

## BONAFIDE CERTIFICATE

Certified that this project report “ALL DIRECTIONAL MOVING PICK AND PLACE ROBOT USING WIRELESS COMMUNICATION” is the bonafide work of “C.ANBALAGAN (0710107004), C.BALA MURALI KRISHNA (0710107012), C.DAYANETHI (0710107017)” who carried out the project work under my supervision.



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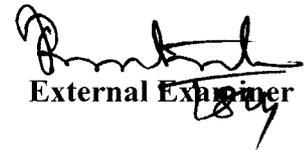
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## Abstract

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## ABSTRACT

The main aim of this project is to minimize the human work, especially in industry to lift heavy goods and automatize that environment.

This project, as the name implies, is an idea of developing a system that allows user to take control on the acceleration and movement of a vehicle by establishing a wireless link and to pick and place the object wherever we want. The proposed method involves the development of the system by interlinking three discrete modules. The first module is the PC module in which the surrounding area of the robot is viewed through the monitor and has a transmitter circuit that consists of an encoder and a transmitter that is coupled to an antenna. This circuit is used to serialize and to transmit the parallel data. The generated control word is routed to the parallel port of the PC to which an external wireless transmitter system is interfaced. Over here, the control word is serialized with synchronization and transmitted at the transmitter module frequency.

The second module is the robot module with the receiver section in the vehicle. Exactly tuned receiver setup in the vehicle, which takes in the receiver data and then convert it into the original data corresponding to the one output at the parallel port. The regenerated control word is routed to the drive circuitry, which assists in proper control of the vehicle.

The third module is the software module which includes the visual basic (VB) programming and C programming. The instructions for the movement of vehicle are given by PC through Visual Basic (VB) programmed in C program which controls the rotation of DC motors.

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# Introduction

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## INTRODUCTION

With their computational and agile skills robots perform tasks that are difficult or hazardous to humans. Advances in microchips, microprocessors, sensors, control, systems, mechanical engineering, transducers, and telecommunications have resulted in widespread growth of robotic processes and applications.

Today's robots are mechanical arms controlled by computers that are programmed to perform a range of handling activities. They are establishing themselves in manufacturing automation systems to produce a range of goods with great precision.

The emerging era of robots calls for different types of skills. Entering non-industrial areas, the first fledgling robots for domestic use are coming off the production lines. Robots are being used in hazardous places, such as outer space or under the sea. Technical advances are gradually endowing robots with properties that actually increase their similarity to humans.

The industry is the arm itself with its gripper or 'end effector'. The arm has several joints, corresponding to those on the comparable human limb. In sophisticated robots, its own motor that acts independently of others controls each joint. The power supply produces a set of forces that move the program in the robot's computer and responsible for the way the machine conducts a specific operation.

Robot is used for constant doing job. In this project robot keeps on moving to pick an object and place it. A gripper is used for this purpose. The gripper is nothing but a Gear motor. When the gripper is opened and closed, the object is picked and it is placed in a particular place. The movement of the robot is done with the help of gear motor. The gear motor is used for accurate movement.

This system is implemented using the voice recognition technique. Where Robot operates based on the given voice as input. The input Signal is communicated with the Robot Using wireless Radio Frequency (433.92 MHz).

Block diagram

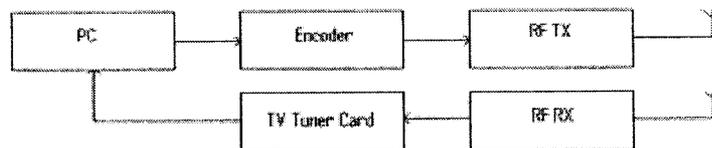
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## BLOCK DIAGRAM

