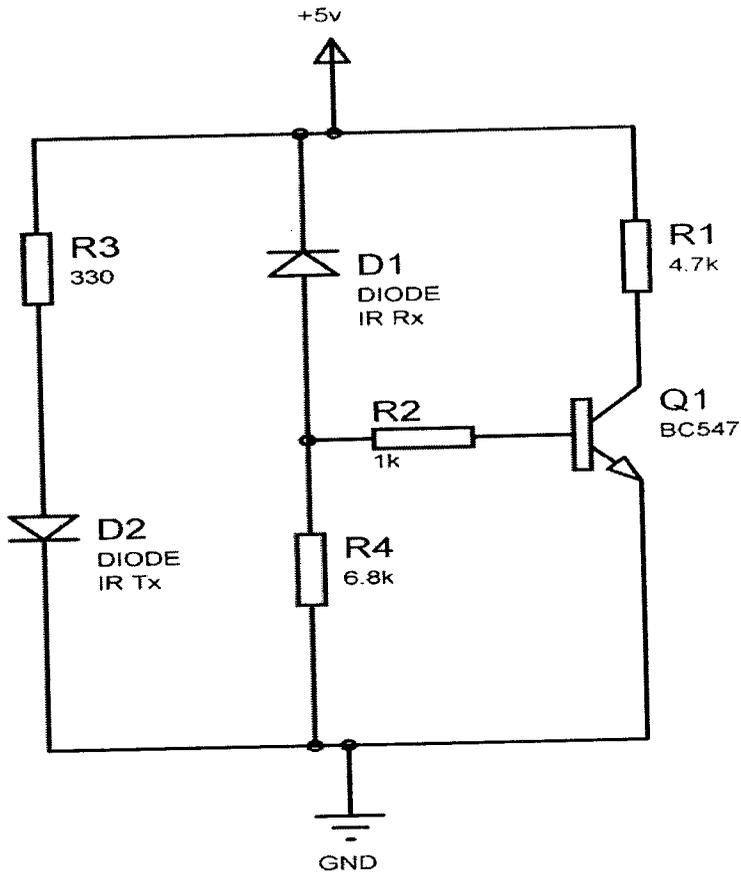
The signals from sensors are received by RF receiver (short distances-around 30m). Then the signal is decoded and sent to microcontroller. The relay unit consists of switches. The switches used here are magnetic switches. The actuators are connected to the relay unit. The actuators are used to actuate buzzers or lights.

2.4 SENSORS USED

2.4.1 IR SENSOR

A Passive Infrared sensor (PIR sensor) is an electronic device that measures infrared (IR) light radiating from objects in its field of view. PIR sensors are often used in the construction of PIR-based motion detectors. Apparent motion is detected when an infrared source with one temperature, such as a human, passes in front of an infrared source with another temperature, such as a wall.

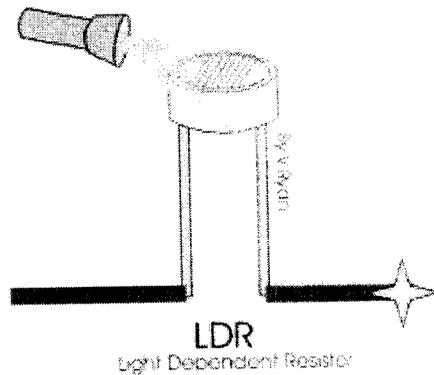
All objects above absolute zero emit energy in the form of radiation. It is usually infrared radiation that is invisible to the human eye but can be detected by electronic devices designed for such a purpose. The term passive in this instance means that the PIR device does not emit an infrared beam but merely passively accepts incoming infrared radiation. “Infra” meaning below our ability to detect it visually, and “Red” because this color represents the lowest energy level that our eyes can sense before it becomes invisible. Thus, infrared means below the energy level of the color red, and applies to many sources of invisible energy



The circuit of this PIR sensor consists of a 330-ohm resistor, 4.7k resistor, 6.8k resistor, 1k resistor, 2 diodes and a phototransistor. The IR sensor is used to detect the motion. If an obstacle crosses it, there is a change in the output of this sensor. Hence, it is used to detect the motion of a person crossing the sensor. If a person crosses the sensor, it displays as 0 otherwise it displays as 1.

2.4.2 *Light Dependent Resistor – LDR*

Two cadmium sulphide (cds) photoconductive cells with spectral responses are similar to that of human eye. The cell resistance falls with increasing light intensity. Hence the resistance is converted to output voltage and displayed. Thus one can detect the day light and night time using this sensor. Other applications include smoke detection, automatic lighting control, batch-counting and burglar alarm systems.



The light sensor consists of an LDR (Light Dependent Resistor) and 2 resistors of 1k and a resistor of 100k. The output voltage is given to the microcontroller circuit.

2.4.3 *POTENTIAL TRANSFORMER:*

Potential transformers are instrument transformers. They have a large number of primary turns and a few secondary turns. It is used to control the large value of voltage. Voltage transformers connected line-to-ground cannot be considered to be grounding transformers and must not be operated with the secondary in closed delta because excessive currents may flow in

the delta. Connect one lead from each voltage transformer directly to the neutral terminal, using a fuse in the line side of the primary only.

FEATURES:

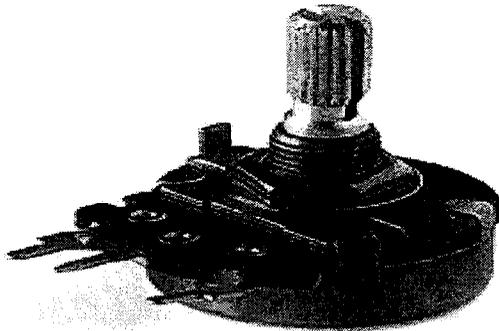
- Primary terminals that are fused are 1/4 - 20 brass screws with one flat washer, lock washer and two nuts.
- Secondary terminals are NO. 10-32 brass screws with one flat washer and lock washer.
- The transformers are tested for partial discharge to Canadian Standards CAN 3-C13-M83. This test can also be carried out to IEC requirements if requested.
- The core and coil assembly is encased in a plastic enclosure and vacuum encapsulated in polyurethane resin.
- Thermal burden rating is for 120 volt secondaries.
- Plated steel mounting base.
- Fuses have 1.63" Dia. Caps and 11.50" clip centers.
- A test card is provided with each unit.

WORKING:

The potential transformer works along the same principle of other transformers. It converts voltages from high to low. It will take the thousands of volts behind power transmission systems and step the voltage down to something that meters can handle. These transformers work for single and three phase systems, and are attached at a point where it is convenient to measure the voltage. Transformers can also be used in electrical instrumentation systems. Due to transformers' ability to step up or step down voltage and current, and the electrical isolation they provide, they

can serve as a way of connecting electrical instrumentation to high-voltage, high current power systems. Potential transformers are designed to provide as accurate a voltage step-down ratio as possible.

2.4.4 POTENTIOMETER



A potentiometer (colloquially known as a "pot") is a three-terminal resistor with a sliding contact that forms an adjustable voltage divider. If only two terminals are used (one side and the wiper), it acts as a variable resistor or rheostat. Potentiometers operated by a mechanism can be used as position transducers, for example, Potentiometers are rarely used to directly control significant power (more than a watt), since the power dissipated in the potentiometer would be comparable to the power in the controlled load (see infinite switch). Instead they are used to adjust the level of analog signals (e.g. volume controls on audio equipment), and as control inputs for electronic circuits. For example, a light dimmer uses a potentiometer to control the switching of a TRIAC and so indirectly control the brightness of lamps.

CHAPTER 3
HARDWARE DESCRIPTION

3.1 AT89S52 8-BIT MICROCONTROLLER WITH 8K BYTES IN-SYSTEM PROGRAMMABLE FLASH

The AT89S52 is a low-power, high-performance CMOS 8-bit microcontroller with 8K bytes of in-system programmable Flash memory. The device is manufactured using Atmel's high-density nonvolatile memory technology and is compatible with the industry-standard 80C51 instruction set and pin out. By combining a versatile 8-bit CPU with in-system programmable Flash on a monolithic chip, the Atmel AT89S52 is a powerful microcontroller which provides a highly-flexible and cost-effective solution to many embedded control applications.

3.1.1 FEATURES

- Compatible with MCS-51® Products
- 8K Bytes of In-System Programmable (ISP) Flash Memory
 - Endurance: 1000 Write/Erase Cycles
- 4.0V to 5.5V Operating Range
- Fully Static Operation: 0 Hz to 33 MHz
- Three-level Program Memory Lock
- 256 x 8-bit Internal RAM
- 32 Programmable I/O Lines
- Three 16-bit Timer/Counters
- Eight Interrupt Sources
- Full Duplex UART Serial Channel
- Low-power Idle and Power-down Modes
- Interrupt Recovery from Power-down Mode and Watchdog Timer.

