

A PROJECT REPORT
ON

**TOLL TAX SYSTEM
USING
MICROCONTROLLER**

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Introduction

MICRO CONTROLLER BASED TOLL TAX SYSTEM

INTRODUCTION:

This project involves Toll Tax System using infrared technology. The term “infrared” refers to a broad range of frequency beginning at top end of those frequencies used for communication and extending up to the low frequency (red) end of the visible spectrum. That means infrared light has a range of wavelength, just like visible light has wavelength that range from red light to violet. “Near infrared” light is closest in wavelength to visible light and “Far infrared” is closer to the microwave region of the electromagnetic spectrum.

Since heat is a form of Infrared light, far infrared detector are sensitive to environmental changes-such as a person moving in the field of view.

In this we are using infrared for sensing the vehicle and there is FND displaying the amount to be paid off.

Platform used

Hardware requirements:

1) Microcontroller AT89C51/89s52

2) LM7805 Regulator

3) Power Supply

4) Function Numeric Display

5) Resistors

6) Capacitors

7) Transistors

8) LEDs

9) Connectors

10) IR Transmitter

11) IR Receiver

12) Pressure Switch

Software requirements:

1) Assembler of ATMEL microcontroller series

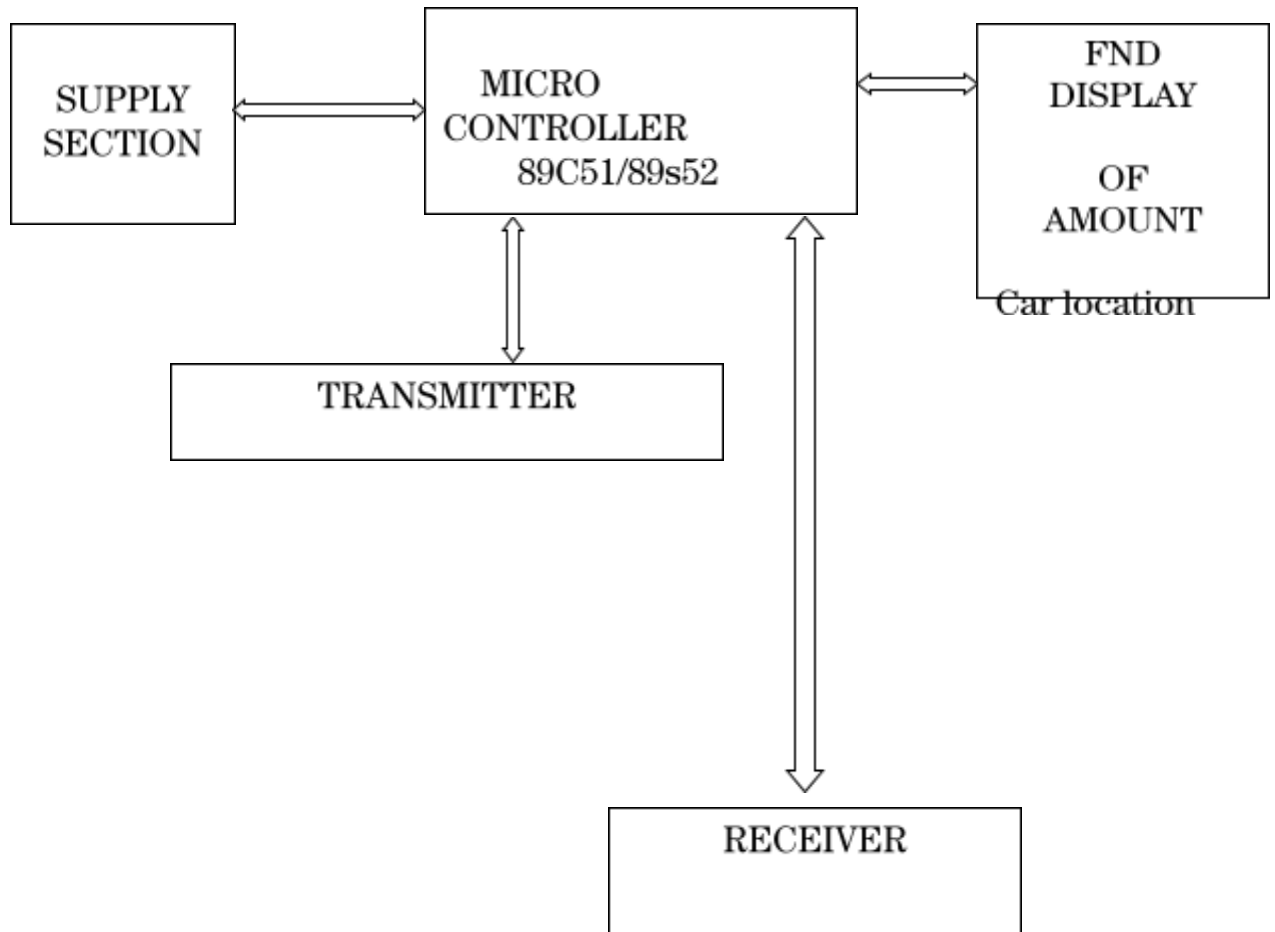
2) PADS for PCB designing

***AIM OF THE
PROJECT***

The aim of this project is to design a high tech toll tax system using microcontroller so that the vehicles need not to stand in a queue for a long time to pay the toll tax . Now by using a microcontroller tax paying become very simple ,There is a alarm which blow as soon as it detect a vehicle ,a vehicle can be sensed through an IR sensor ,and the amount to be paid off is also display ,when driver paid off the tax it allow to move further .This system takes very small time, thus prevent the jam to occur .

Block diagram

BLOCK DIAGRAM OF TOLL TAX SYSTEM



WORKING OF THE PROJECT

This system is based on transmission and reception of IR. IR sensors are sensitive to car moving in the field of view. For car parking a region IR is send in that region from one end and it is received on the other end. When a car enters in that region it cut the infrared, so at that moment receiver doesn't detect any signal and absence of IR is sensed by receiver which in turn generate a low pulse on the microcontroller pin ,then microcontroller read the pin and run according to software loaded in it and blow an alarm. The transmitter and receiver are connected to the main device. The main device has power supply, micro controller and a FND connected to it.

CIRCUIT DIAGRAM

Component list

Item	Quantity	Reference	Part
1	1	BZ1	BUZZER
2	2	C1,C4	C CER 104PF
3	2	C2,C3	C CER 39PF
4	1	C5	C EL13 1000M/35V
5	4	C6,C7,C8,C9	C EL5 10M/63V
6	4	D1,D2,D3,D4	1N4007
7	1	D5	LED
8	1	F1	4FND
9	1	J1	RLMT 04 (M)
10	4	J2,J3,J4,J5	RLMT 03 (M)
11	6	Q1,Q2,Q3,Q4,Q5,Q6	BC558
12	2	Q7,Q8	BC547
13	15	R1,R3,R4,R5,R6,R7,R8,R9, R10,R11,R12,R13,R14,R17, R19	R 470E
14	1	R2	R 220E
15	6	R15,R16,R22,R24,R25,R27	R 2K2
16	1	R18	R 1K
17	4	R20,R21,R23,R26	R 1K5
18	1	R28	R RSEL
19	1	U1	89C51
20	1	U2	LM7805H
21	1	Y1	XTAL 12MHz

CIRCUIT DESCRIPTION

POWER SUPPLY SECTION:

Consists of:

1. **RLMT Connector**--- It is a connector used to connect the step down transformer to the bridge rectifier.
2. **Bridge Rectifier** --- It is a full wave rectifier used to convert ac into dc , 9-15v ac made by transformer is converted into dc with the help of rectifier.
3. **Capacitor:** -----It is an electrolytic capacitor of rating 1000M/35V used to remove the ripples. Capacitor is the component used to pass the ac and block the dc.
4. **Regulator:** ----LM7805 is used to give a fixed 5v regulated supply.
5. **Capacitor:** -----It is again an electrolytic capacitor 10M/65v used for filtering to give pure dc.
6. **Capacitor:** ----- It is an ceramic capacitor used to remove the spikes generated when frequency is high(spikes).

So the output of supply section is 5v regulated dc.

MICROCONTROLLER SECTION:

Requires three connections to be successfully done for it's operation to begin.

1. **+5v supply:** This +5v supply is required for the controller to get start which is provided from the power supply section. This supply is provided at pin no.31 and 40 of the 89c51 controller.
2. **Crystal Oscillator:** A crystal oscillator of 12 MHz is connected at pin no.19,x1 and pin no.18,x2 to generate the frequency for the controller. The crystal oscillator works on piezoelectric effect. The clock generated is used to determine the processing speed of the controller. Two capacitors are also connected one end with the oscillator while the other end is connected with the ground. As it is recommended in the book to connect two ceramic capacitor of 20 pf—40pf to stabilize the clock generated.
3. **Reset section:** It consists of an rc network consisting of 10M/35V capacitor and one resistance of 1k. This section is used to reset the controller connected at pin no.9 of AT89c51.

DISPLAY SECTION:

FND (Functional Numeric Display)

FND is similar to the seven segment display but it has one more segment db for decimal. It has eight leds. The current specification for an led is 5MA-25MA. The safe range for the current to select is the mid value that is 12MA and voltage required is 5v so the resistance required to limit the current in led is calculated by the ohm's law i.e. $V=IR$, $R=V/I$ and hence R comes to about 470ohm.

FND are connected to the microcontroller at i/o port like p0,p1,p2,or p3

And also a transistor is required to get the fnd on or off. The base resistance required for the transistor is also 470ohm.

The message to be displayed on fnd is programmed through software.

RELAY SECTION:

RELAY is an isolator and an electrical switch. The relay used is 12V-5A. To control the operation of relay an NPN transistor BC547 has been used. Whenever high signal comes at the base of NPN transistor it is switched on and whenever low arrives it is switched off. Base of the transistor is connected with the I/O pin of the microcontroller.

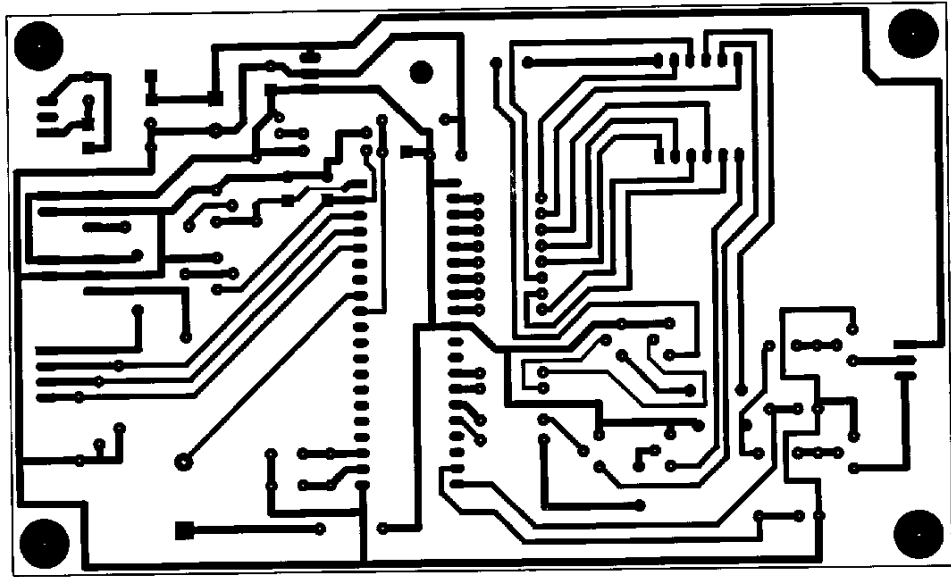
Base resistance of 1k5 is connected at the base of the transistor. Whenever low is sensed at the pin of microcontroller transistor gets off and the output of the collector becomes high and the relay which is connected at the output of the collector becomes off. The reverse action of it takes place when high is sensed at the pin of microcontroller.

