AUTOMATED TRAFFIC SENSING TRAFFIC SIGNALING SYSTEM

Project Report submitted in partial fulfillment of the requirement for the degree of

Bachelor of Technology

in

Electronics and Communication Engineering

By

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May 2010

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Certificate

This is to certify that the project report entitled Automated Traffic Sensing and Traffic Signaling System, submitted by Sumit Kumar (061129), Tarun Bajaj (061135), Udit Mitra (061137) in partial fulfillment for the award of degree of Bachelor of Technology in Electronics and Communication Engineering to Jaypee University of Information Technology, Waknaghat, Solan has been carried out under my supervision.

Date : May 2010

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Certified that this work has not been submitted partially or fully to any other University or Institute for the award of this or any other degree or diploma

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Date: 15th May, 2010

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ABSTRACT

Safety and comfort of road users is fast becoming a matter of grave concern. The number of accidents on roads has shot up greatly with the increase in vehicular traffic, so has the race to build a safer and much more reliable system for traffic control and management. Traffic management rides on an extremely balanced equation. A change in timing of Traffic Lights has adverse effects on Traffic. A change applied too early may lead to congestion on other roads and a change too late may wreak havoc; long traffic jams, instances of road rage, accidents etc. The ideal automated traffic signal is yet to be built.

However, some systems have come up, and they can be found in various parts of the world, each having their own niggles and shortcomings.

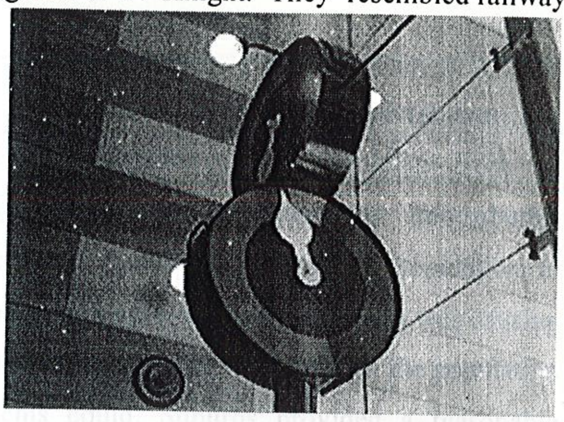
This report presents an adaptive traffic control system where the traffic load is continuously measured by sensors connected to a microcontroller-based system. The traffic lights of an area are interconnected with a communication network through which traffic load and synchronization information is exchanged. As a result, the duration of each traffic light cycle changes dynamically. This means that the timing of the traffic light changes according to the load, the side with the greatest load is given timewise priority.

CHAPTER 1

Introduction

1.1 Traffic Signals : Brief History

In December 10, 1868, the first traffic lights were installed outside the British Houses of Parliament in London, by the railway engineer J. P. Knight. They resembled railway signals of the time with semaphore arms and red and green gas lamps for night use. The gas lantern was turned with a lever at its base so that the appropriate light faced traffic. Unfortunately, it exploded on 2 January 1869, injuring or killing the policeman who was operating it. The modern electric traffic light is an



American invention. As early as 1912 in Salt Lake City, Utah, policeman Lester Wire invented the first red-green electric traffic lights. On 5 August 1914, the American Traffic Signal Company installed a traffic signal system on the corner of East 105th Street and Euclid Avenue in Cleveland, Ohio. It had two colors, red and green, and a buzzer, based on the design of James Hoge, to provide a warning for color changes. The first four-way, three-color traffic light was created by police officer William Potts in Detroit, Michigan in 1920.

1.2 Common Problems

In most parts of the world, traffic lights have a meager setup using a microcontroller with fixed signal timings. This has been the norm for quite a long time now. However, in the present times of ever increasing vehicular traffic these systems appear to be quite cumbersome. Fixed signal timings mean no heed is paid to the traffic density. This leads to long queues at traffic lights causing congestion on roads and extreme discomfort to road users, which in turn leads to excessive disobedience of traffic signals and accidents. That is, even more delays!

1.3 Need for Traffic Sensing

Interest in Traffic Sensing comes from the problems caused by traffic congestion and a synergy of new technologies for simulation, real-time control, and communications networks. Traffic congestion has been increasing worldwide due to ballooning motorization, urbanization, population growth, and changes in population density. Congestion reduces efficiency of transportation infrastructure and increases travel time, air pollution, and fuel consumption.

The United States, for example, saw large increases in both motorization and urbanization starting in the 1920s that led to migration of the population from the sparsely populated rural areas and the densely packed urban areas into suburbs. The industrial economy replaced the agricultural economy, leading the population to move from rural locations into urban centers. At the same time, motorization was causing cities to expand because motorized transportation could not support the population density that the existing mass transit systems could. Suburbs provided a reasonable compromise between population density and access to a wide variety of employment, goods, and services that were available in the more densely populated urban centers. Further, suburban infrastructure could be built quickly, supporting a rapid transition from a rural/agricultural economy to an industrial/urban economy.

1.4 Existing Systems

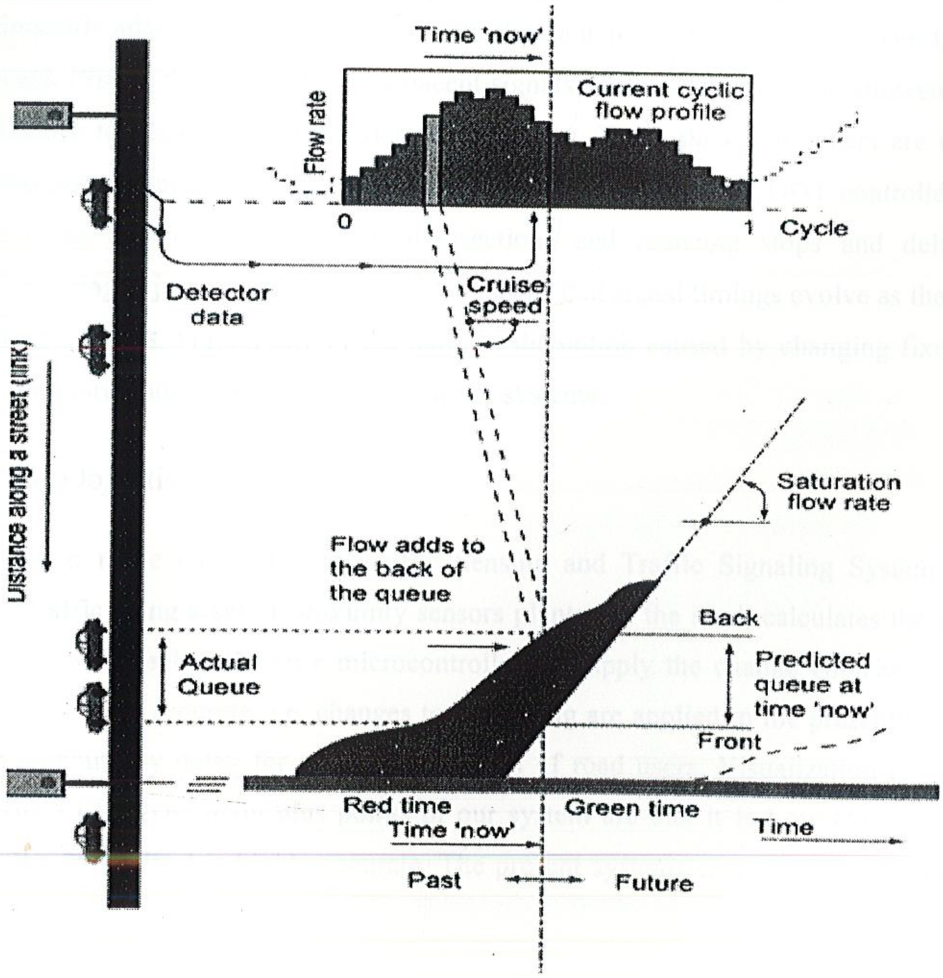
1.4.1 Los Angeles ITS, USA

The Los Angeles ITS, perhaps the world's oldest Intelligent Traffic Management System is still operational. It uses a network of Traffic Cameras planted all over the city roads which are observed by traffic officials sitting at a main control room. Watching the changing traffic conditions they change the signal timings manually. The only drawback of this system is that it requires manual control over the signals. Otherwise it has proved to be quite reliable.

1.4.2 SCOOT, UK

This system coordinates the operation of all the traffic signals in an area to give good progression to vehicles through the network. Whilst coordinating all the signals, it responds intelligently and continuously as traffic flow changes and fluctuates throughout the day. It removes the dependence of less sophisticated systems on signal plans, which have to be expensively updated.

The Kernel software at the heart of a SCOOT system is standard to all installations. The additional software (the "knitting" or UTC software) which links the SCOOT Kernel to on-street equipment and which provides the user interface is specific to the supplier.



The operation of the SCOOT model is summarised in the diagram above. SCOOT obtains information on traffic flows from detectors. As an adaptive system, SCOOT depends on good traffic data so that it can respond to changes in flow. Detectors are normally required on every link. Their location is important and they are usually positioned at the upstream end of the approach link. Inductive loops are normally used.

When vehicles pass the detector, SCOOT receives the information and converts the data into its internal units and uses them to construct "Cyclic flow profiles" for each link. The sample profile shown in the diagram is color coded green and red according to the state of the traffic signals when the vehicles will arrive at the stop line at normal cruise speed.

The data from the model is then used by SCOOT in three optimizers which are continuously adapting three key traffic control parameters - the amount of green for each approach (Split), the time between adjacent signals (Offset) and the time allowed for all approaches to a signaled intersection (Cycle time). These three optimizers are used to continuously adapt these parameters for all intersections in the SCOOT controlled area, minimizing wasted green time at intersections and reducing stops and delays by synchronizing adjacent sets of signals. This means that signal timings evolve as the traffic situation changes without any of the harmful disruption caused by changing fixed time plans on more traditional urban traffic control systems.

1.5 Our Objective

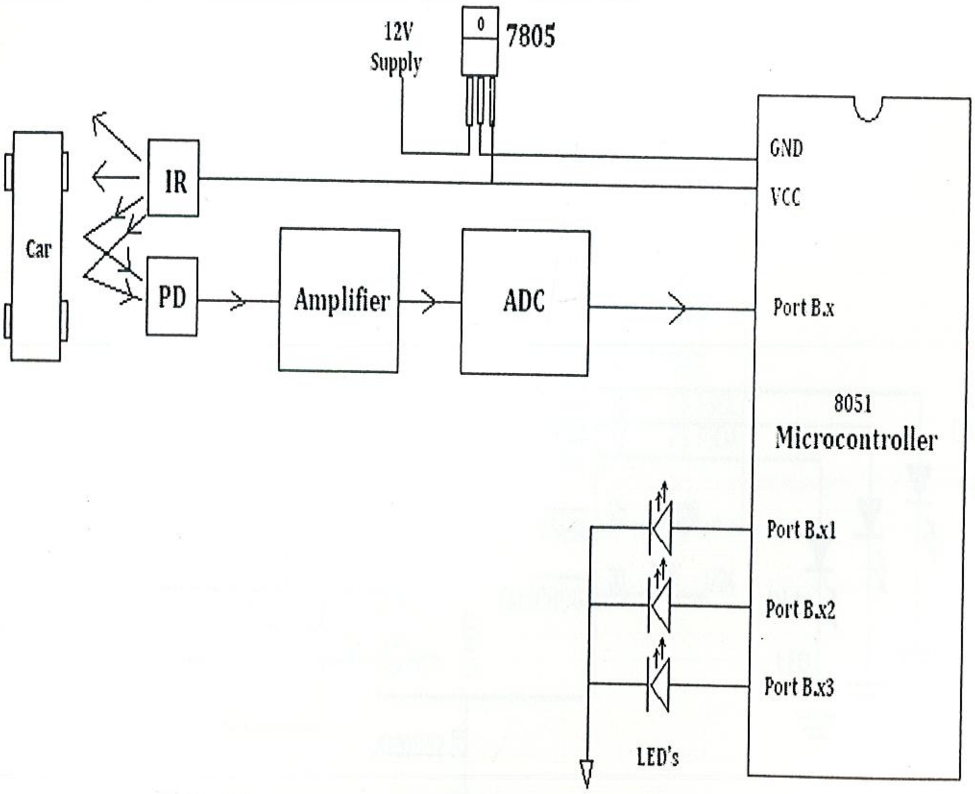
We aim to make an Intelligent Traffic Sensing and Traffic Signaling System which senses traffic using a set of proximity sensors planted in the road, calculates the density using the code embedded on a microcontroller and apply the change On-The-Go. This system is highly accurate; i.e. changes to the timing are applied in the presently running cycle without any delay for maximum comfort of road users. Visualization is via high intensity LEDs. The main plus points of our system are that it is Low Cost (hardware costs Rs. 3000/- and is highly accurate. The present systems cost anywhere upwards of Rs. 15,00,000/-

