AUTOMATIC RAILWAY GATE CONTROLLING AND SIGNALLING

PROJECT REPORT

SUBMITTED IN PARTIAL FULFILLMENT

OF THE REQUIREMENT FOR THE DEGREE OF

BACHELOR OF TECHNOLOGY

IN

ELECTRONICS AND COMMUNICATION ENGINEERING

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ABSTRACT

The railway gate is to be controlled so that the road traffic is to be predicted .The railway gate is to be closed when a train is passing by the way. The opening and closing of the gate is to be done using stepper motors and this stepper motor is controlled by micro controller. The signaling of the train is also controlled depending upon the gate position. Only when gate is closed the green signal is otherwise red signal. So in this project the railway signaling includes the gate control is done using microcontroller. The automatic opening and closing of the gate and also the signaling which depending on the gate position that will be controlled by the microcontroller.

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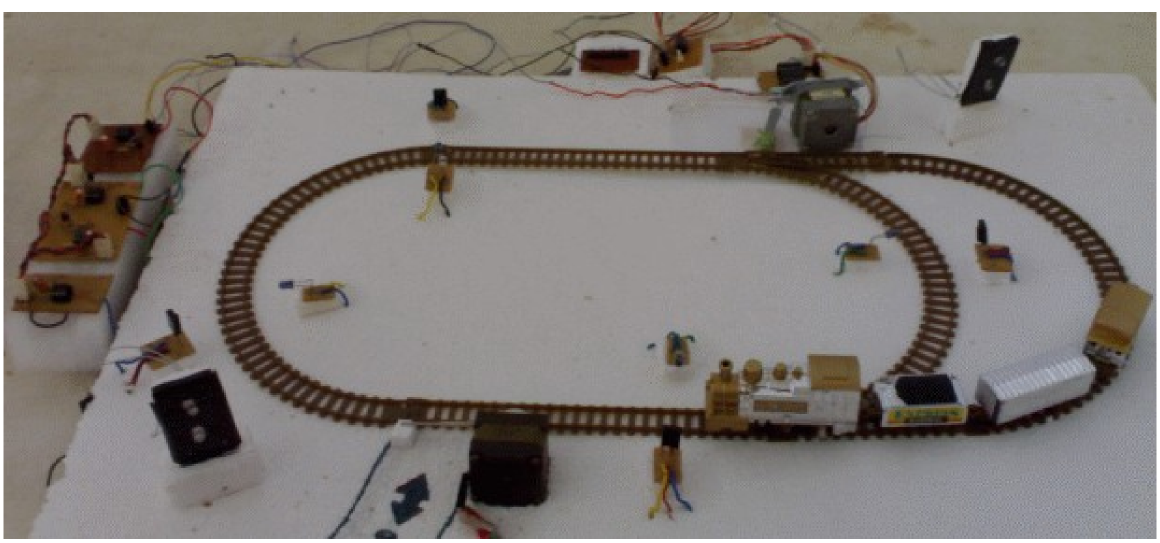
INTRODUCTION

Present project is designed using 8051 microcontroller to avoid railway accidents happening at unattended railway gates, if implemented in spirit. This project utilizes two powerful IR transmitters and two receivers; one pair of transmitter and receiver is fixed at up side (from where the train comes) at a level higher than a human being in exact alignment and similarly the other pair is fixed at down side of the train direction. Sensor activation time is so adjusted by calculating the time taken at a certain speed to cross at least one compartment of standard minimum size of the Indian railway. We have considered 5 seconds for this project. Sensors are fixed at 1km on both sides of the gate. We call the sensor along the train direction as ‘foreside sensor’ and the other as ‘aft side sensor’. When foreside receiver gets activated, the gate motor is turned on in one direction and the gate is closed and stays closed until the train crosses the gate and reaches aft side sensors. When aft side receiver gets activated motor turns in opposite direction and gate opens and motor stops. Buzzer will immediately sound at the fore side receiver activation and gate will close after 5 seconds, so giving time to drivers to clear gate area in order to avoid trapping between the gates and stop sound after the train has crossed.

The same principle is applied for track switching. Considering a situation wherein an express train and a local train are traveling in opposite directions on the same track; the express train is allowed to travel on the same track and the local train has to switch on to the other track. Two sensors are placed at the either sides of the junction where the track switches. If there's a train approaching from the other side, then another sensor placed along that direction gets activated and will send an interrupt to the controller. The interrupt service routine switches the track. Indicator lights have been provided to avoid collisions. Here the switching operation is performed using a stepper motor. Assuming that within a certain delay, the train has passed the track is switched back to its original position, allowing the first train to pass without any interruption. This concept of track switching can be applied at 1km distance from the stations.

The project is simple to implement and subject to further improvement.



Aim of the project:

Here our main intention is to control the railway gate using microcontroller at the same time providing the signaling to indicate the position of the gate i.e., open or close. It means when train is passing gate is closed and green signal indicates its position to the railway crossing vehicular and when the train pass over the railway crossing gate is open indicating by red signal

Methodology:

Hardware used in the project is:

- Voltage regulator
- Microcontroller
- IR receiver
- ULN 2003

- Stepper motor

Software used in the project is:

- Embedded ‘c’ programming
- Keil compiler

BLOCK DIAGRAM DESCRIPTION

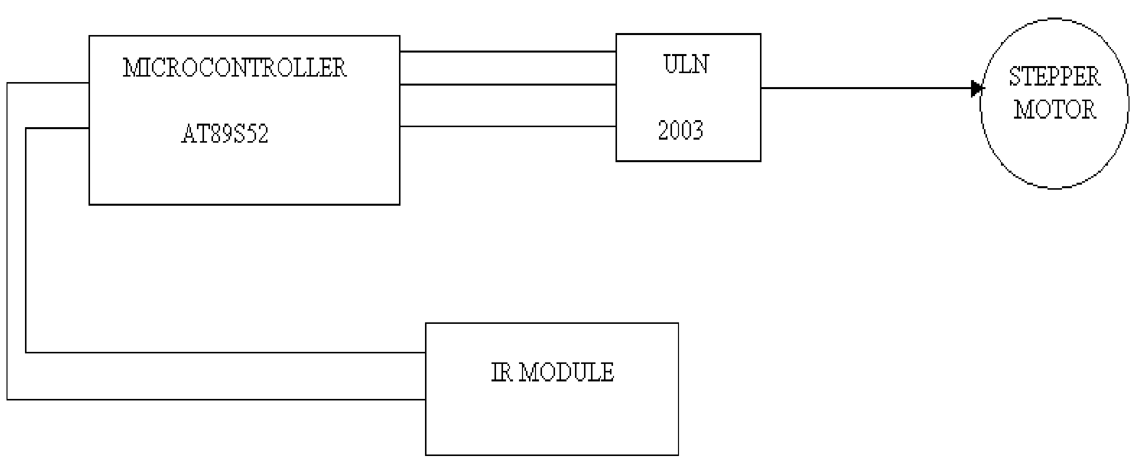


Fig: BLOCK DIAGRAM

The block diagram of the embedded security system consists of the following modules:

- 555 timer
- IR Receiver
- Microcontroller
- Buzzer alarm
- Power supply

555 TIMERS

The 555 timer has been employed to generate a square wave of 56 KHz frequency. The 555 timer has connected for astable operation. With an astable operation, the frequency and duty cycle accurately controlled by two external resistors and capacitor connected to the 555 timer. The output signal for this module is used to drive the Infrared Emitting Diode.

A 555 timer IC is most versatile and highly reliable linear IC. It is used for generating accurate time delay or oscillations. SIGNETICS corporation first introduce the device SE\NE 555 . This device is available as 8 pin metal can, 8 pin mini DIP. The SE 555 is designed for the operating temperature range from -55 degree centigrade to +125 degree centigrade while the NE 555 operates on a range from 0 degree centigrade to 70 degree centigrade. The NE 555 timer operates on +5v to +18v power supply. It has adjustable duty cycle from micro seconds to hours.

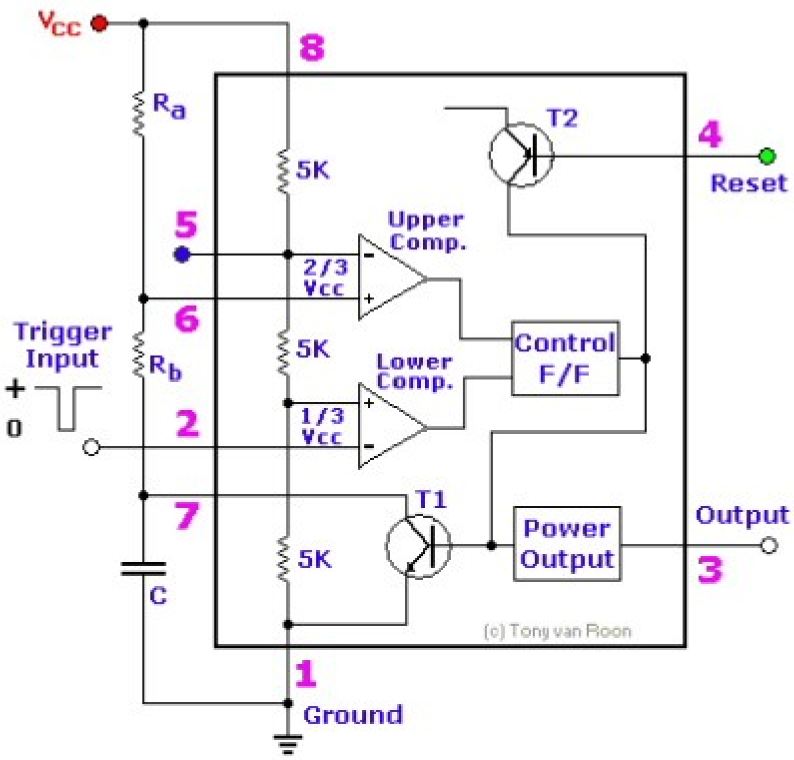
It has highly current output. It can source or sink 200mA. It is compatible with both TTL and CMOS logic circuits.