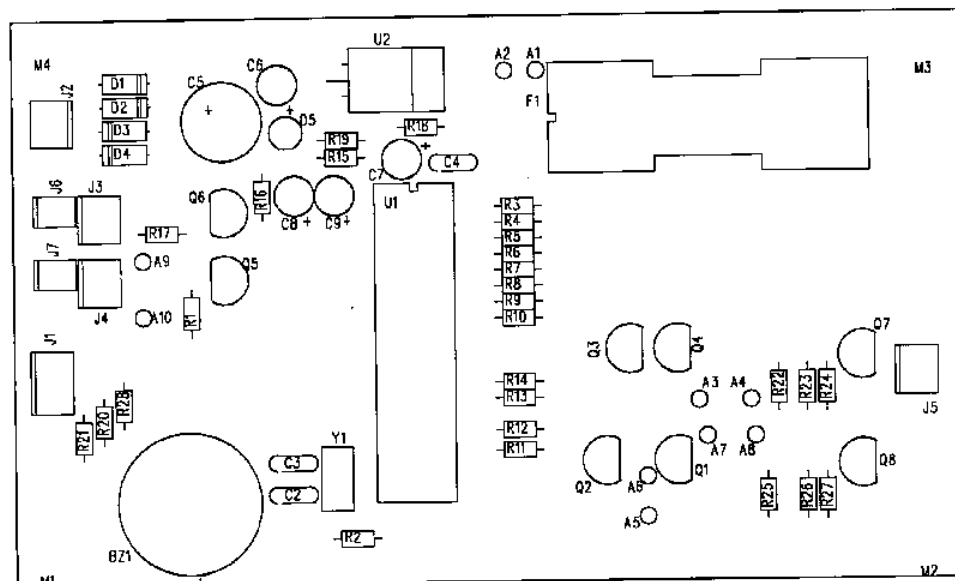
This section also consists of pull up & pull down resistance. A 2k2 resistance is used as pull up. In any case when more than 5v comes then pull up resistance sinks the excess voltage & maintains 5v. If pull up is not used then the 12v of relay can damage the processor when the transistor BC547 is on. A pull down resistor of value 2k2 is also used.

BUZZER SECTION:

This section includes a buzzer as well as a resistance to limit the current. The buzzer operates in the range of 20-25mA. The voltage given to the buzzer is 5v and also the buzzer can operate between 3V-24V. The resistance used is calculated by using the ohm's law. Buzzer is an indicating device which is used for checking the software condition and also used for indicating any specific condition.

PCB LAYOUT





STEPS FOR MAKING PCB

- Prepare the layout of the circuit (positive).
- Cut the photofilm (slightly bigger) of the size of the layout.
- Place the layout in the photoprinter machine with the photofilm above it. Make sure that the bromide (dark) side of the film is in contact with the layout.
- Switch on the machine by pressing the push button for 5 sec.
- Dip the film in the solution prepared (developer) by mixing the chemicals A & B in equal quantities in water.
- Now clean the film by placing it in the tray containing water for 1 min.
- After this, dip the film in the fixer solution for 1 min. now the negative of the
Circuit is ready.
- Now wash it under the flowing water.
- Dry the negative in the photocure machine.
- Take the PCB board of the size of the layout and clean it with steel wool to make the surface smooth.
- Now dip the PCB in the liquid photoresist, with the help of dip coat machine.
- Now clip the PCB next to the negative in the photo cure machine, drying for approximate 10-12 minute.
- Now place the negative on the top of the PCB in the UV machine, set the timer for about 2.5 minute and switch on the UV light at the top.

- Take the LPR developer in a container and rigorously move the PCB in it.
- After this, wash it with water very gently.
- Then apply LPR dye on it with the help of a dropper so that it is completely covered by it.
- Now clamp the PCB in the etching machine that contains ferric chloride solution for about 10 minutes.
- After etching, wash the PCB with water, wipe it a dry cloth softly.
- Finally rub the PCB with a steel wool, and the PCB is ready.

programming

INCLUDE 89c51.mc

buzzer EQU p1.7
PS1 EQU p1.2
relay1 EQU p2.0
relay2 EQU p2.1

main:

CLR relay1
CLR relay2

mainloop:

JB p1.2,la1
CLR buzzer
SETBbuzzer
MOV dis_buf,#00H
MOV dis_buf+1,#02h
MOV dis_buf+2,#0ah
MOV dis_buf+3,#0ah
JMP na3

na2:

MOV dis_buf,#00H
MOV dis_buf+1,#01h
MOV dis_buf+2,#0ah
MOV dis_buf+3,#0ah

na3:

la1:

JB p1.1,na4
CLR buzzer
SETBbuzzer
MOV dis_buf,#0aH
MOV dis_buf+1,#0ah
MOV dis_buf+2,#0ah
MOV dis_buf+3,#0ah

*SETB*relay1
CLR relay2

call delay
CLR relay1
CLR relay2

na4:

JB p1.0,la2
CLR buzzer
*SETB*buzzer

CLR relay1
*SETB*relay2

call delay

CLR relay1
CLR relay2

la2:

JMP mainloop

table:

DB c0h
DB f9h
DB a4h
DB b0h
DB 99h
DB 92h
DB 82h
DB f8h
DB 80h
DB 90h
DB FFH ;blank
DB 87H ;t

DB 83H

DB afh

DB 92h

DB a7h

DB 86h

DB c8h

DB a7h ;c

DB 86h ;e

DB 82h ;g

DB afh ;r

delay:

NOP

nop

RET

SENSING UNIT DESCRIPTION

IR SENSOR:

DESCRIPTION:

The LTM-97 series are miniaturized receivers for infrared remote control systems. It is a single unit type module which incorporates a PIN diode and a receiving preamplifier IC. The demodulated output signal can directly be decoded by a microprocessor.

IR Transmitter:

IR transmitter is used to transmit the Infrared. This infrared transmitter sends 68 KHz carrier under the control of micro controller. Micro controller can turn the infrared transmission on and off. Infrared carrier at around 68 KHz carrier frequencies is widely used in T.V. remote controlling and receiver for these signal are quite easily available. A 555 timer is used to give 68 KHz frequency signal to infrared LED.

IR Receiver:

This is also called “EYE”. This EYE is widely used in T.V. receiver. It is used to detect the IR transmission.

MICROCONTROLLER AT89C51/89s52

Features

- Compatible with MCS-51™ Products
- 8K Bytes of In-System Re programmable 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

DESCRIPTION

The AT89C52 is a low-power, high-performance CMOS 8-bit microcomputer with 8Kbytes 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 that provides a highly flexible and cost-effective solution to many embedded control applications.

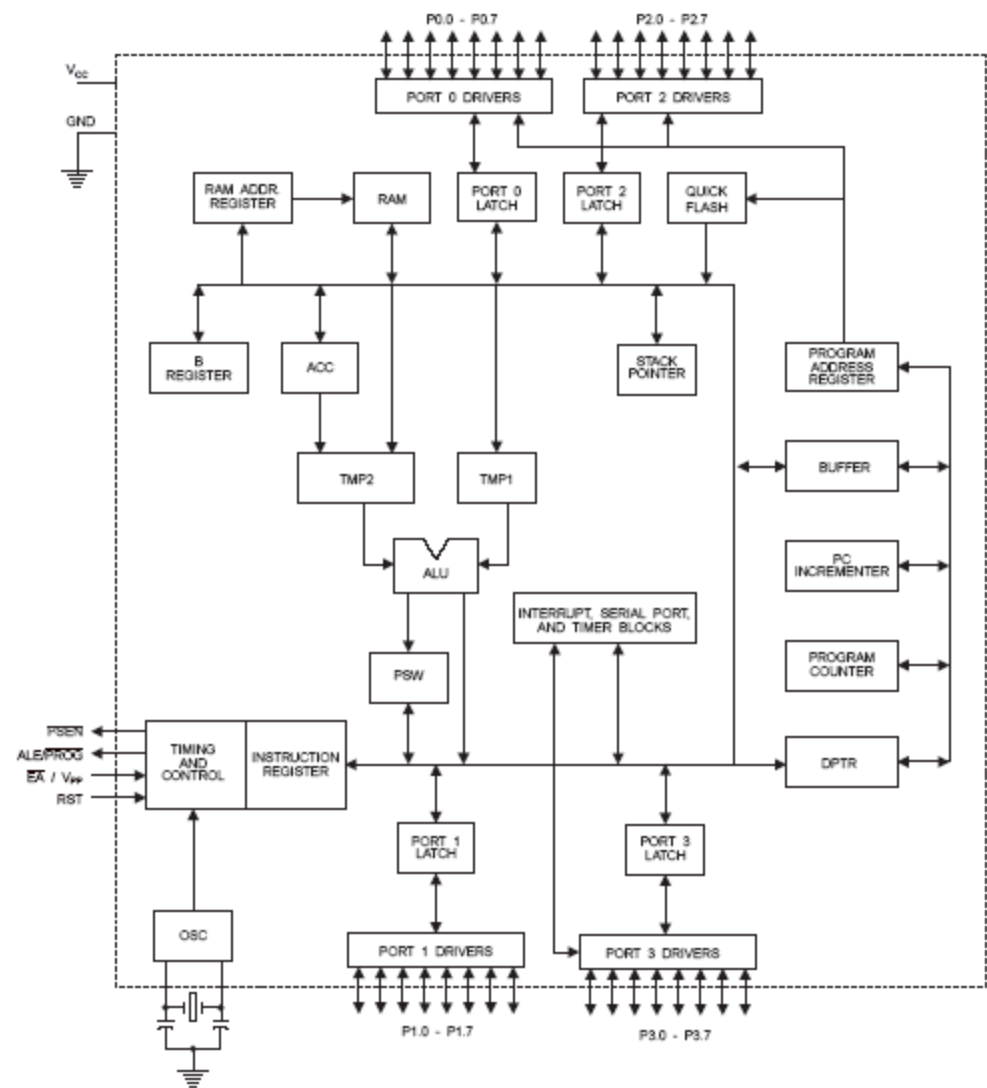
The AT89C52 provides the following standard features: 8K bytes of Flash, 256 bytes of RAM, 32 I/O lines, three 16-bit timer/counters, a six-vector two-level interrupt architecture, a full-duplex serial port, on-chip oscillator, and clock circuitry. In addition, the AT89C52 is designed with static logic 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

PDIP

(T2) P1.0	1	40	VCC
(T2 EX) P1.1	2	39	P0.0 (AD0)
P1.2	3	38	P0.1 (AD1)
P1.3	4	37	P0.2 (AD2)
P1.4	5	36	P0.3 (AD3)
P1.5	6	35	P0.4 (AD4)
P1.6	7	34	P0.5 (AD5)
P1.7	8	33	P0.6 (AD6)
RST	9	32	P0.7 (AD7)
(RXD) P3.0	10	31	$\overline{\text{EA/VPP}}$
(TXD) P3.1	11	30	ALE/PROG
($\overline{\text{INT0}}$) P3.2	12	29	$\overline{\text{PSEN}}$
($\overline{\text{INT1}}$) P3.3	13	28	P2.7 (A15)
(T0) P3.4	14	27	P2.6 (A14)
(T1) P3.5	15	26	P2.5 (A13)
($\overline{\text{WR}}$) P3.6	16	25	P2.4 (A12)
($\overline{\text{RD}}$) P3.7	17	24	P2.3 (A11)
XTAL2	18	23	P2.2 (A10)
XTAL1	19	22	P2.1 (A9)
GND	20	21	P2.0 (A8)

Block Diagram



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.