CHAPTER 2

Block Diagram

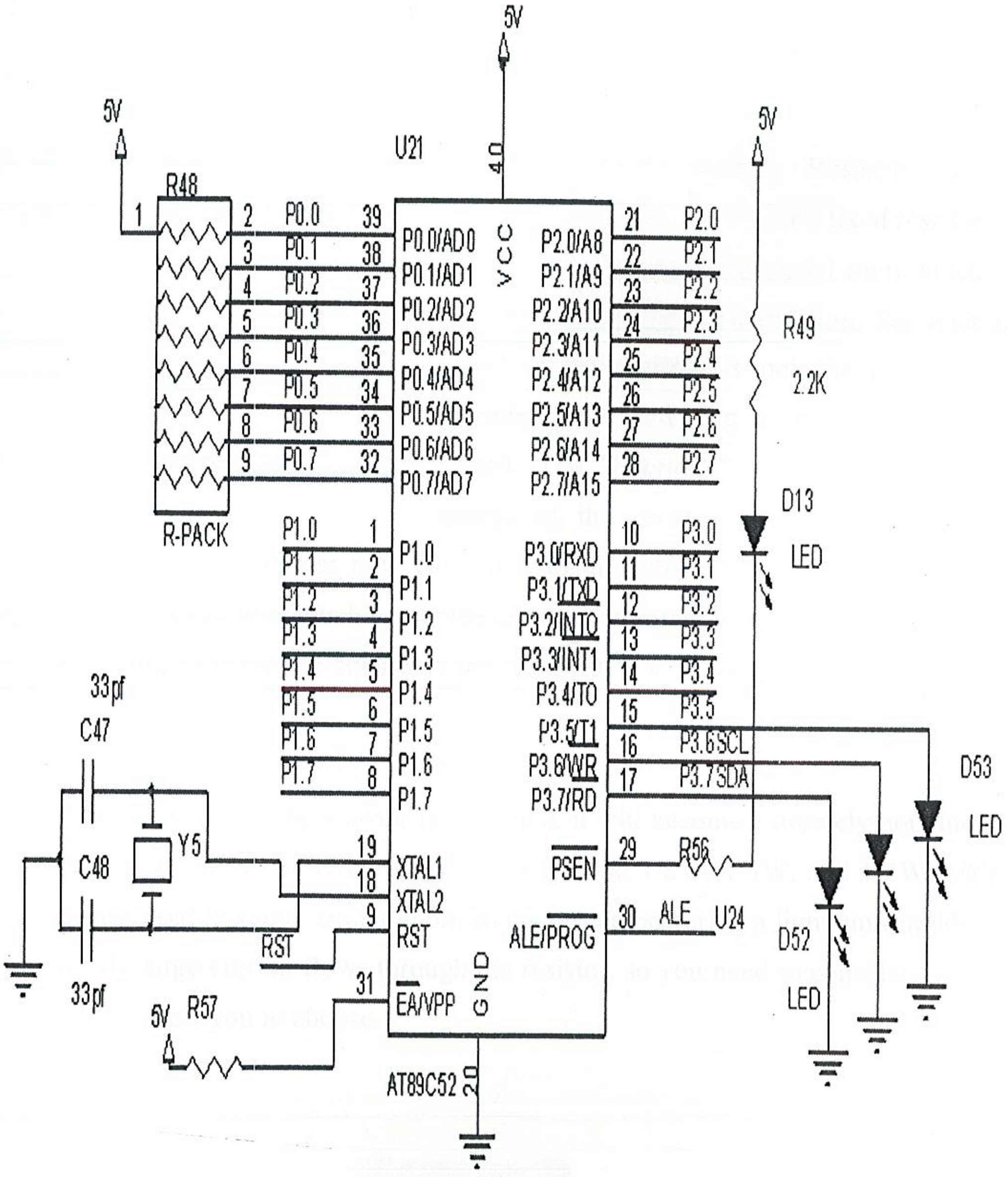
2.1 Block Diagram

A Block diagram is basically the building block of any project to start on. By taking the help of block diagram one can see what will be the outcome and how we can achieve our output.



Block Diagram of Traffic Sensing and Traffic Signaling System

2.2 Schematic Diagram



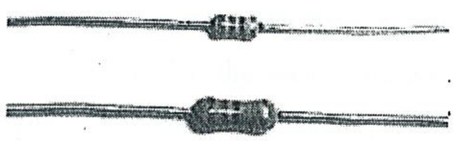
CHAPTER 3

Hardware Requirements

3.1 The Basic Components

3.1.1 The Resistor

The resistor's function is to reduce the flow of electric current. Resistance value is designated in units called the "Ohm". There are two classes of resistors; fixed resistors and the variable resistors. They are also classified according to the material from which they are made. The typical resistor is made of either carbon film or metal film. The resistance



value of the resistor is not the only thing to consider when selecting a resistor for use in a circuit. The "tolerance" and the electric power ratings of the resistor are also important. The tolerance of a resistor denotes how close it is to the actual rated resistance value. The power rating indicates how much power the resistor can safely tolerate.

Power is calculated using the square of the current (I^2) x the resistance value (R) of the resistance

$$P=I^2R$$

If the maximum rating of the resistor is exceeded, it will become extremely hot, and even burn. Resistors in electronic circuits are typically rated 1/8W, 1/4W, and 1/2W. 1/8W is almost always used in signal circuit applications. When powering a light emitting diode, a comparatively large current flows through the resistor, so you need to consider the power rating of the resistor you to choose.

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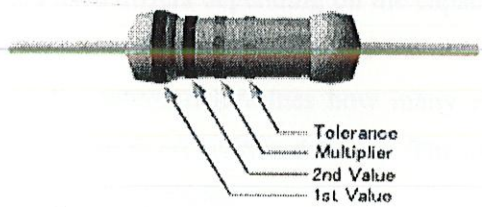
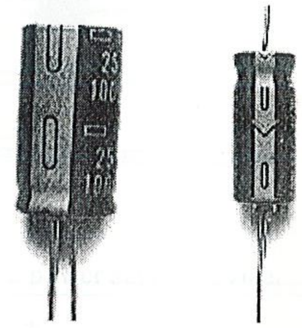


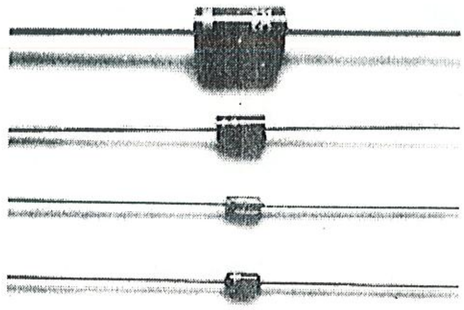
3.1.2 The Capacitor

The Capacitor's function is to store electricity, or electrical energy. The capacitor also functions as a filter, passing alternating current (AC), and blocking direct current (DC). The capacitor is constructed with two electrode plates facing each other, but separated by an insulator. When DC voltage is applied to the capacitor, an electric charge is stored on each electrode. While the capacitor is charging up, current flows. The current will stop flowing when the capacitor has fully charged. When a circuit tester, such as an analog meter set to measure resistance, is connected to a 10 microfarad (μF) electrolytic capacitor, a current will flow, but only for a moment. You can confirm that the meter's needle moves off of zero, but returns to zero right away. When you connect the meter's probes to the capacitor in reverse, you will note that current once again flows for a moment.



The capacitor can be used as a filter that blocks DC current. (A "DC cut" filter.). However, in the case of alternating current, the current will be allowed to pass. Alternating current is similar to repeatedly switching the test meter's probes back and forth on the capacitor. Current flows every time the probes are switched. The value of a capacitor (the capacitance), is designed in units called Farad (F). The capacitance of a capacitor is generally very small, so units such as the microfarad (10 to 6 F), nano farad(10 to 9 F) and Pico farad (10 to 12F) are used. . Recently, a new capacitor with very high capacitance has been developed. The Electric Double Layer capacitor has capacitance designated in Farad units. These are known as "Super Capacitors." There are two ways in which the capacitance can be written. One uses letters and numbers, the other uses only numbers. In either case, there are only three characters used. [10n] and [103] denote the same value of capacitance. The method used differs depending on the capacitor supplier. In the case that the value is displayed with the three-digit code, the 1st and 2nd digits from the left, and the 3rd digit is a multiplier which determines how many zeros are to be added to the capacitance. Pico farad (pF) units are written this way. The capacitor has an insulator (the dielectric) between 2 sheets of electrodes.

3.1.3 The Diode



A diode is a semiconductor device which allows current to flow through it in only one direction. Although a transistor is also a semiconductor device, it does not operate the way a diode does. A diode is specifically made to allow current to flow through it in only one direction. Some ways in which the diode can be used are listed here:

1. A diode can be used as a rectifier that converts AC to DC for a power supply device.
2. Diodes can be used to separate the signal from radio frequencies.
3. Diodes can be used as an on/off switch that controls current.

Current flows from the anode side to the cathode side. Although all diodes operate with the same general principle, there are different types suited to different applications. When a small voltage is applied to the diode in the forward direction, current flows easily. Because the diode has a certain amount of resistance, the voltage will drop slightly as current flows through the diode. A typical diode causes a voltage drop of about (0.6 - 1V) (In the case of silicon diode, almost 0.6V).When voltage is applied in the reverse direction through a diode; the diode will have a great resistance to current flow. Different diodes have different characteristics when reverse-biased. A given diode should be selected depending on how it will be used in the circuit. The current that will flow through a diode biased in the reverse direction will vary from several mA to just μA, which is very small. The limiting voltages and currents permissible must be considered on a case by case basis. For example, when using diodes for rectification, part of the time they will be required to withstand a reverse voltage. If the diodes are not chosen carefully, they will break down.

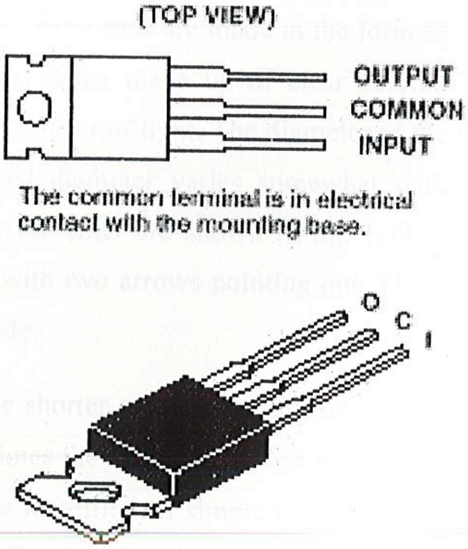
3.1.4 Pull-Up Resistor

The pull up resistor is used in electronic logic circuits to ensure that inputs to logic systems settle at expected logic levels if external devices are disconnected or high-impedance. They may also be used at the interface between two different types of logic devices, possibly operating at different power supply voltages.