FUNCTIONAL BLOCK DIAGRAM OF 555 TIMER:

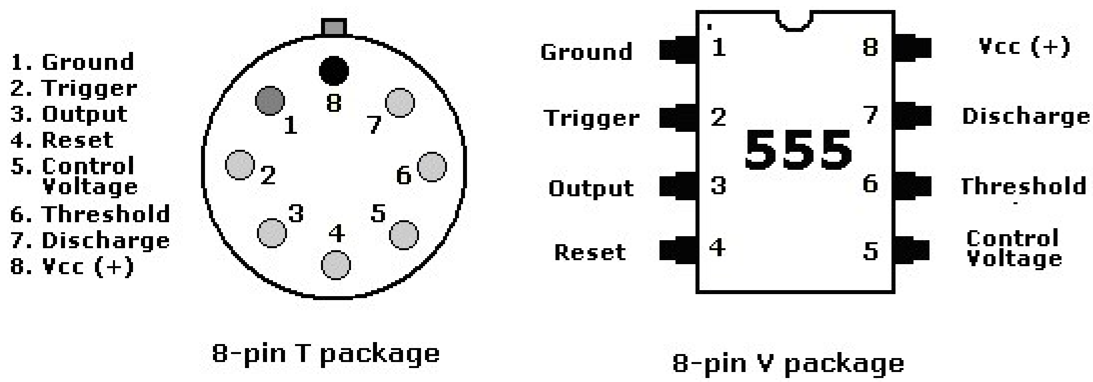
The block diagram of 555 timers is shown in figure5.7 it consists of two comparators resistive divider network flip-flop and a discharge transistor. The upper comparator has a threshold input and a control input. The control voltage is 2\3 VCC. When ever the threshold voltage exceeds the control the high output from the comparator will set the flip-flop. The collector of the discharge transistor is goes to pin number 7. When this pin is connected to an external timing capacitor. High Q output from the flip-flop will saturate the transistor and discharge the capacitor. When Q is low transistor opens and the capacitor will charge.

The complementary signal of the flip-flop is taken as output of the 555 (pin no 3). The reset pin prevents the flip-flop from working. Hence in most applications reset pin is connected to supply voltage. The lower comparator is connected trigger input and a fixed voltage 1\3 VCC. When the trigger voltage is slightly less than 1\3 VCC the comparator output goes high and reset the flip-flop. Pin no1 is known as ground the supply pin 8.

Block Diagram of 555 Timer :



PIN DIAGRAM OF 555 TIMER:



PIN DIAGRAM DESCRIPTION:

Ground (Pin 1):

- Not surprising this pin is connected directly to ground.

Trigger (Pin 2):

- This pin is the input to the lower comparator and is used to set the latch, which in turn causes the output to go high.

Output (Pin 3):

- Output high is about 1.7V less than supply. Output high is capable of I_{source} up to 200mA while output low is capable of I_{sink} up to 200mA.

Reset (Pin 4):

- This is used to reset the latch and return the output to a low state. The reset is an overriding function. When not used connect to V+.

Control (Pin 5):

- Allows access to the 2/3V+ voltage divider point when the 555 timer is used in voltage control mode. When not used connect to ground through a 0.01 uF capacitor.

Threshold (Pin 6):

- This is an input to the upper comparator. See data sheet for comprehensive explanation.

Discharge (Pin 7):

- This is the open collector to Q14 in figure 4 below. See data sheet for comprehensive explanation.

V+ (Pin 8):

This connects to VCC and the Philips data book states the ICM7555 CMOS version operates 3V - 16V DC while the NE555 version is 3V - 16V DC. Note comments about effective supply filtering and bypassing this pin below under "General considerations with using a 555 timer".

INFRARED RECEIVER :

This project makes use of an infrared sensor module, which consists of an Infrared emitting IR receiver TSOP 1356. The output of IR receiver is connected to pin 1 of the microcontroller 8952. This sensor is used near the gate. Whenever the train passes it sense the obstacle and a logic low appear at the microcontroller.

TSOP 13xx series are miniaturized receivers for infrared remote control systems. PIN diode and preamplifier are assembled on lead frame, the epoxy package is designed as IR filter. The demodulated output signal can directly be decoded by a microprocessor. TSOP 13xx is the standard IR remote control receiver series, supporting all major transmission codes.

- Pin 1 is grounded.
- A capacitor (C3) of 4.7 micro farads connected between pin 1 and pin 2.
- Pin 2 is connected to a supply of +5V through a resistor (R4) of 1k ohms.

The output of TSOP 1356 is active low. When there is a proper transmission and reception between the LED and IR receiver, the output of TSOP 1356 is logic high. The carrier frequency should be close to 56 kHz. Whenever there is no link between IR transmitter and receiver, the output pin 3 of TSOP 1356 will be logic low.

Many different receiver circuits exists on the market. The most important selection criteria are the modulation frequency used and the availability in you region.

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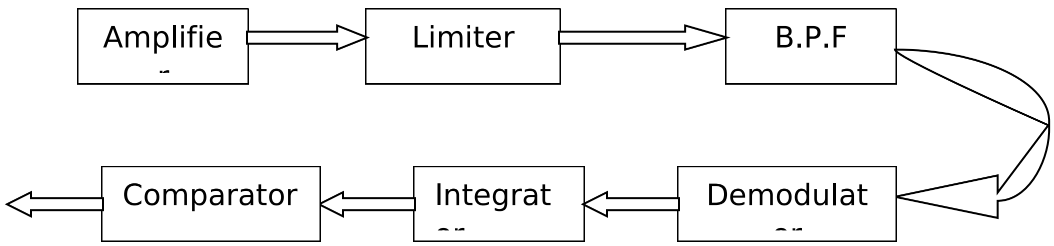

Block Diagram of an IR receiver

In the picture above you can see a typical block diagram of an IR receiver. The received IR signal is picked up by the IR detection diode on the left side of the diagram.

As you can see only the AC signal is sent to the Band Pass Filter. The B.P.F is tuned to the modulation of the handset unit. A common frequency ranges from 30 kHz to 60 kHz in consumer electronics. The next stages are a detector, integrator and comparator. The purpose of these three blokes is to detect the presence of the modulation frequency. If the modulation frequency is present, the output of the comparator will be pulled low.

All these blokes are integrated into a single electronic component. There are many different manufactures of these components on the market. And most devices are available in several versions each of which are tuned to a particular modulation frequency.

The amplifier is set to a very high gain. Therefore the system tends to start oscillating very easily. Placing a large capacitor of al least 22 microfarads close to the receiver's power connections is mandatory to decouple of 330 ohms in series with the power supply to further decouple the power supply from the rest of the circuit.

FEATURES:

- Phone detector and preamplifier in one package

- Internal filter for PCM frequency
- TTL and CMOS compatibility
- Output active is low
- High immunity against ambient light
- Continuous data transmission possible

MICROCONTROLLER (AT89S52)

This project employs the 8-bit microcontroller from ATMEL (AT89S52). The microcontroller in our security system is used for sending signals to the auto dialer and buzzer alarm. A number is already stored in the EEPROM of the microcontroller. When a logic low signal appears at the pin 1 of the microcontroller, the number stored in the memory is sent to the auto dialer.

Description of 8952 Microcontroller:

The AT89S52 provides the following standard features: 8Kbytes of Flash, 256 bytes of RAM, 32 I/O lines, three 16-bit timer/counters, six-vector two-level interrupt architecture, a full duplex serial port, on-chip oscillator, and clock circuitry. In addition, the AT89S52 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. By combining a versatile 8-bit CPU with Flash on a monolithic chip, the Atmel AT89S52 is a powerful microcomputer which provides a highly flexible and cost effective solution to many embedded control applications with MCS-51 Products.

Features of Microcontroller (8052):

- Compatible
- 8 Kbytes 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 vector two level Interrupt Sources
- Programmable Serial Channel
- Low Power Idle and Power Down Modes