3.1.2 PIN CONFIGURATION OF AT89S52

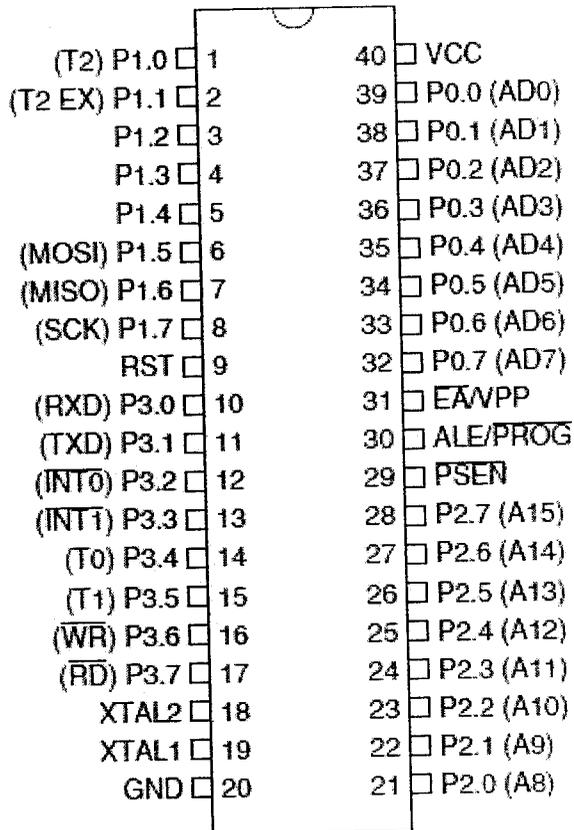


Fig 3.13 Pin Configuration of 89S52

3.1.3 ARCHITECTURE OF AT89S52

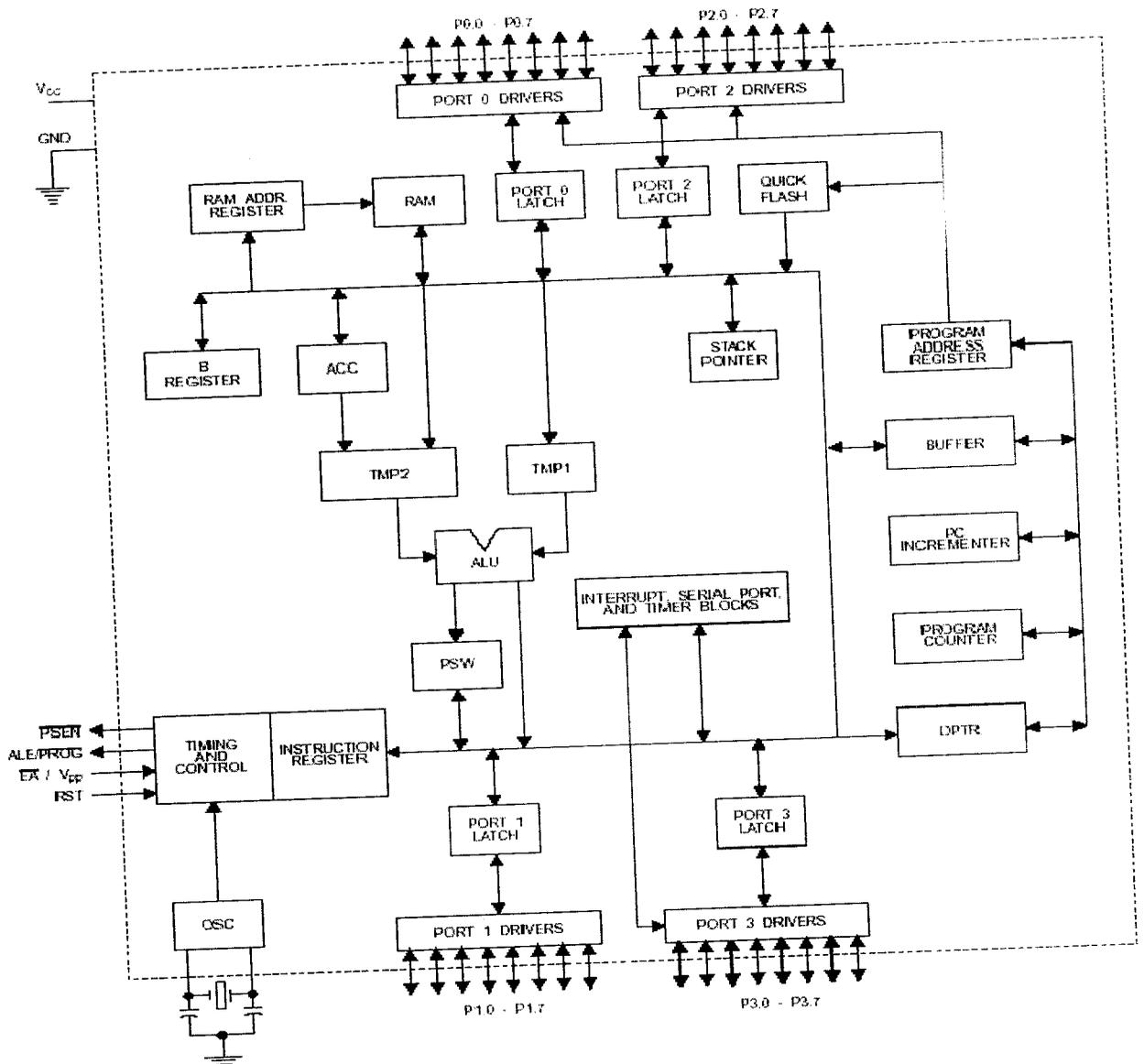


Fig 3.14 Block Diagram of 89S52

CPU REGISTERS

The 89S52 contain 34 general-purpose, or working, registers. Two of these, registers A and B hold results of many instructions, particularly for arithmetical and logical operations. The other 32 are arranged as part of internal RAM in four banks, Bank0-Bank3, of eight registers each.

PROGRAM COUNTER (PC)

The 89S52 contain two 16-bit registers: Program counter (PC) and the data pointer (DPTR). Each is used to hold the address of a word in memory.

Program instruction bytes are fetched from locations in memory that are addressed by the PC. Program ROM may be on the chip at addresses 000h to FFFh, external to the chip for address that exceed FFFh, or totally external for all address from 0000h to FFFFh.

The PC is automatically incremented after every instruction byte is fetched and may also be altered by certain instructions. The PC is the only register that does not have an internal address.

The Program Counter (PC) is a 2-byte address that tells the 89S52 where the next instruction to execute is found in memory. When the 89S52 is initialized PC always starts at 0000h and is incremented each time an instruction is executed. It is important to note that PC isn't always incremented by one. Since some instructions require 2 or 3 bytes the PC will be incremented by 2 or 3 in these cases.

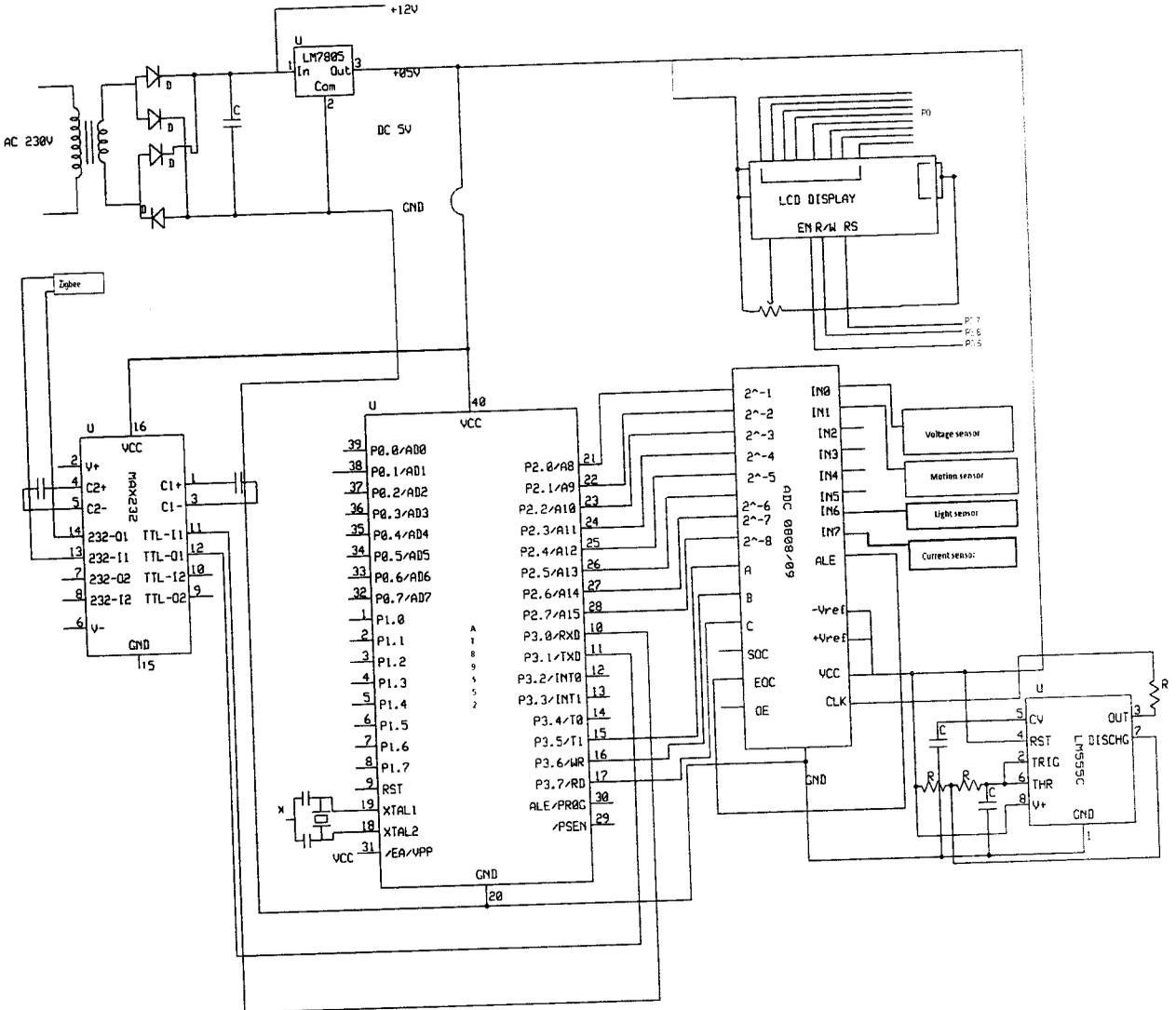
DATA POINTER (DPTR)

The DPTR register is made up of two 8-bit registers, named DPH and DPL, which are used to furnish memory addresses for internal and external code access and external data access. The DPTR is under the control of program instructions name, DPH and DPL. DPTR does not have a single internal address; DPH and DPL are each assigned an address.

The Data Pointer (DPTR) is the 89C51's only user-accessible 16-bit (2-byte) register. DPTR, as the name suggests, is used to point to address something like HL register pair in 8085 microprocessor. It is used by a number of commands that allow the 89C51 to access external memory and internal memory.

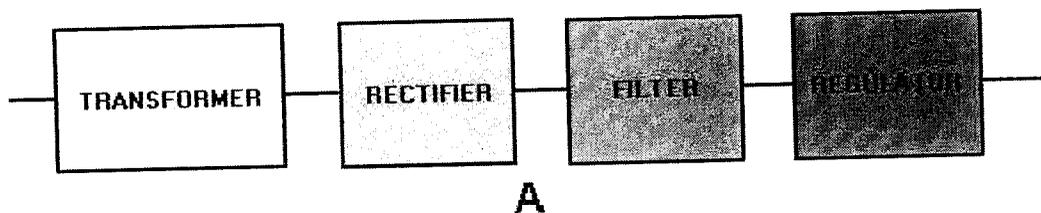
While DPTR is most often used to point to data in external memory, many programmers often take advantage of the fact that it's the only true 16-bit register available. It is often used to store 2-byte values that have nothing to do with memory locations.

3.1.4 CIRCUIT LAYOUT



3.2 POWER SUPPLY

A power supply (sometimes known as a power supply unit or PSU) is a device or system that supplies electrical or other types of energy to an output load or group of loads. The term is most commonly applied to electrical energy supplies, less often to mechanical ones, and rarely to others.



The power supply circuit supplies 5v d.c. power to the hardware components. It consists of a step-down transformer to convert the 230V a.c. voltage to 12V a.c. voltage. The rectifier is used to convert the ac signal to dc signal. Capacitors are used as filters and are used to reject the unwanted frequencies. The regulator used here is LM7805.

3.2.1 TRANSFORMER:

A transformer is a device that transfers electrical energy from one circuit to another through inductively coupled wires. 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 V_S is scaled from the primary V_P by a factor

ideally equal to the ratio of the number of turns of wire in their respective windings:

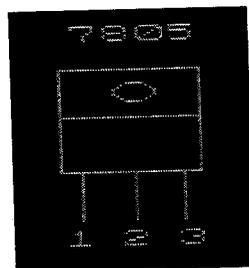
$$\frac{V_S}{V_P} = \frac{N_S}{N_P}$$

By appropriate selection of the numbers of turns, a transformer thus allows an alternating voltage to be stepped up — by making N_S more than N_P or stepped down, by making it less.

3.2.2 VOLTAGE REGULATOR

LM7805

IC voltage regulators offer low cost, high reliability, small size and good performance. LM 7805 is a positive fixed voltage regulator with three terminals. The last two numbers of 7805 indicate (05) the output voltage.



Features

- Output Current up to 1A
- Output Voltages of 5, 6, 8, 9, 10, 12, 15, 18, 24
- Thermal Overload Protection
- Short Circuit Protection
- Output Transistor Safe Operating Area Protection

LM78xx devices are available in the TO-220 package and with several fixed output voltages, making them useful in a wide range of applications. Each type employs internal current limiting, thermal shutdown and safe operating area protection, making it essentially indestructible. If adequate heat sinking is provided, they can deliver over 1A output current. Although designed primarily as fixed voltage regulators, these devices can be used with external components to obtain adjustable voltages and currents.

3.3 ADC AND INTERFACING

ADC0808 8-BIT MP COMPATIBLE A/D CONVERTERS WITH 8-CHANNEL MULTIPLEXER

The ADC0808 data acquisition component is a monolithic CMOS device with an 8-bit analog-to-digital converter, 8-channel multiplexer and microprocessor compatible control logic. The 8-bit A/D converter uses successive approximation as the conversion technique. The converter features a high impedance chopper stabilized comparator, a 256R voltage divider with analog switch tree and a successive approximation register. The 8-channel multiplexer can directly access any of 8-single-ended analog signals.