The idea of such a resistor is closely related to the idea of three-state logic. Such a resistor weakly "pulls" the voltage of the non-voltage-source wire it is connected to towards its voltage source level (high such as 5V in the case of a pull-up resistor, or low such as 0V in the case of the pull-down resistor) when the other components on the line are inactive. This is because when all other terminating connections on the line are inactive, they are high-impedance and act like they are disconnected. Since the other components act as though they are disconnected, the circuit acts as though it is disconnected, and no current will flow on the line, and the voltage of the non-voltage-source wire (common between the other components on the line) will be that of the voltage source (again either high or low) following the rules of Ohm's law.

3.1.5 7805 Series Voltage Regulator

The LM78XX series of three terminal regulators is available with several fixed output voltages making them useful in a wide range of applications. One of these is local on card regulation, eliminating the distribution problems associated with single point regulation. The voltages available allow these regulators to be used in logic systems, instrumentation, HiFi, and other solid state electronic equipment. Although designed primarily as fixed voltage regulators these devices can be used with external components to obtain adjustable voltages and currents.



The LM78XX series is available in an aluminum TO-3 package which will allow over 1.0A load current if adequate heat sinking is provided. Current limiting is included to limit the peak output current to a safe value. If internal power dissipation becomes too high for the heat sinking provided, the thermal shutdown circuit takes over preventing the IC from overheating. It is not necessary to bypass the output, although this does improve transient response. Input bypassing is needed only if the regulator is located far from the filter capacitor of the power supply.

3.1.6 Light-Emitting Diodes (LEDs)

Light emitting diode (LED) is basically a P-N junction semiconductor diode particularly designed to emit visible light. There are infrared emitting LEDs which emit invisible light. The LEDs are now available in many color red, green and yellow,. A normal LED at 2.4V and consumes ma of current. The LEDs are made in the form of flat tiny P-N junction enclosed in a semi-spherical dome made up of clear colored epoxy resin. The dome of a LED acts as a lens and diffuser of light. The diameter of the base is less than a quarter of an inch. The actual diameter varies somewhat with different makes. The common circuit symbols for the LED are shown in fig. 1. It is similar to the conventional rectifier diode symbol with two arrows pointing out. There are two leads- one for anode and the other for cathode.

LEDs often have leads of dissimilar length and the shorter one is the cathode. This is not strictly adhered to by all manufacturers. Sometimes the cathode side has a flat base. If there is doubt, the polarity of the diode should be identified. A simple bench method is to use the ohmmeter incorporating 3-volt cells for ohmmeter function. When connected with the ohmmeter: one way there will be no deflection and when connected the other way round there will be a large deflection of a pointer.

Action

An LED consists of a junction diode made from the semi conducting compound gallium arsenate phosphate. It emits light when forward biased, the color depending on the composition and impurity content of the compound. At present red, yellow and green LEDs are available. When a p-n junction diode is forward biased, electrons move across the junction from the n-type side to the p-type side where they recombine with holes near the junction. The same occurs with holes going across the junction from the p-type side. Every recombination results in the release of a certain amount of energy, causing, in most semiconductors, a temperature rise. In gallium arsenate phosphate some of the energy is emitted as light, which gets out of the LED because the junction is formed very close to the surface of the material. An LED does not light when reverse biased and if the bias is 5 V or more it may be damaged.

External Resistor

Unless an LED is of the 'constant-current type' (incorporating an integrated circuit regulator for use on a 2 to 18 V d.c. or a. c. supply), it must have an external resistor R connected in series to limit the forward current, which typically, may be 10 mA (0.01 A). Taking the voltage drop (Vf) across a conducting LED to be about 1.7 V, R can be calculated approximately from:

$$R = \frac{(\text{supply voltage} - 1.7)\ \text{V}}{0.01\text{A}}$$

For example, on a 5 V supply, R = 3.3/0.01 = 330 Ohm.

3.1.7 IR (Infra-Red) LED

There are a couple key differences in the electrical characteristics of infrared LEDs versus visible light LEDs. Infrared LEDs have a lower forward voltage, and a higher rated current compared to visible LEDs. This is due to differences in the material properties of the junction. A typical drive current for an infrared LED can be as high as 50 milliamps, so dropping in a visible LED as a replacement for an infrared LED could be a problem with some circuit designs.

IR LEDs aren't rated in millicandelas, since their output isn't visible (and candelas measure light in a way weighted to the peak of the visible spectrum). They are usually rated in milliwatts, and conversions to candelas aren't especially meaningful.

3.1.8 IR Photodetector

These detectors are optimized to specific wavelengths, and are appropriate for use over a spectral range beginning at 1.5 microns and dropping off fairly sharply beyond their optimized wavelength.

The detectors come in photoconductive and photovoltaic types. Photovoltaic detectors create a measurable voltage and current in response to photon bombardment, much like a solar cell. Photoconductive devices change resistance when photons come in. A low noise bias current must be used to measure the resistance change. Photoconductive devices tend to have somewhat higher signal (responsivity) and sometimes slightly better signal-to-noise than photovoltaic equivalents when operated at optimum frequencies. For this reason, the photovoltaic devices are preferred for most applications.

Most infrared phototransistors are also sensitive to visible light and therefore will need to be shielded in someway to prevent the device from being swamped by the rooms lighting. This can be done by hiding the phototransistor inside a lineside structure or placing it inside a short piece of opaque tubing as shown below. The back of the phototransistor can be painted black to prevent room light from entering if it is in the open.

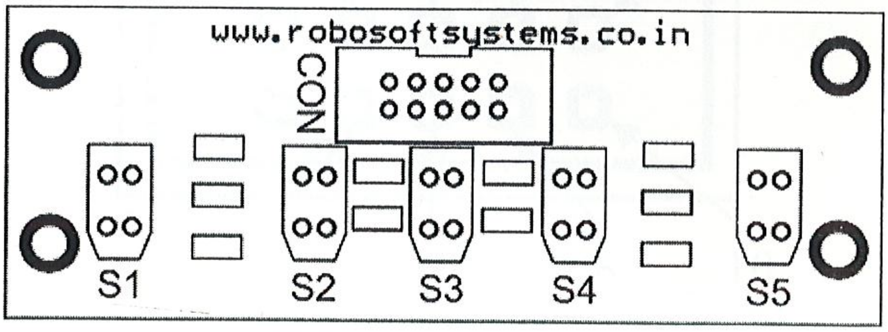
3.1.9 The Sensor Module

The Sensor Module consists of a horde of components. Most importantly, the IR-LED and the IR Photodiode, IR being Infra-Red, Amplifiers and Analog to Digital Convertors to amplify and convert the miniscule outputs from the sensors to a value that is recognizable by the microcontroller.

The TCRT-LFSM–Analogue sensor is used as a line sensor, but it can be used as a general-purpose proximity or reflectance sensor. The module consist of 5 IR emitter and receiver (phototransistor) pairs Each phototransistor. Theses high performance TCRT sensors IR LEDs emits IR light and phototransistor receive that IR light after reflection. TCRT gives out different analogue voltage for different color and distance.

TCRT provides day light blocking filter so erratic behaviour is avoided. The module is very compact and it gives analogue output. The power consumption is low for this module.

Range for output voltage depend on your input voltage. It is recommended to use sensor board on normal TTL power supply that is +5V DC.

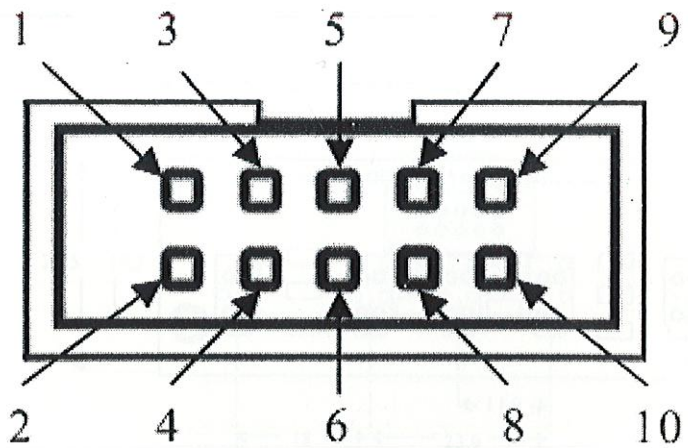


TCRT sensors Module Board

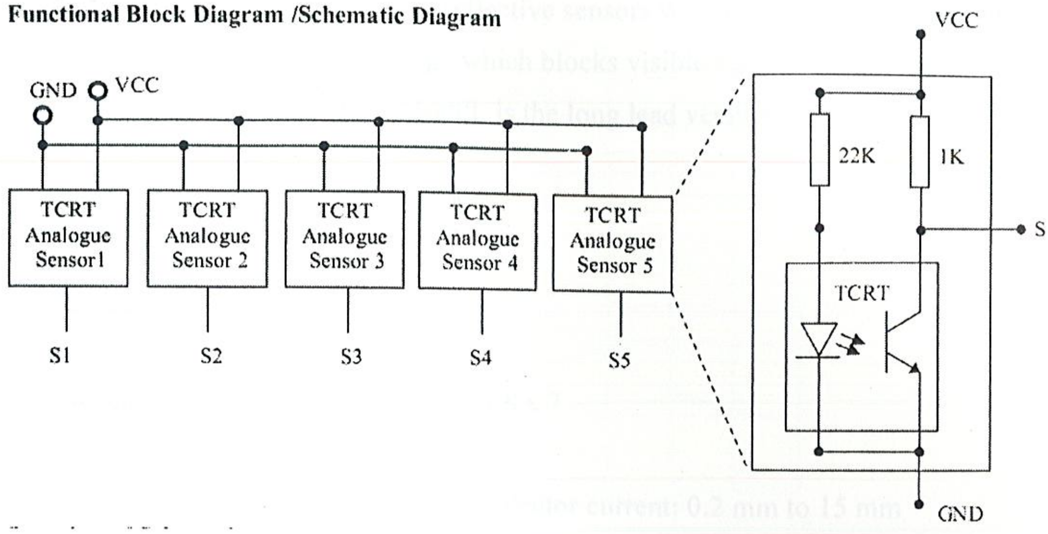
Pin Configuration

If you hold the sensor in your hand with notch of connector facing upward as shown in figure then your pins will be

Pin No.	Connection	Pin No.	Connection
1	GND	6	Sensor5
2	VCC	7	Sensor3
3	Sensor1	8	NC
4	Sensor4	9	VCC
5	Sensor2	10	GND



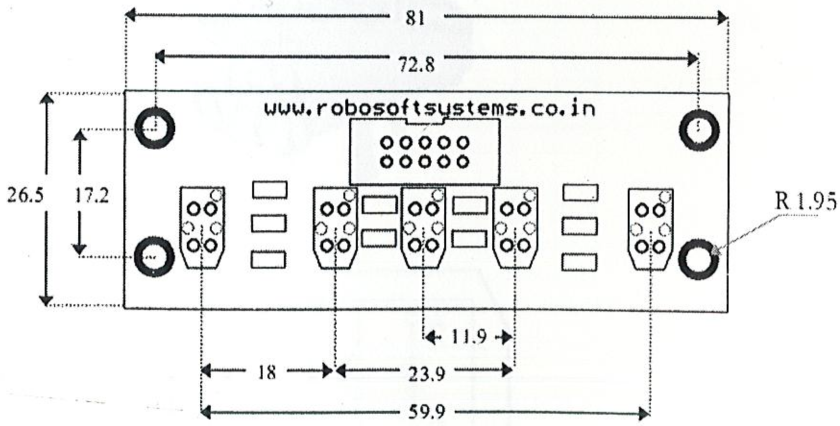
Functional Block Diagram /Schematic Diagram



Maximum Ratings

Symbol	Quantity	Minimum	Typical	Maximum	Unit
V_{DD}	Operating Voltage	4.5	5	5.5	V
V_{SS}	Ground Reference voltage	-	0	-	V

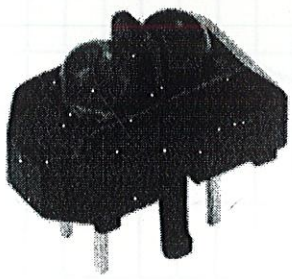
Pin Out Dimensions



The TCRT5000 and TCRT5000L are reflective sensors which include an infrared emitter and phototransistor in a leaded package which blocks visible light. The package includes two mounting clips. TCRT5000L is the long lead version.