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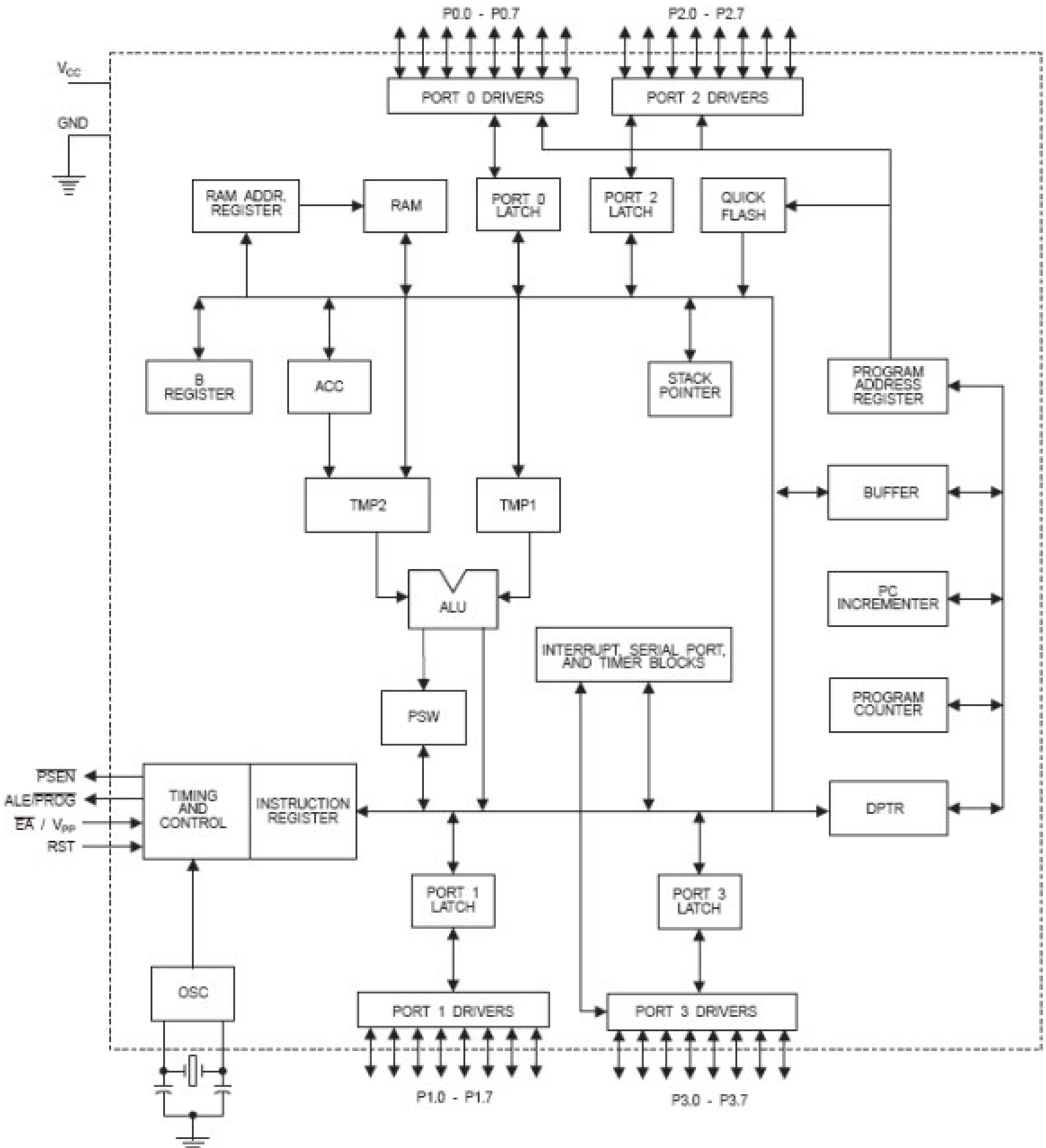
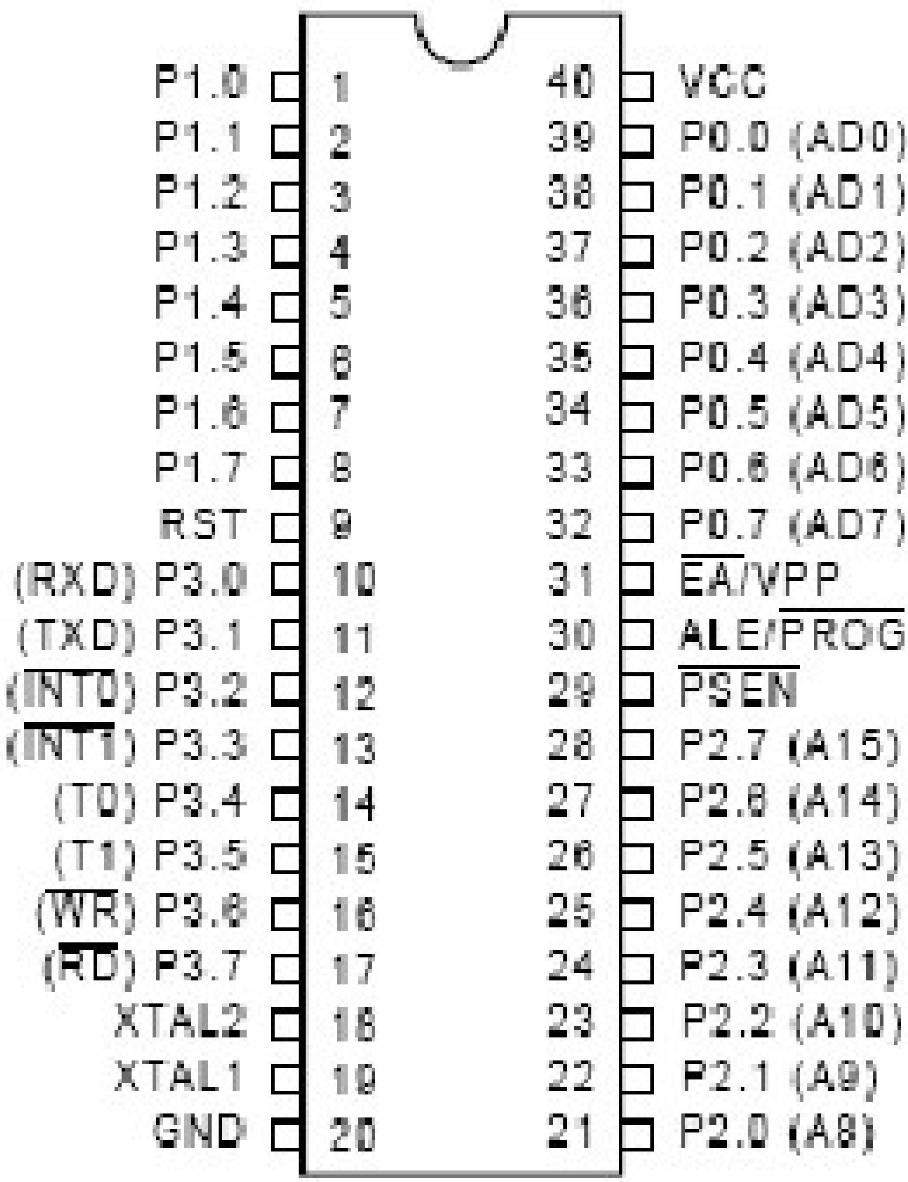
Block Diagram of Microcontroller:



Pin Diagram of 8952:



Pin Description:

VCC:

Pin 40 provides Supply voltage to the chip. The voltage source is +5v

GND:

Pin 20 is the grounded

Port 0:

Port 0 is an 8-bit open drain bidirectional I/O port from pin 32 to 39. 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 may 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 bidirectional I/O port with internal pull-ups from pin 1 to 8. 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 program verification.

Port 2:

Port 2 is an 8-bit bidirectional I/O port with internal pull-ups from pin 21 to 28. 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 use 16-bit addresses (MOVX @ DPTR). In this application it uses strong internal pull-ups when emitting 1s. During accesses to external data memory 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 bidirectional I/O port with internal pull-ups from pin 10 to 17. 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 of the AT89C51 as listed below:

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)

Special Features of 89S52:

- Port 3 also receives some control signals for Flash programming and programming verification.

RST:

Pin 9 is the Reset input. It is active high. Upon applying a high pulse to this pin, the microcontroller will reset and terminate all activities. A high on this pin for two machine cycles while the oscillator is running resets the device.

ALE/PROG:

Address Latch is an output pin and is active high. Address Latch Enable 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 also receives the 12-volt programming enable voltage (VPP) during Flash programming, for parts that require 12-volt VPP.

XTAL1:

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

XTAL2:

- Output from the inverting oscillator amplifier.

Timer 0 and 1:

- Timer 0 and Timer 1 in the AT89C52 operate the same way as Timer 0 and Timer 1 in the AT89S52.

Timer 2:

Timer 2 is a 16-bit Timer/Counter that can operate as either a timer or an event counter. The type of operation is selected by bit C/T2 in the SFR T2CON. Timer 2 has three operating modes: capture, auto-reload (up or down counting), and baud rate generator. The modes are selected by bits in T2CON, as shown in Table 5.2. Timer 2 consists of two 8-bit registers, TH2 and TL2. In the Timer function, the TL2 register is incremented every machine cycle. Since a machine cycle consists of 12 oscillator periods, the count rate is 1/12 of the oscillator frequency.

Timer 2 Operating Modes:

In the Counter function, the register is incremented in response to a 1-to-0 transition at its corresponding external input pin, T2. In this function, the external input is sampled during S5P2 of every machine cycle. When the samples show a high in one cycle and a low in the next cycle, the count is incremented. The new count value appears in the register during S3P1 of the cycle following the one in which the transition was detected. Since two machine cycles (24 oscillator periods) are required to recognize a 1-to-0 transition, the maximum count rate is 1/24 of the oscillator frequency. To ensure that a given level is sampled at least once before it changes, the level should be held for at least one full machine cycle.

There are no restrictions on the duty cycle of external input signal, but it should for at least one full machine to ensure that a given level is sampled at least once before it changes

Interrupts:

The AT89S52 has a total of six interrupt vectors: two external interrupts (INT0 and INT1), three timer interrupts (Timers 0, 1, and 2), and the serial port interrupt.

BUZZER ALARM

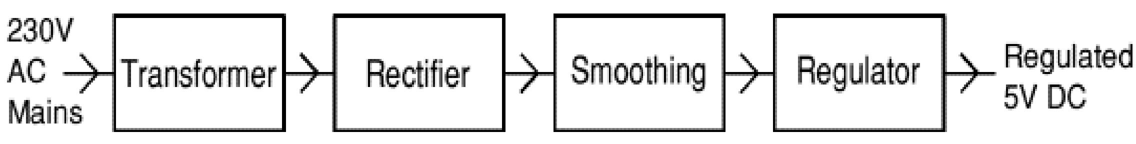
When the security system detects an intruder, the microcontroller activates the buzzer alarm and the telephone auto dialer. The buzzer alarm serves the following three functions:

- It alerts the occupants and neighbors that someone has broken into the building.
- It drives the intruder away.
- It signals to the police which house has been broken into.

POWER SUPPLY

Supply of 230V, 50Hz ac signal from main supply board is given to a step down transformer. The transformer is selected such that its output ranges from 10V to 12V, which is supplied to the power supply block for making the output compatible with the TTL logic supply. This TTL logic supply acts as the power supply for the microcontroller, IR sensor, auto dialer, timer circuit and buzzer. Thus the main function of the power supply is to give the voltage supply required for the logic families, which is an output of +5V.