3.3.1 Features

- Easy interface to all microprocessors
- Operates ratiometrically or with 5 VDC or analog span

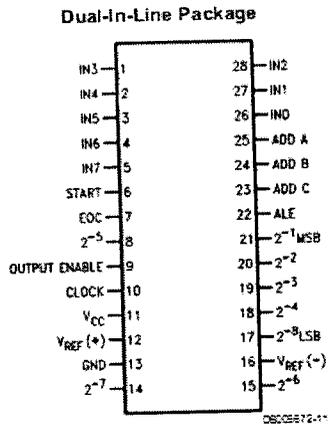
- Y No zero or full-scale adjust required
- 8-channel multiplexer with address logic
- 0V to 5V input range with single 5V power supply
- Outputs meet TTL voltage level specifications
- Standard hermetic or molded 28-pin DIP package
- 28-pin molded chip carrier package

3.3.2 FUNCTIONAL DESCRIPTION

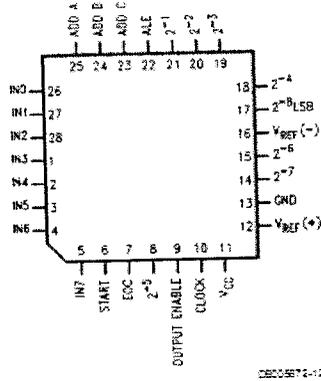
The A/D converter's successive approximation register (SAR) is reset on the positive edge of the start conversion (SC) pulse. The conversion is begun on the falling edge of the start conversion pulse. A conversion in process will be interrupted by receipt of a new start conversion pulse. Continuous conversion may be accomplished by tying the end of-conversion (EOC) output to the SC input. End-of-conversion will go low between 0 and 8 clock pulses after the rising edge of start conversion. The most important section of the A/D converter is the comparator. It is this section which is responsible for the ultimate accuracy of the entire converter. It is also the comparator drift which has the greatest influence on the repeatability of the device. A chopper-stabilized comparator provides the most effective method of satisfying all the converter requirements. The chopper-stabilized comparator converts the DC input signal into an AC signal. This signal is then fed through a high gain AC amplifier and has the DC level restored. This technique limits the drift component of the amplifier since the drift is a DC component which is not passed by the AC amplifier. This makes the entire A/D converter extremely insensitive to temperature, long term drift and input offset errors.

3.3.3 Pin diagram of adc0808:

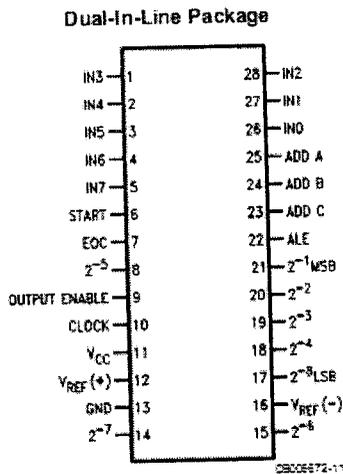
Connection Diagrams



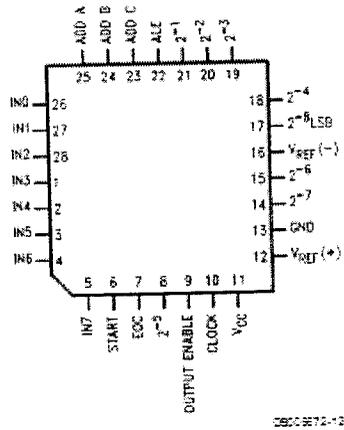
Molded Chip Carrier Package



Connection Diagrams



Molded Chip Carrier Package



3.3.4 NEED FOR ANALOG TO DIGITAL CONVERSION

In lot of embedded systems microcontrollers needs to take analog input. Most of the sensors & transducers such as temperature, humidity, pressure, are analog. For interfacing these sensors to microcontrollers we require to convert the analog output of these sensors to digital so that the controller can read it. Some microcontrollers have built in Analog to Digital Convertor (ADC) so there is no need of external ADC. For microcontrollers that don't have internal ADC external ADC is used. One of the most commonly used ADC is ADC0808. ADC 0808 is a Successive approximation type with 8 channels i.e. it can directly access 8 single ended analog signals.

3.4 INTERFACING ADC0808 WITH A MICROCONTROLLER

PIN DETAILS OF ADC 0808:

I/O Pins

ADDRESS LINE A, B, C

The device contains 8-channels. A particular channel is selected by using the address decoder line. The TABLE 1 shows the input states for address lines to select any channel.

Analog Channel	ADDRESS LINES		
	C	B	A
IN0	0	0	0
IN1	0	0	1
IN2	0	1	0
IN3	0	1	1

ALE- ADDRESS LATCH ENABLE

The address is latched on the Low – High transition of ALE.

START

The ADC's Successive Approximation Register (SAR) is reset on the positive edge i.e. Low-High of the Start Conversion pulse. Whereas the conversion is begun on the falling edge i.e., High – Low of the pulse.

OUTPUT ENABLE

Whenever data has to be read from the ADC, Output Enable pin has to be pulled high thus enabling the TRI-STATE outputs, allowing data to be read from the data pins D0-D7.

END OF CONVERSION (EOC)

This Pin becomes 'High' when the conversion has ended, so the controller comes to know that the data can now be read from the data pins.

INTERFACING

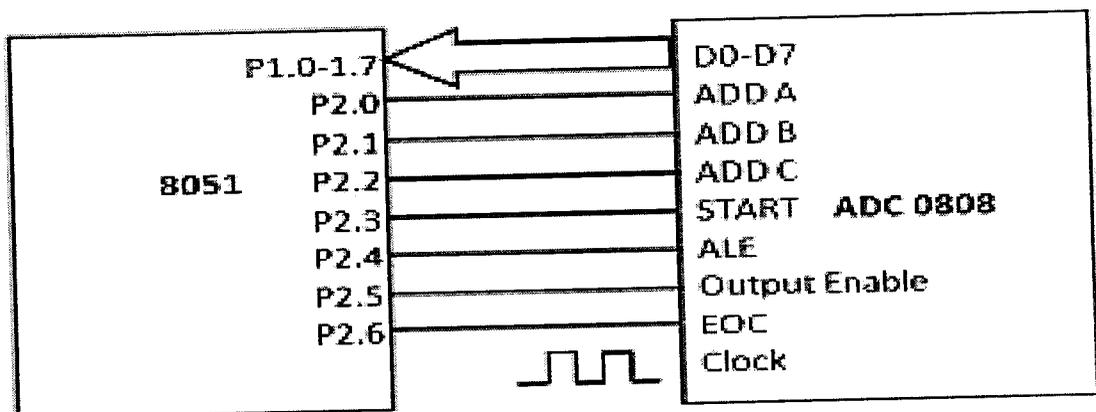


Fig 3.4 Interfacing diagram of adc0808

ALGORITHM

1. Start.
2. Select the channel.
3. A Low – High transition on ALE to latch in the address.
4. A Low – High transition on Start to reset the ADC's SAR.
5. A High – Low transition on ALE.
6. A High – Low transition on start to start the conversion.
7. Wait for End of cycle (EOC) pin to become high.
8. Make Output Enable pin High.
9. Take Data from the ADC's output
10. Make Output Enable pin Low.
11. Stop

The total numbers of lines required are:

1. Data lines: 8
2. ALE: 1
3. START: 1
4. EOC:1
5. Output Enable:1

Calculating Step Size

ADC 0808 is an 8 bit ADC i.e. it divides the voltage applied at $V_{\text{ref+}}$ & $V_{\text{ref-}}$ into 2^8 i.e. 256 steps.

$$\text{Step Size} = (V_{\text{ref+}} - V_{\text{ref-}})/256$$

Suppose $V_{\text{ref+}}$ is connected to V_{cc} i.e. 5V & $V_{\text{ref-}}$ is connected to the Gnd then the step size will be

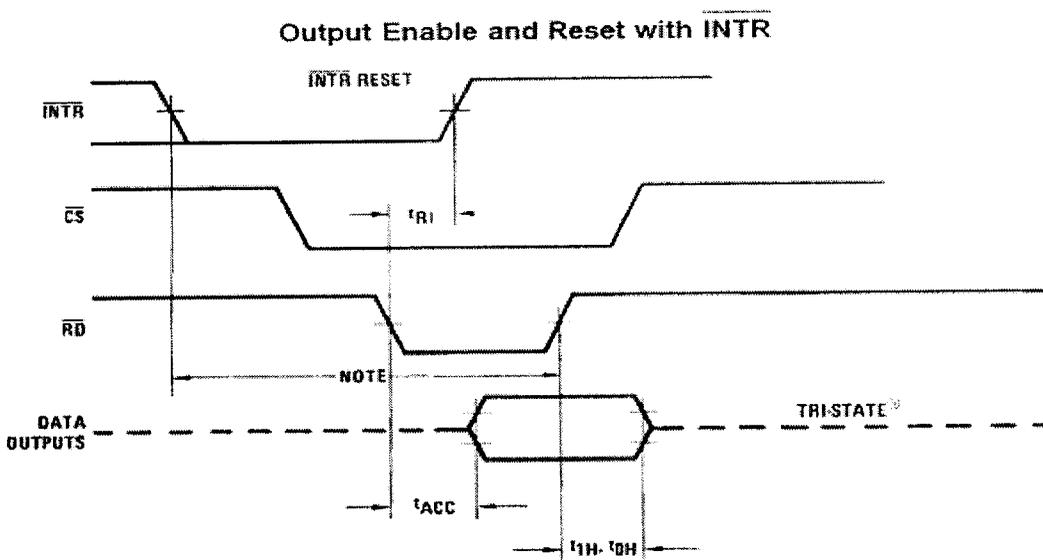
$$\text{Step size} = (5 - 0)/256 = 19.53 \text{ mv.}$$

Calculating D_{out} :

The data we get at the D0 - D7 depends upon the step size & the Input voltage i.e. V_{in} .

$D_{out} = V_{in} / \text{step Size}$. If we are interfacing sensors like LM35 which has output $10\text{mv}/^{\circ}\text{C}$ then set the V_{ref+} to 2.56v so that the step size will be $\text{Step size} = (2.56 - 0)/256 = 10 \text{ mv}$. So now whatever reading that you get from the ADC will be equal to the actual temperature.

TIMING DIAGRAM OF ADC 0808:



FREE RUNNING MODE OF ADC 0808:

Free running mode is to operate the ADC without interfacing it with the microprocessor. This is done to eliminate all uncertainties in the ADC chip and to have a thorough understanding of its working before interfacing. The three main signals (ALE, START and OE) are given manually instead of receiving it as an instruction from the microprocessor.

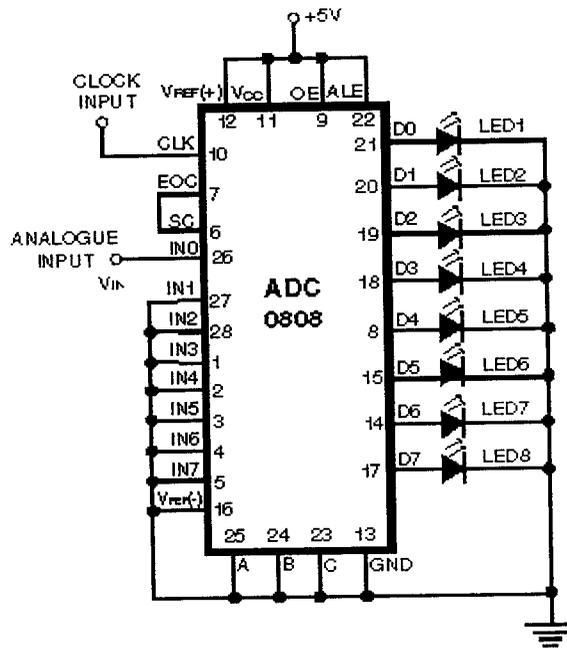


Fig 3.6 Free running mode of adc0808

In the above diagram, Channel 0 at pin 26 is selected as the input line by grounding the address decoder pins 23, 24 and 25 therefore giving it a value of 000. The clock input is given to pin 10 using an external oscillator. V_{ref}(-) is grounded and V_{ref}(+) is connected to the supply thereby giving the input voltage a range of full 5V. OE (output enable) is made high therefore enabling the latch. The process is made continuous by connecting EOC (end of conversion) to SC (start of conversion) so that at the end of one cycle, the EOC pulse will trigger SC to start conversion again. The process is initiated by manually giving a high-low pulse to ALE. The output can be viewed by

connecting LEDs to the output pins (pin 8, 14, 15, 17, 18, 19, 20, 21 and 22) and using a driver to light them when the output is high and switches off when the output is low. Thus from the free running mode, the algorithm to run an ADC .