FEATURES

- Package type: leaded
- Detector type: phototransistor
- Dimensions (L x W x H in mm): 10.2 x 5.8 x 7
- Peak operating distance: 2.5 mm
- Operating range within > 20 % relative collector current: 0.2 mm to 15 mm
- Typical output current under test: IC = 1 mA
- Daylight blocking filter
- Emitter wavelength: 950 nm
- Lead (Pb)-free soldering released
- Compliant to RoHS directive 2002/95/EC and in accordance to WEEE 2002/96/EC



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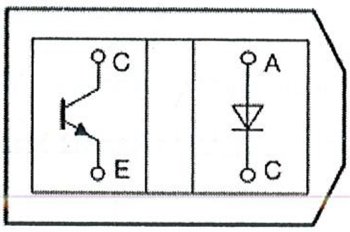

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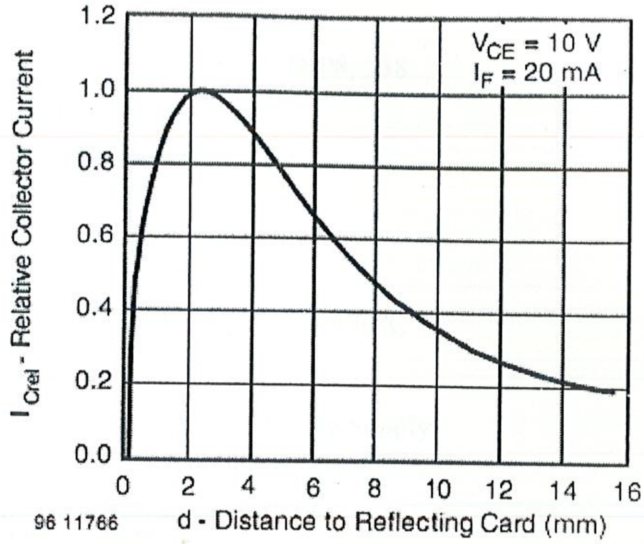


Fig. 9 - Relative Collector Current vs. Distance

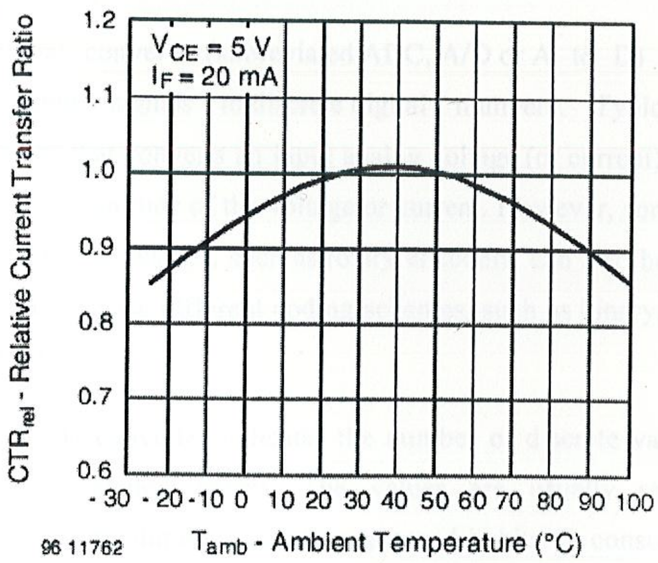


Fig. 5 - Relative Current Transfer Ratio vs. Ambient Temperature

3.1.10 LM358 Amplifier Specifications:

- OP AMP, DUAL LOW POWER, DIP8, 358
- Bandwidth:1MHz
- No. of Amplifiers:2
- No. of Pins:8
- Op Amp Type: Low Power
- Operating Temperature Range:0°C to +70°C
- Case Style: DIP
- Operational Amplifier Features: Single Supply
- Slew Rate:0.1V/µs
- Supply Voltage + Nom:5V
- Termination Type: Through Hole

3.1.11 Analog to Digital Convertor

An analog-to-digital converter (abbreviated ADC, A/D or A to D) is a device which converts continuous signals to discrete digital numbers. Typically an ADC is an electronic device that converts an input analog voltage (or current) to a digital number proportional to the magnitude of the voltage or current. However, some non-electronic or only partially electronic devices, such as rotary encoders, can also be considered ADCs. The digital output may use different coding schemes, such as binary, Gray code or two's complement binary.

The resolution of the converter indicates the number of discrete values it can produce over the range of analog values. The values are usually stored electronically in binary form, so the resolution is usually expressed in bits. In consequence, the number of discrete values available, or "levels", is usually a power of two. For example, an ADC with a resolution of 8 bits can encode an analog input to one in 256 different levels, since $2^8 = 256$. The values can represent the ranges from 0 to 255 (i.e. unsigned integer) or from -128 to 127 (i.e. signed integer), depending on the application. Most converters sample with 6 to 24 bits of resolution, and produce fewer than 1 megasample per second.

3.1.12 PCB Etching

Etching is where the excess copper is removed to leave the individual tracks or traces asthey are sometimes called. Buckets, bubble tanks, and spray machines lots of different ways to etch, but most firms currently use high pressure conveyerised spray equipment. Spray etching is fast, ammoniacal etching solutions when sprayed can etch 55 microns of copper a minute. Less than 40 seconds to etch a standard 1 oz, 35 micron circuit board. Many different chemical solutions can be used to etch circuit boards. Ranging from slow controlled speed etches used for surface preparation to the faster etches used for etching the tracks. Some are best used in horizontal spray process equipment while others are best used in tanks. Etchents for PTH work have to be selective and be non aggressive to tin / tin lead plating, which is used as the etch resist. Copper etching is normally exothermic, where high speed etching is carried out solution cooling is normally required. This is normally done by placing titanium water cooling coils into the etchent. Almost all etching solutions liberate toxic corrosive fumes, extraction is highly recommended. All etchents are corrosive and toxic, mainly due to the high metal content.

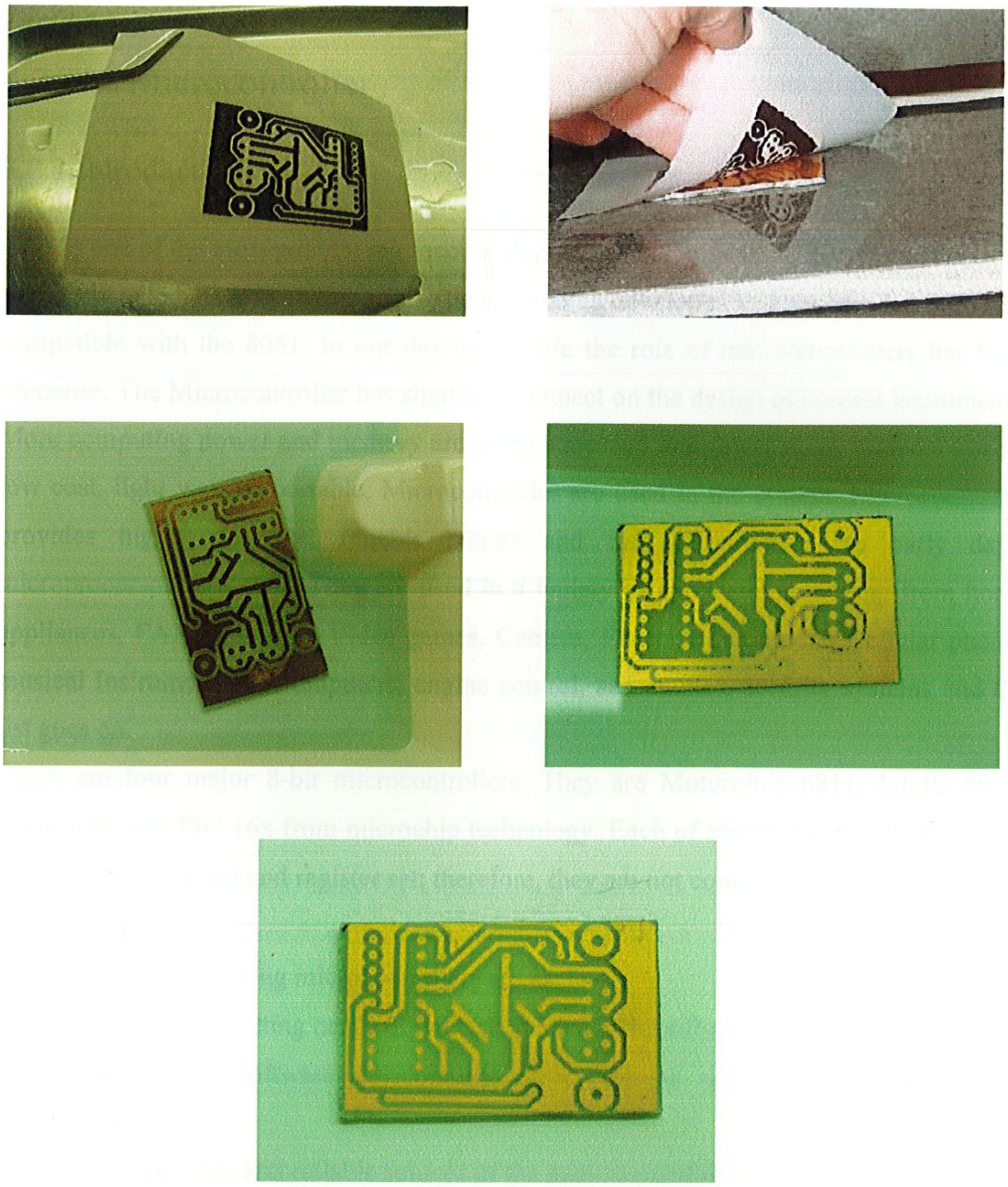
PCB LAYOUT: The PCB layout is a mirrored positive one - black on white. Mirrored as viewed from the silkscreen top (component) side. The PCB layout is printed 1:1 on paper by means of a laser printer or copier machine. The laser printer or copier toner will not run out when it gets wet or oily. The ink of an inkjet paper print does run out and inkjet printers are therefore useless with the described method.

PCB PREPARATION: The PCB layout paper is drenched with sunflower-seed oil. Sunflower-seed oil is common available from your local grocery or wall market. Superfluous oil should be removed carefully with tissue paper. The sunflower-seed oil is used to make the white part of the layout paper transparent for light. If you prefer to use the PCB layout more than once let the drenched PCB layout paper dry at least 48 hours. The layout paper should be carefully dried on forehand as much as possible with tissue paper. Sunflower-seed oil is drying oil. Exposed to the air over a number of hours, the layout paper becomes rigid again. A kind of polymerization takes place.

PCB UV EXPOSURE: The protective plastic layer is removed - peeled back - from the photosensitive PCB. The toner side of the greased layout is placed on the copper of the PCB. Captured air-bubbles are gently pressed away from underneath the layout. The PCB with the layout is now covered with an appropriate sized windowpane and placed on a piece of plain polished tile or marble. The tile or marble absorbs the heat coming from the UV bulb, which is significant. Three to four minutes 300W bulb UV exposure from a distance of 30-40 cm will do the photo process. Take care when finished and removing the PCB, it gets hot.