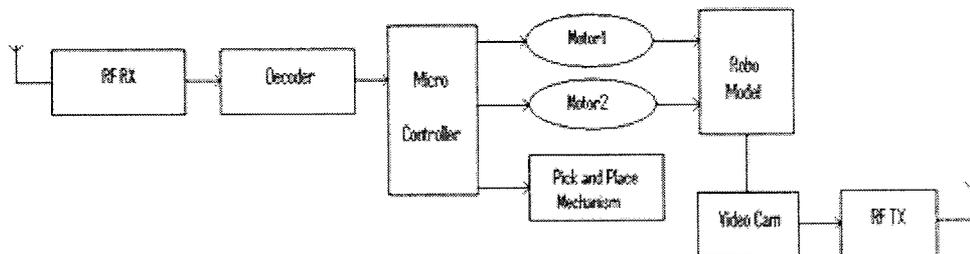
### 2.1 OVERVIEW OF THE BLOCK DIAGRAM

As explained in the introduction the complete block diagram can be divided into three modules. Fig1.1 show the complete bock diagram of the Pick and Place Robot along with Wireless Camera.

#### PC SECTION



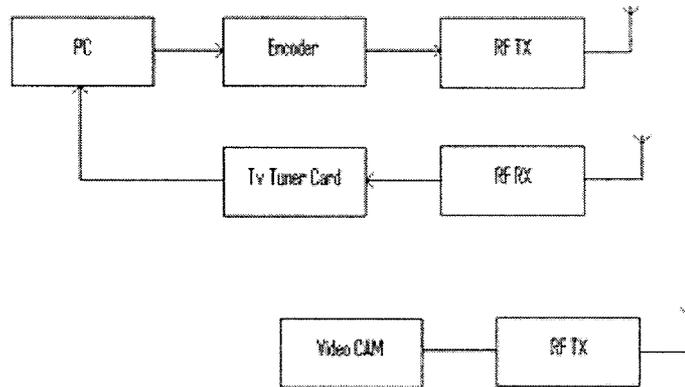
#### ROBO SECTION



**Fig 2.1 Block Diagram**

The working of the three sections namely PC section, Robo section and Software section are clearly explained below.

## PC MODULE



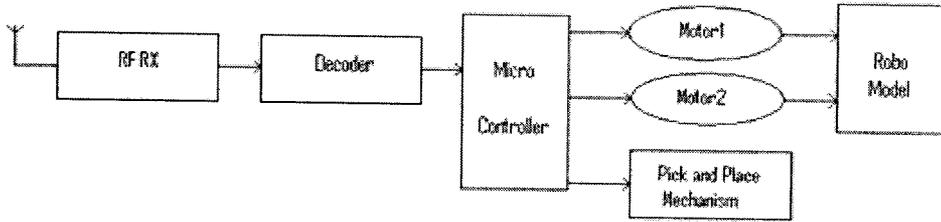
**Fig 2.2 Block Diagram Of PC Module**

Wireless camera in the Robot module views the surroundings where the robot has been placed. Then the video signal is amplitude modulated by the RF transmitter and transmitted through the antenna.

The amplitude modulated video signal is received by the RF receiver in the PC module. The video signal from the RF receiver is captured and video image is viewed through the monitor of computer by the TV tuner card.

The instructions for the movement of the Robot are given by PC through Embedded C programming. These instructions i.e. control words are transmitted to the encoder through DB25 parallel port. The encoder is for the serialization of data from PC and to ensure error free transmission by enabling redundancy of output data. The encoder output pins are shorted so that the output encoded signal is the combination of (A0-A9) address signal and (D11-D17) data signal. The serialized data from the encoder is transmitted to the RF transmitter. The RF transmitter generates a 433MHz carrier signal and modulates the serialized data from the encoder. The type of modulation carried out here is Amplitude Shift Keying. The modulated signal is transmitted through the antenna.

## ROBO MODULE



**Fig 2.3 Block Diagram Of Robo Module**

The RF receiver is used to receive the modulated data which is transmitted by the RF transmitter. Then the demodulated signal is given to decoder in order to get the decoded original signal. Serially encoded data is decoded into parallel data by the decoder. The decoder separate the address (A0-A9) and data signal (D11-D17). Then the output data signal is given to the microcontroller.