FLOWCHART

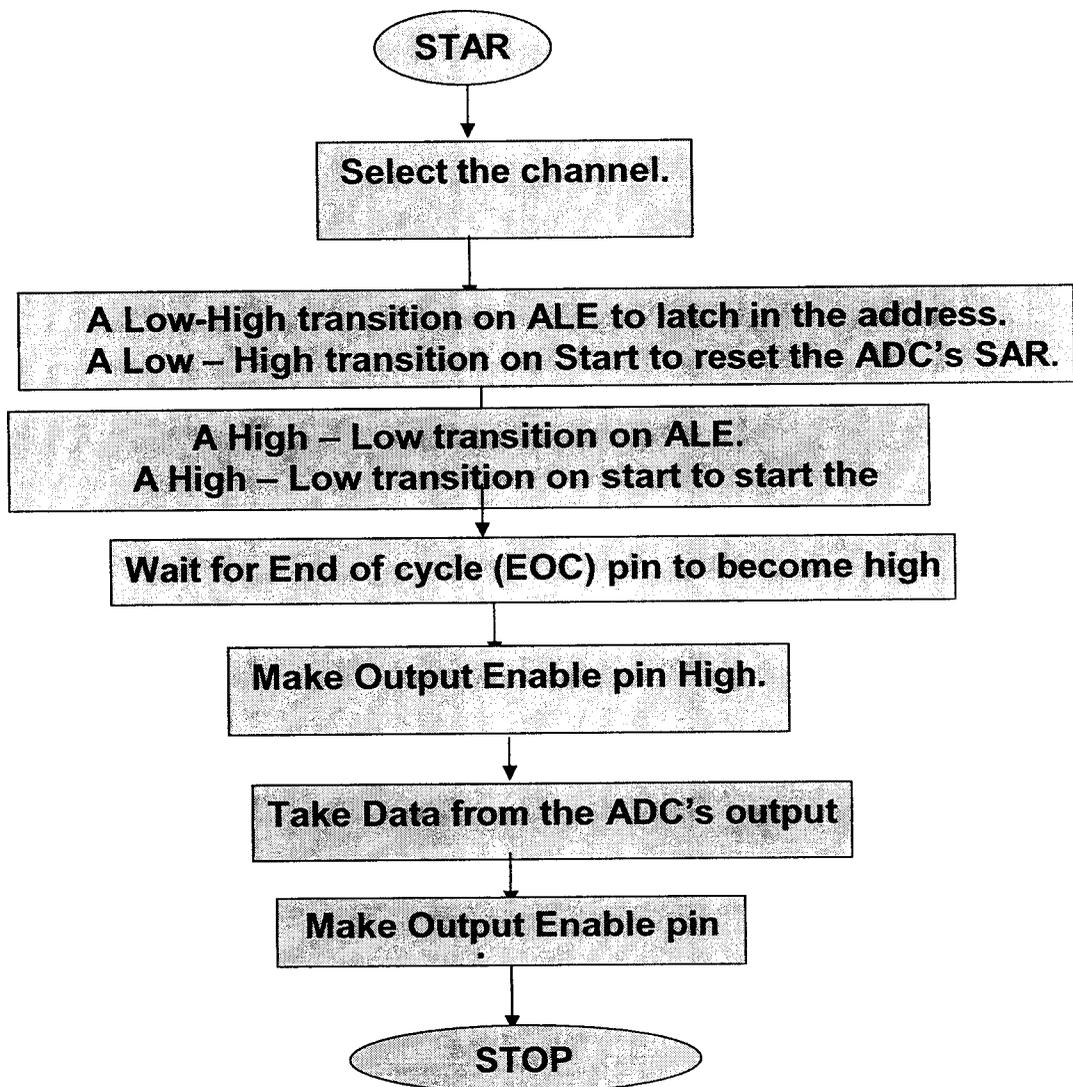


Fig 3.7 Flow chart for free running mode

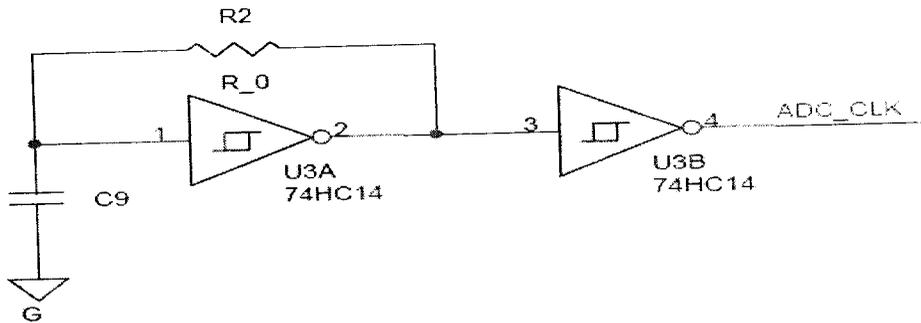


Fig 3.8 Oscillator using Hex Schmitt Trigger

A

DC0808 does not have a self clocking circuit facility. It requires an external oscillator and in our project we have used HEX SCHMITT TRIGGER INVERTER (IC 7414) to produce clock frequency.

A Schmitt trigger is a bistable multivibrator and it can be used to implement another type of multivibrator, the relaxation oscillator. This is achieved by connecting a single resistor–capacitor network to an inverting Schmitt trigger the capacitor connects between the input and ground and the resistor connects between the output and the input. The operating frequency can be calculated using the formula

$$F = 1/(R*C)$$

Where F is the clock frequency required

R is the resistor

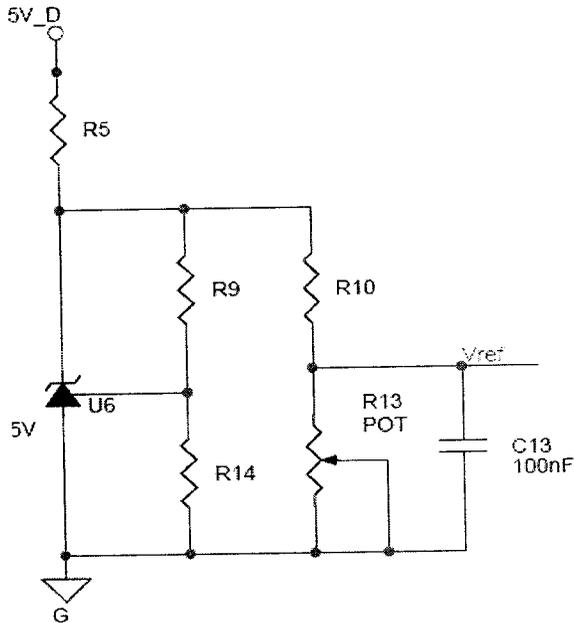
C is the capacitor connected to the Schmitt Trigger

In the project,

C= 100pF, R= 30KΩ,

Therefore F = 330 Khz

REFERENCE VOLTAGE $V_{ref}(+)$:



The reference voltage $V_{ref}(+)$ set at pin 12 determines the resolution of the ADC. Since it is an 8-Bit converter and the resolution of the temperature sensor is 10mv/C. $V_{ref} = \text{Range}/\text{Value of one digital output} = 256/10\text{mv} = 2.56\text{V}$. The voltage given at pin 12 should be $V_{ref}/2$ according to the datasheet of the converter. Therefore a precision voltage of 2.56v is further divided to 1.28V using a POT/Resistor arrangement and given to the V_{ref} in ADC0808.

3.5 INTERFACING DEVICES

3.5.1 MAX232

The MAX232 is an integrated circuit that converts signals from an RS-232 serial 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.

The drivers provide RS-232 voltage level outputs (approx. ± 7.5 V) from a single + 5 V supply via on-chip charge pumps and external capacitors. This makes it useful for implementing RS-232 in devices that otherwise do not need any voltages outside the 0 V to + 5 V range, as power supply design does not need to be made more complicated just for driving the RS-232 in this case.

The receivers reduce RS-232 inputs (which may be as high as ± 25 V), to standard 5 V TTL levels. These receivers have a typical threshold of 1.3 V, and a typical hysteresis of 0.5 V.

The later MAX232A is backwards compatible with the original MAX232 but may operate at higher baud rates and can use smaller external capacitors – 0.1 μ F in place of the 1.0 μ F capacitors used with the original device.¹

The newer MAX3232 is also backwards compatible, but operates at a broader voltage range, from 3 to 5.5 V. Pin to pin compatible: ICL232, ST232, ADM232, HIN232.

RS232 Line Type & Logic Level	RS232 Voltage	TTL Voltage to/from MAX232
Data Transmission (Rx/Tx) Logic 0	+3V to +15V	0V
Data Transmission (Rx/Tx) Logic 1	-3V to -15V	5V
Control Signals (RTS/CTS/DTR/DSR) Logic 0	-3V to -15V	5V
Control Signals (RTS/CTS/DTR/DSR) Logic 1	+3V to +15V	0V

3.5.2 LM555 timer

The 555 Timer IC is an integrating circuit (chip) used in a variety of timer, pulse generation and oscillator applications. The IC was designed by Hans R. Camenzind in 1970 and brought to market in 1971 by Signetics (later acquired by Philips). The original name was the SE555 (metal can)/NE555 (plastic DIP) and the part was described as "The IC Time Machine". It has been claimed that the 555 gets its name from the three 5 kΩ resistors used in typical early implementations,^[2] but Hans Camenzind has stated that the number was arbitrary.^[3] The part is still in wide use, thanks to its ease of use, low price and good stability. As of 2003, it is estimated that 1 billion units are manufactured every year.

The 555 has three operating modes:

- **Monostable mode:** in this mode, the 555 functions as a "one-shot". Applications include timers, missing pulse detection, bouncefree switches, touch switches, frequency divider, capacitance measurement, pulse-width modulation (PWM) etc

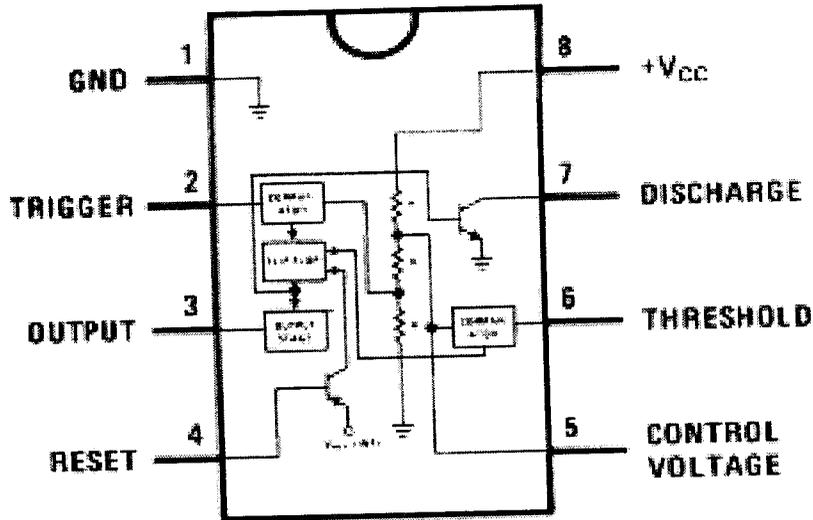
- *Astable - free running mode*: the 555 can operate as an oscillator. Uses include LED and lamp flashers, pulse generation, logic clocks, tone generation, security alarms, pulse position modulation, etc.
- *Bistable mode or Schmitt trigger* : the 555 can operate as a flip-flop, if the DIS pin is not connected and no capacitor is used. Uses include bouncefree latched switches, etc.