PCB DEVELOPMENT: The PCB is developed with a 1% solution of sodium hydroxide NaOH. You can make this solvent by adding 10 gram of sodium hydroxide pellets to 1liter of water and mix it until everything is dissolved. Use a brush to speed up the developing and clean the PCB during this process if the PCB is still greasy due to theapplied sunflower-seed oil. The developing process takes about 1 minute. It is sometimes difficult to guess when the developing is finished. The traces should become clear and the exposed photosensitive layer has dissolved (during the brushing you see darker cloud coming off the PCB surface).

PCB ETCHING: The developed PCB is etched with a 220 g/l solution of ammonium peroxydisulfate (NH) S O a.k.a. ammonium persulfate, 220 gram added to 1 liter of water and mix it until everything is dissolved. Theoretically it should be possible to etch slightly more than 60 grams of copper with 1 liter etching solution. Assume 50% efficiency, about 30 grams of copper. Etching at ambient temperature might take over an hour, it is better to heat up the etching solvent to about 35-45 degrees Celcius. The etching solution heating up could be done in a magnetron; the etching - rocking the etching tray - takes about 15-30 minutes at this temperature. If you have a heated, air-bubble circulated etching fluid tank available, this is probably the fastest way to etch. At higher temperatures the etching performance decreases. The etching process is an exothermic reaction, it generates heat. When the ammonium peroxydisulfate is dissolved it is a clear liquid. After an etching procedure it gradually becomes blue and more deeper blue - the chemical reaction creates dissolved copper sulfate $CuSO_4$ Ammonium peroxydisulphate.



The Etching Process

3.2 The Microcontroller

3.2.1 Introduction

8051 is one of the most popular microcontrollers in use today. Many derivatives of microcontrollers have been there since they are being developed that are based on-and compatible with the 8051. In our day-to-day life the role of micro-controllers has been immense. The Microcontroller has significant impact on the design of control instruments. More computing power and memory are being squeezed into fewer IC'S, to make system low cost, light weight, portable, Microcontroller are used in the system. Microcontroller provides highly accurate, reliable results and fast computation. In early days, microprocessors are used. They are used in a variety of applications ranging from home appliances, FAX machines, Video games, Camera, Exercise equipment, Cellular phones musical Instruments to Computers, engine control, aeronautics, security systems and the list goes on.

There are four major 8-bit microcontrollers. They are Motorola's 6811, Intel's 8051, Zilog's z8, and PIC 16x from microchip technology. Each of above microcontroller has a unique instruction set and register set; therefore, they are not compatible with each other.

Three criteria in choosing microcontrollers are as:

1. Meeting the computing needs of the task at hand efficiently and cost effectively.
2. Availability of software development tools such as compilers, assemblers, and debuggers.
3. Wide availability and reliable sources of the microcontroller.

Following are the criteria for selecting a microcontroller:

1. Choose a microcontroller that must meet the task at hand effectively. Among other considerations in this category are:

- Speed : It should be highest one that the microcontroller supports.
- Packaging : Check whether comes in 40 pin dual in line package or quad flat
- package or some other packing format. This is important in terms of space
- assembling technique and prototyping the end product.

- Power consumption : This is especially critical for battery powered products.
- The amount of RAM and ROM available on the chip.
- The number of I/O pins and the timers available on the chip.

2. Choose a microcontroller how easy it is in developing products around it. Key considerations include the availability of an assembler, debugger code efficient C language compiler, emulator, technical support and both in house and outside expertise.

S No.	Feature		8052	8051	8031
1	ROM	(bytes)	8K	4K	0K
2	RAM	(bytes)	256	128	128
3	Timers		3	2	2
4	I/O pins		32	32	32
5	Serial ports		1	1	1
6	Interrupt source		8	6	6

3. The third criterion in choosing a microcontroller is its ready availability in needed quantities both at present and in future. For some designers this is even more important then first two criteria.

3.2.2 Embedded Systems

We are living in the Embedded World. You are surrounded with many embedded products and your daily life largely depends on the proper functioning of these gadgets. Television, Radio, CD player of your living room, Washing Machine or Microwave Oven in your kitchen, Card readers, Access Controllers, Palm devices of your work space enable you to do many of your tasks very effectively. Apart from all these, many controllers embedded in your car take care of car operations between the bumpers and most of the times you tend to ignore all these controllers.

In recent days, you are showered with variety of information about these embedded controllers in many places. All kinds of magazines and journals regularly dish out details about latest technologies, new devices, fast applications which make you believe that your basic survival is controlled by these embedded products. Now you can agree to the fact that these embedded products have successfully invaded into our world. You must be wondering about these embedded controllers or systems. What is this Embedded System?

The computer you use to compose your mails, or create a document or analyze the database is known as the standard desktop computer. These desktop computers are manufactured to serve many purposes and applications.

You need to install the relevant software to get the required processing facility. So, these desktop computers can do many things. In contrast, embedded controllers carryout a specific work for which they are designed. Most of the time, engineers design these embedded controllers with a specific goal in mind. So these controllers cannot be used in any other place.

Theoretically, an embedded controller is a combination of a piece of microprocessor based hardware and the suitable software to undertake a specific task.

These days designers have many choices in microprocessors/microcontrollers. Especially, in 8 bit and 32 bit, the available variety really may overwhelm even an experienced designer. Selecting a right microprocessor may turn out as a most difficult first step and it is getting complicated as new devices continue to pop-up very often.

In the 8 bit segment, the most popular and used architecture is Intel's 8031. Market acceptance of this particular family has driven many semiconductor manufacturers to develop something new based on this particular architecture. Even after 25 years of existence, semiconductor manufacturers still come out with some kind of device using this 8031 core.

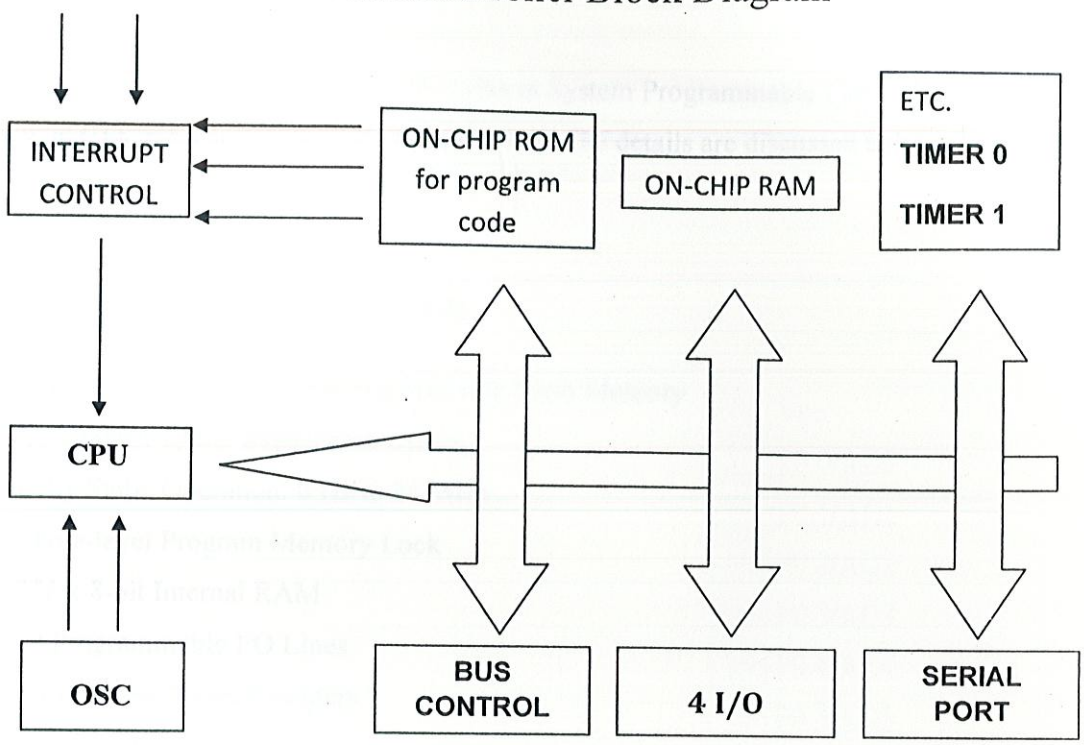
3.2.3 Microcontroller V/S Microprocessors

What is the difference between a microprocessor and microcontroller? The microprocessors (such as 8086, 80286, 68000 etc.) contain no RAM, no ROM and no I/O ports on the chip itself. For this reason they are referred as general- purpose microprocessors. A system designer using general- purpose microprocessor must add external RAM, ROM, I/O ports and timers to make them functional. Although the addition of external RAM, ROM, and I/O ports make the system bulkier and much more expensive, they have the advantage of versatility such that the designer can decide on the amount of RAM, ROM and I/o ports needed to fit the task at hand. This is the not the case with microcontrollers. A microcontroller has a CPU (a microprocessor) in addition to the fixed amount of RAM, ROM, I/O ports, and timer are all embedded together on the chip: therefore, the designer cannot add any external memory, I/O, or timer to it. The fixed amount of on chip RAM, ROM, and number of I/O ports in microcontrollers make them ideal for many applications in which cost and space are critical. In many applications, for example a TV remote control, there is no need for the computing power of a 486 or even a 8086 microprocessor. In many applications, the space it takes, the power it consumes, and the price per unit are much more critical considerations than the computing power. These applications most often require some I/O operations to read signals and turn on and off certain bits. It is interesting to know that some microcontrollers manufactures have gone as far as integrating an ADC and other peripherals into the microcontrollers.

3.2.4 Microcontrollers For Embedded Systems

In the literature discussing microprocessors, we often see a term embedded system. Microprocessors and microcontrollers are widely used in embedded system products. An embedded product uses a microprocessor (or microcontroller) to do one task and one task only. A printer is an example of embedded system since the processor inside it performs one task only: namely, get data and print it. Contrasting this with a IBM PC which can be used for a number of applications such as word processor, print server, network server,

Microcontroller Block Diagram



video game player, or internet terminal. Software for a variety of applications can be loaded and run. Of course the reason a PC can perform myriad tasks is that it has RAM memory and an operating system that loads the application software into RAM and lets the CPU run it. In an embedded system, there is only one application software that is burned into ROM. An PC contains or is connected to various embedded products such as the keyboard, printer, modem, disk controller, sound card, CD-ROM driver, mouse and so on. Each one of these peripherals has a microcontroller inside it that performs only one task. For example, inside every mouse there is a microcontroller to perform the task of finding the mouse position and sending it to the PC.

Although microcontrollers are the preferred choice for many embedded systems, there are times that a microcontroller is inadequate for the task. For this reason, in many years the manufacturers for general-purpose microprocessors have targeted their microprocessor for the high end of the embedded market.