In addition, P1.0 and P1.1 can be configured to be the timer/counter 2 external count input (P1.0/T2) and the timer/counter 2 trigger input (P1.1/T2EX), respectively, as shown in the following table.

Port 1 also receives the low-order address bytes during

Flash programming and verification.

Port Pin	Alternate Functions
P1.0	T2 (external count input to Timer/Counter 2), clock-out
P1.1	T2EX (Timer/Counter 2 capture/reload trigger and direction control)

Port 2

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 use 16-bit addresses (MOVX @ DPTR). In this application, Port 2 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 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 of the AT89C51, as shown in the following table. Port 3 also receives some control signals for Flash programming.

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

RST

Reset input. A high on this pin for two machine cycles while the oscillator is running resets the device.

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 micro controller 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 when 12-volt programming is selected.

Special Function Registers

A map of the on-chip memory area called the Special Function Register (SFR) space is shown in Table 1.

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 product new features. In that case, the reset or inactive values of the new bits will always be 0.

Timer 2 Registers

Control and status bits are contained in registers T2CON (shown in Table 2) and T2MOD (shown in Table 4) for Timer 2. The register pair (RCAP2H, RCAP2L) are the Capture/Reload registers for Timer 2 in 16-bit capture mode or 16-bit auto-reload mode.

Interrupt Registers

The individual interrupt enable bits are in the IE register. Two priorities can be set for each of the six interrupt sources in the IP register. Instructions that use indirect addressing access the upper 128 bytes of RAM. For example, the following indirect addressing instruction, where R0 contains 0A0H, accesses the data byte at address 0A0H, rather than P2 (whose address is 0A0H).

MOV @R0, #data

Note that stack operations are examples of indirect addressing, so the upper 128 bytes of data RAM are available as stack space.

Table 2. T2CON – Timer/Counter 2 Control Register

T2CON Address = 0C8H					Reset Value = 0000 0000B			
Bit Addressable								
Bit	TF2	EXF2	RCLK	TCLK	EXEN2	TR2	C/T2	CP/RL2
	7	6	5	4	3	2	1	0

Symbol	Function
TF2	Timer 2 overflow flag set by a Timer 2 overflow and must be cleared by software. TF2 will not be set when either RCLK = 1 or TCLK = 1.
EXF2	Timer 2 external flag set when either a capture or reload is caused by a negative transition on T2EX and EXEN2 = 1. When Timer 2 Interrupt is enabled, EXF2 = 1 will cause the CPU to vector to the Timer 2 Interrupt routine. EXF2 must be cleared by software. EXF2 does not cause an interrupt in up/down counter mode (DCEN = 1).
RCLK	Receive clock enable. When set, causes the serial port to use Timer 2 overflow pulses for its receive clock in serial port Modes 1 and 3. RCLK = 0 causes Timer 1 overflow to be used for the receive clock.
TCLK	Transmit clock enable. When set, causes the serial port to use Timer 2 overflow pulses for its transmit clock in serial port Modes 1 and 3. TCLK = 0 causes Timer 1 overflows to be used for the transmit clock.
EXEN2	Timer 2 external enable. When set, allows a capture or reload to occur as a result of a negative transition on T2EX. If Timer 2 is not being used to clock the serial port, EXEN2 = 0 causes Timer 2 to ignore events at T2EX.
TR2	Start/Stop control for Timer 2. TR2 = 1 starts the timer.
C/T2	Timer or counter select for Timer 2. C/T2 = 0 for timer function. C/T2 = 1 for external event counter (falling edge triggered).
CP/RL2	Capture/Reload select. CP/RL2 = 1 causes captures to occur on negative transitions at T2EX if EXEN2 = 1. CP/RL2 = 0 causes automatic reloads to occur when Timer 2 overflows or negative transitions occur at T2EX when EXEN2 = 1. When either RCLK or TCLK = 1, this bit is ignored and the timer is forced to auto-reload on Timer 2 overflow.

Data Memory

The AT89C52 implements 256 bytes of on-chip RAM. The upper 128 bytes occupy a parallel address space to the Special Function Registers. That means the upper 128 bytes have the same addresses as the SFR space but are physically separate from SFR space.

When an instruction accesses an internal location above address 7FH, the address mode used in the instruction

specifies whether the CPU accesses the upper 128 bytes of RAM or the SFR space. Instructions that use direct addressing access SFR space.

For example, the following direct addressing instruction accesses the SFR at location 0A0H (which is P2).

```
MOV 0A0H, #data
```

Timer 0 and 1

Timer 0 and Timer 1 in the AT89C52 operate the same way as Timer 0 and Timer 1 in the T89C51.

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 (shown in Table 2). 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 3. 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 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.

frequency.

Table 3. Timer 2 Operating Modes

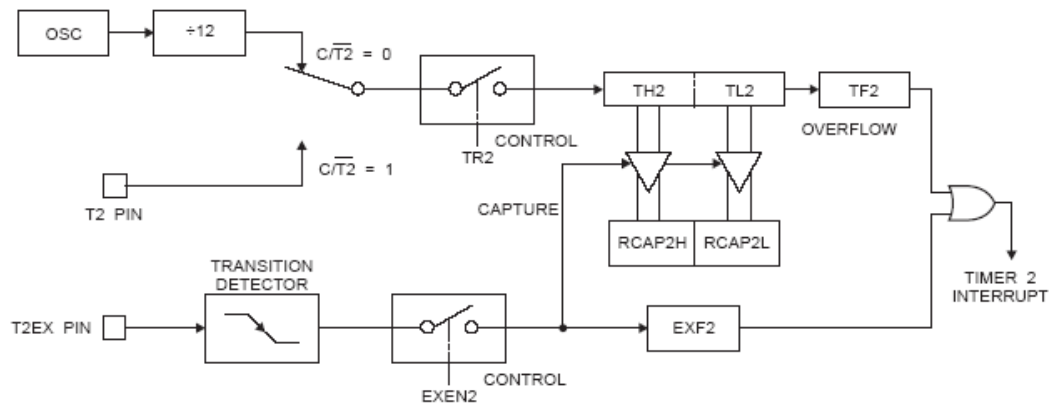
RCLK +TCLK	CP/RLZ	TR2	MODE
0	0	1	16-bit Auto-reload
0	1	1	16-bit Capture
1	X	1	Baud Rate Generator
X	X	0	(Off)

In the Counter function, the register is incremented in response to a 1-to-0 transition at its corresponding external

Capture Mode

In the capture mode, two options are selected by bit EXEN2 in T2CON. If EXEN2 = 0, Timer 2 is a 16-bit timer or counter which upon overflow sets bit TF2 in T2CON. This bit can then be used to generate an interrupt. If EXEN2 = 1, Timer 2 performs the same operation, but a 1-to-0 transition at external input T2EX also causes the current value in TH2 and TL2 to be captured into CAP2H and RCAP2L, respectively. In addition, the transition at T2EX causes bit EXF2 in T2CON to be set. The EXF2 bit, like TF2, can generate an interrupt. The capture mode is illustrated in Figure 1.

Figure 1. Timer in Capture Mode



Auto-reload (Up or Down Counter)

Timer 2 can be programmed to count up or down when configured in its 16-bit auto-reload mode. This feature is invoked by the DCEN (Down Counter Enable) bit located in the SFR T2MOD (see Table 4). Upon reset, the DCEN bit is set to 0 so that timer 2 will default to count up. When DCEN is set, Timer 2 can count up or down, depending on the value of the T2EX pin.

Figure 2 shows Timer 2 automatically counting up when DCEN = 0. In this mode, two options are selected by bit EXEN2 in T2CON. If EXEN2 = 0, Timer 2 counts up to 0FFFFH and then sets the TF2 bit upon overflow. The overflow also causes the timer registers to be reloaded with the 16-bit value in RCAP2H and RCAP2L. The values in Timer in Capture Mode RCAP2H and RCAP2L are preset by software. If EXEN2 = 1, a 16-bit reload can be triggered either by an overflow or by a 1-to-0 transition at external input T2EX. This transition also sets the EXF2 bit. Both the TF2 and EXF2 bits can generate an interrupt if enabled. Setting the DCEN bit enables Timer 2 to count up or down, as shown in Figure 3. In this mode, the T2EX pin controls

the direction of the count. A logic 1 at T2EX makes Timer 2 count up. The timer will overflow at 0FFFFH and set the TF2 bit. This overflow also causes the 16-bit value in RCAP2H and RCAP2L to be reloaded into the timer registers, TH2 and TL2, respectively. A Logic 0 at T2EX makes Timer 2 count down. The timer underflows when TH2 and TL2 equal the values stored in RCAP2H and RCAP2L. The underflow sets the TF2 bit and causes 0FFFFH to be reloaded into the timer Registers. The EXF2 bit toggles whenever Timer 2 overflows or underflows and can be used as a 17th bit of resolution. In this operating mode, EXF2 does not flag an interrupt.

Baud Rate Generator

Timer 2 is selected as the baud rate generator by setting TCLK and/or RCLK in T2CON (Table 2). Note that the baud rates for transmit and receive can be different if Timer 2 is used for the receiver or transmitter and Timer 1 is used for the other function. Setting RCLK and/or TCLK puts Timer 2 into its baud rate generator mode, as shown in Figure4. The baud rate generator mode is similar to the auto-reload mode, in that a rollover in TH2 causes the Timer 2 registers to be reloaded with the 16-bit value in registers RCAP2H and RCAP2L, which are preset by software.

The baud rates in Modes 1 and 3 are determined by Timer2's overflow rate according to the following equation.

$$\text{Modes 1 and 3 Baud Rates} = \frac{\text{Timer 2 Overflow Rate}}{16}$$

The Timer can be configured for either timer or counter operation. In most applications, it is configured for timer operation (CP/T2 = 0). The timer operation is different for Timer 2 when it is used as a baud rate generator. Normally, as a timer, it increments every machine cycle (at 1/12 the oscillator frequency). As a baud rate generator, however, it increments every state time (at 1/2 the oscillator frequency). The baud rate formula is given below.

$$\frac{\text{Modes 1 and 3}}{\text{Baud Rate}} = \frac{\text{Oscillator Frequency}}{32 \times [65536 - (\text{RCAP2H}, \text{RCAP2L})]}$$

where (RCAP2H, RCAP2L) is the content of RCAP2H and RCAP2L taken as a 16-bit unsigned integer. Timer 2 as a baud rate generator is shown in Figure 4. This figure is valid only if RCLK or TCLK = 1 in T2CON. Note that a rollover in TH2 does not set TF2 and will not generate an interrupt. Note too, that if EXEN2 is set, a 1-to-0 transition in T2EX will set EXF2 but will not cause a reload from (RCAP2H, RCAP2L) to (TH2, TL2). Thus when Timer 2 is in use as a baud rate generator, T2EX can be used as an extra external interrupt.