Features

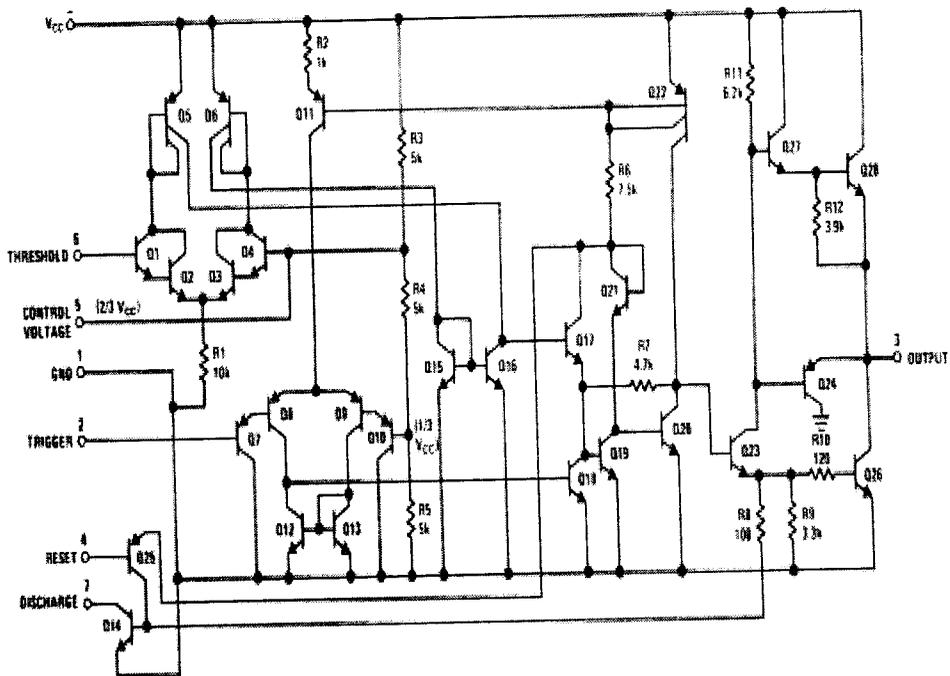
- Direct replacement for SE555/NE555.
- Timing from microseconds through hours.
- Operates in both astable and monostable modes.
- Adjustable duty cycle.
- Output can source or sink 200 mA.
- Output and supply TTL compatible.
- Temperature stability better than 0.005% per °C.
- Normally on and normally off output.
- Available in 8-pin MSOP package.

CONNECTION DIAGRAM

Dual-In-Line, Small Outline and Molded Mini Small Outline Packages



SCHEMATIC DIAGRAM



3.6 RELAYS

A **relay** is an electrically operated switch. Many relays use an electromagnet to operate a switching mechanism, but other operating principles are also used. Relays find applications where it is necessary to control a circuit by a low-power signal, or where several circuits must be controlled by one signal.

3.6.1 BASIC OPERATION:

A simple electromagnetic relay, such as the one taken from a car in the first picture, is an adaptation of an electromagnet. It consists of a coil of wire surrounding a soft iron core, an iron yoke, which provides a low reluctance path for magnetic flux, a movable iron armature, and a set, or sets, of contacts.

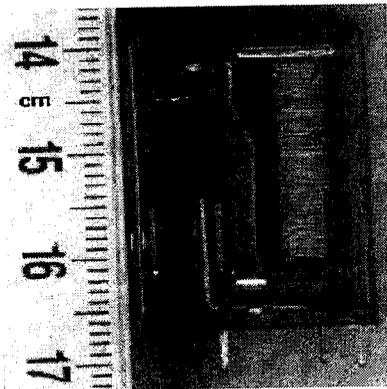


Fig 3.6 Relay

When an electric current is passed through the coil, the resulting magnetic field attracts the armature and the consequent movement of the movable contact or contacts either makes or breaks a connection with a fixed contact. If the set of contacts was closed when the relay was De-energized, then the movement opens the contacts and breaks the connection, and vice versa if

the contacts were open. When the current to the coil is switched off, the armature is returned by a force, approximately half as strong as the magnetic force, to its relaxed position.

3.6.2 RELAY DRIVER CIRCUIT:

Driving Relays : Using the outputs of the HT-12D or HT-648L decoder ICs to drive relays is quite simple. Here are schematics showing how to drive relays directly from the data-output pins of the decoder.

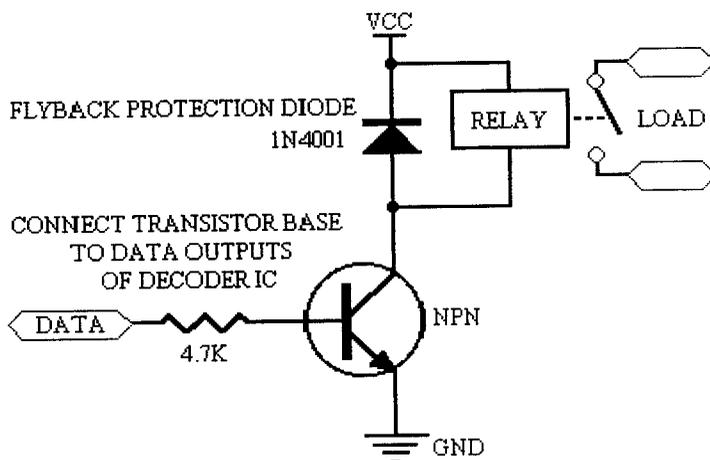


fig4.10

NPN Relay Driver Circuit

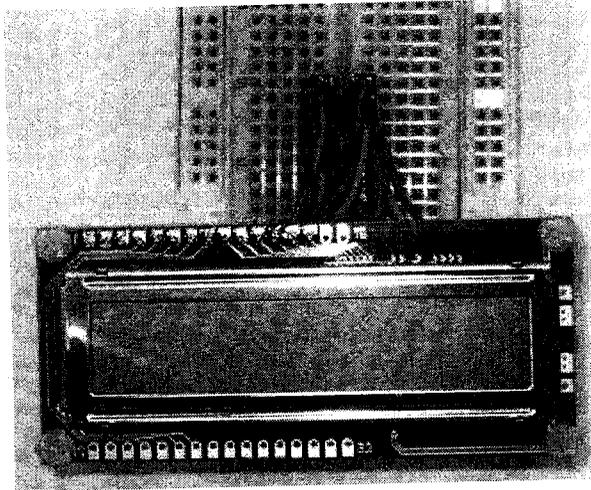
3.6.3 APPLICATIONS:

- Control a high-voltage circuit with a low-voltage signal, as in some types of modems or audio amplifiers,
- Control a high-current circuit with a low-current signal, as in the starter solenoid of an automobile.

3.7 LCD

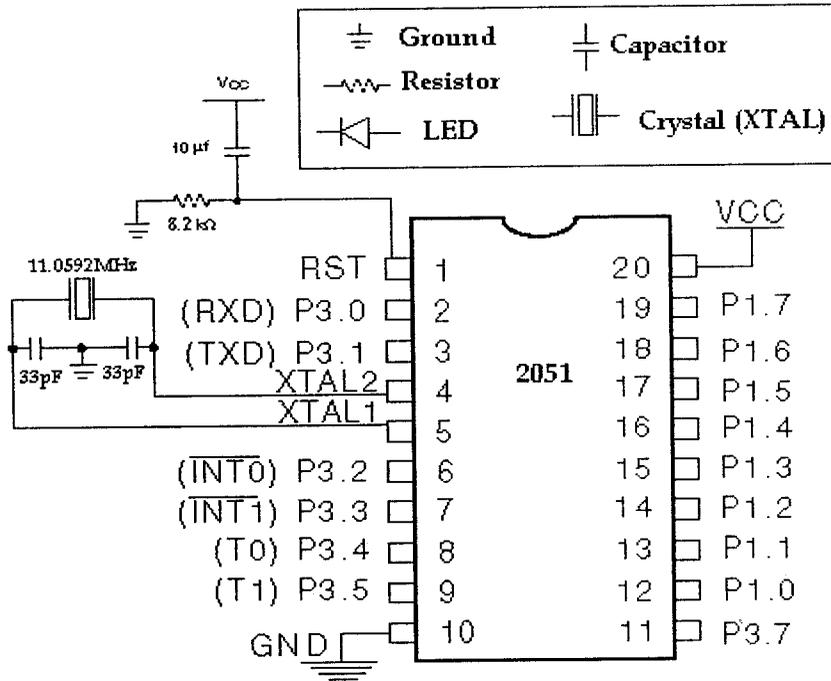
A liquid crystal display (commonly abbreviated LCD) is a thin, flat display device made up of any number of color or monochrome pixels arrayed in front of a light source or reflector. It is often utilized in battery-powered electronic devices because it uses very small amounts of electric power.

The LCD Module comes with a 16 pin connector. This can be plugged into the breadboard as shown below.



To connect the LCD Module to a standard 40 pin 8051, use the pin names listed below to find the correct pin number on the 8051 microcontroller. The example programs below do not need to be modified to work with a 40 pin 8051.

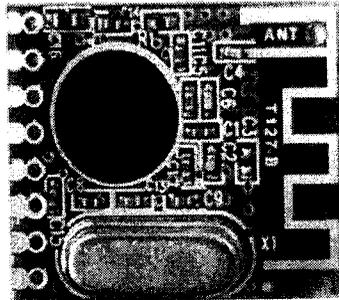
The basic 2051 configuration is shown below.



After you have built a basic 2051 configuration as shown above, you can connect the LCD Module as shown in the table above. In addition, you need to add the following connections. Connect LCD Pin 3 to Vcc (5 Volts). Connect LCD Pin 8 to Ground. Connect a 510 ohm resistor between LCD Pin 5 and ground. Connect a 2.2k ohm resistor from LCD Pin 2 and Vcc. Connect a 2.2k ohm resistor from LCD Pin 13 to Vcc.

3.8 ZIGBEE

TYPICAL LAYOUT:



This is an FSK Transceiver module, which is designed using the Chipcon IC(CC2500). It is a true single-chip transceiver; it is based on 3 wire digital serial interface and an entire Phase-Locked Loop (PLL) for precise local oscillator generation .so the frequency could be setting. It can use in UART / NRZ / Manchester encoding / decoding. It is a high performance and low cost module.

It gives 30 meters range with onboard antenna. In a typical system, this trans-receiver will be used together with a microcontroller. It provides extensive hardware support for packet handling, data buffering, burst transmissions , clear channel assessment, link quality indication and wake on radio . It can be used in 2400-2483.5 MHz ISM/SRD band systems. (eg. RKE-two way Remote Keyless Entry, wireless alarm and security systems, AMR-automatic Meter Reading, Consumer Electronics, Industrial monitoring and control, Wireless Game Controllers, Wireless

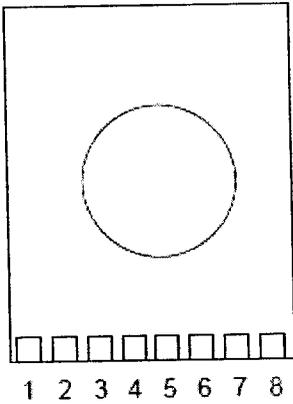
Audio/Keyboard/Mouse). It could easily to design product requiring wireless connectivity. It can be used on wireless security system or specific remote-control function and others wireless system. Operating Range is 30 meters without requiring any external antenna.

Features

- Low power consumption.
- Integrated bit synchronizer.
- Integrated IF and data filters.
- High sensitivity (type -104dBm)
- Programmable output power -20dBm~1dBm
- Operation temperature range : -40~+85 deg C
- Operation voltage: 1.8~3.6 Volts.
- Available frequency at : 2.4~2.483 GHz
- Digital RSSI.

Applications

- Car & Home security system.
- Remote keyless entry / Garage door controller.
- Wireless game controllers/mouse/keyboard/audio.
- Automation system.



- Pin1: VCC
- Pin2: SI
- Pin3: SCLK
- Pin4: SO
- Pin5: GDO2
- Pin6: GND
- Pin7: GDO0
- Pin8: CSn

Pin Description:

Pin #	Pin name	Pin Type	Description
1	VCC	Power	1.8~3.6V power supply
2	SI	Digital Input	Serial configuration interface, data input
3	SCLK	Digital Input	Serial configuration interface, clock input
4	SO	Digital Output	Serial configuration interface, clock input Optional general output pin when CSN is high
5	GDO2	Digital I/O	Digital output pin for general use >Test signals >FIFO status signals >Clear Channel indicator >Clock output, down-divided from Xosc >Serial output RX data
6	GND	Ground	
7	GDO0	Digital I/O	Digital output pin for general use: >Test signals >FIFO status signals >Clear Channel indicator >Clock output RX data >Serial output RX data >Serial input TX data Also used as analog test I/O for prototype/production testing
8	CSn	Digital Input	Serial configuration interface ,chip select

CHAPTER 4
HARDWARE IMPLEMENTATION

4.1 ENCODERS AND DECODERS

4.1.1 ENCODER

Features

- Operating voltage:
2.4V~12V for the HT12E
- Low power and high noise immunity CMOS technology
- Low standby current: 0.1 μ A (typ.) at VDD=5V
- Minimum transmission word
- Built-in oscillator needs only 5% resistor
- Data code has positive polarity
- Minimal external components
- HT12A/E: 18-pin DIP/20-pin SOP package

General Description

The 2^{12} encoders are a series of CMOS LSIs for remote control system applications. They are capable of encoding information which consists of N address bits and 12_N data bits. Each address/ data input can be set to one of the two logic states. The programmed addresses/data are transmitted together with the header bits via an RF or an infrared transmission medium upon receipt of a trigger signal. The capability to select a TE trigger on the HT12E enhances the application flexibility of the 2^{12} series of encoders.