3.2.5 The AT89C52 Microcontroller

It is an 8-bit Microcontroller with 4K bytes in System Programmable Flash Memory. It can be both serially and parallely programmed. The details are discussed below:

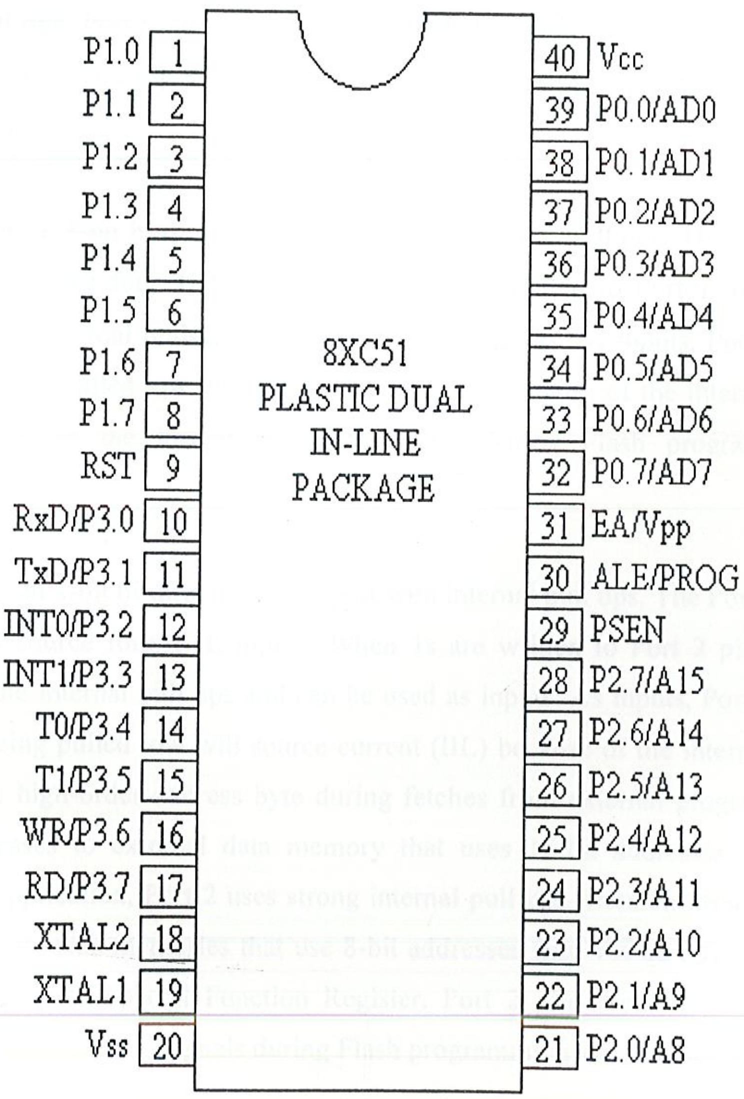
3.2.5.1 Features

- Compatible with MCS-51™ Products
- 8K Bytes of In-System Reprogrammable Flash Memory
- Endurance: 1,000 Write/Erase Cycles
- Fully Static Operation: 0 Hz to 24 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
- Programmable Serial Channel
- Low-power Idle and Power-down Modes

3.2.5.2 Description

The AT89C52 is a low-power, high-performance CMOS 8-bit micro computer with 8K bytes of Flash programmable and erasable read only memory (PEROM). The device is manufactured using Atmel's high-density nonvolatile memory technology and is compatible with the industry-standard 80C51 and 80C52 instruction set and pin out. The on-chip Flash allows the program memory to be reprogrammed in-system or by a conventional nonvolatile memory programmer. By combining a versatile 8-bit CPU with Flash on a monolithic chip, the Atmel AT89C52 is a powerful microcomputer which provides a highly-flexible and cost-effective solution to many embedded control applications. The AT89C52 provides the following standard features: 8K bytes of Flash, 256 bytes of RAM, 32 I/O lines, three 16-bit timer/counters, a six-vector two-level interrupt architecture, full-duplex serial port, on-chip oscillator, and clock circuitry. In addition, the AT89C52 is designed with static logic for operation down to zero frequency and supports two software selectable power saving modes. The Idle Mode stops the CPU while allowing the RAM, timer/counters, serial port, and interrupt system to continue functioning. The Power-down mode saves the RAM contents but freezes the oscillator, disabling all other chip functions until the next hardware reset.

3.2.5.3 Pin Description



VCC: Supply voltage.

GND: Ground.

Port 0: Port 0 is an 8-bit open drain bi-directional I/O port. As an output port, each pin can sink eight TTL inputs. When 1s are written to port 0 pins, the pins can be used as high impedance inputs. Port 0 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. Port 0 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: Port 1 is an 8-bit bi-directional I/O port with internal pull ups. The Port 1 output buffers can sink/source four TTL inputs. When 1s are written to Port 1 pins, they are pulled high by the internal pull-ups and can be used as inputs. As inputs, Port 1 pins that are externally being pulled low will source current (IIL) because of the internal pull ups. Port 1 also receives the low-order address bytes during Flash programming and verification.

Port2 : Port 2 is an 8-bit bi-directional I/O port with internal pull ups. The Port 2 output buffers can sink/source four TTL inputs. When 1s are written to Port 2 pins, they are pulled high by the internal pull ups and can be used as inputs. As inputs, Port 2 pins that are externally being pulled low will source current (IIL) because of the internal pull ups. Port 2 emits the high-order address byte during fetches from external program memory and during accesses to external data memory that uses 16-bit addresses (MOVX @ DPTR). In this application, Port 2 uses strong internal pull ups when emitting 1s. During accesses to external data memories that use 8-bit addresses (MOVX @ RI), Port 2 emits the contents of the P2 Special Function Register. Port 2 also receives the high-order address bits and some control signals during Flash programming and verification.

Port 3: Port 3 is an 8-bit bi-directional I/O port with internal pull ups. The Port 3 output buffers can sink/source four TTL inputs. When 1s are written to Port 3 pins, they are pulled high by the internal pull ups and can be used as inputs. As inputs, Port 3 pins that are externally being pulled low will source current (IIL) because of the pull ups. Port 3 also serves the functions of various special features, as shown in the following table. Port 3 also receives some control signals for Flash programming and verification.

Port Pin	Alternate Functions
P3.0	RXD (serial input port)
P3.1	TXD (serial output port)
P3.2	$\overline{INT0}$ (external interrupt 0)
P3.3	$\overline{INT1}$ (external interrupt 1)
P3.4	T0 (timer 0 external input)
P3.5	T1 (timer 1 external input)
P3.6	$\overline{WR}$ (external data memory write strobe)
P3.7	$\overline{RD}$ (external data memory read strobe)

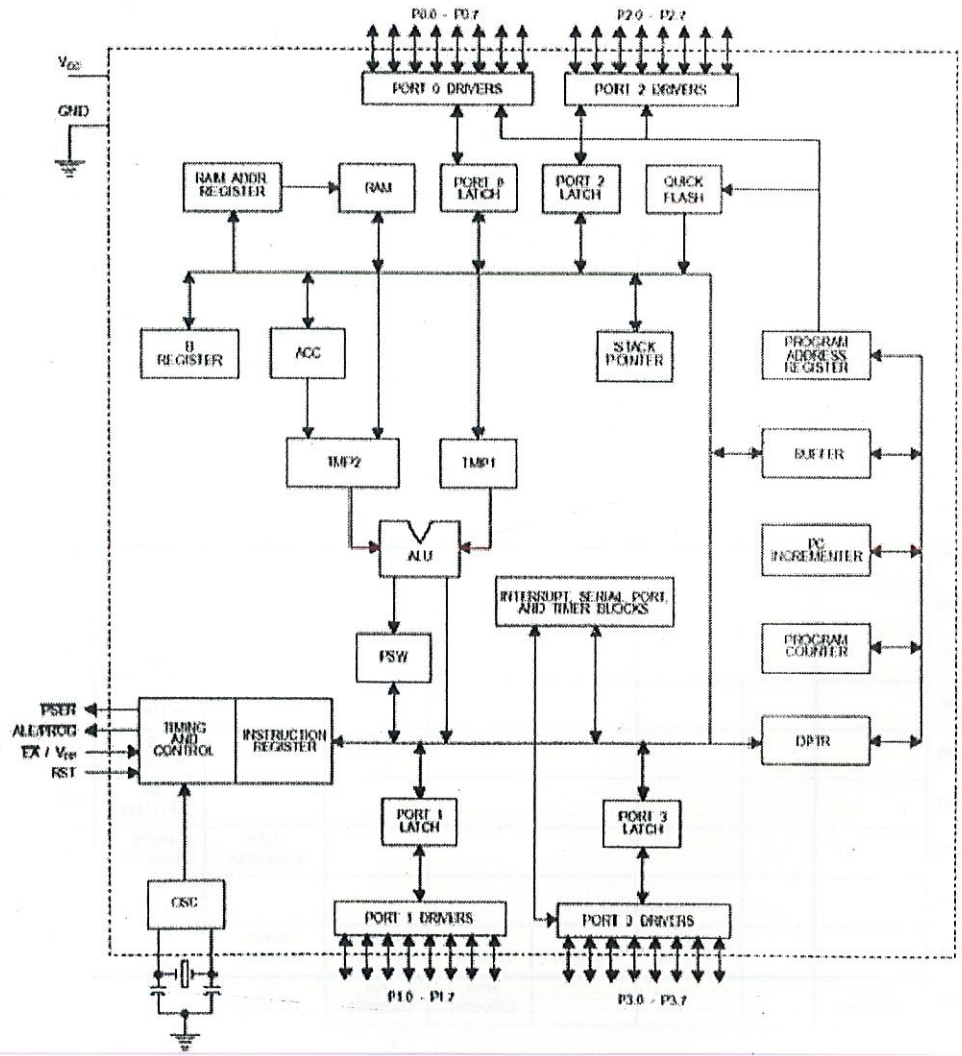
ALE/PROG: Address Latch Enable is an output pulse for latching the low byte of the address during accesses to external memory. This pin is also the program pulse input (PROG) during Flash programming. In normal operation, ALE is emitted at a constant rate of 1/6 the oscillator frequency and may be used for external timing or clocking purposes. Note, however, that one ALE pulse is skipped during each access to external data memory. If desired, ALE operation can be disabled by setting bit 0 of SFR location 8EH. With the bit set, ALE is active only during a MOVX or MOVC instruction. Otherwise, the pin is weakly pulled high. Setting the ALE-disable bit has no effect if the microcontroller is in external execution mode.

PSEN: Program Store Enable is the read strobe to external program memory. When the AT89C52 is executing code from external program memory, PSEN is activated twice each machine cycle, except that two PSEN activations are skipped during each access to external data memory.

EA/VPP: External Access Enable. EA must be strapped to GND in order to enable the device to fetch code from external program memory locations starting at 0000H up to

FFFFH. Note, however, that if lock bit 1 is programmed, EA will be internally latched on reset. EA should be strapped to VCC for internal program executions. This pin alsoreceives the 12-volt programming enable voltage (VPP) during Flash programming when 12-volt programming is selected.

Block Diagram



XTAL1: Input to the inverting oscillator amplifier and input to the internal clock operating circuit.

XTAL2: Output from the inverting oscillator amplifier.

RESET

The pin 9 of the microcontroller 8051 is the RESET pin. Upon applying a high pulse to this pin, the micro controller will reset and terminate all activities. This is often called as power-on reset. Activating a power-on reset will cause all the values in the registers to be lost. It will set program counter to all 0's. the reset can be given by either power-on reset circuit or by using a momentary switch.

3.2.5.4 SFRs

Table 1. AT89C52 SFR Map and Reset Values

0F8H									0FFH
0F0H	B 00000000								0F7H
0E8H									0EFH
0E0H	ACC 00000000								0E7H
0D8H									0DFH
0D0H	PSW 00000000								0D7H
0C8H	T2CON 00000000	T2MOD XXXXXX00	RCAP2L 00000000	RCAP2H 00000000	TL2 00000000	TH2 00000000			0CFH
0C0H									0C7H
0B8H	IP XX000000								0BFH
0B0H	P3 11111111								0B7H
0A8H	IE 0X000000								0AFH
0A0H	P2 11111111								0A7H
98H	SCON 00000000	SBUF XXXXXXXX							9FH
90H	P1 11111111								97H
88H	TCON 00000000	TMOD 00000000	TL0 00000000	TL1 00000000	TH0 00000000	TH1 00000000			8FH
80H	P0 11111111	SP 00000111	DPL 00000000	DPH 00000000				PCON 0XXX0000	87H

A map of the on-chip memory area called the Special Function Register (SFR) space is shown in table above. Note that not all of the addresses are occupied, and unoccupied addresses may not be implemented on the chip. Read accesses to these addresses will in general return random data, and write accesses will have an indeterminate effect. User software should not write 1s to these unlisted locations, since they may be used in future products to invoke new features. In that case, the reset or inactive values of the new bits will always be 0.