For example a 5V regulated supply can be shown as below

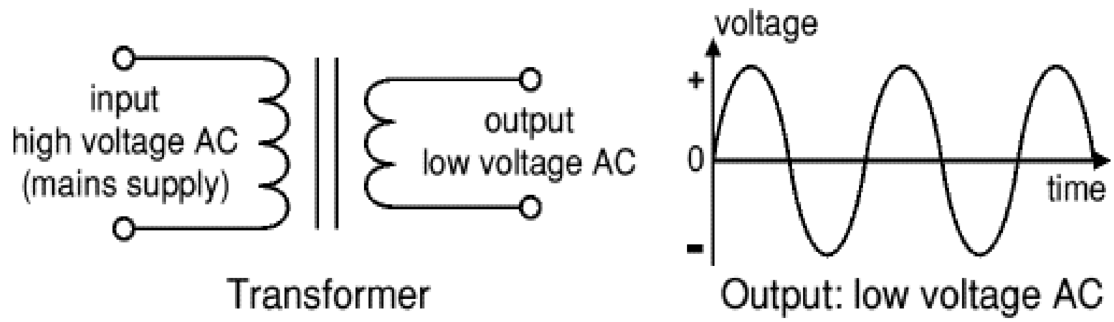


Block Diagram of a Regulated Power Supply System

Similarly, 12v regulated supply can also be produced by suitable selection of the individual elements. Each of the blocks is described in detail below and the power supplies made from these blocks are described below with a circuit diagram and a graph of their output:

TRANSFORMER:

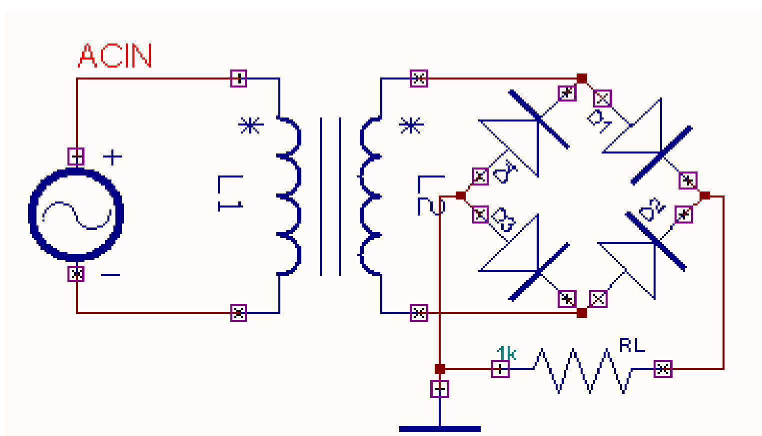
A transformer steps down high voltage AC mains to low voltage AC. Here we are using a center-tap transformer whose output will be sinusoidal with 12 volts peak to peak value.



The low voltage AC output is suitable for lamps, heaters and special AC motors. It is not suitable for electronic circuits unless they include a rectifier and a smoothing capacitor. The transformer output is given to the rectifier circuit.

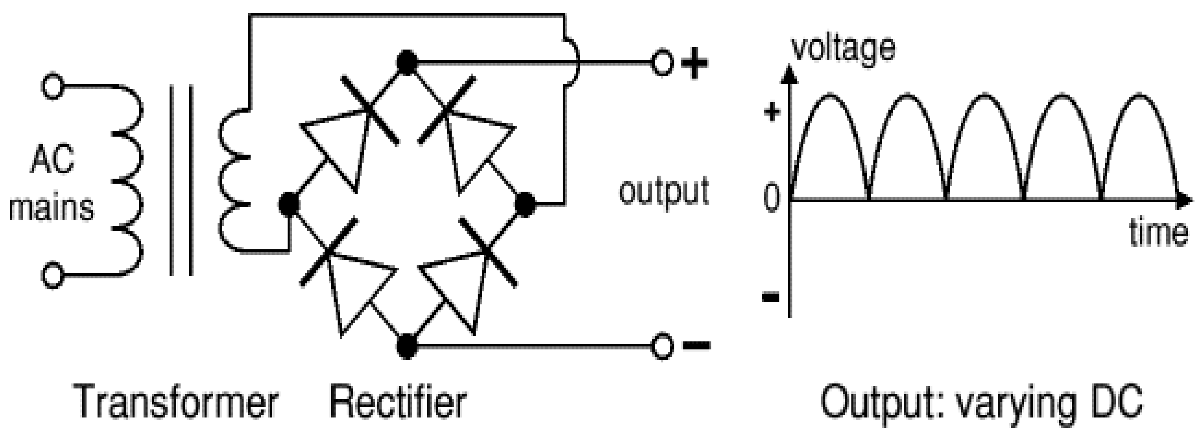
RECTIFIER:

A rectifier converts AC to DC, but the DC output is varying. There are several types of rectifiers; here we use a bridge rectifier.



The Bridge rectifier is a circuit, which converts an ac voltage to dc voltage using both half cycles of the input ac voltage. The Bridge rectifier circuit is shown in the figure. The circuit has four diodes connected to form a bridge. The ac input voltage is applied to the diagonally opposite ends of the bridge. The load resistance is connected between the other two ends of the bridge. For the positive half cycle of the input ac voltage, diodes D1 and D3 conduct, whereas diodes D2 and D4 remain in the OFF state. The conducting diodes will be in series with the load resistance R_L and hence the load current flows through R_L. For the negative half cycle of the input ac voltage, diodes D2 and D4 conduct whereas, D1 and D3 remain OFF. The conducting diodes D2 and D4 will be in series with the load resistance R_L and hence the current flows through R_L in the same direction as in the previous half cycle. Thus a bi-directional wave is converted into unidirectional.

The output waveform of the rectifier is shown as below:

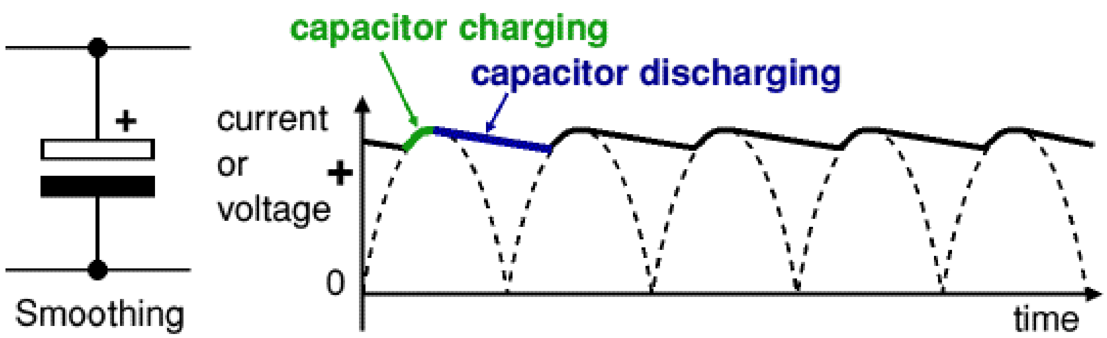


The varying DC output is suitable for lamps, heaters and standard motors. It is not suitable for electronic circuits unless they include a smoothing capacitor.

SMOOTHING:

The smoothing block smoothes the DC from varying greatly to a small ripple. The ripple voltage is defined as the deviation of the load voltage from its DC value. Smoothing is also named as filtering.

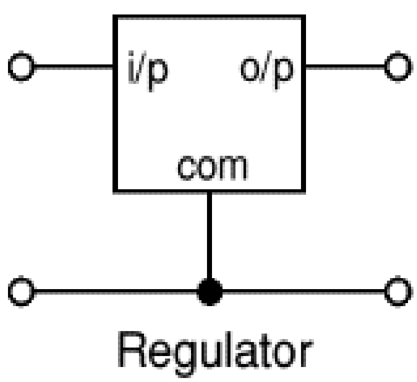
Filtering is frequently effected by shunting the load with a capacitor. The action of this system depends on the fact that the capacitor stores energy during the conduction period and delivers this energy to the loads during the no conducting period. In this way, the time during which the current passes through the load is prolongated, and the ripple is considerably decreased. The action of the capacitor is shown with the help of waveform. The waveform of the rectified output after smoothing is given below:



REGULATOR:

A regulator eliminates ripple by setting DC output to a fixed voltage

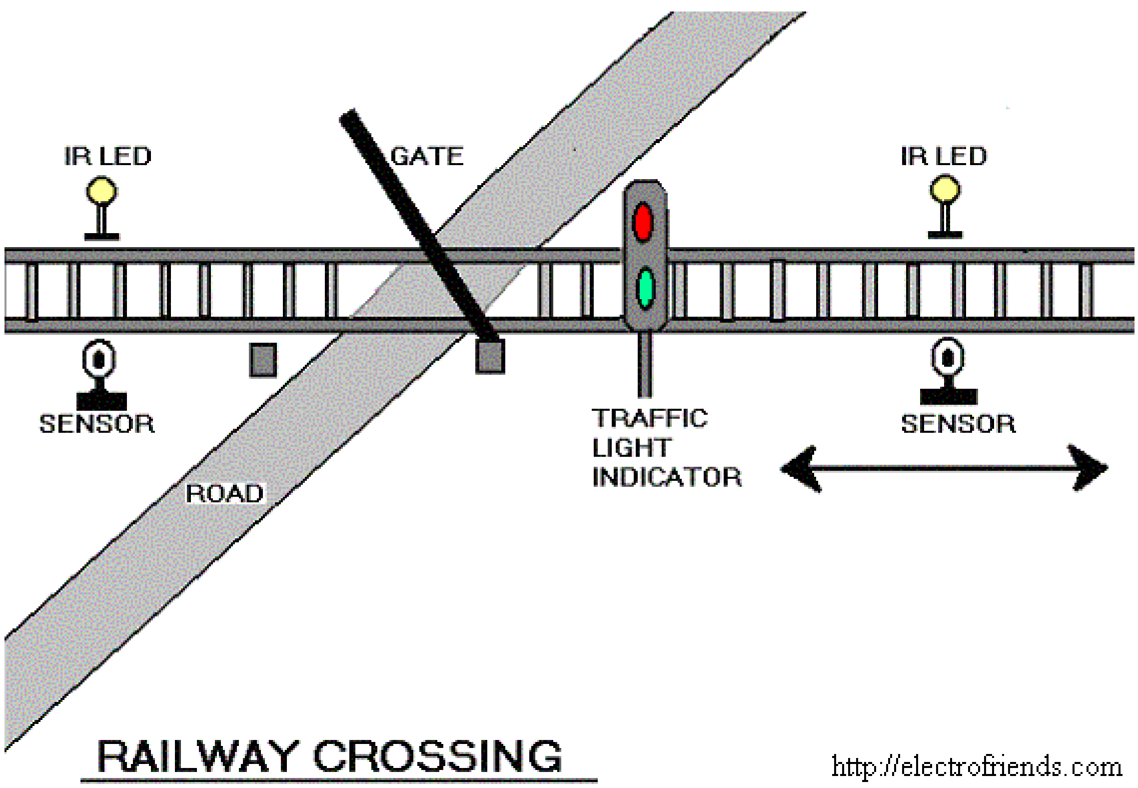
Voltage regulator ICs are available with fixed (typically 5, 12 and 15V)



BASIC IDEA

GATE CONTROL:

Railways being the cheapest mode of transportation are preferred over all the other means .When we go through the daily newspapers we come across many railway accidents occurring at unmanned railway crossings. This is mainly due to the carelessness in manual operations or lack of workers. We, in this project has come up with a solution for the same. Using simple electronic components we have tried to automate the control of railway gates. As a train approaches the railway crossing from either side, the sensors placed at a certain distance from the gate detects the approaching train and accordingly controls the operation of the gate. Also an indicator light has been provided to alert the motorists about the approaching train.



EMBEDDED SYSTEMS

DEFINITIONS :

Embedded system is a combination of hardware and software, it is also named as "Firm ware". An embedded system is a special purpose computer system, which is completely encapsulated by the device it controls. It is a computer-controlled system. An embedded system is a specialized system that is a part of a larger system or machine. As a part of a larger system it largely determines its functionality. Embedded systems are electronic devices that incorporate microprocessors with in their implementations. The main purpose of the microprocessors are simplify the system design and improve flexibility. In the embedded systems, the software is often stored in a read only memory (RAM) chip. Embedded systems provide several major functions including monitoring of the analog environment by reading data from sensors and controlling actuators.

The general purpose definition of embedded system is that they are devices used to control, monitor or assist the operation of equipment, machinery or plant. "Embedded" reflects the fact that they are an integral part of the system. All embedded systems are including computers or microcontrollers. Some of these computers are however very simple systems as compared with a personal computer. The very simple embedded systems are capable of performing only a simple function or set of function to meet a single predetermine purpose. In more complex systems an application program that enables the embedded system to the used for a particular purpose in a specific application determines the functioning of the embedded system the ability to have a program means that the same embedded system can be used for variety of different purpose. Controller input comes from a detector or sensor and its output goes to a switch oractivator which (for example) may start or stop the operation of a machine.

EXAMPLES OF EMBEDDED SYSTEMS:

Embedded systems are found in wide range of application areas. Originally they were used only for expensive industrial control applications, but as technology brought down the cost of dedicated processors, they began to appear in moderately expensive applications such as automobiles, communication and office equipments and television Today's embedded systems are so inexpensive that they are used in almost every electronic product in our life. Embedded systems are often designed for mass production.

Some examples of embedded systems:

- Automatic Teller Machines
- Cellular telephone and telephone switches
- Computer network equipment
- Computer printers
- Disk drives
- Engine controllers and antilock break controllers for automobiles
- Home automation products
- Handheld calculators
- Household appliances
- Medical equipment
- Measurement equipment
- Multifunction wrist watches
- Multifunction printers

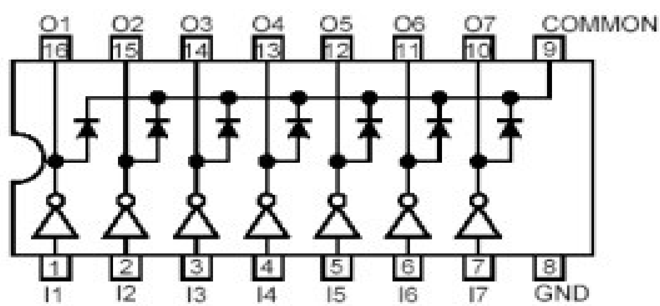
ULN 2003

ULN STEPPER MOTOR DRIVER:

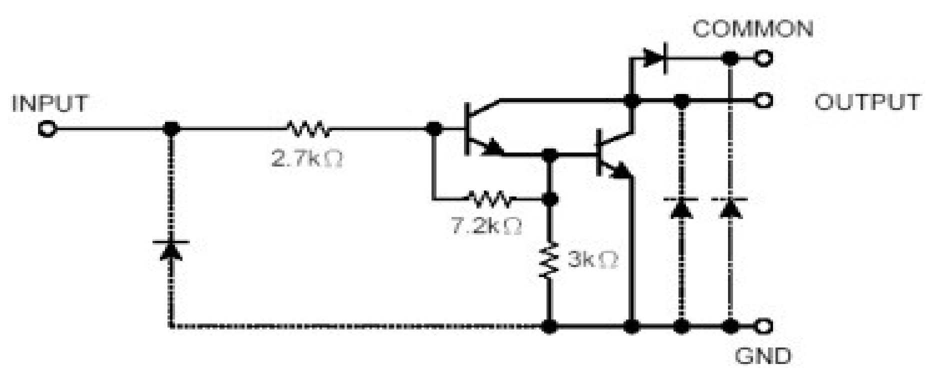
ULN is mainly suited for interfacing between low-level circuits and multiple peripheral power loads,. The series ULN20XX high voltage, high current darlington arrays feature continuous load current ratings. The driving circuitry in- turn decodes the coding and conveys the necessary data to the stepper motor, this module aids in the movement of the arm through steppers.

ULN2003 *LINEAR INTEGRATED CIRCUIT*

- **PIN CONNECTION**



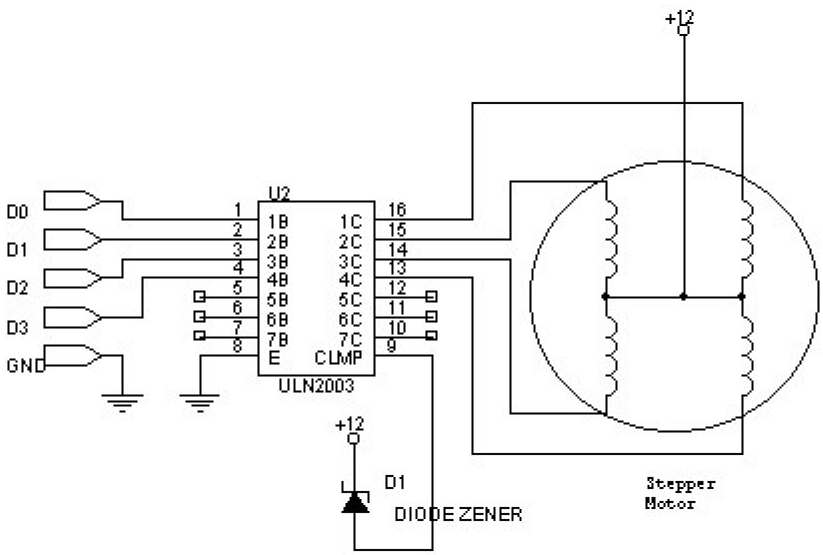
- **BLOCK DIAGRAM**



Note: The input and output parasitic diodes cannot be used as clamp diodes.

The driver makes use of the ULN2003 driver IC, which contains an array of 7 power Darlington arrays, each capable of driving 500mA of current. At an approximate duty cycle, depending on ambient temperature and number of drivers turned on, simultaneously typical power loads totaling over 230w can be controlled.

The device has base resistors, allowing direct connection to any common logic family. All the emitters are tied together and brought out to a separate terminal. Output protection diodes are included; hence the device can drive inductive loads with minimum extra components. Typical loads include relays, solenoids, stepper motors, magnetic print hammers, multiplexed LED, incandescent displays and heaters.



Driving a Stepper Motor using uln2003:

Note that the first pin (identified in the procedure shown above) is connected to D0 of the parallel port (through the ULN2003, of course). Each successive pin of the stepper motor is connected to successive data lines on the parallel port. If this order is not correct, the motor will not rotate, but will wiggle around from side to side. The clamp circuit shown does not connect the clamp directly to the supply voltage. Instead, it uses a zener diode. This ensures that the decaying current in the coils are not abruptly cut off, which produces a lot of heat.

It is simple, it involves setting the bits on the port on and off in a specific sequence. The step sequence is given below for full step and half steps. At any time only one pin is active in the full step.

Full Step

Step No.	D0	D1	D2	D3
1	1	0	0	0
2	0	1	0	0
3	0	0	1	0
4	0	0	0	1

Half Step

Step No.	D0	D1	D2	D3
1	1	0	0	0
2	1	1	0	0
3	0	1	0	0
4	0	1	1	0
5	0	0	1	0
6	0	0	1	1
7	0	0	0	1
8	1	0	0	1

The difference between half step and full step is that for the same step rate, half-step gives you half the speed, twice the resolution, and roughly twice the power consumption. It also gives you twice the torque. To reverse the direction of the motor, send the sequence in reverse order.