PIN DESCRIPTION

PIN NAME	I/O	INTERNAL CONNECTION	DESCRIPTION
A0-A7	I	NMOS transmission gate protection diode	Input pins for address A0-A7 setting
AD8-AD11	I	NMOS transmission gate protection diode	Input pins for address AD8- AD11
DOUT	O	CMOS OUT	Encoder data serial transmission output.
/TE	I	CMOS in pull high	Transmission enable, active low
OSC1	I	OSCILLATOR1	Oscillator input pin
OSC2	O	OSCILLATOR2	Oscillator output pin
VDD	I	-	Negative power supply, grounds
VSS	I	-	Positive power supply

4.1.2 DECODER

Features

- Operating voltage: 2.4V~12V
- Low power and high noise immunity CMOS technology
- Low standby current
- Binary address setting
- Received codes are checked 3 times
- Built-in oscillator needs only 5% resistor
- Valid transmission indicator
- Easy interface with an RF or an infrared transmission medium
- Minimal external components

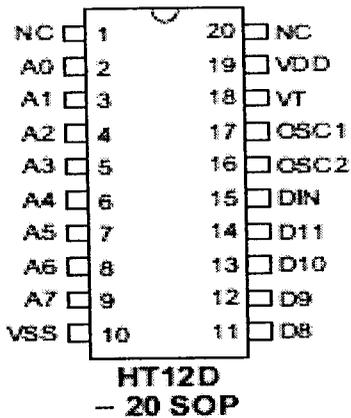
GENERAL DESCRIPTION

The 2^{12} decoders are a series of CMOS LSIs for remote control system applications. They are paired with Holtek's 2^{12} series of encoders. For proper operation, a pair of encoder/decoder with the same number of addresses and data format should be chosen. The decoders receive serial addresses and data from a programmed 2^{12} series of encoders that are transmitted by a carrier using an RF or an IR transmission medium. They compare the serial input data three times continuously with their local addresses. If no error or unmatched codes are found, the input data codes are decoded and then transferred to the output pins. The VT pin also goes high to indicate a valid transmission. The 2^{12} series of decoders are capable of decoding information that consist of N bits of address and 12_N bits of data. Of this series, the HT12D is arranged to provide 8 address bits

PIN CONFIGURATION

8-Address

4-Data

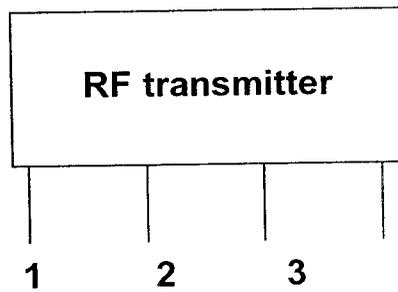


PIN DESCRIPTION

Pin Name	I/O	Internal Connection	Description
A0-A11	I	NMOS TRANSMISSION GATE	Input pins for address A0-A11 setting They can be externally set to VDD or VSS.
D8-D11	O	CMOS OUT	Output data pins
DIN	I	CMOS IN	Serial data input pin
VT	O	CMOS OUT	Valid transmission, active high
OSC1	I	OSCILLATOR	Oscillator input pin
OSC2	O	OSCILLATOR	Oscillator output pin
VSS	I	—	Negative power supply (GND)
VDD	I	—	Positive power supply

4.2 RF TRANSMITTER AND RECEIVER:

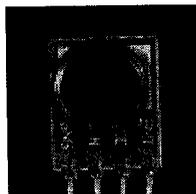
4.2.1 RF TRANSMITTER MODULE:



Functional block of Tx section consists of

- 1 - Antenna
- 2 - Data input
- 3 - Ground
- 4 - VCC

In this transmitting section the 1st pin is the antenna pin where we can able to fix the antenna for transmitting the data in the Radio Frequency, the 2nd pin is the data input pin in which the output of the encoder is given; the 3rd pin is the ground.

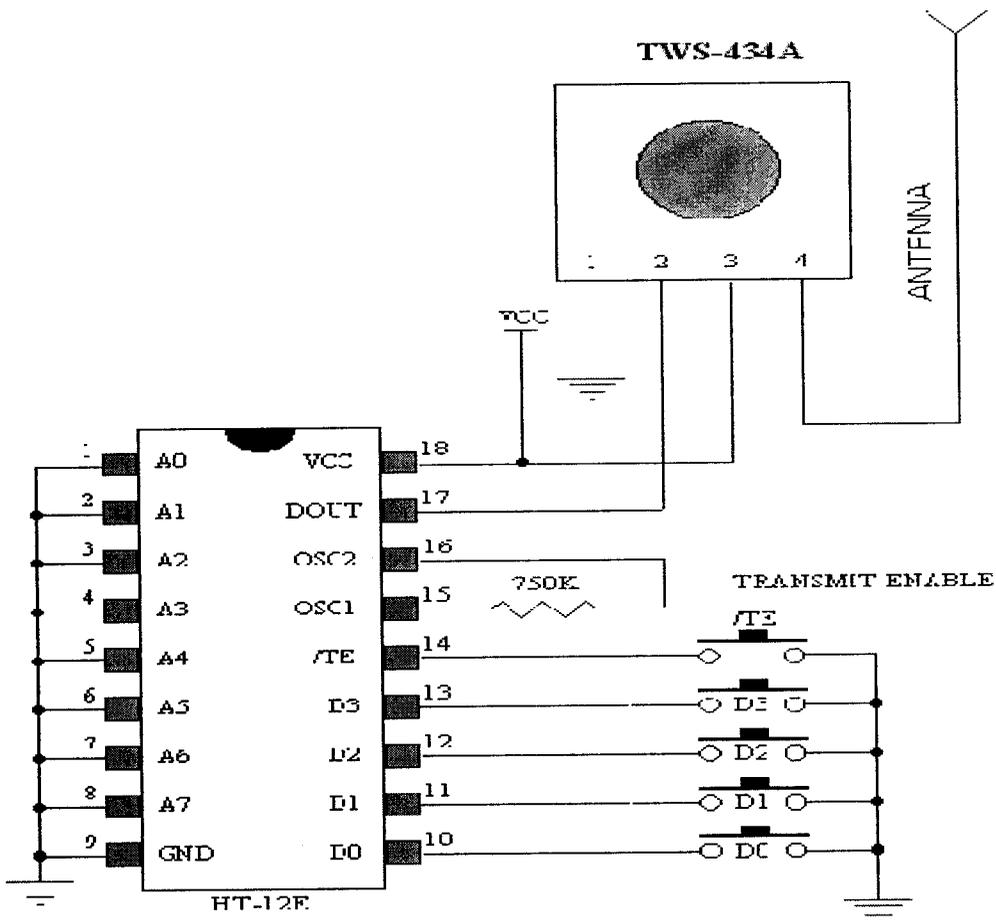


TWS-434

The TWS-434 and RWS-434 are extremely small, and are excellent for applications requiring short-range.

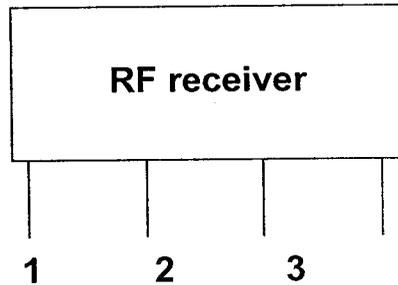
TWS-434

The TWS-434 transmitter accepts both linear and digital inputs, can operate from 1.5 to 12 Volts-DC, and makes building a miniature hand-held RF transmitter very easy. The TWS-434 is approximately the size of a standard postage stamp.



The above figure shows the transmitter section using the HT-12E encoder IC for a 4-bit RF remote control system.

4.2.2 RF RECEIVER MODULE:



Functional block of Rx section consists of

- 1 - Antenna
- 2 - Data input
- 3 - Ground
- 4 - VCC

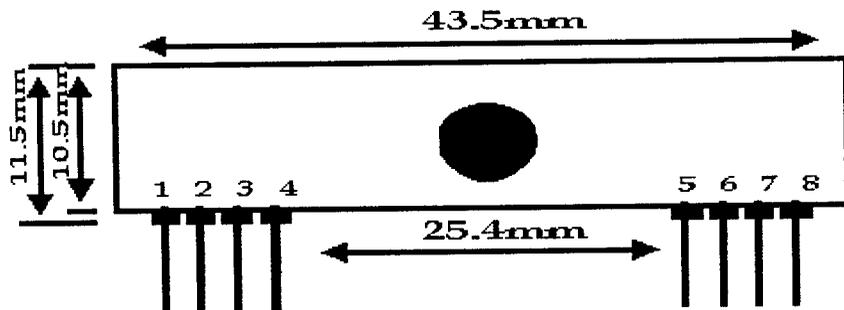
In this receiving section the 1st pin is the antenna pin where we can able to fix the antenna to receive the data in the Radio Frequency, the 2nd pin is the data output pin to the decoder circuit, the 3rd pin is the ground and the 4th pin is the VCC which is given to operate the receiver section.



RWS-434

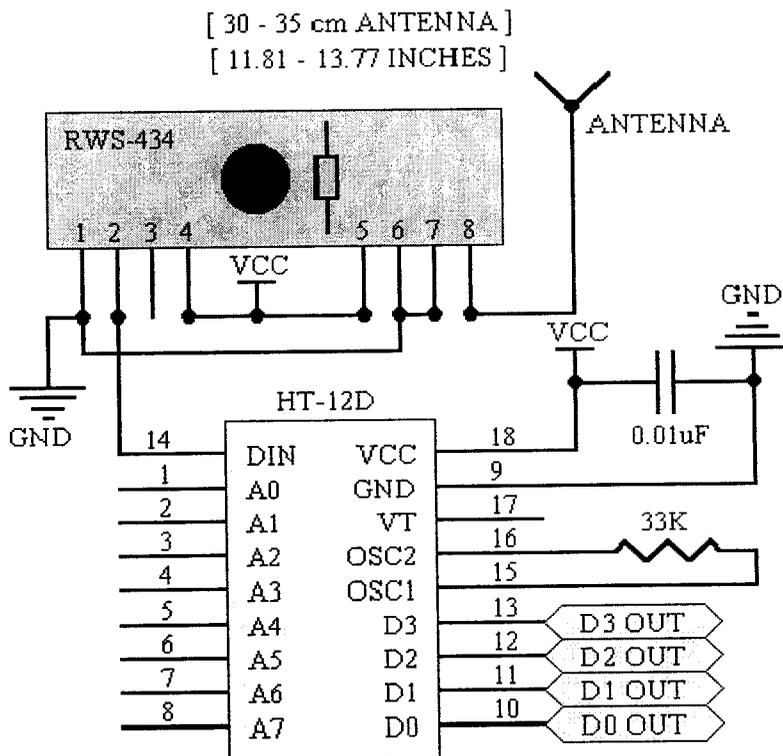
RWS-434: The receiver also operates at 433.92MHz, and has a sensitivity of 3uV. The RWS-434 receiver operates from 4.5 to 5.5 volts-DC, and has both linear and digital outputs.

RWS-434 PIN DIAGRAM



- pin 1 : Gnd
- pin 2 : Digital Output
- pin 3 : Linear Output
- pin 4 : Vcc
- pin 5 : Vcc
- pin 6 : Gnd
- pin 7 : Gnd
- pin 8 : Ant (About 30 - 35 cm)

RF RECEIVER CIRCUIT



CHAPTER 5
SOFTWARE IMPLEMENTATION

5.1 VISUAL BASIC

What is Visual Basic ?