The microcontroller IC hat is made use of is the AT89C51 from Atmel. The microcontroller AT89C51 is interfaced with the DC motor relay circuit. The working of DC motor is controlled by the microcontroller. The microcontroller AT89C51 is programmed in C program and it is compiled according to the assembly language of the microcontroller AT89C51 through the compiler K LIN C.

## SOFTWARE MODULE

The instructions for the movement of vehicle are given by PC through Visual Basic (VB) programming. The working of DC motor is controlled by the microcontroller Atmel AT89S52. The microcontroller AT89S52 is programmed in C program and it is compiled according to the assembly language of the microcontroller AT89S52 through the compiler K LIN C.

## 2.2 OVER ALL CIRCUIT DIAGRAM

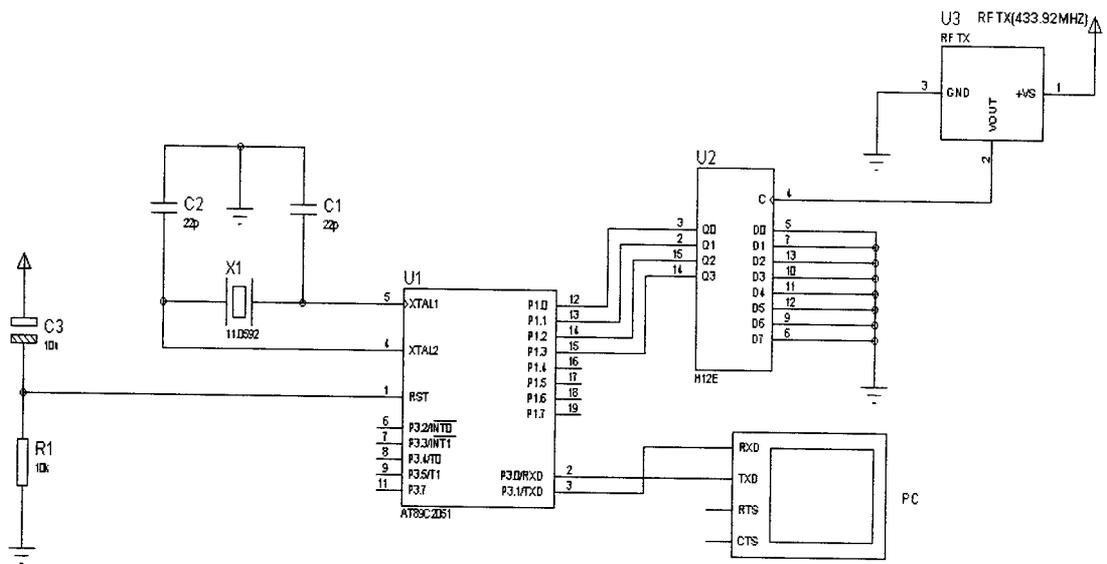


Fig 2.4 Transmitter side

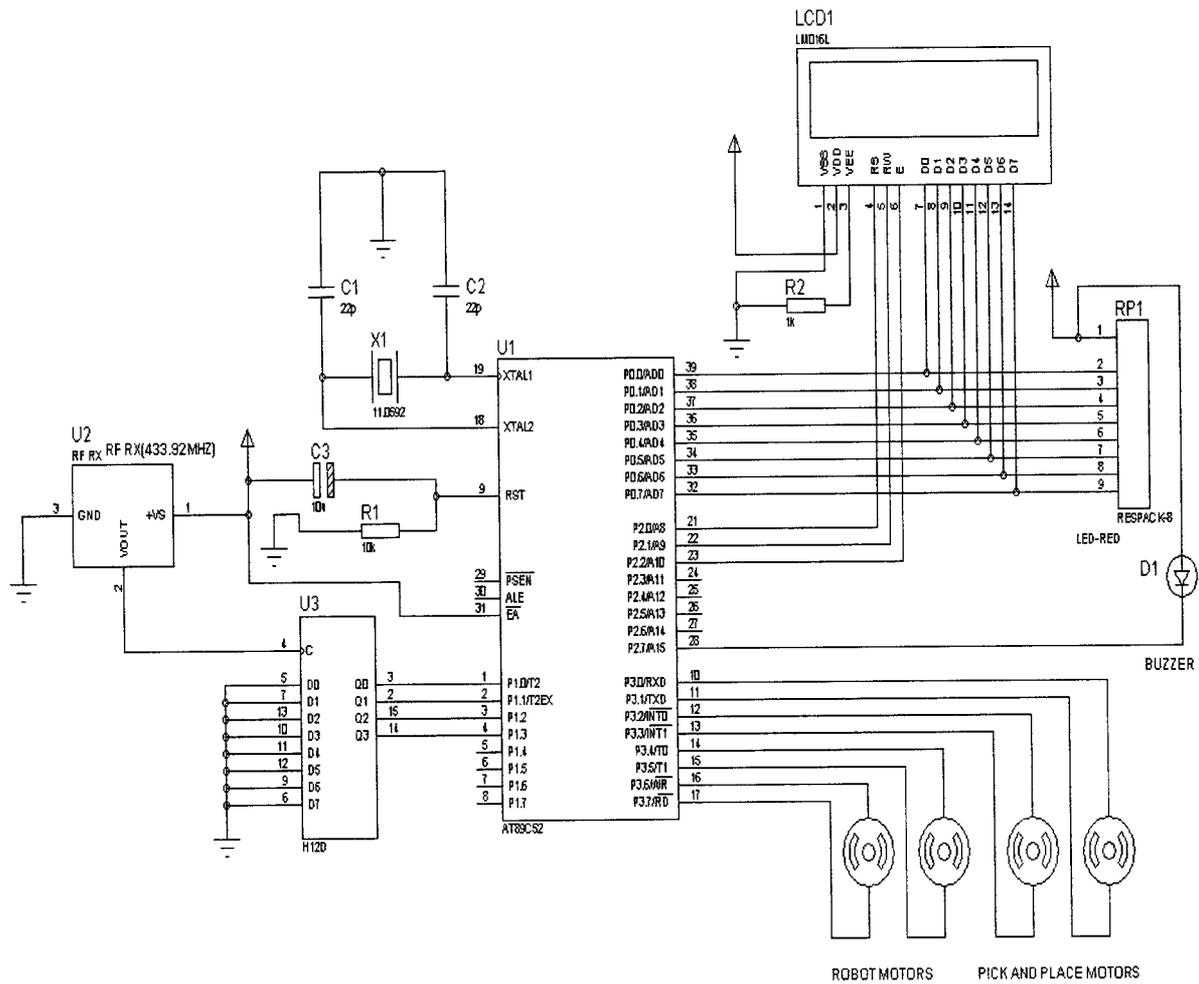


Fig 2.5 Receiver Side

## 2.3 POWER SUPPLY

### BLOCK DIAGRAM

The present chapter introduces the operation of power supply circuits built using filters, rectifiers, and then voltage regulators. Starting with an ac voltage, a steady dc voltage is obtained by rectifying the ac voltage, then filtering to a dc level, and finally, regulating to obtain a desired fixed dc voltage. The regulation is usually obtained from an IC voltage regulator unit, which takes a dc voltage and provides a somewhat lower dc voltage, which remains the same even if the input dc voltage varies, or the output load connected to the dc voltage changes.

The block diagram containing the parts of a typical power supply and the voltage at various points in the unit. The ac voltage, typically 120 V rms, is connected to a transformer, which steps that ac voltage down to the level for the desired dc output. A diode rectifier then provides a full-wave rectified voltage that is initially filtered by a simple capacitor filter to produce a dc voltage. This resulting dc voltage usually has some ripple or ac voltage variation. A regulator circuit can use this dc input to provide a dc voltage that not only has much less ripple voltage but also remains the same dc value even if the input dc voltage varies somewhat, or the load connected to the output dc voltage changes. This voltage regulation is usually obtained using one of a number of popular voltage regulator IC units.