Note that when Timer 2 is running (TR2 = 1) as a timer in the baud rate generator mode, TH2 or TL2 should not be read from or written to. Under these conditions, the Timer is incremented every state time, and the results of a read or write may not be accurate. The RCAP2 registers may be read but should not be written to, because a write might overlap a reload and cause write and/or reload errors. The timer should be turned off (clear TR2) before accessing the Timer 2 or RCAP2 registers.

Programmable Clock Out

A 50% duty cycle clock can be programmed to come out on P1.0, as shown in Figure 5. This pin, besides being a regular I/O pin, has two alternate functions. It can be programmed to input the external clock for Timer/Counter 2 or to output a 50% duty cycle clock ranging from 61 Hz to 4 MHz at a 16 MHz operating frequency. To configure the Timer/Counter 2 as a clock generator, bit C/T2 (T2CON.1) must be cleared and bit T2OE (T2MOD.1) must be set. Bit TR2 (T2CON.2) starts and stops the timer. The clock-out frequency depends on the oscillator frequency and the reload value of Timer 2 capture registers (RCAP2H, RCAP2L), as shown in the following equation.

$$\text{Clock-Out Frequency} = \frac{\text{Oscillator Frequency}}{4 \times [65536 - (\text{RCAP2H}, \text{RCAP2L})]}$$

In the clock-out mode, Timer 2 roll-overs will not generate an interrupt. This behavior is similar to when Timer 2 is used as a baud-rate generator. It is possible to use Timer 2 as a baud-rate generator and a clock generator simultaneously. Note, however, that the baud-rate and clock-out Frequencies cannot be determined independently from one another since they both use RCAP2H and RCAP2L.

UART

The UART in the AT89C52 operates the same way as the UART in the AT89C51.

Interrupts

The AT89C52 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. These interrupts are all shown in Figure 6. Each of these interrupt sources can be individually enabled or disabled by setting or clearing a bit in Special Function Register IE. IE also contains a global disable bit, EA, which disables all interrupts at once.

Note that Table shows that bit position IE.6 is unimplemented. In the AT89C51, bit position IE.5 is also unimplemented. User software should not write 1s to these bit positions, since they may be used in future AT89

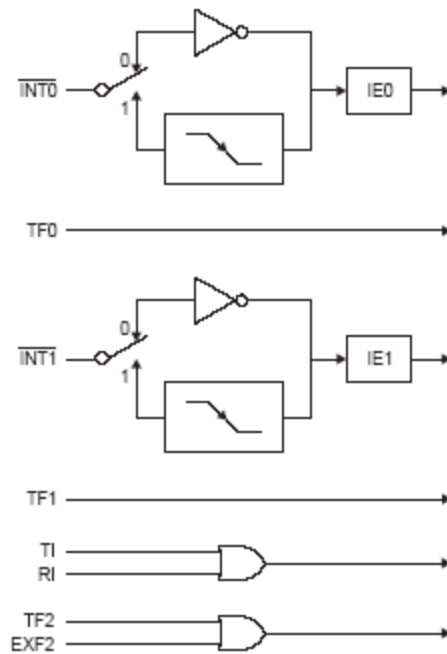
products. Timer 2 interrupt is generated by the logical OR of bits TF2 and EXF2 in register T2CON. Neither of these flags is cleared by hardware when the service routine is vectored to. In fact, the service routine may have to determine whether it was TF2 or EXF2 that generated the interrupt, and that bit will have to be cleared in software. The Timer 0 and Timer 1 flags, TF0 and TF1, are set at S5P2 of the cycle in which the timers overflow. The values are then polled by the circuitry in the next cycle. However, the Timer 2 flag, TF2, is set at S2P2 and is polled in the same cycle in which the timer overflows.

Table 5. Interrupt Enable (IE) Register

(MSB)				(LSB)			
EA	–	ET2	ES	ET1	EX1	ET0	EX0
Enable Bit = 1 enables the interrupt.							
Enable Bit = 0 disables the interrupt.							

Symbol	Position	Function
EA	IE.7	Disables all interrupts. If EA = 0, no interrupt is acknowledged. If EA = 1, each interrupt source is individually enabled or disabled by setting or clearing its enable bit.
–	IE.6	Reserved.
ET2	IE.5	Timer 2 interrupt enable bit.
ES	IE.4	Serial Port interrupt enable bit.
ET1	IE.3	Timer 1 interrupt enable bit.
EX1	IE.2	External interrupt 1 enable bit.
ET0	IE.1	Timer 0 interrupt enable bit.
EX0	IE.0	External interrupt 0 enable bit.
User software should never write 1s to unimplemented bits, because they may be used in future AT89 products.		

Figure 6. Interrupt Sources



Oscillator Characteristics

XTAL1 and XTAL2 are the input and output, respectively, of an inverting amplifier that can be configured for use as an on-chip oscillator, as shown in Figure 7. Either a quartz crystal or ceramic resonator may be used. To drive the device from an external clock source, XTAL2 should be left

Un connected while XTAL1 is driven, as shown in Figure 8. There are no requirements on the duty cycle of the external clock signal, since the input to the internal clocking circuitry is through a divide-by-two flip-flop, but minimum and maximum voltage high and low time specifications must be observed.

Component description

SEVEN-SEGMENT DISPLAY:

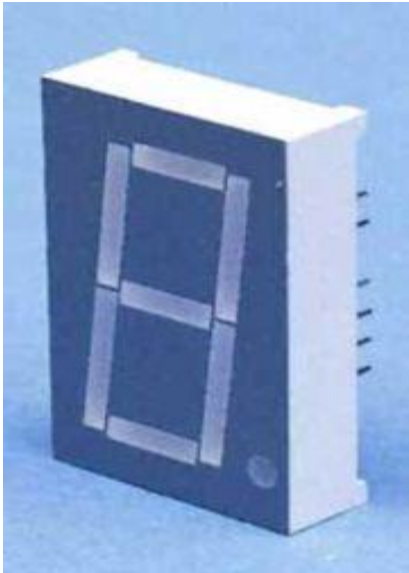
A seven-segment display (abbreviation: "7-seg(ment) display"), is a form of Display device that is an alternative to the more complex dot-matrix displays. Seven-segment displays are commonly used in electronics as a method of displaying decimal numeric feedback on the internal operations of devices.

Contents :

[1 Concept and visual structure](#)

[2 Implementations](#)

[3 Alphabetic display](#)



Concept and visual structure:

A typical 7-segment LED display component, with decimal point.

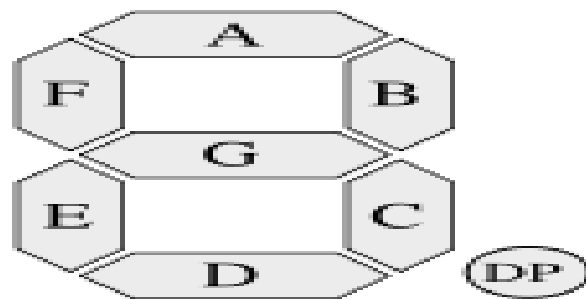
A seven segment display, as its name indicates, is composed of seven elements. Individually on or off, they can be combined to produce simplified representations of the Hindu-Arabic numerals. Each of the numbers 0, 6, 7 and 9 may be represented by two or more different glyphs on seven-segment displays.

The seven segments are arranged as a rectangle of two vertical segments on each side with one horizontal segment on the top and bottom. Additionally, the seventh segment bisects the rectangle horizontally. There are also

fourteen-segment displays and sixteen-segment displays (for full alphanumerics); however, these have mostly been replaced by dot-matrix displays.

Often the seven segments are arranged in an oblique, or italic, arrangement, which aids readability.

The segments of a 7-segment display are referred to by the letters A to G, as follows:



where the optional **DP** decimal point (an "eighth segment") is used for the display of non-integer numbers.

Implementations:

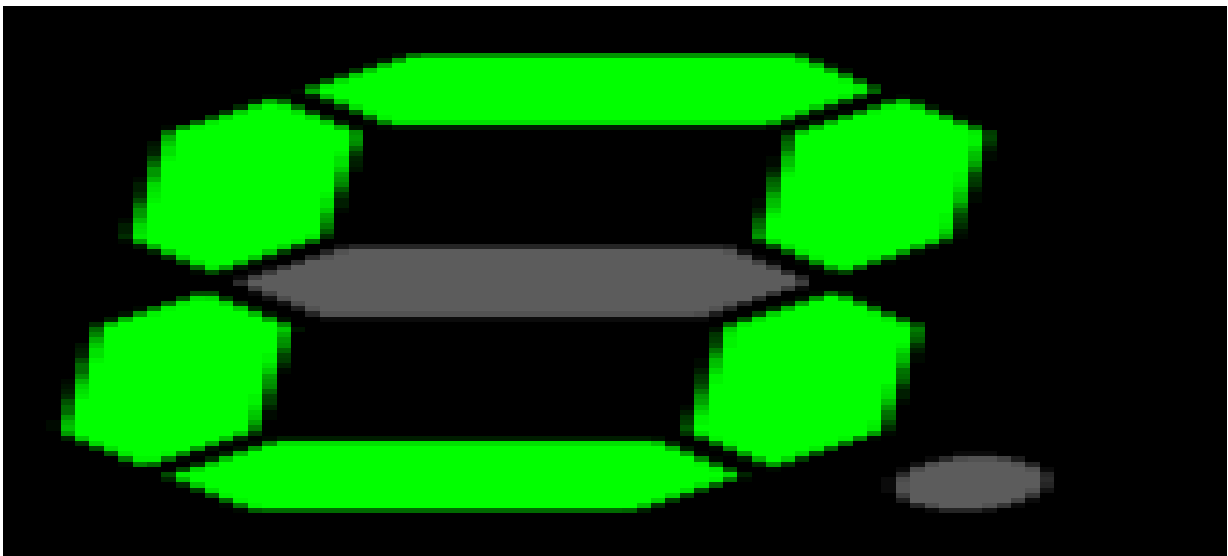
Most separate 7-segment displays use an array of light-emitting diodes (LEDs), though other types exist using alternative technologies such as cold cathode gas discharge, vacuum fluorescent, incandescent filament, liquid crystal display (LCD), etc. For gas price totems and other large signs, electromagnetically flipped light-reflecting segments (sometimes called "vanes") are still commonly used. An alternative to the 7-segment display in the 1950s through the 1970s was the vacuum tube-like nixie tube.

For many applications, dot-matrix LCDs have largely superseded LED displays, though even in LCDs 7-segment

displays are very common. Unlike LEDs, the shapes of elements in an LCD panel are arbitrary since they are formed on the display by a kind of printing process. In contrast, the shapes of LED segments tend to be simple rectangles, reflecting the fact that they have to be physically moulded to shape, which makes it difficult to form more complex shapes than the segments of 7-segment displays. However, the high common recognition factor of 7-segment displays, and the comparatively high visual contrast obtained by such displays relative to dot-matrix digits, makes seven-segment multiple-digit LCD screens very common on basic calculators.