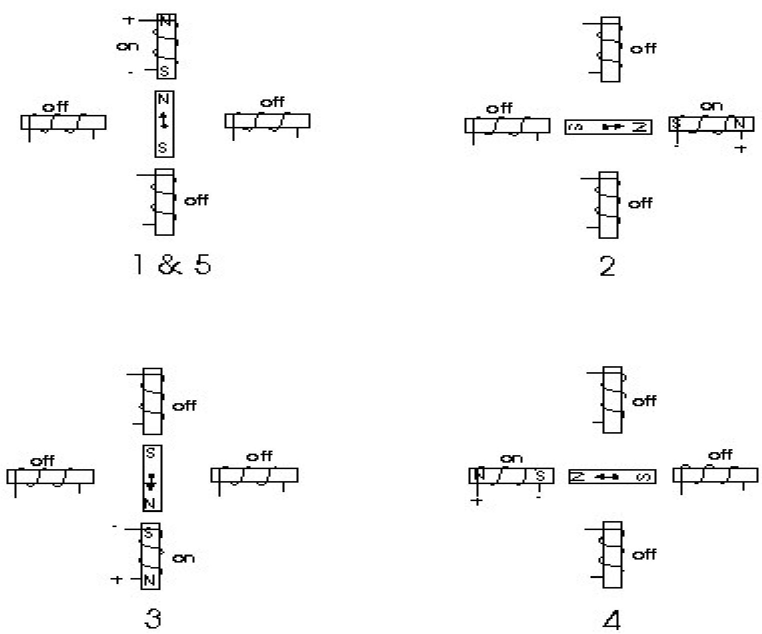
The main features of ULN2003 are as follows:

- Seven darlington per package
- Output current 500ma per driver (600ma peak)
- Output voltage 50v
- Integrated suppression diodes for inductive loads
- Outputs can be paralleled for high current TTL/CMOS/DTL compatible inputs
- Inputs pinned opposite outputs to simplify layout.
- Transient protected outputs

Stepper motor

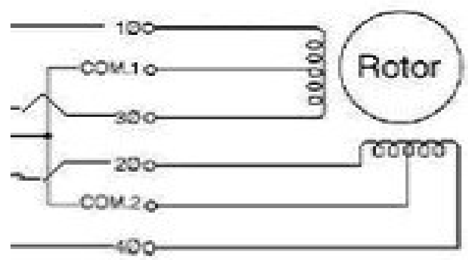
A stepper motor is an electromechanical device which converts electrical pulses into discrete mechanical movements. The stepper motor is used for position control in applications like disk drives and robotics.

The name stepper is used because this motor rotates through a fixed angular step in response to each input current pulse received by its controller. In recent years, there has been wide-spread demand of stepping motors because of the explosive growth of computer industry. Their popularity is due to the effect that they can be controlled directly by computers, microprocessors and programmable controllers. Stepper motors are ideally suited for situations where precise position and precise speed control are required without the use of closed-loop feedback. When a definite number of pulses are supplied, the shaft turns through a definite known angle. This fact makes the emptor well suited for open-loop position control because no feedback need be taken from the output shaft.



Every stepper motor has a permanent magnet rotor also known as shaft surrounded by a stator poles. The most common stepper motor s have four stator windings that are paired with a center-tapped. This type of stepper motor is commonly referred to as a four-phase stepper motor.

The center tap allows a change of current direction in each of two coils when a winding is grounded, there by resulting in a polarity change of the stator.



The shaft or spindle of a stepper motor rotates in discrete step increments when electrical command pulses are applied to it in the proper sequence. The direction of the rotation is determined by the stator poles. the stator poles are determined by the current sent through the wire coils. As the polarity of the current is changed, the polarity is also changed causing the reverse motion of the motor The sequence of the applied pulses is directly related to the direction of motor shafts rotation.. The speed of the motor shafts rotation is directly related to the frequency of the input pulses and the length of rotation is directly related to the number of input pulses applied. While a conventional motor shaft moves freely, stepper motor shaft moves ina fixed repeatable increment which allows one to move it to a precise position. This repeatable fixed movement is possible as a result of basic magnetic theory where poles of he same polarity repel and opposite poles attract.

The stepper motor converts digital signals into fixed mechanical increment of motion. It thereby provides a natural interface with the digital computer. It is a synchronous motor such that the rotor rotates a specific incremental number of degrees for each pulse input given to the motor system. These motors can provide accurate positioning without the need of position feedback sensors when compared to other motors. The position is known simply by keeping track of the input step pulses. Usually, position information can be obtained simply by keeping count of the pulses sent to the motor thereby eliminating the need of expensive position sensors and feedback control

Stepper motors are rated by the torque they produce, step angle, steps per second and the number of teeth on rotor. The minimum degree of rotation with which the stepper motor turns for a single pulse if supply to one wire or a pair is called **step angle**. The minimum step angle is always a function of the number of teeth on rotor .i.e., the smaller the step angle the more teeth the rotor possess.

Steps per complete revolution= Number of phases (coils) x Number of teeth on rotor

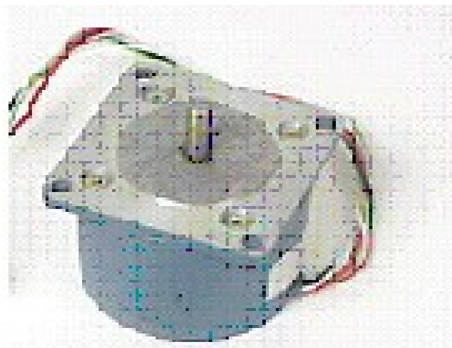
Smaller the step angle, greater the number of steps per revolution and higher the resolution or the accuracy of positioning obtained. The step angles can be as small as 0.72˚ or as large as 90˚.

The motor speed is measured in steps per second.

Steps per second = (Revolution per minute x steps per Revolution)/ 60

Stepping motors has the extraordinary ability to operate at very high speeds (upto 20,000 steps per second) and yet to remain fully in synchronism with the command pulses, when the pulse rate is high, the shaft rotation seems continuous. If the stepping rate is increased too quickly, the motor loses synchronism and stops. Stepper motors are designed to operate for long periods with the rotor held in a fixed position and with rated current flowing in the stator windings whereas for most of the other motors, this results in collapse of back emf and a very high current which can lead to a quick burn out.

A stepper motor is a special kind of motor that moves in individual steps which are usually .9 degrees each. Each step is controlled by energizing coils inside the motor causing the shaft to move to the next position. Turning these coils on and off in sequence will cause the motor to rotate forward or reverse. The time delay between each step determines the motor's speed. Steppers can be **moved to any desired position reliably** by sending them the proper number of step pulses.



A stepper motor's shaft has permanent magnets attached to it. Around the body of the motor is a series of coils that create a magnetic field that interacts with the permanent magnets. When these coils are turned on and off the magnetic field cause the rotor to move. As the coils are turned on and off in sequence the motor will rotate forward or reverse.

BACK EMF:

A motor is a machine which converts electric energy into mechanical energy. Its action is based on the principle that when a current carrying conductor is placed in a magnetic field, it experiences a mechanical force whose direction is given by Fleming's left hand rule.

- The left hand is held with the thumb, index finger and middle finger mutually at right angles.
- The **F**irst finger represents the direction of the magnetic **F**ield.
- The Se**c**ond finger represents the direction of the **C**urrent (in the classical direction, from positive to negative).
- The Thumb represents the direction of the Thrust or resultant Motion.

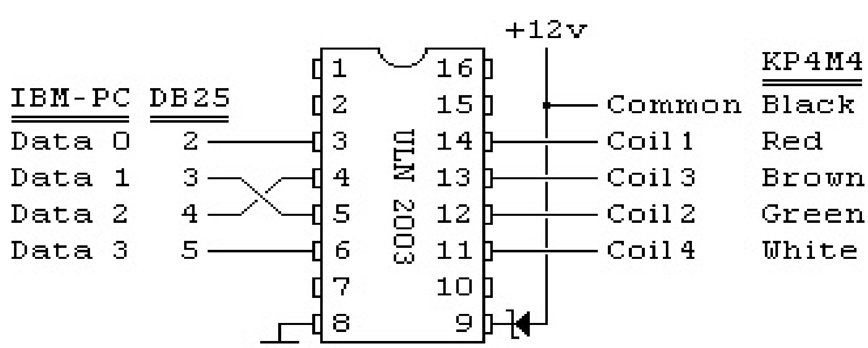
Energy conversion is not possible unless there is some opposition whose overcoming provides the necessary means for such conversion. In case of generator it was the magnetic drag which provided the necessary opposition. The equivalent in the case of a motor is called as the back emf.

As soon as the armature or the rotor starts rotating, dynamically (or emotionally) induced emf is produced in the armature conductors. The direction of this induced emf as found by the Fleming's right hand rule, is in direct opposition to the applied voltage. That is why this is known as BACK EMF or counter emf. The electrical work done in overcoming this opposition is converted into mechanical energy developed in the armature. Therefore, it is obvious that but for the production of this opposing emf energy could not have been possible.

When the armature rotates the conductors also rotate and hence cut the flux. In accordance with the laws of electromagnetic induction, emf is induced in them whose direction, is in opposition to the applied voltage. This induced emf is called back emf. Obviously supply voltage has to drive armature current against the opposition of back emf.

These motors also suffer from EMF, which means that once the coil is turned off it starts to generate current because the motor is still rotating. There needs to be an explicit way to handle this extra current in a circuit otherwise it can cause damage and affect performance of the motor.

The ULN2003 / MC1413 is a 7-bit 50V 500mA TTL-input NPN Darlington driver. This is more than adequate to control a four phase unipolar stepper motor such as the KP4M4-001.