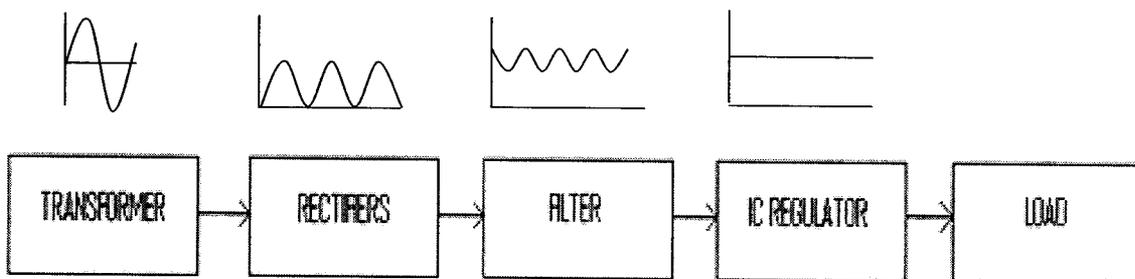
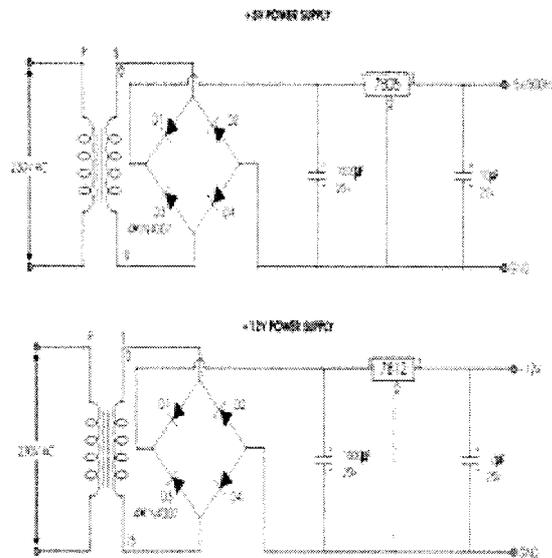


Fig 2.6 Block Diagram Of Power Supply

## IC Voltage Regulators

Voltage regulators comprise a class of widely used ICs. Regulator IC units contain the circuitry for reference source, comparator amplifier, control device, and overload protection all in a single IC. Although the internal construction of the IC is somewhat different from that described for discrete voltage regulator circuits, the external operation is much the same. IC units provide regulation of either a fixed positive voltage, a fixed negative voltage, or an adjustably set voltage.



**Fig2.7 Circuit Diagram Of Power Supply**

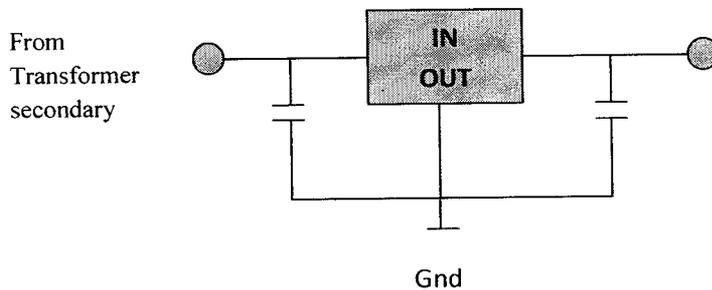
A power supply can be built using a transformer connected to the ac supply line to step the ac voltage to a desired amplitude, then rectifying that ac voltage, filtering with a capacitor and RC filter, if desired, and finally regulating the dc voltage using an IC regulator. The regulators can be selected for operation with load currents from hundreds of milli amperes to tens of amperes, corresponding to power ratings from milliwatts to tens of watts.

### THREE-TERMINAL VOLTAGE REGULATORS

Fig shows the basic connection of a three-terminal voltage regulator IC to a load. The fixed voltage regulator has an unregulated dc input voltage,  $V_i$ , applied to one input terminal, a regulated output dc voltage,  $V_o$ , from a second terminal, with the third terminal connected to

ground. For a selected regulator, IC device specifications list a voltage range over which the input voltage can vary to maintain a regulated output voltage over a range of load current. The specifications also list the amount of output voltage change resulting from a change in load current (load regulation) or in input voltage (line regulation).