Visual Basic (VB) is the third-generation event-driven programming language and integrated development environment (IDE) from Microsoft for its COM programming model. Visual Basic is relatively easy to learn and use. Visual Basic was derived from BASIC and enables the rapid application development (RAD) of graphical user interface (GUI) applications, access to databases using Data Access Objects, Remote Data Objects, or ActiveX Data Objects, and creation of ActiveX controls and objects. Scripting languages such as VBA and VBScript are syntactically similar to Visual Basic, but perform differently.^[3]

A programmer can put together an application using the components provided with Visual Basic itself. Programs written in Visual Basic can also use the Windows API, but doing so requires external function declarations.

Why VB ?

Like the BASIC programming language, Visual Basic was designed to be easily learned and used by beginner programmers. The language not only allows programmers to create simple GUI applications, but can also develop complex applications. Programming in VB is a combination of visually arranging components or controls on a form, specifying attributes and actions of those components, and writing additional lines of code for more functionality. Since default attributes and actions are defined for the components, a simple program can be created without the programmer having to write many lines of code. Performance problems were experienced

by earlier versions, but with faster computers and native code compilation this has become less of an issue.

Visual Basic has the following traits which differ from C-derived languages:

- Multiple assignment available in C language is not possible. $A = B = C$ does not imply that the values of A, B and C are equal. The boolean result of "Is B = C?" is stored in A. The result stored in A would therefore be either false or true.
- Boolean constant True has numeric value -1.
- Logical and bitwise operators are unified.
- Variable array
- base.
- Relatively strong integration with the Windows operating system and the Component Object Model. The native types for strings and arrays are the dedicated COM types, BSTR and SAFEARRAY.
- Banker's rounding as the default behavior when converting real numbers to integers with the Round function.
- Integers are automatically promoted to reals in expressions involving the normal division operator (/) so that division of one integer by another produces the intuitively correct result.
- By default, if a variable has not been declared or if no type declaration character is specified, the variable is of type Variant.

5.2 EMBEDDED C

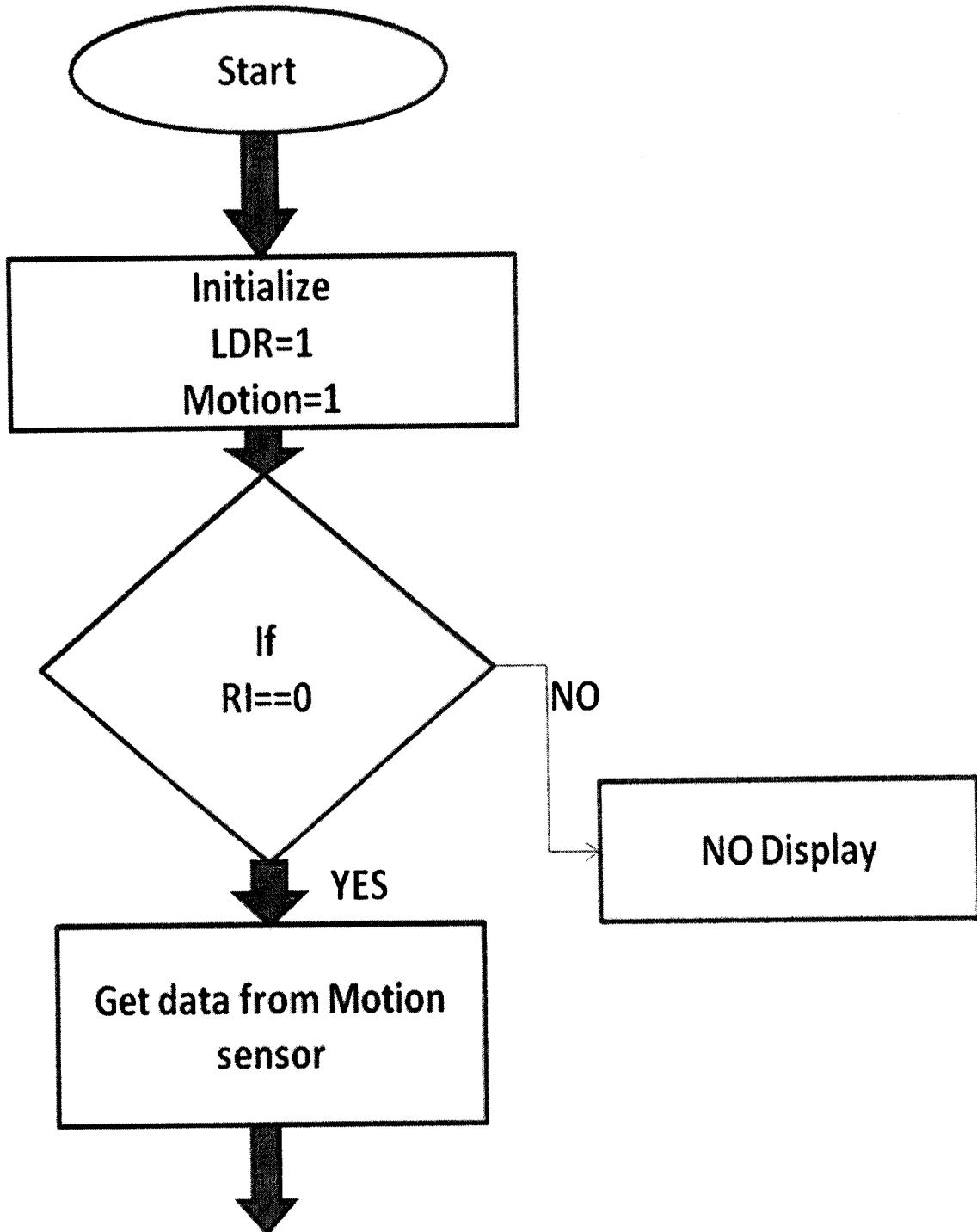
What is EMBEDDED C?

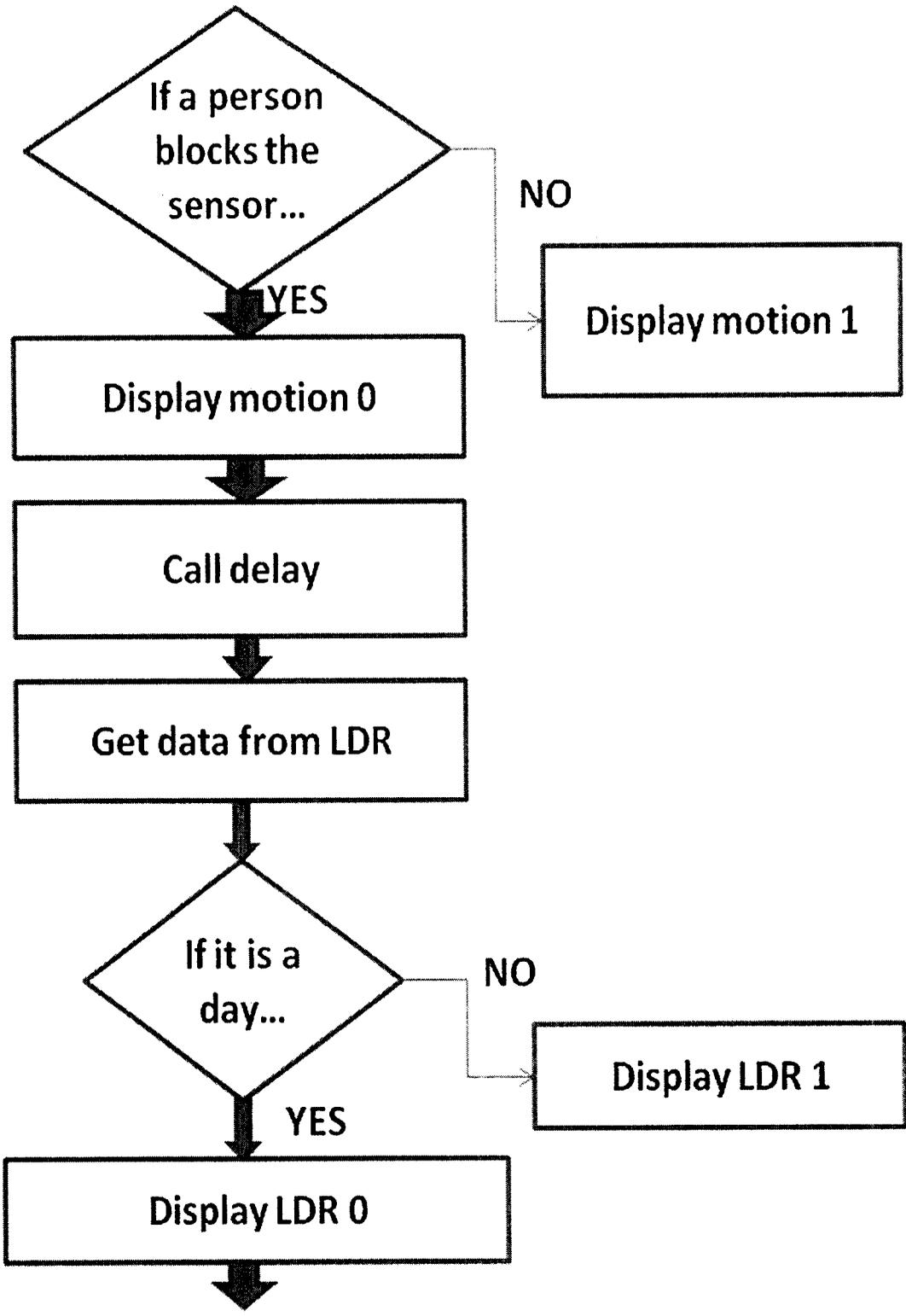
C is a general-purpose computer programming language developed between 1969 and 1973 by Dennis Ritchie at the Bell Telephone Laboratories for use with the Unix operating system. An embedded system is a computer system designed to do one or a few dedicated and/or specific functions often with real time computing constraints. C programming language is used to program embedded systems and is called embedded C.

Why EMBEDDED C is used for programming microcontroller?

C remains a very popular language for micro-controller developers due to the code efficiency and reduced overhead and development time. C offers low-level control and is considered more readable than assembly. Many free C compilers are available for a wide variety of development platforms. The compilers are part of an IDEs with ICD support, breakpoints, single-stepping and an assembly window. The performance of C compilers has improved considerably in recent years, and they are claimed to be more or less as good as assembly, depending on who you ask. Most tools now offer options for customizing the compiler optimization. Additionally, using C increases portability, since C code can be compiled for different types of processors.