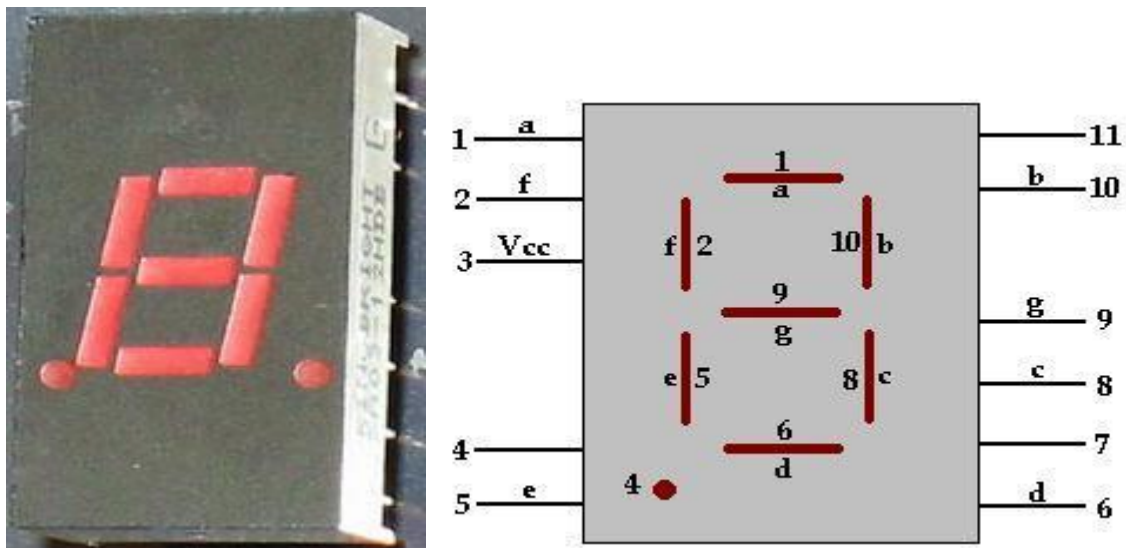
Alphabetic display:

In addition to the ten numerals, seven segment displays can be used to show letters of the latin, cyrillic and greek alphabets including punctuation, but only few representations are unambiguous and intuitive at the same time: uppercase A, B, C, E, F, G, H, I, J, L, N, O, P, S, U, Y, Z, and lowercase a, b, c, d, e, g, h, i, n, ñ, o, q, r, t, u. Detailed tables of alternative seven-segment symbols for letters and punctuation are given in the section Character representations, below.



HOW 7-SEGMENT DISPLAY WORKS?

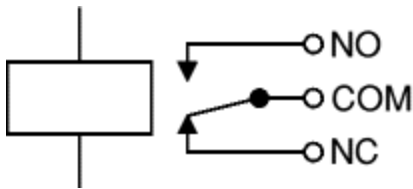
The 7 segment display is found in many displays such as microwaves or fancy toaster ovens and occasionally in non cooking devices. It is just 7 LEDs that have been combined into one case to make a convenient device for displaying numbers and some letters. The display is shown on the left. The pinout of the display is on the right.



This version is a common anode version. That means that the positive leg of each LED is connected to a common point which is pin 3 in this case. Each LED has a negative leg that is connected to one of the pins of the device. To make it work you need to connect pin 3 to 5 volts. Then to make each segment light up, connect the ground pin for that led to ground. A resistor is required to limit the current. Rather than using a resistor from each LED to ground, you can just

use one resistor from Vcc to pin 3 to limit the current. The following table shows how to form the numbers 0 to 9 and the letters A, b, C, d, E, and F.

RELAYS

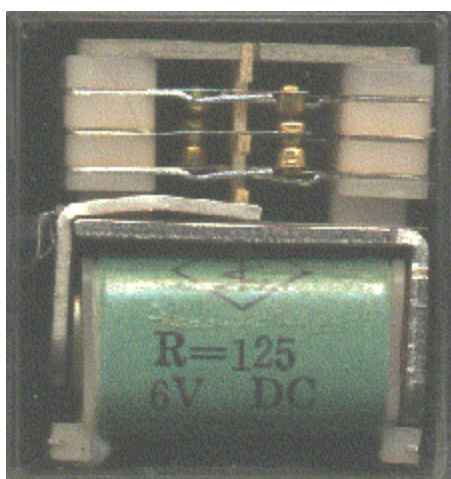


Circuit symbol for a relay



Relays

Photographs © [Rapid Electronics](#)



A relay is an electrically operated switch. Current flowing through the coil of the relay creates a magnetic field, which attracts a lever and changes the switch contacts. The coil current can be on or off so relays have two switch positions and they are double throw (changeover) switches.

Relays allow one circuit to switch a second circuit that can be completely separate from the first. For example a low voltage battery circuit can use a relay to switch a 230V AC mains circuit. There is no electrical connection inside the relay between the two circuits, the link is magnetic and mechanical.

The coil of a relay passes a relatively large current, typically 30mA for a 12V relay, but it can be as much as 100mA for relays designed to operate from lower voltages. Most ICs (chips) cannot provide this current and a [transistor](#) is usually used to amplify the small IC current to the larger value required for the relay coil. The maximum output current for the popular 555 timer IC is 200mA so these devices can supply relay coils directly without amplification.

Relays are usually SPDT or DPDT but they can have many more sets of switch contacts, for example relays with 4 sets of changeover contacts are readily available. For further information about switch contacts and the terms used to describe them please see the page on [switches](#).

Most relays are designed for PCB mounting but you can solder wires directly to the pins providing you take care to avoid melting the plastic case of the relay.

The supplier's catalogue should show you the relay's connections. The coil will be obvious and it may be connected either way round. Relay coils produce brief high voltage 'spikes' when they are switched off and this can destroy transistors and ICs in the circuit. To prevent damage you must connect a [protection diode](#) across the relay coil.

The animated picture shows a working relay with its coil and switch contacts. You can see a lever on the left being attracted by magnetism when the coil is switched on. This lever moves the switch contacts. There is one set of contacts (SPDT) in the foreground and another behind them, making the relay DPDT.

The relay's switch connections are usually labeled COM, NC and NO:

- COM = Common, always connect to this, it is the moving part of the switch.
- NC = Normally Closed, COM is connected to this when the relay coil is off.
- NO = Normally Open, COM is connected to this when the relay coil is on.
- Connect to COM and NO if you want the switched circuit to be on when the relay coil is on.
- Connect to COM and NC if you want the switched circuit to be on when the relay coil is off.

Choosing a relay

You need to consider several features when choosing a relay:

1. Physical size and pin arrangement

If you are choosing a relay for an existing PCB you will need to ensure that its dimensions and pin arrangement are suitable. You should find this information in the supplier's catalogue.

2. Coil voltage

The relay's coil voltage rating and resistance must suit the circuit powering the relay coil. Many relays have a coil rated for a 12V supply but 5V and 24V relays are also readily available. Some relays operate perfectly well with a supply voltage which is a little lower than their rated value.

3. Coil resistance

The circuit must be able to supply the current required by the relay coil. You can use [Ohm's law](#) to calculate the current:

$$\text{Relay coil current} = \frac{\text{Supply voltage}}{\text{Coil resistance}}$$

For example: A 12V supply relay with a coil resistance of 400 Ω passes a current of 30mA. This is OK for a 555 timer IC (maximum output current 200mA), but it is too much for most ICs and they will require a transistor to amplify the current.

4. Switch ratings (voltage and current)

The relay's switch contacts must be suitable for the circuit they are to control. You will need to check the voltage and current ratings. Note that the voltage rating is usually higher for AC, for example: "5A at 24V DC or 125V AC".

5. Switch contact arrangement (SPDT, DPDT etc)

Most relays are SPDT or DPDT which are often described as "single pole changeover" (SPCO) or "double pole changeover" (DPCO).

COMPARISON BETWEEN TRANSISTORS & RELAYS

Advantages of relays:

- Relays can switch AC and DC, transistors can only switch DC.
- Relays can switch high voltages, transistors cannot.
- Relays are a better choice for switching large currents ($> 5A$).
- Relays can switch many contacts at once.
-

Disadvantages of relays:

- Relays are bulkier than transistors for switching small currents.
- Relays cannot switch rapidly (except reed relays), transistors can switch many times per second.
- Relays use more power due to the current flowing through their coil.

Relays require more current than many chips can provide, so a low power transistor may be needed to switch the current for the relay's coil.

Crystal Oscillator

It is often required to produce a signal whose frequency or pulse rate is very stable and exactly known. This is important

in any application where anything to do with time or exact measurement is crucial. It is relatively simple to make an oscillator that produces some sort of a signal, but another matter to produce one of relatively precise frequency and stability. AM radio stations must have a carrier frequency accurate within 10Hz of its assigned frequency, which may be from 530 to 1710 kHz. SSB radio systems used in the HF range (2-30 MHz) must be within 50 Hz of channel frequency for acceptable voice quality, and within 10 Hz for best results. Some digital modes used in weak signal communication may require frequency stability of less than 1 Hz within a period of several minutes. The carrier frequency must be known to fractions of a hertz in some cases. An ordinary quartz watch must have an oscillator accurate to better than a few parts per million. One part per million will result in an error of slightly less than one half second a day, which would be about 3 minutes a year. This might not sound like much, but an error of 10 parts per million would result in an error of about a half an hour per year. A clock such as this would need resetting about once a month, and more often if you are the punctual type. A programmed VCR with a clock this far off could miss the recording of part of a TV show. Narrow band SSB communications at VHF and UHF frequencies still need 50 Hz frequency accuracy. At 440 MHz, this is slightly more than 0.1 part per million.

Ordinary L-C oscillators using conventional inductors and capacitors can achieve typically 0.01 to 0.1 percent frequency stability, about 100 to 1000 Hz at 1 MHz. This is OK for AM and FM broadcast receiver applications and in other low-end analog receivers not requiring high tuning accuracy. By careful design and component selection, and with rugged mechanical construction, .01 to 0.001%, or even better (.0005%) stability can be achieved. The better figures will

undoubtedly employ temperature compensation components and regulated power supplies, together with environmental control (good ventilation and ambient temperature regulation) and “battleship” mechanical construction. This has been done in some communications receivers used by the military and commercial HF communication receivers built in the 1950-1965 era, before the widespread use of digital frequency synthesis. But these receivers were extremely expensive, large, and heavy. Many modern consumer grade AM, FM, and shortwave receivers employing crystal controlled digital frequency synthesis will do as well or better from a frequency stability standpoint.

An oscillator is basically an amplifier and a frequency selective feedback network (Fig 1). When, at a particular frequency, the loop gain is unity or more, and the total phaseshift at this frequency is zero, or some multiple of 360 degrees, the condition for oscillation is satisfied, and the circuit will produce a periodic waveform of this frequency. This is usually a sine wave, or square wave, but triangles, impulses, or other waveforms can be produced. In fact, several different waveforms often are simultaneously produced by the same circuit, at different points. It is also possible to have several frequencies produced as well, although this is generally undesirable.