### FIXED POSITIVE VOLTAGE REGULATORS



**Fig 2.8 Pin Diagram Of 7805 Voltage Regulator**

The series 78 regulators provide fixed regulated voltages from 5 to 24 V. Figure 19.26 shows how one such IC, a 7812, is connected to provide voltage regulation with output from this unit of +12V dc. An unregulated input voltage  $V_i$  is filtered by capacitor C1 and connected to the IC's IN terminal. The IC's OUT terminal provides a regulated + 12V which is filtered by capacitor C2 (mostly for any high-frequency noise). The third IC terminal is connected to ground (GND). While the input voltage may vary over some permissible voltage range, and the output load may vary over some acceptable range, the output voltage remains constant within specified voltage variation limits. These limitations are spelled out in the manufacturer's specification sheets.

Pc module

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## PC MODULE

### 3.1 PC MODULE

In PC section, for the interfacing of the PC with the transmitter section which includes encoder and RF transmitter DB9 serial port is used. Explanation of the serial port is given below.

#### DB9 Serial Port

The RS232 connector was originally developed to use 25 pins. In this **DB25** connector pinout provisions were made for a secondary serial RS232 communication channel. In practice, only one serial communication channel with accompanying handshaking is present. Only very few computers have been manufactured where both serial RS232 channels are implemented. Examples of this are the Sun Sparc Station 10 and 20 models and the Dec Alpha Multia. Also on a number of Telebit modem models the secondary channel is present. It can be used to query the modem status while the modem is on-line and busy communicating. On personal computers, the smaller **DB9** version is more commonly used today. The diagrams show the signals common to both connector types in black. The defined pins only present on the larger connector are shown in red. Note, that the protective ground is assigned to a pin at the large connector where the connector outside is used for that purpose with the **DB9** connector version.

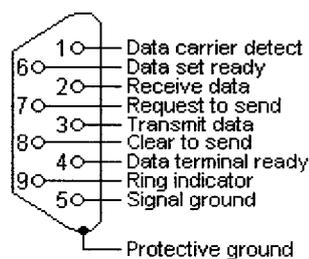


Fig 3.1 Pin Design Of DB9 Serial Port

## MAX232

The MAX232 is a dual driver/receiver that includes a capacitive voltage generator to supply TIA/EIA-232-F voltage levels from a single 5-V supply. Each receiver converts TIA/EIA-232-F inputs to 5-V TTL/CMOS levels. These receivers have a typical threshold of 1.3 V, a typical hysteresis of 0.5 V, and can accept  $\pm 30$ -V inputs. Each driver converts TTL/CMOS input levels into TIA/EIA-232-F levels. The driver, receiver, and voltage-generator functions are available as cells in the Texas Instruments Lin ASIC library.