5.3 FLOWCHART

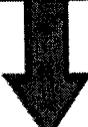




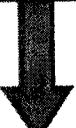
Call delay



Initialize
s1=0 ; s2=0 ; s3=0
to select voltage

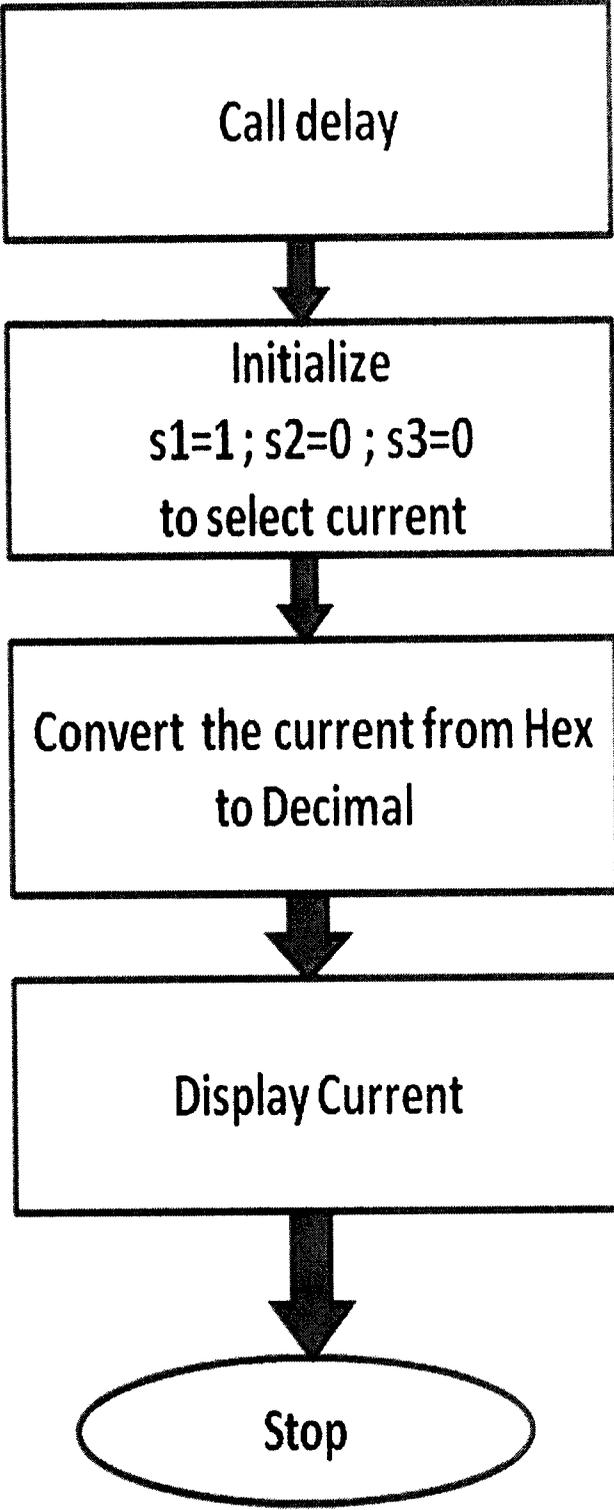


Convert the voltage from
Hex to Decimal



Display Voltage



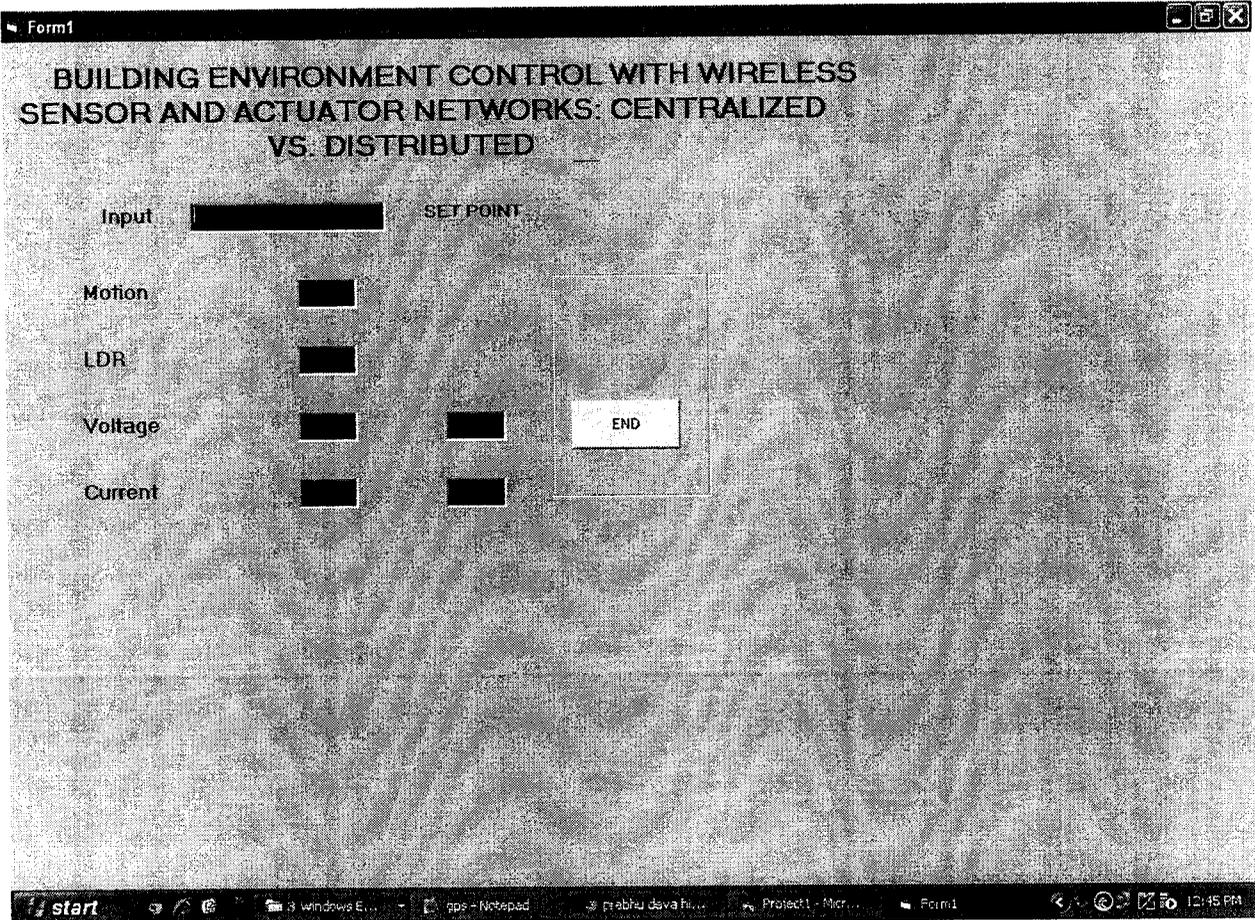


5.4 ALGORITHM

- Step 1: Initialize motion and LDR sensors to 1.
- Step 2: If RI is 0, check the data from motion sensor.
- Step 3: If a person blocks the path display as 'Motion 0' otherwise display as 'Motion 1'.
- Step 4: Then the data from LDR is to be checked.
- Step 5: If it is a day, display as 'LDR 0' or if it is a night, display as 'LDR 1'.
- Step 6: s1, s2, s3 channels are used for channel selection by the ADC.
- Step 7: If s1=s2=s3=0 is used , the value of voltage is displayed.
- Step 8: If s1=1, s2=0, s3=0, the value of current is displayed.
- Step 9: Delay is used in between each operation.

CHAPTER 6
TEST DATA

SCREEN SHOT FROM VISUAL BASIC



CHAPTER 7

CONCLUSION & FUTURESCOPE

CONCLUSION & FUTURESCOPE

We've presented the models for building environment control using wireless sensor and actuator networks.

Two control schemes are described in detail:

a centralized control (CC) scheme and a distributed control (DC).

They differ from each other in many aspects.

- 1) Both the CC and the DC are able to achieve our control objective finally.
- 2) In the CC, transmission failure of control command packets prevents the actuators from being under controlled. The DC is more robust against packet loss than the CC.
- 3) With TSM applied, simulation results indicate that the actuation latency of the DC is less than that of the CC when the average packet loss rates are the same for the CC and the DC.
- 4) The energy consumption due to radio communications of a sensor grows faster as the network scale (number of sensors) increases in the DC than that in the CC.
- 5) The CC is inappropriate for large scaled WSANs at least because its computational complexity grows tremendously with the network scale. Whereas, The DC has shown excellent scalability because control relies on only local communication.

However, the DC suffers from that its control performance is sensitive to certain parameters and In our future work, we will study them and try to make them adaptive for different application cases.

CHAPTER 8
BIBLIOGRAPHY

BIBLIOGRAPHY

IEEE PAPERS USED FOR REFERENCE

- Building Environment Control with Wireless Sensor and Actuator Networks: Centralized vs. Distributed

Xianghui Cao, *Student Member, IEEE*, Jiming Chen, *Member, IEEE*, Yang Xiao, *Senior Member, IEEE*, and Youxian Sun.

BOOKS REFERRED:

- J.S. Sandhu, A.M. Agogino and A.K. Agogino. Wireless sensor networks for commercial lighting control: Decision making with multiagent systems. In *Proc. of AAAI-04*, Jul. 2004.
- A. Deshpande, C. Guestrin and S. Madden. Resource-aware wireless sensor-actuator networks. *IEEE Data Engineering*, 18(1):40–47, 2005.

CHAPTER 9
APPENDICES

9.1 CODING

```
//#include<reg51.h>
#include"lcd_zenbio.h"
void adc_check();
void adc_check1(unsigned int val);
sbit s1=P1^0;
sbit s2=P1^1;
sbit s3=P1^2;
sfr adcout=0xa0;
#define MYDATA P2

sbit motion=P1^7;
sbit ldr=P1^6;

unsigned char t[]="Motion:";
unsigned char p[]="Volt:";
unsigned char v[]="LDR  :";
unsigned char c[]="Curr:";

//unsigned char h[]="HB:"; void caldelay(unsigned int aa);
void temp();
void volt();

void txs(unsigned char var)
{
TI=0;
SBUF=var;
while(TI==0);
}
unsigned char adata()
{
unsigned char val=0;
val=val|(MYDATA&0x80)>>7;
val=val|(MYDATA&0x40)>>5;
val=val|(MYDATA&0x20)>>3;
val=val|(MYDATA&0x10)>>1;
val=val|(MYDATA&0x8)<<1;
val=val|(MYDATA&0x4)<<3;
```

```
    val=val|(MYDATA&0x2)<<5;
    val=val|(MYDATA&0x1)<<7;
    return val;
```

```
    }
```

```
}
```

```
unsigned char rval=0;
```

```
void main()
```

```
{
```

```
int i,j;
```

```
unsigned int power;
```

```
ldr=1;
```

```
motion=1;
```

```
TMOD=0X20; SCON=0X50;
```

```
TH1=0XFD;
```

```
TR1=1;
```

```
//int i,j;
```

```
//buzz=0;
```

```
lcdinit();
```

```
lcdcmd(0x80);
```

```
for(i=0;t[i]!='\0';i++)
```

```
{
```

```
    lcddata(t[i]);
```

```
}
```

```
lcdcmd(0x89);
```

```
for(j=0;p[j]!='\0';j++)
```

```
{
```

```
    lcddata(p[j]);
```

```
}
```

```
lcdcmd(0xc0); for(j=0;v[j]!='\0';j++)
```

```
{
```

```
    lcddata(v[j]);
```

```
}
```

```
lcdcmd(0xc9);
```

```
for(j=0;c[j]!='\0';j++)
```

```

{
    lcddata(c[j]);
}
while(1)
{
    while(RI==0)
    {
        txs('M'); lcdcmd(0x87);
        if(motion==0)
        {
            lcddata('0');
            txs('0');
        }
        else
        {
            txs('1');
            lcddata('1');
        }
        caldelay(1000);
        txs('L');
        lcdcmd(0xc7);
        if(ldr==0)
        {
            lcddata('0');
            txs('0'); }
        else
        {
            txs('1');
            lcddata('1');
        }
        caldelay(1000);
        s3=0;s2=0;s1=0;
        caldelay(10000);
        power=adata();
        //power=power+0x0f;
        txs('V');
        lcdcmd(0x8D);
        adc_check1(power);
        s3=0;s2=0;s1=1;
        caldelay(10000);
    }
}

```

```

        //P0=(adcout>>1);
        txs('C');
        lcdcmd(0xCd);
        caldelay(1000);
        power=adata();
        adc_check1(power);
        switch(rval)
        {
            default:break;
        }
    }
    rval=SBUF;
    RI=0;
}
}

```

```

void adc_check1(unsigned int val)
{
    int hun,ten,one;
    unsigned char dummy;
    dummy=val;
    hun=dummy/100;
    txs(hun+0x30);
    lcddata(hun+0x30); caldelay(1000);
    ten=(dummy/10)%10;
    txs(ten+0x30);
    lcddata(ten+0x30);
    caldelay(1000);
    one=dummy%10;
    txs(one+0x30);
    lcddata(one+0x30);
    caldelay(1000);
}

```

```

void adc_check()
{
    int hun,ten,one;
    unsigned char dummy;
    dummy=adata();
    hun=dummy/100;
    txs(hun+0x30);

```

```
lcddata(hun+0x30);
caldelay(1000);
ten=(dummy/10)%10;
txs(ten+0x30);
lcddata(ten+0x30);
caldelay(1000);
one=dummy%10;
txs(one+0x30);
lcddata(one+0x30);
caldelay(1000);
```

```
    }
void caldelay(unsigned int aa)
{
    for(;aa>0;aa--)
    {
        if(RI==1)
        {
            rval=SBUF;
            RI=0;
        }
    }
}
```