`It is recommended to connect a 12v zener diode between the power supply and V_{DD} (Pin 9) on the chip, to absorb reverse (or "back") EMF from the magnetic field collapsing when motor coils are switched off. (See Douglas W. Jones' rather more sophisticated example) .

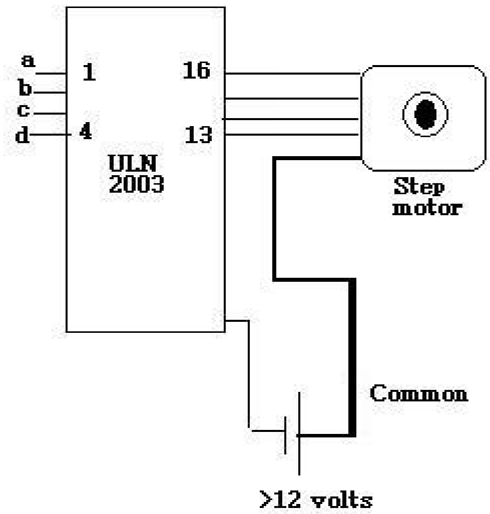
Driving a stepper motor:

The four leads of the stator winding are controlled by the four bits of the 8051 port (p1.0-p1.3). However, since the 8051 lacks sufficient current to drive the stepper motor windings, we must use a driver such as uln2003a to energize the stator. Instead of the uln2003a, we could have used transistors as drivers.

However, notice that if transistors are used as drivers, we must also use diodes to take care of inductive current generated when the coil is turned off. One reason that the uln2003a is preferable to the use of transistors as drivers is that the uln2003 has as internal diode to take care of back emf.

Most stepper motor circuits that are available online have a bunch of transistors, Sometimes power transistors too quite a complicated circuit that drives you away far form using it. Well i felt for most robotic use the stepper motor can be driven by a simple ULN2003 IC that costs just 12 bucks in my backyard.

While controlling the stepper motor with a embedded or distributed micromole for a specific application, the controlling signals from the controller to the stepper motor must be boosted up using a driven circuitry in order to have the compatibility between them. In the following figure, we show that the stepper motor is driven with ULN 2003 driven circuitry.



Identify the wire : Common and windings

- The following steps show the 8051 connection to the stepper motor
- Use an ohmmeter to measure the resistance of the leads. This should identify which COM leads are connected to which winding leads.
- The common wire(s) are connected to positive side of the motor's power supply.

To distinguish common wire from a coil-end wire is by measuring the resistance. Resistance between common wire and coil-end wire is always half of what it is between coil-end and coil-end wires. Just take your millimeter and check the resistance between the wires. one wire is a common and it must bear a resistance of 75 ohms with all the other wires then that is the common wire. This is due to the fact that there is actually twice the length of coil between the ends and only half from center (common wire) to the end.

A pulse is an electrical signal that repeats ON and OFF voltages as shown in the

- Illustration below. Each cycle of ON and OFF (1 cycle) is called a "pulse."
- Normally, 5 volts is used. ON is high and OFF is low.

Working principle of Stepper motor:

To make a stepper motor rotate, you must constantly turn on and off the coils. If you simply energize one coil the motor will just jump to that position and stay there resisting change. This energized coil pulls full current even though the motor is not turning. The stepper motor will generate a lot of heat at standstill. The ability to stay put at one position rigidly is often an advantage of stepper motors. The torque at standstill is called the holding torque.

Because steppers can be controlled by turning coils on and off, they are easy to control using digital circuitry and microcontroller chips. The controller simply energizes the coils in a certain pattern and the motor will move accordingly. At any given time the computer will know the position of the motor since the number of steps given can be tracked. This is true only if some outside force of greater strength than the motor has not interfered with the motion.

When a phase winding of a stepper motor is energized with current, a magnetic flux is developed in the saturate direction of this flux is determined by the "right hand rule" which states:" if the coil is grasped in the right hand with fingers pointing in the direction of the recurrent in the winding (the thumb is extended at right angle to the fingers), then the thumb will point in the direction of the magnetic field."

The number of times the stepper motor turns on and off depends on the number of teeth present on the rotor and this is shown with an example in which four-step sequence is considered. Four-step sequence means, after completing every four steps, the rotor moves only one tooth pitch. In this example, the rotor has only 25 teeth and so it makes 100 steps for one complete rotation.

Ilustrates one complete rotation of a stepper motor. At position 1, we can see that the rotor is beginning at the upper electromagnet, which is currently active (has voltage applied to it). To move the rotor clockwise (CW), the upper electromagnet is deactivated and the right electromagnet is activated, causing the rotor to move 90 degrees CW, aligning itself with the active magnet. This process is repeated in the same manner at the south and west electromagnets until we once again reach the starting position.

You may double the resolution of some motors by a process known as "**half-stepping**". Instead of switching the next electromagnet in the rotation on one at a time, with half stepping you turn on both electromagnets, causing an equal attraction between, thereby doubling the resolution.

There are basically two types of stepper motors depending on the arrangements of the electromagnetic coils. They are unipolar and bipolar

Unipolar:

In a unipolar stepper motor, there are four separate electromagnets. To turn the motor, first coil "1" is given current, then it's turned off and coil 2 is given current, then coil 3, then 4, and then 1 again in a repeating pattern. Current is only sent through the coils in one direction; thus the name unipolar.

A unipolar stepper motor will have 5 (or 6) wires coming out of it. Four of those wires are each connected to one end of one coil. The extra wire (or 2) is called "common" and is connected to the other ends of all four coils. To operate the motor, the "common" wire is connected to the supply voltage, and the other four wires are connected to ground through transistors, so the transistors control whether current flows or not. A microcontroller or stepper motor controller is used to activate the transistors in the right order. These are the cheapest way to get precise angular movements.

Bipolar motor:

In a bipolar motor, there are only two coils, and current must be sent through a coil first in one direction and then in the other direction; thus the name bipolar. Bipolar motors need more than 4 transistors to operate them, but they are also more powerful than a unipolar motor of the same weight. To be able to send current in both directions, engineers can use an H-bridge to control each coil or a step motor driver chip. This type of motor is not regularly used for robotics.

Bipolar controllers can switch between supply voltage, ground, and unconnected. Unipolar controllers can only connect or disconnect a cable, because the voltage is already hard wired. Unipolar controllers need center-tapped windings.

It is possible to drive unipolar stepper motors with bipolar drivers. The idea is to connect the output pins of the driver to 4 transistors. The transistor must be grounded at the emitter and the driver pin must be connected to the base. Collector is connected to the coil wire of the motor.

Stepper motor advantages and disadvantages:

Advantages:

- The rotation angle of the motor is proportional to the input pulse.
- the motor has full torque at standstill(if the windings are energized)
- Precise positioning and repeatability of movement since good stepper motors have an accuracy of 3-5% of a step and this error is non cumulative from one step to the next.
- Excellent response to starting/stopping/reversing.
- Very reliable since they are no contact brushes in the motor. Therefore the life of the motor is simply dependent on the life of the bearing.
- The mottos response to the digital input pulses provides open-loop control, making the motor simpler and less costly to control.
- it is possible to achieve very slow speed synchronous rotation with a load that is directly coupled to the shaft .
- a wide range of rotational speeds can be realized as the speed is proportional to the frequency of the input pulses.

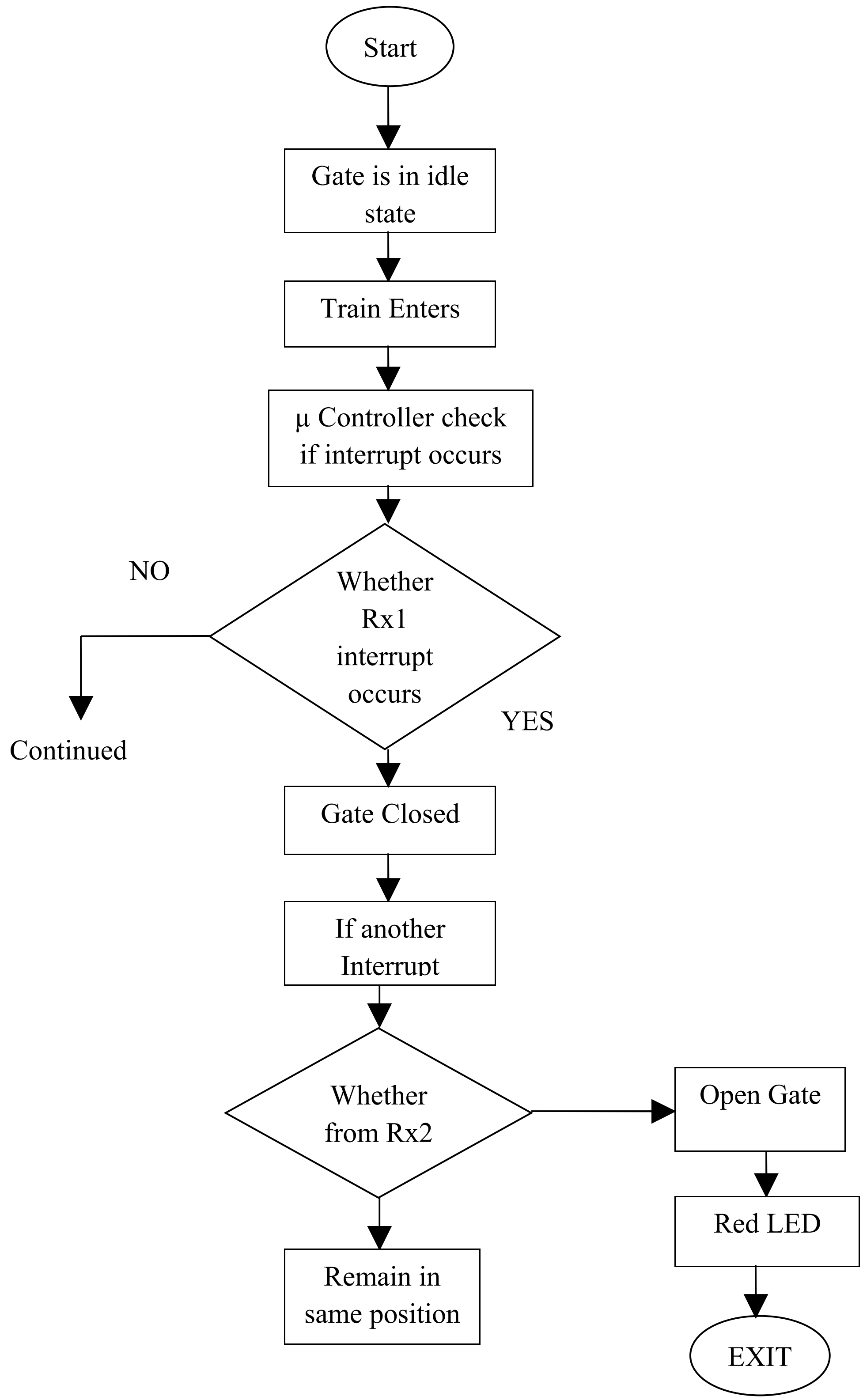
Disadvantages:

- Resonances can occur if not properly controlled
- Not easy to operate at extremely high speeds.
- This motor can also be heated at standing because of the torque required to hold it in position.