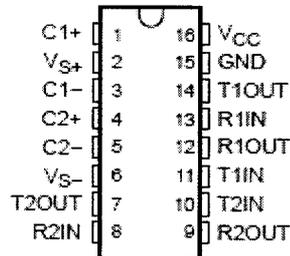


Fig 3.2 Pin Diagram Of MAX232

## INTERFACING OF MAX232

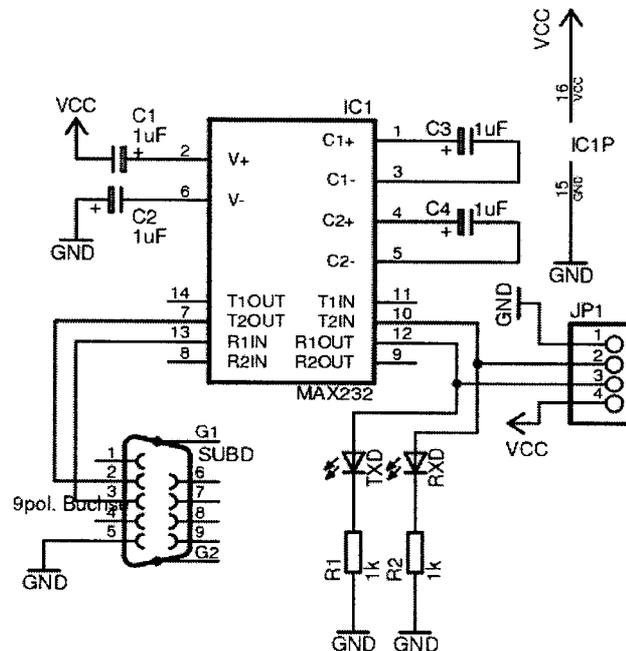


Fig 3.3 Interface Of Max232 IC With DB9 Port

## AT89C2051 MICROCONTROLLER

This IC is used for transferring the data from PC to RF Transmitter through DB9 serial port.

### DESCRIPTION

The AT89C2051 is a low-voltage, high-performance CMOS 8-bit microcomputer with 2K bytes of Flash programmable and erasable read-only memory (PEROM). The device is manufactured using Atmel's high-density nonvolatile memory technology and is compatible with the industry-standard MCS-51 instruction set. By combining a versatile 8-bit CPU with Flash on a monolithic chip, the Atmel AT89C2051 is a powerful microcomputer which provides a highly-flexible and cost-effective solution to many embedded control applications.

The AT89C2051 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.

### PIN CONFIGURATION

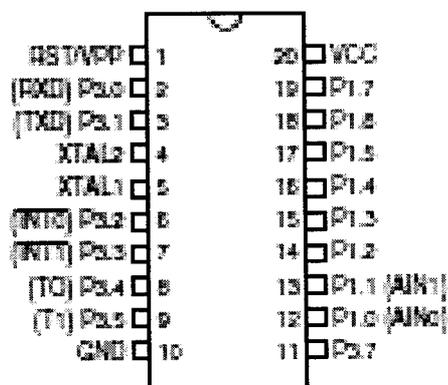


Fig 3.4 Pin Diagram Of IC AT89C2051

## **3.2 ENCODER (2<sup>12</sup> SERIES)**

The second section of the PC module is the encoder interfacing of serial port causes the transmission of information data or control words from the PC to the encoder. The main purpose of its installation in the transmission circuitry is for the serialization of data from PC. Explanation of the encoder is given below.

The encoder IC is made use of is the HT12E from HOLTEK. The main purpose of its installation in the transmission circuitry is for the serialization of data from PC and to ensure error free transmission by enabling redundancy of output data.

### **3.2.1 Features**

- Operating voltage:
  - 2.4V~5V for the HT12A/B/C
  - 2.4V~12V for the HT12E
- Low power and high noise immunity CMOS technology
- Low stand-by current· Minimum transmission word:
- Four words for the HT12E
- One word for the HT12A/B/C
- A built-in oscillator with only a 5% resistor

### **3.2.2 Applications**

- Burglar alarm system
- Smoke and fire alarm system
- Garage door controllers
- Car door controllers
- Car alarm system
- Security system
- Cordless telephones

### 3.2.3 GENERAL DESCRIPTION

The 212 encoders are a series of CMOS LSIs for remote control system applications. They are capable of encoding information which consists of N address bits and 12–N data bits. Each address/data input can be set to one of the two logic states. The programmed addresses/data are transmitted together with the header bits via an RF or an Infra-Red transmission medium upon receipt of a trigger signal. The capability to select a TE trigger on the HT12E or a DATA trigger on the HT12A/B/C further enhances the application flexibility of the 212 series of encoders. The HT12A/B/C additionally provides a 38KHz carrier for Infra-Red systems.