3.3 Component List

1. IC-1	7805 (Regulator)
2. IC-2	AT89C52 (Microcontroller)
3. IC-3	LM 358 Opamp
4. D1-D4	IN 4007 (Diodes)
5. LED	Light Emitting Diode
6. Crystal Oscillator	11.0592 Mhz.
7. Photodiode	
8. IR-LED	
9. Resistor	100Ω, 1kΩ, 47Ω
10. Capacitor	1000uF, 10uF, 33
11. Transformer	220V-12V Step Down Transformer
12. Pull Up Resistors	
13. Push-to-On Switch	

CHAPTER 4

Circuit Diagram and Code

4.1 Introduction To OrCAD (Schematic Design Tool)

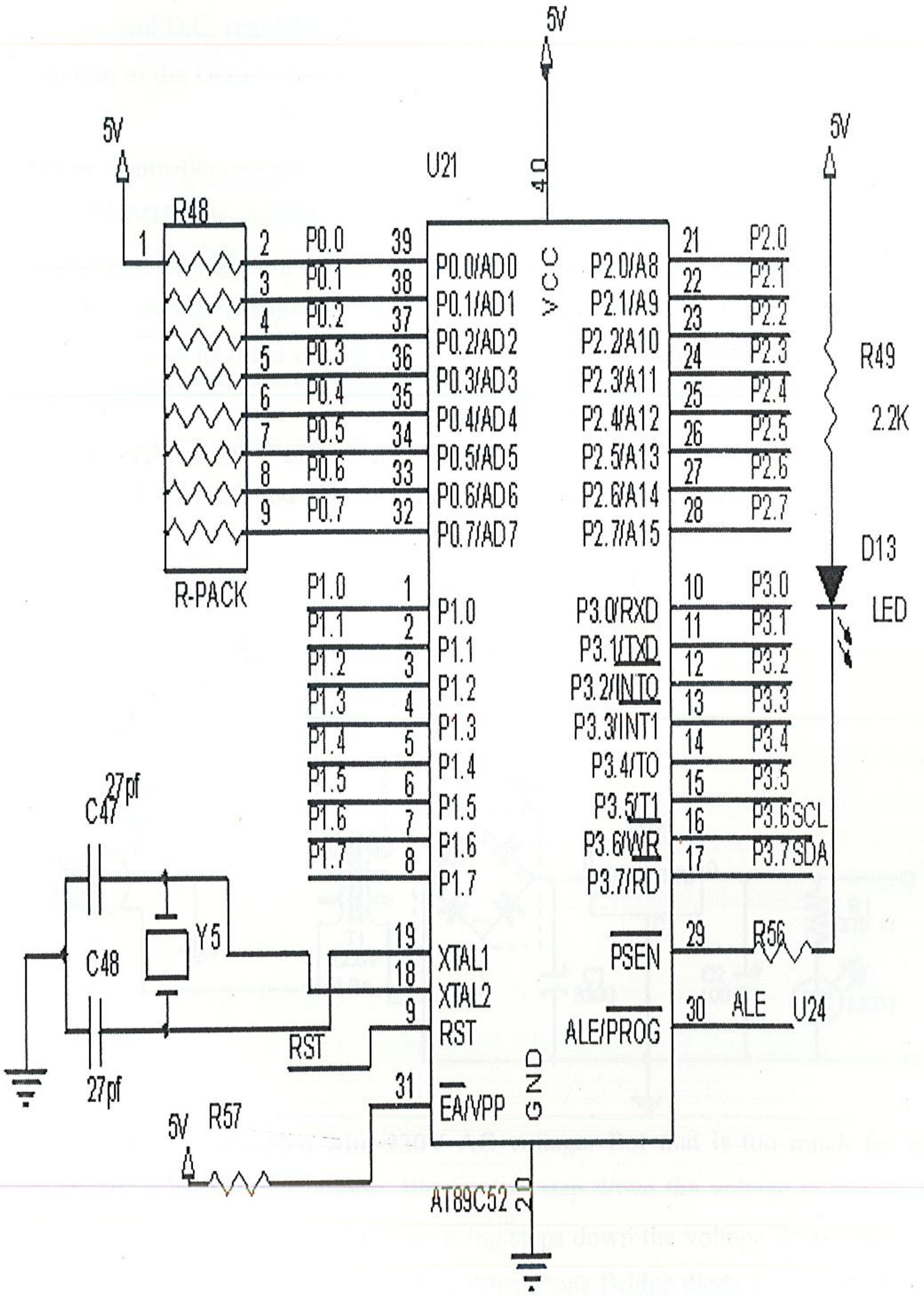
OrCAD is a software tool suite used primarily for electronic design automation. The software is used mainly to create electronic prints for manufacturing of printed circuit boards, by electronic design engineers and electronic technicians to manufacture electronic schematics and diagrams, and for their simulation.
The name OrCAD is a portmanteau, reflecting the software's origins: Oregon + CAD.
The OrCAD product line is fully owned by Cadence Design Systems. The latest iteration has the ability to maintain a database of available integrated circuits. This database may be updated by the user by downloading packages from component manufacturers, such as Analog Devices or Texas Instruments.

The Cadence OrCAD product line includes affordable, high-performance PCB design tools that boost productivity for smaller design teams and individual PCB designers.

To stay competitive in today's market, engineers must take a design from engineering through manufacturing with shorter design cycles and faster time to market. To be successful, you need a set of powerful, intuitive, and integrated tools that work seamlessly across the entire design flow.

OrCAD personal productivity tools (including PSpice) have a long history of addressing these demands. Designed to boost productivity for smaller design teams and individual PCB designers, OrCAD PCB design suites grow with your needs and technology challenges. The powerful, tightly integrated PCB design suites include design capture, librarian tools, a PCB editor, an auto/interactive router, and optional analog and mixed-signal simulator.

4.2 Circuit Diagram



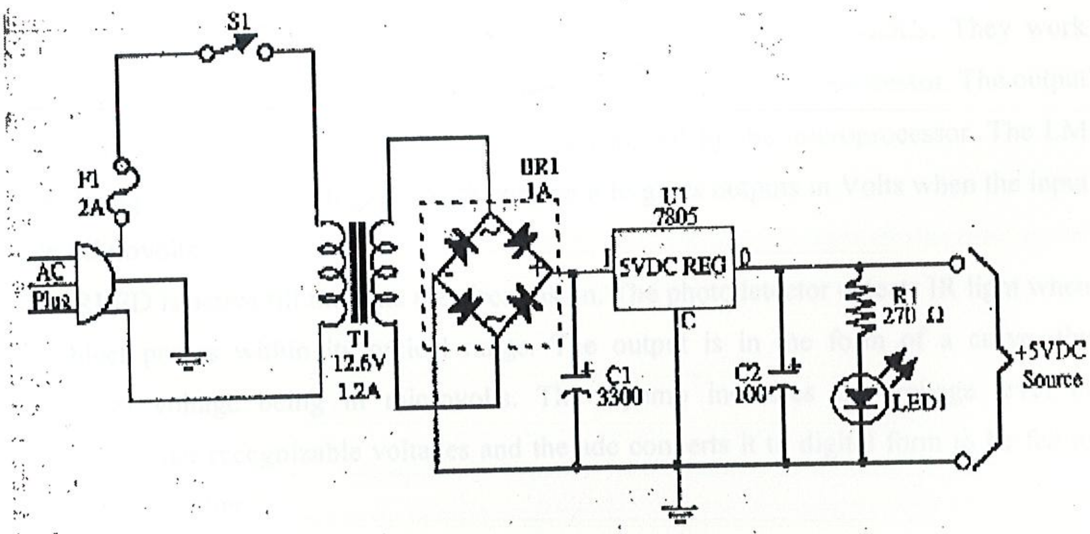
4.3 Schematic Description

We can break the project into three parts like micro controller section, power supply section, and D.C. regulated power supply section. The Circuit shows the complete diagram of the Density based traffic control system

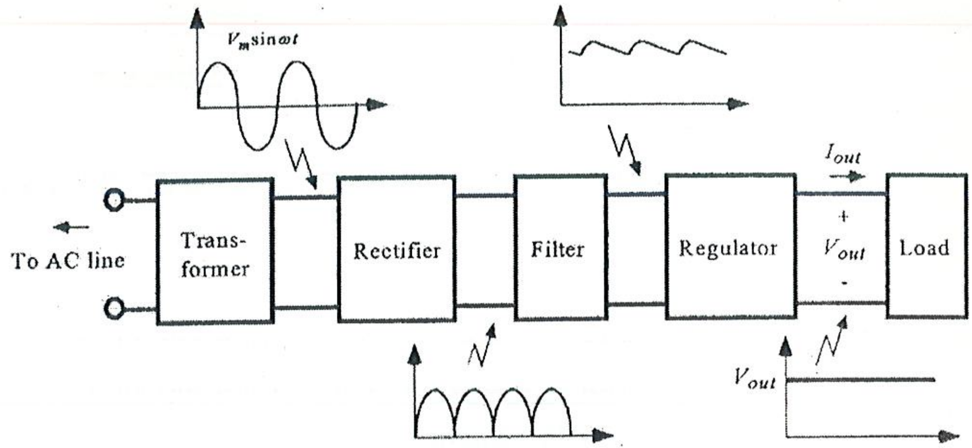
Micro controller section contains only micro controller AT89C52 and a crystal of 11.0592 MHz for oscillator. As the micro controller works on the program inside the memory, the program generates the login therefore it does not require any logic circuits. As the controller keeps all the memory and I/O ports inside it, it contains very less components in its outer configuration. Power to the IC supplied is +5v DC

Power supply is an important part of operation of the Microcontroller. Microcontroller operates at +5v DC and also for other ICs and displays.

4.3.1 DC Supply



Wall Plugs are provided with 230V AC voltage. But that is too much for low power applications such as our circuit. We need to step down the voltage to our requirements. The Step Down Transformer we are using steps down the voltage from 220V AC to 12V AC. To convert to DC we will imply a Wheatstone Bridge diode arrangement and attach it to a capacitor filter with a capacitor of 1000uF to get pure DC. IN4001 diodes will be used. The 7805 Linear Voltage Regulator gives a regulated output of 5V DC.



Components of a typical linear power supply

4.3.2 Sensor Module

The sensor module consists of LM 358 Amplifiers, Resistors and ADCs. They work together in tandem to produce an output that is readable by the microprocessor. The output by the phototransistors is in uV, too low to be detected by the microprocessor. The LM 358 Opamp has a very high gain which enables it to gives outputs in Volts when the input is in Microvolts.

The IRLED is active till the time the circuit is on. The photodetector detects IR light when an object passes within its optical range. The output is in the form of a curve, the maximum voltage being in microvolts. The Opamp increases the voltage level to microcontroller recognizable voltages and the adc converts it to digital form to be fed to the microcontroller.