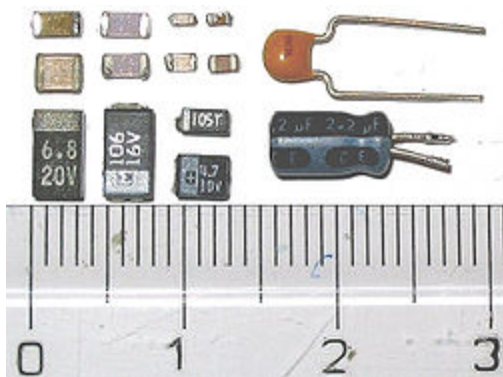
CAPACITOR

A **capacitor** or **condenser** is a [passive electronic component](#) consisting of a pair of [conductors](#) separated by a [dielectric](#) (insulator). When a [potential difference](#) (voltage) exists across the conductors, an [electric field](#) is present in the dielectric. This field stores [energy](#) and produces a mechanical force between the conductors. The effect is greatest when there is a narrow separation between large

areas of conductor, hence capacitor conductors are often called plates.

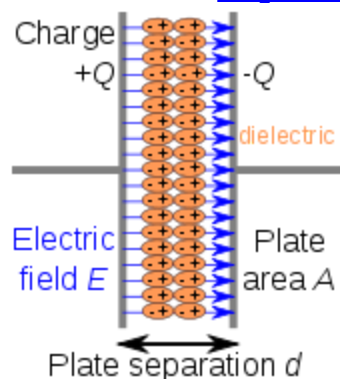
An ideal capacitor is characterized by a single constant value, [capacitance](#), which is measured in [farads](#). This is the ratio of the [electric charge](#) on each conductor to the potential difference between them. In practice, the dielectric between the plates passes a small amount of [leakage current](#). The conductors and [leads](#) introduce an [equivalent series resistance](#) and the dielectric has an electric field strength limit resulting in a [breakdown voltage](#).

Capacitors are widely used in electronic circuits to block the flow of [direct current](#) while allowing [alternating current](#) to pass, to filter out interference, to smooth the output of [power supplies](#), and for many other purposes. They are used in [resonant circuits](#) in radio frequency equipment to select particular [frequencies](#) from a signal with many frequencies.



Theory of operation

Main article: [Capacitance](#)



Charge separation in a parallel-plate capacitor causes an internal electric field. A dielectric (orange) reduces the field and increases the capacitance.



A simple demonstration of a parallel-plate capacitor

A capacitor consists of two [conductors](#) separated by a non-conductive region. The non-conductive substance is called the [dielectric medium](#), although this may also mean a [vacuum](#) or a [semiconductor depletion region](#) chemically identical to the conductors. A capacitor is assumed to be self-contained and isolated, with no net [electric charge](#) and no influence from an external electric field. The conductors thus contain equal and opposite charges on their facing surfaces, and the dielectric contains an electric field. The capacitor is a reasonably general model for electric fields within electric circuits.

An ideal capacitor is wholly characterized by a constant capacitance C , defined as the ratio of charge $\pm Q$ on each conductor to the voltage V between them

$$C = \frac{Q}{V}$$

Sometimes charge buildup affects the mechanics of the capacitor, causing the capacitance to vary. In this case, capacitance is defined in terms of incremental changes:

$$C = \frac{dq}{dv}$$

In [SI](#) units, a capacitance of one [farad](#) means that one [coulomb](#) of charge on each conductor causes a voltage of one [volt](#) across the device.

Energy storage

[Work](#) must be done by an external influence to move charge between the conductors in a capacitor. When the external influence is removed, the charge separation persists and energy is stored in the electric field. If charge is later allowed to return to its [equilibrium](#) position, the energy is released. The work done in establishing the electric field, and hence the amount of energy stored, is given by:

$$W = \int_{q=0}^Q V dq = \int_{q=0}^Q \frac{q}{C} dq = \frac{1}{2} \frac{Q^2}{C} = \frac{1}{2} CV^2 = \frac{1}{2} VQ.$$

Current-voltage relation

The current $i(t)$ through a component in an electric circuit is defined as the rate of change of the charge $q(t)$ that has passed through it. Physical charges cannot pass through the dielectric layer of a capacitor, but rather build up in equal and opposite quantities on the electrodes: as each electron accumulates on the negative plate, one leaves the positive plate. Thus the accumulated charge on the electrodes is equal to the integral of the current, as well as being proportional to the voltage (as discussed above). As with any [antiderivative](#), a [constant of integration](#) is added to represent the initial voltage $v(t_0)$. This is the integral form of the capacitor equation,

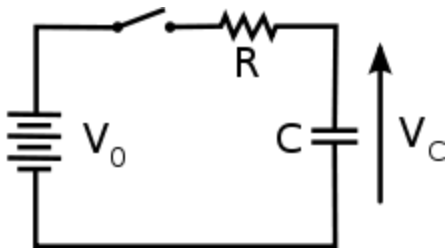
$$v(t) = \frac{q(t)}{C} = \frac{1}{C} \int_{t_0}^t i(\tau) d\tau + v(t_0).$$

Taking the derivative of this, and multiplying by C , yields the derivative form, ^[12]

$$i(t) = \frac{dq(t)}{dt} = C \frac{dv(t)}{dt}.$$

The [dual](#) of the capacitor is the [inductor](#), which stores energy in the [magnetic field](#) rather than the electric field. Its current-voltage relation is obtained by exchanging current and voltage in the capacitor equations and replacing C with the inductance L .

DC circuits



A simple resistor-capacitor circuit demonstrates charging of a capacitor.

A series circuit containing only a [resistor](#), a capacitor, a switch and a constant DC source of voltage V_0 is known as a *charging circuit*. If the capacitor is initially uncharged while the switch is open, and the switch is closed at $t = 0$, it follows from [Kirchhoff's voltage law](#) that

$$V_0 = v_{\text{resistor}}(t) + v_{\text{capacitor}}(t) = i(t)R + \frac{1}{C} \int_0^t i(\tau) d\tau.$$

Taking the derivative and multiplying by C , gives a [first-order differential equation](#),

$$RC \frac{di(t)}{dt} + i(t) = 0.$$

At $t = 0$, the voltage across the capacitor is zero and the voltage across the resistor is V_0 . The initial current is then $i(0) = V_0 / R$. With this assumption, the differential equation yields

$$i(t) = \frac{V_0}{R} e^{-t/\tau_0}$$

$$v(t) = V_0 \left(1 - e^{-t/\tau_0} \right),$$

where $\tau_0 = RC$ is the [time constant](#) of the system.

As the capacitor reaches equilibrium with the source voltage, the voltage across the resistor and the current through the entire circuit [decay exponentially](#). The case of *discharging* a charged capacitor likewise demonstrates exponential decay, but with the initial capacitor voltage replacing V_0 and the final voltage being zero.

RESISTOR

Resistors are used to limit the value of current in a circuit. Resistors offer opposition to the flow of current. They are expressed in ohms for which the symbol is 'Ω'. Resistors are broadly classified as

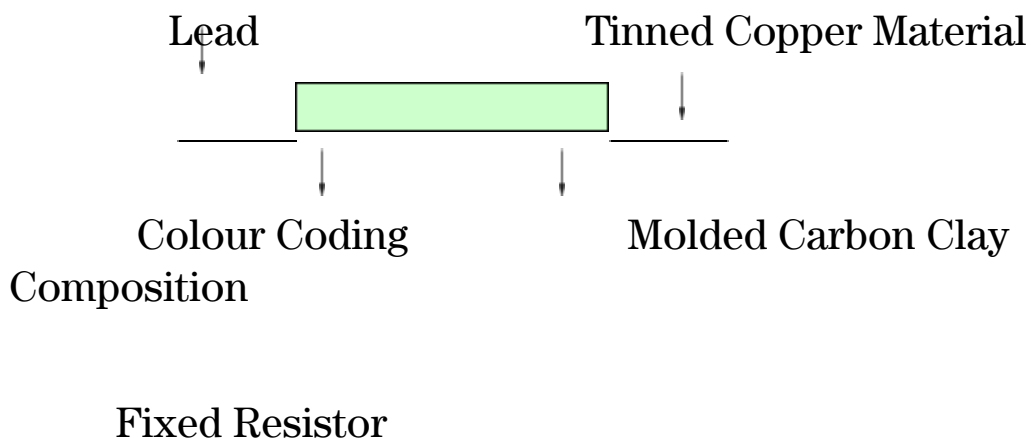
- (1) Fixed Resistors
- (2) Variable Resistors

Fixed Resistors :

The most common of low wattage, fixed type resistors is the molded-carbon composition resistor. The resistive material is of carbon clay composition. The leads are made of tinned copper. Resistors of this type are readily available in value ranging from few ohms to about 20MΩ, having a tolerance

range of 5 to 20%. They are quite inexpensive. The relative size of all fixed resistors changes with the wattage rating.

Another variety of carbon composition resistors is the metalized type. It is made by deposition a homogeneous film of pure carbon over a glass, ceramic or other insulating core. This type of film-resistor is sometimes called the precision type, since it can be obtained with an accuracy of $\pm 1\%$.



A Wire Wound Resistor :

It uses a length of resistance wire, such as nichrome. This wire is wound on to a round hollow porcelain core. The ends of the winding are attached to these metal pieces inserted in the core. Tinned copper wire leads are attached to these metal pieces. This assembly is coated with an enamel coating powdered glass. This coating is very smooth and gives mechanical protection to winding. Commonly available

wire wound resistors have resistance values ranging from 1Ω to $100K\Omega$, and wattage rating up to about 200W.

Coding Of Resistor :

Some resistors are large enough in size to have their resistance printed on the body. However there are some resistors that are too small in size to have numbers printed on them. Therefore, a system of colour coding is used to indicate their values. For fixed, moulded composition resistor four colour bands are printed on one end of the outer casing. The colour bands are always read left to right from the end that has the bands closest to it. The first and second band represents the first and second significant digits, of the resistance value. The third band is for the number of zeros that follow the second digit. In case the third band is gold or silver, it represents a multiplying factor of 0.1 to 0.01. The fourth band represents the manufacture's tolerance.

RESISTOR COLOUR CHART

0 black	0 black	0 black	0 black
1 brown	1 brown	1 brown	1 brown
2 red	2 red	2 red	2 red
3 orange	3 orange	3 orange	3 orange
4 yellow	4 yellow	4 yellow	4 yellow
5 green	5 green	5 green	5 green
6 blue	6 blue	6 blue	6 blue
7 purple	7 purple	7 purple	7 purple
8 silver	8 silver	8 silver	8 silver
9 white	9 white	9 white	9 white

For example, if a resistor has a colour band sequence: yellow, violet, orange and gold

Then its range will be—

Yellow=4, violet=7, orange= 10^3 , gold= $\pm 5\%$ = $47\text{K}\Omega \pm 5\%$
= $2.35\text{K}\Omega$

Most resistors have 4 bands:

- The first band gives the first digit.

- The second band gives the second digit.
- The third band indicates the number of zeros.
- The fourth band is used to show the tolerance (precision) of the resistor.



This resistor has red (2), violet (7), yellow (4 zeros) and gold bands.

So its value is $270000\ \Omega = 270\ \text{k}\Omega$.

The standard colour code cannot show values of less than $10\ \Omega$. To show these small values two special colours are used for the third band: **gold**, which means $\times 0.1$ and **silver** which means $\times 0.01$. The first and second bands represent the digits as normal.