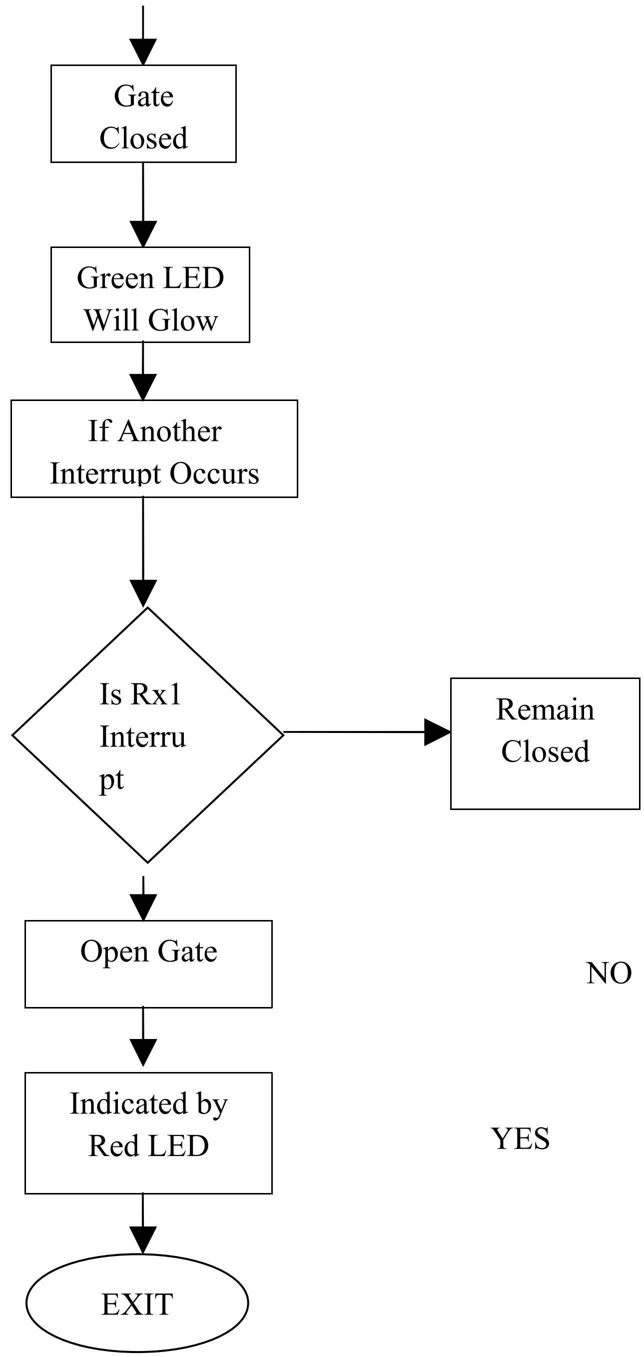
When to use stepper motors:

Computer-controlled stepper motors are one of the most versatile forms of positioning systems, particularly when digitally controlled as part of a servo system. Stepper motors can be used to advantage where you need to control rotation angle, position and synchronism. Stepper motors are used in floppy disk drives, flatbed scanners, and typewriters, printers-y plotters, milling machines, valve actuators, medical equipment, fax machines, automotives and many more devices.

Flow Chart :



Start
Gate is in idle state
Train Enters
µ Controller check if interrupt occurs
NO
Whether Rx1 interrupt occurs
YES
Continued
Gate Closed
If another Interrupt
Whether from Rx2
Open Gate
Red LED
Remain in same position
EXIT


Gate Closed
Green LED Will Glow
If Another Interrupt Occurs
Is Rx1 Interrupt
Remain Closed
NO
YES
Open Gate
Indicated by Red LED
EXIT

SOURCECODE:

```
#include<reg51.h>

sbit close=P1^1;

sbit open=P1^7;

sbit buzzer=P0^7;

sbit red=P0^2;

sbit green=P0^0;

unsigned char flag=0;

delay(unsigned int);

open gate();

closegate();

main()

{

P2=0x00;

buzzer=1;

red=1;
```

```
green=1;

open=close=1;

//delay(200)//

while(1)

{

P0x00;

buzzer=1;

open=close=1;

red=green=1;

while (open==0||close==0)

{

if(open==0)                    //7th pin//

{

green=1;

red=0;

buzzer = 0;     //flag1=1//

opengate();

buzzer=1;

while(close=1);                    //3rd pin//
```

```
green=0;

red=1;

buzzer=0;

close gate();

//flag1=0/

buzzer=1;

flag=1;

}

 if (close==0)              //3rd pin//

{

green=0;

red=1;

buzzer=0;

opengate ();

//flag1=0//

buzzer=1;

delay (75);

while (open==1);

green=1;
```

```
red=0;
buzzer=0;
//flag1=1//
closegate();
buzzer=1;
flag=1;
}
if(open==1)&&(close==1))
break;
}
}
}
opengate()
{
int m;
fo(m=0;m<8;m++)
{
p2=0x11;
delay(75);
```

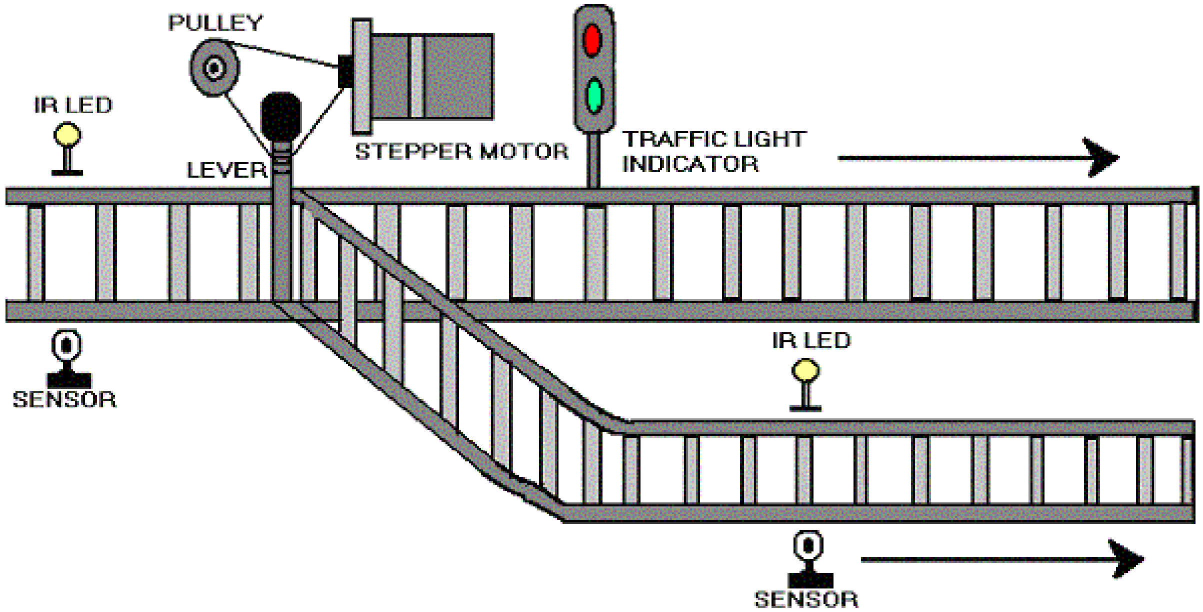
```
p2=0x22;
delay(75);
p2=0x44;
delay(75);
 p2=0x88;
 delay(75);
}
}
closegate()
{
int i;
for(i=0;i<5;i++)
{
 p2=0x88;
delay(75);
p2=0x44;
delay(75);
p2=0x22;
delay(75);
```

```
 p2=0x11;
 delay(75);
}
}
delay(unsigned int time)
{
unsigned char i,j;
for(i=0;i<time;i++)
for(j=0;j<150;j++)
}
```

APPLICATION

TRACK SWITCHING:

Using the same principle as that for gate control, we have developed a concept of automatic track switching. Considering a situation wherein an express train and a local train are travelling in opposite direction on the same track, the express train is allowed to travel on the same track and the local train has to switch on to the other track, indicator lights have been provided to avoid collision. Here the operation is performed using a stepper motor. In practical purpose this can be achieved using electromagnets.



TRACK SWITCHING http://electrofriends.com

CONCLUSION

The project work" Automatic Railway Gate Control", Now a days so many accidents are happen at railway gate because of manual control. To avoid this severe accidents we have to change manual work to this latest technology (Automatic Railway Gate Control), we can avoid maximum number of accidents.

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