4.3.3 Port Mapping

The 8051 microcontroller has 4 ports, each port having 8 pins. In this case we have used one port for each side of the intersection, applying 5 input lines from the sensors and 3 output linnes for output on LEDs. Pins 1 to 5 correspond to Sensors 1 to 5 and pins 6 to 8 correspond to the Red, Yellow and Green LEDs. The rest of the pins are used for special functions like Reset, VCC, GND

4.3.4 Algorithm

Default Go Time = 6 secs. Per Side (No Sensors Activated)

Go Time for side when 1 sensor activated = 10 secs.
Go Time for side when 2 sensors activated = 15 secs.
Go Time for side when 3 sensors activated = 20 secs.
Go Time for side when 4 sensors activated = 25 secs
Go Time for side when 5 sensors activated = 30 secs

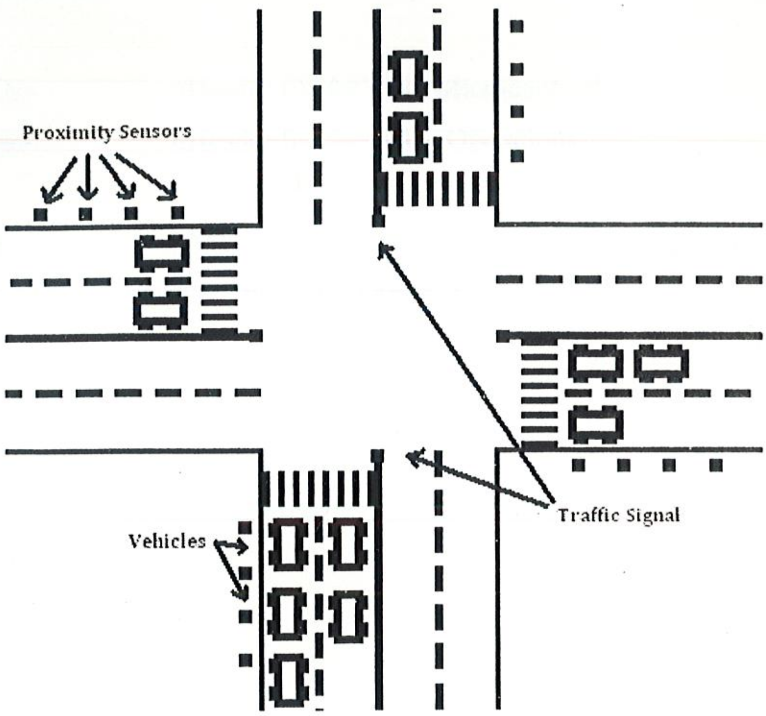
The Stop time of the other sides increases correspondingly to the number of sensors activated of the previous side

The ports are checked turn wise for the number of activated sensors and the Go time is set according to the function above.

When the Green light of the signal is about to end, the yellow light of the next signal turns on indicating the road users that the signal is about to turn green.

STOP TIMES	No Sensors	1 Sensor	2 Sensors	3 Sensors	4 Sensors	5 Sensors
Side 1	0	0	0	0	0	0
Side 2	6	10	15	20	25	30
Side 3	12	20	30	40	50	60
Side 4	18	30	45	60	75	90

Note : All values are in seconds.



4.3.5 Writing the Code:

Programming is done on Keil software. Various steps to program 8051 :

- Write the code in a notepad file
- *.hex file is generated using keil software
- *.hex file is then burnt into the micro-controller using burner

4.3.6 Program Code

```
#include<reg51.h>        //Header file for 8051 Microcontroller
#include<delay.h>        //Header file for Delay Operations

#define s22 P20          //TCRT sensors are used here, that give high o/p when there
#define s21 P21          // is any object detection
#define s23 P22
#define s25 P23
#define s24 P24
#define r2 P27
#define y2 P26
#define g2 P25

#define s12 P10
#define s11 P11
#define s13 P12
#define s15 P13
#define s14 P14
#define g1 P17
#define y1 P16
#define r1 P15

#define s02 P00
#define s01 P01
#define s03 P02
#define s05 P03
#define s04 P04
#define g0 P07
#define y0 P06
#define r0 P05
```

```
#define s32 P30
#define s31 P31
#define s33 P32
#define s35 P33
#define s34 P34
#define g3 P37
#define y3 P36
#define r3 P35
unsigned char delay1,delay2,delay3,delay4;

void check1()
{
        if(s01==1||s02==1||s03==1||s04==1||s05==1)
        {
                if(s01==1)
                delay1=10;
                if(s02==1)
                delay1=15;
                if(s03==1)
                delay1=20;
                if(s04==1)
                delay1=25;
                if(s05==1)
                delay1=30;
        }
        else
                delay1=6;
}


void check2()
```

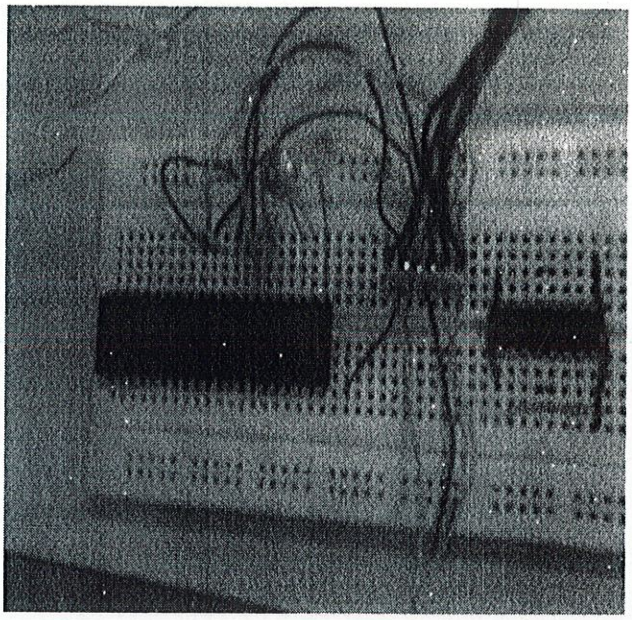
```
{
        if(s11==1||s12==1||s13==1||s14==1||s15==1)
        {
                if(s11==1)
                delay2=10;
                if(s12==1)
                delay2=15;
                if(s13==1)
                delay2=20;
                if(s14==1)
                delay2=25;
        if(s15==1)
                delay2=30;
        }
        else
                delay2=6;
}
void check3()

        if(s21==1||s22==1||s23==1||s24==1||s25==1)
        {
                if(s21==1)
                delay3=10;
                if(s22==1)
                delay3=15;
                if(s23==1)
                delay3=20;
                if(s24==1)
                delay3=25;
                if(s25==1)
                delay3=30;
```

```
        }
        else
                delay3=6;
}
void check4()

        if(s31==1||s32==1||s33==1||s34==1||s35==1)
        {
                if(s31==1)
                delay4=10;
                if(s32==1)
                delay4=15;
                if(s33==1)
                delay4=20;
                if(s34==1)
                delay4=25;
                if(s35==1)
                delay4=30;
        }
        else
                delay4=6;
}
void main()
{
        r1=r2=r3=r0=y1=y2=y3=y0=g1=g2=g3=g0=1;            //off all leds
        s01=s02=s03=s04=s05=1;            // make input sensor pins
        s11=s12=s13=s14=s15=1;            // make input sensor pins
        s21=s22=s23=s24=s25=1;            // make input sensor pins
        s31=s32=s33=s34=s35=1;            // make input sensor pins
        while(1)
        {
```

```
        check2();
        r1=1;r2=r3=r0=0;
        y1=y2=y3=y0=g2=g3=g0=1;
        g1=0;                          /// 0 mean on 1 mean off
        secdelay(delay2);
        y1=y2=y0=1;y3=0;r3=1;
        secdelay(3);
        check4();
        r3=1;r2=r0=r1=0;
        y1=y2=y3=y0=g2=g1=g0=1;
        g3=0;
        secdelay(delay4);
        y1=y3=y0=1;y2=0;r2=1;
        secdelay(3);

        check3();
        r2=1;r3=r1=r0=0;
        y1=y2=y3=y0=g3=g1=g0=1;
        g2=0;
        secdelay(delay3);
        y1=y3=y2=1;y0=0;r0=1;
        secdelay(3);
        check1();
        r0=1;r2=r3=r1=0;
        y1=y2=y3=y0=g2=g3=g1=1;
        g0=0;
        secdelay(delay1);
        y2=y3=y0=1;y1=0;r1=1;
        secdelay(3);
}
}
```

4.3.7 Burning the Code

Using the Keil software we compile the above mentioned program after which a hex file was generated. Now, we burned the code to the microcontroller using the burning process available in the labs.

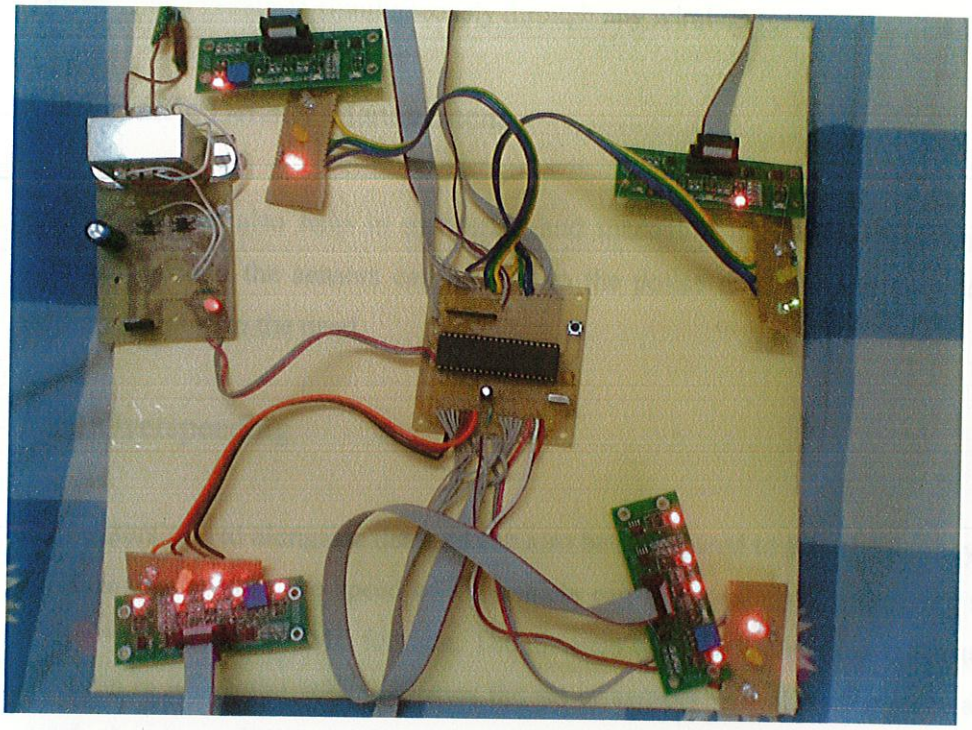


CHAPTER 5

Conclusion and Future Scope

5.1 Conclusion

An adaptive traffic signal has been presented. It has the advantage of sensing which avoids excessive delays and congestion. It also has an advantage of being a low cost solution and can be implemented very easily.



5.2 Future Scope

This kind of Traffic Signal is for the Future. Traffic Safety can be guaranteed and violators can be punished using various add-on systems which can be attached to our system.

5.2.1 Traffic Violators Imaging

This system has the provision to be able to hook up to a camera which can shoot pictures of vehicles jumping the lights. A set of sensors can be planted in the road beyond the Stop Line. Any vehicle crossing those set of sensors which will be active only during the Stop period will send a trigger to the microcontroller which in turn will guide the camera to shoot an image of the affected sector of the intersection and the image will be sent to the Traffic Police Database simultaneously through any wireless means.

5.2.2 Traffic Density Management

Our system can also help in measuring and managing traffic density. The Raw data gathered through the sensors can be sent to the police database and they can re-route traffic according to the need.

5.2.3 Overspeeding

The sensors placed alongside the road can also be configured to see whether any vehicle is overspeeding or not. The speed of the vehicle can be calculated by applying the simple SPEED=DISTANCE/TIME formula. The distance between the sensors is already known. The time in which the vehicle crosses the set of sensors will allow the calculation of its speed. A minor change in the programming of the microcontroller will enable it to perform this function.

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