For example:

red, **violet**, **gold** bands represent $27 \times 0.1 = 2.7\ \Omega$

blue, **green**, **silver** bands represent $56 \times 0.01 = 0.56\ \Omega$

The fourth band of the colour code shows the tolerance of a resistor. Tolerance is the precision of the resistor and it is given as a percentage. For example a $390\ \Omega$ resistor with a tolerance of $\pm 10\%$ will have a value within 10% of $390\ \Omega$, between $390 - 39 = 351\ \Omega$ and $390 + 39 = 429\ \Omega$ (39 is 10% of 390).

A special colour code is used for the fourth band tolerance:

silver $\pm 10\%$, **gold** $\pm 5\%$, **red** $\pm 2\%$, **brown** $\pm 1\%$.

If no fourth band is shown the tolerance is $\pm 20\%$.

VARIABLE RESISTOR: In electronic circuits, sometimes it becomes necessary to adjust the values of currents and voltages. For example it is often desired to change the volume of sound, the brightness of a television picture etc. Such adjustments can be done by using variable resistors.

Although the variable resistors are usually called rheostats in other applications, the smaller variable resistors commonly used in electronic circuits are called potentiometers.

Resistor shorthand:

Resistor values are often written on circuit diagrams using a code system which avoids using a decimal point because it is easy to miss the small dot. Instead the letters R, K and M are used in place of the decimal point. To read the code: replace the letter with a decimal point, then multiply the value by 1000 if the letter was K, or 1000000 if the letter was M. The letter R means multiply by 1.

For example:

560R means 560 Ω

2K7 means 2.7 $k\Omega$ = 2700 Ω

39K means 39 $k\Omega$

1M0 means 1.0 $M\Omega$ = 1000 $k\Omega$

Power Ratings of Resistors



High power resistors
(5W top, 25W bottom)

Photographs © [Rapid Electronics](#)

Electrical energy is converted to heat when current flows through a resistor. Usually the effect is negligible, but if the resistance is low (or the voltage across the resistor high) a large current may pass making the resistor become noticeably warm. The resistor must be able to withstand the heating effect and resistors have power ratings to show this.

Power ratings of resistors are rarely quoted in parts lists because for most circuits the standard power ratings of 0.25W or 0.5W are suitable. For the rare cases where a higher power is required it should be clearly specified in the parts list, these will be circuits using low value resistors (less than about 300 Ω) or high voltages (more than 15V).

The power, P, developed in a resistor is given by:

$P = I^2 \times R$ where: P = power developed in the resistor in watts
or (W)

$P = V^2 / R$ I = current through the resistor in amps (A)

R = resistance of the resistor in ohms (Ω)

V = voltage across the resistor in volts (V)

Examples:

- A 470Ω resistor with 10V across it, needs a power rating $P = V^2/R = 10^2/470 = 0.21\text{W}$.

In this case a standard 0.25W resistor would be suitable.

- A 27Ω resistor with 10V across it, needs a power rating $P = V^2/R = 10^2/27 = 3.7\text{W}$.

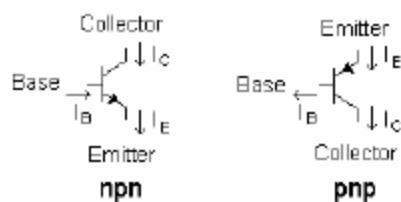
A high power resistor with a rating of 5W would be suitable.

TRANSISTORS

A transistor is an active device. It consists of two PN junctions formed by sandwiching either p-type or n-type semiconductor between a pair of opposite types.

There are two types of transistor:

1. n-p-n transistor
2. p-n-p transistor



An n-p-n transistor is composed of two n-type semiconductors separated by a thin section of p-type. However a p-n-p type semiconductor is formed by two p-sections separated by a thin section of n-type.

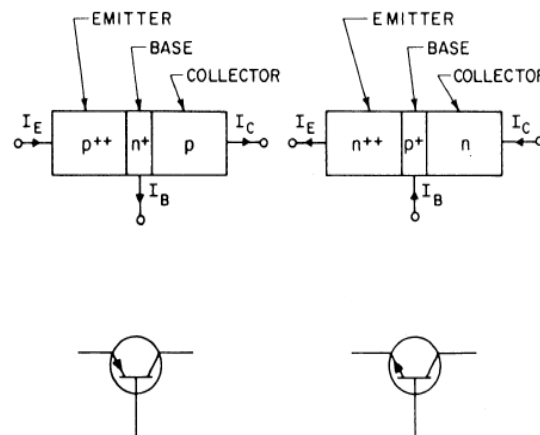
Transistor has two pn junctions one junction is forward biased and other is reversed biased. The forward junction has

a low resistance path whereas a reverse biased junction has a high resistance path.

The weak signal is introduced in the low resistance circuit and output is taken from the high resistance circuit. Therefore a transistor transfers a signal from a low resistance to high resistance.

Transistor has three sections of doped semiconductors. The section on one side is emitter and section on the opposite side is collector. The middle section is base.

Emitter : The section on one side that supplies charge carriers is called emitter. The emitter is always forward biased w.r.t. base.



Collector : The section on the other side that collects the charge is called collector. The collector is always reversed biased.

Base : The middle section which forms two pn-junctions between the emitter and collector is called base.

A transistor raises the strength of a weak signal and thus acts as an amplifier. The weak signal is applied between emitter-base junction and output is taken across the load R_c

connected in the collector circuit. The collector current flowing through a high load resistance R_c produces a large voltage across it. Thus a weak signal applied in the input appears in the amplified form in the collector circuit.

Heat sink



Waste heat is produced in transistors due to the current flowing through them. Heat sinks are needed for power transistors because they pass large currents. If you find that a transistor is becoming too hot to touch it certainly needs a heat sink! The heat sink helps to dissipate (remove) the heat by transferring it to the surrounding air.

CONNECTORS

Connectors are basically used for interface between two. Here we use connectors for having interface between PCB and 8051 Microprocessor Kit.

There are two types of connectors they are male and female. The one, which is with pins inside, is female and other is male.

These connectors are having bus wires with them for connection.

For high frequency operation the average circumference of a coaxial cable must be limited to about one wavelength, in order to reduce multimodal propagation and eliminate erratic reflection coefficients, power losses, and signal distortion.

The standardization of coaxial connectors during World War II was mandatory for microwave operation to maintain a low reflection coefficient or a low voltage standing wave ratio.

Seven types of microwave coaxial connectors are as follows:

- 1.APC-3.5
- 2.APC-7
- 3.BNC
- 4.SMA
- 5.SMC
- 6.TNC
- 7.Type N

LED (LIGHT EMITTING DIODE)

A junction diode, such as LED, can emit light or exhibit electro luminescence. Electro luminescence is obtained by injecting minority carriers into the region of a pn junction where radiative transition takes place. In radiative transition, there is a transition of electron from the conduction band to the valence band, which is made possibly by emission of a photon. Thus, emitted light comes from the hole electron recombination. What is required is that electrons should make a transition from higher energy level to lower energy level releasing photon of wavelength corresponding to the energy difference associated with this transition. In LED the supply of high-energy electron is provided by forward biasing the diode, thus injecting electrons into the n-region and holes into p-region.

The pn junction of LED is made from heavily doped material. On forward bias condition, majority carriers from both sides of the junction cross the potential barrier and enter the opposite side where they are then minority carrier and cause local minority carrier population to be larger than normal. This is termed as minority injection. These excess minority carrier diffuse away from the junction and recombine with majority carriers.

In LED, every injected electron takes part in a radiative recombination and hence gives rise to an emitted photon. Under reverse bias no carrier injection takes place and consequently no photon is emitted. For direct transition from conduction band to valence band the emission wavelength.

In practice, every electron does not take part in radiative recombination and hence, the efficiency of the device may be described in terms of the quantum efficiency which is defined as the rate of emission of photons divided by the rate of supply of electrons. The number of radiative recombination,

that take place, is usually proportional to the carrier injection rate and hence to the total current flowing.

LED Materials:

One of the first materials used for LED is GaAs. This is a direct band gap material, i.e., it exhibits very high probability of direct transition of electron from conduction band to valence band. GaAs has $E_g = 1.44$ eV. This works in the infrared region.

GaP and GaAsP are higher band gap materials. Gallium phosphide is an indirect band gap semiconductor and has poor efficiency because band to band transitions are not normally observed.

Gallium Arsenide Phosphide is a tertiary alloy. This material has a special feature in that it changes from being direct band gap material.

Blue LEDs are of recent origin. The wide band gap materials such as GaN are one of the most promising LEDs for blue and green emission. Infrared LEDs are suitable for optical coupler applications.

ADVANTAGES OF LEDs:

- 1. Low operating voltage, current, and power consumption makes LEDs compatible with electronic drive circuits. This also makes easier interfacing as compared to filament incandescent and electric discharge lamps.**
2. The rugged, sealed packages developed for LEDs exhibit high resistance to mechanical shock and vibration and allow LEDs to be used in severe environmental conditions where other light sources would fail.

3. LED fabrication from solid-state materials ensures a longer operating lifetime, thereby improving overall reliability and lowering maintenance costs of the equipment in which they are installed.
4. The range of available LED colours-from red to orange, yellow, and green-provides the designer with added versatility.
5. LEDs have low inherent noise levels and also high immunity to externally generated noise.
6. Circuit response of LEDs is fast and stable, without surge currents or the prior “warm-up”, period required by filament light sources.
7. LEDs exhibit linearity of radiant power output with forward current over a wide range.

LEDs have certain limitations such as:

1. Temperature dependence of radiant output power and wave length.
2. Sensitivity to damages by over voltage or over current.
3. Theoretical overall efficiency is not achieved except in special cooled or pulsed conditions.

Buzzer



Fig: Symbol of a Buzzer



Fig: A Simple Buzzer

It is an electronic signaling device which produces buzzing sound. It is commonly used in automobiles, phone alarm systems and household appliances. Buzzers work in the same manner as an alarm works. They are generally equipped with sensors or switches connected to a control unit and the control unit illuminates a light on the appropriate button or control panel, and sound a warning in the form of a continuous or intermittent buzzing or beeping sound.

The word "buzzer" comes from the rasping noise that buzzers made when they were electromechanical devices, operated from stepped-down AC line voltage at 50 or 60 cycles.

Typical uses of buzzers and beepers include alarms, timers and confirmation of user input such as a mouse click or keystroke.

2.9.1 Types of Buzzers

The different types of buzzers are electric buzzers, electronic buzzers, mechanical buzzers, electromechanical, magnetic buzzers, piezoelectric buzzers and piezo buzzers.

(i) Electric buzzers –

A basic model of electric buzzer usually consists of simple circuit components such as resistors, a capacitor and 555 timer IC or an integrated circuit with a range of timer and

multi-vibrator functions. It works through small bits of electricity vibrating together which causes sound.

(ii) Electronic buzzers –

An electronic buzzer comprises an acoustic vibrator comprised of a circular metal plate having its entire periphery rigidly secured to a support, and a piezoelectric element adhered to one face of the metal plate. A driving circuit applies electric driving signals to the vibrator to vibrationally drive it at a $1/N$ multiple of its natural frequency, where N is an integer, so that the vibrator emits an audible buzzing sound. The metal plate is preferably mounted to undergo vibration in a natural vibration mode having only one nodal circle. The drive circuit includes an inductor connected in a closed loop with the vibrator, which functions as a capacitor, and the circuit applies signals at a selectively variable frequency to the closed loop to accordingly vary the inductance of the inductor to thereby vary the period of oscillation of the acoustic vibrator and the resultant frequency of the buzzing sound.

(iii) Mechanical Buzzer-

A joy buzzer is an example of a purely mechanical buzzer.

(iv) Piezo Buzzers/ Piezoelectric Buzzers –



A *piezo buzzer* is made from two conductors that are separated by Piezo crystals. When a voltage is applied to these crystals, they push on one conductor and pull on the other. The result of this push and pull is a sound wave. These buzzers can be used for many things, like signaling when a period of time is up or making a sound when a particular button has been pushed. The process can also be reversed to use as a guitar pickup.

When a sound wave is passed, they create an electric signal that is passed on to an audio amplifier.

Piezo buzzers are small electronic devices that emit sounds when driven by low voltages and currents. They are also called piezoelectric buzzers. They usually have two electrodes and a diaphragm. The diaphragm is made from a metal plate and piezoelectric material such as a ceramic plate.

(v) Magnetic Buzzers –



Magnetic buzzers are magnetic audible signal devices with built-in oscillating circuits. The construction combines an oscillation circuit unit with a detection coil, a drive coil and a magnetic transducer. Transistors, resistors, diodes and other small devices act as circuit devices for driving sound generators. With the application of voltage, current flows to the drive coil on primary side and to the detection coil on the secondary side. The amplification circuit, including the transistor and the feedback circuit, causes vibration. The oscillation current excites the coil and the unit generates an AC magnetic field corresponding to an oscillation frequency. This AC magnetic field magnetizes the yoke comprising the magnetic circuit. The oscillation from the intermittent magnetization prompts the vibration diaphragm to vibrate up and down, generating buzzer sounds through the resonator.

In this project, a magnetic buzzer has been used.

2.9.2 Circuit of buzzer –

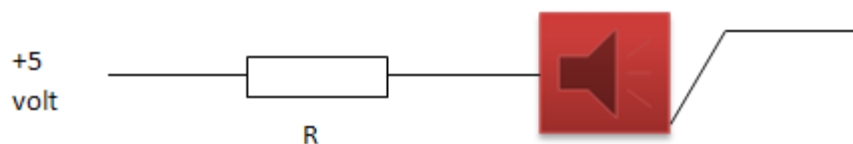


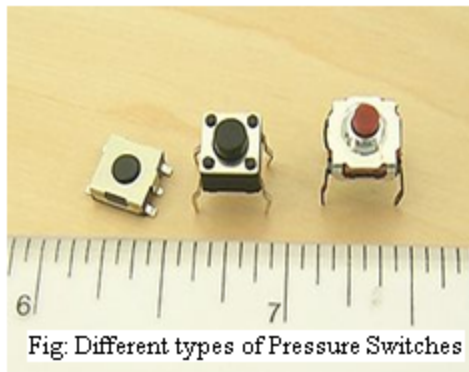
Fig: Circuit of Buzzer used

2.9.3 Role of buzzer in this project

Buzzer in this system gives the beep when car moves inside cutting the infrared light. Basically it generates the signal to indicate that car has entered in the parking space.

2.10 Pressure Sensor/Switch

A pressure sensor or switch measures pressure. Pressure is usually expressed in terms of force per unit area. A pressure sensor usually acts as a transducer; it generates a signal as a function of the pressure imposed.



Pressure sensors can be classified in term of pressure ranges they measure, temperature ranges of operation, and most importantly the type of pressure they measure. In terms of pressure type, pressure sensors can be divided into five categories:

1) Absolute pressure sensor

This sensor measures the pressure relative to perfect vacuum pressure.

2) Gauge pressure sensor

This sensor is used in different applications because it can be calibrated to measure the pressure relative to a given atmospheric pressure at a given location.

3) Vacuum pressure sensor

This sensor is used to measure pressure less than the atmospheric pressure at a given location.

4) Differential pressure sensor

This sensor measures the difference between two or more pressures introduced as inputs to the sensing unit.

5) Sealed pressure sensor

This sensor is the same as the gauge pressure sensor except that it is previously calibrated by manufacturers to measure pressure relative to sea level pressure.

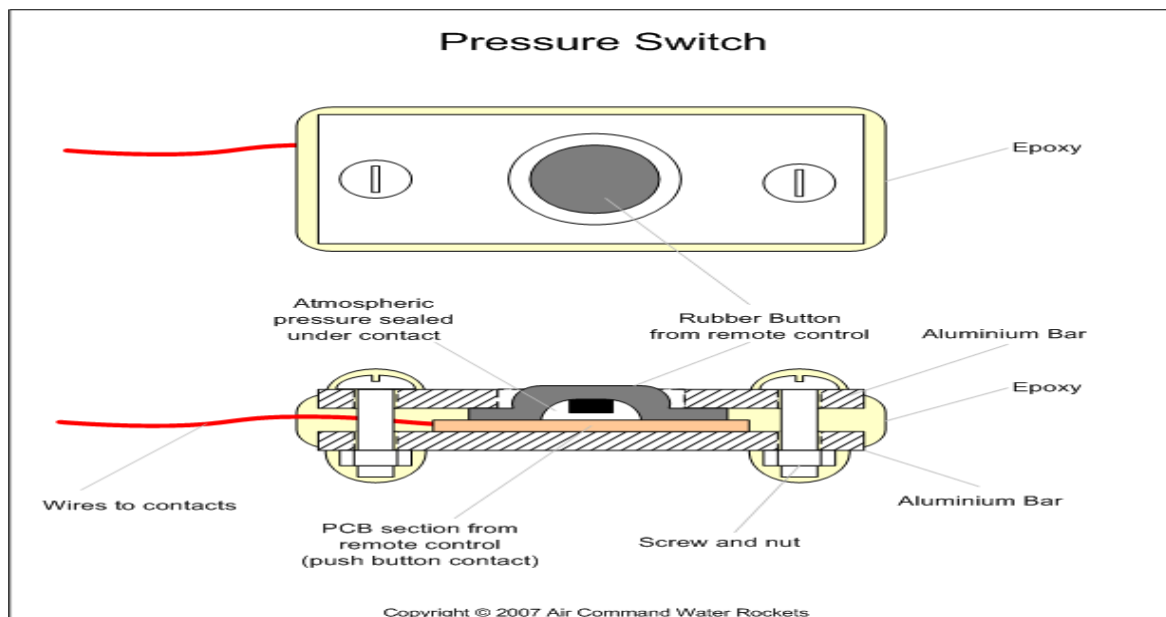


Fig: Operation of pressure switch

1.10.1 Pressure Sensing Technology

There are two basic categories of analog pressure sensors:

(i) Force collector types - These types of electronic pressure sensors generally use a force collector (such a diaphragm, piston, bourdon tube, or bellows) to measure strain (or deflection) due to applied force (pressure) over an area.

(ii) Other types - These types of electronic pressure sensors use other properties (such as density) to infer pressure of a gas, or liquid.

Here we'll discuss only about Force collector type of pressure sensors. Force collecting pressure sensors are of following types:

Piezoresistive Strain Gauge-

Uses the piezoresistive effect of bonded or formed strain gauges to detect strain due to applied pressure. Generally, the strain gauges are connected to form a wheat stone bridge circuit to maximize the output of the sensor. This is the most commonly employed sensing technology for general purpose pressure measurement.

Capacitive - Uses a diaphragm and pressure cavity to create a variable capacitor to detect strain due to applied pressure. Common technologies use metal, ceramic, and silicon diaphragms. Generally, these technologies are most applied to low pressures (Absolute, Differential and Gauge)

Electromagnetic - Measures the displacement of a diaphragm by means of changes in inductance (reluctance), LVDT, Hall Effect, or by eddy current principal.

Piezoelectric - Uses the piezoelectric effect in certain materials such as quartz to measure the strain upon the sensing mechanism due to pressure. This technology is commonly employed for the measurement of highly dynamic pressures.

Optical - Uses the physical change of an optical fiber to detect strain due to applied pressure.

Potentiometric - Uses the motion of a wiper along a resistive mechanism to detect the strain caused by applied pressure .

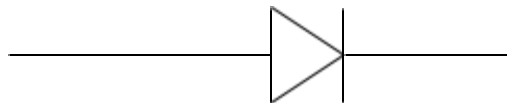
DIODE

ACTIVE COMPONENT-

Active component are those component for not any other component are used its operation. I used in this project only function diode, these component description are described as bellow.

SEMICONDUCTOR DIODE-

A PN junctions is known as a semiconductor or crystal diode. A crystal diode has two terminal when it is connected in a circuit one thing is decide is weather a diode is forward or reversed biased. There is a easy rule to ascertain it. If the external CKT is trying to push the conventional current in the direction of arrow, the diode is forward biased. One the other hand if the conventional current is trying is trying to flow opposite the arrow head, the diode is reversed biased putting in simple words.



1. If arrowhead of diode symbol is positive W.R.T Bar of the symbol, the diode is forward biased.
2. The arrowhead of diode symbol is negative W.R.T bar, the diode is the reverse bias.

When we used crystal diode it is often necessary to know that which end is arrowhead and which end is bar. So following methods are available.

1. Some manufacturers actually point the symbol on the body of the diode e.g. BY127 by 114 crystal diode manufactured by BEB.

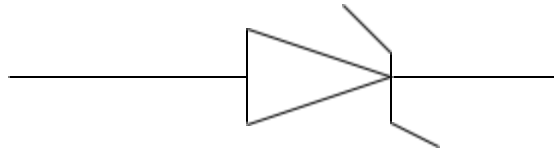


2. Sometimes red and blue marks are on the body of the crystal diode. Red mark does not arrow where's blue mark indicates bar e.g. OA80 crystal diode.

ZENER DIODE-

It has been already discussed that when the reverse bias on a crystal diode is increased a critical voltage, called break down voltage. The break down or

zener voltage depends upon the amount of doping. If the diode is heavily doped depletion layer will be thin and consequently the break down of the junction will occur at a lower reverse voltage. On the other hand, a lightly doped diode has a higher break down voltage, it is called zener diode



A properly doped crystal diode, which has a sharp break down voltage, is known as a zener diode.

APPLICATION:

1. This system can be successfully employed at the highways.
2. It can also be used where the traffic density is very high so in order to manage heavy traffic this automatic system can be proved to be very helpful.
3. Since this system is automatic this eliminates the need of manual operation of opening the entry and exit gate and hence can be applied
4. for managing the different lanes of different vehicles.

FUTURE SCOPE:

1. This system can be made more advanced by using cameras to watch the vehicles taking entry through gate.
2. Future enhancement is to use sensors for detecting the amount to be deposited and collecting it automatically.
3. Modifying it for the application where there different lanes through big and small vehicles are taking the entry.

CONCLUSION

Microcontroller based high tech toll tax system forms a vital link in the management chain. It can be widely implemented on toll tax places .this system make saves time of driver and also of person on service for taking toll tax .This system automate the whole system for toll tax . A display unit is used to display the amount to be given and a buzzer produces an alarming sound to catch the attention of the person at the reception.

LED's are also provided for better monitoring and management of the requests. On the whole it can serve the purpose of managing the traffic .

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