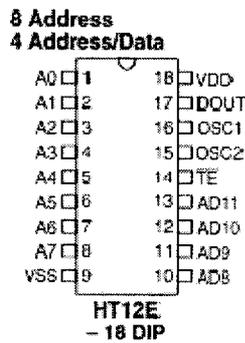


Fig3.5 Pin Diagram Of HT12E

### SELECTION TABLE

Function Item	Address No.	Address/Data No.	Data No.	Oscillator	Trigger	Package	Carrier Output	Negative Polarity
HT12A	8	0	4	455K Hz resonator	D8~D11	18 DIP/ 20 SOP	38K Hz	No
HT12B	8	0	4	455K Hz resonator	D8~D11	18 DIP/ 20 SOP	38K Hz	Yes
HT12C	0	0	10	455K Hz resonator	D2~D11	16 DIP/ 16 SOP	38K Hz	No
	2					18 DIP		
HT12E	8	4	0	RC oscillator	TE	18 DIP/ 20 SOP	No	No

Table 3.1 Selection Table Of HT12E

### 3.2.4 BLOCK DIAGRAM

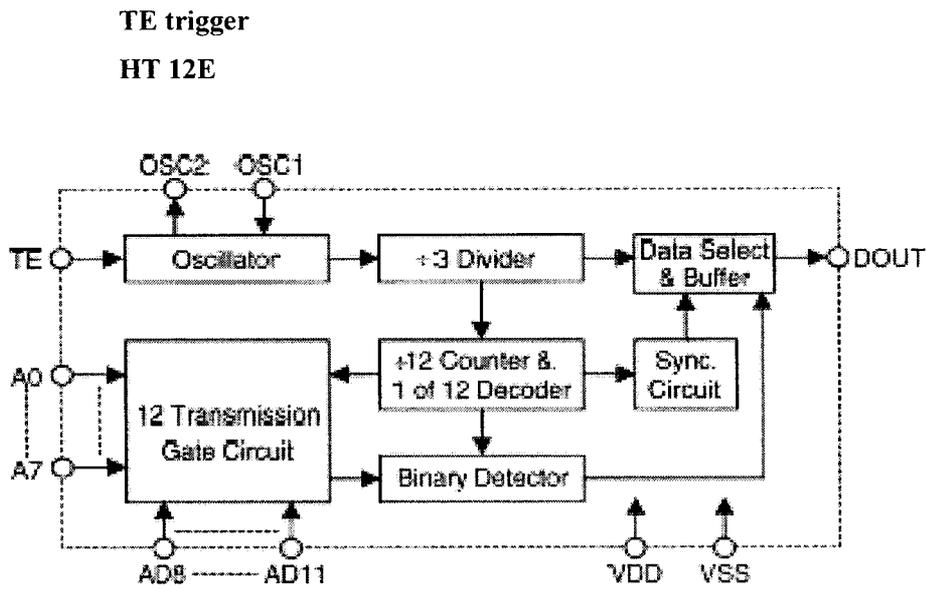


Fig 3.6 Block Diagram Of HT12E

### 3.2.5 APPROXIMATE INTERNAL CONNECTORS

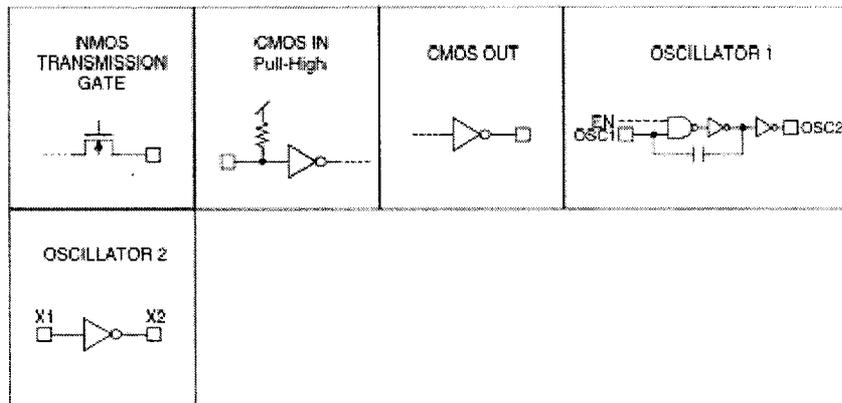


Fig 3.7 Internal Block Diagram Of HT12E

### 3.2.6 PIN DESCRIPTION

Pin Name	I/O	Internal Connection	Description
A0-A7	I	CMOS IN Pull-High (HT12A/B/C) NMOS TRANSMISSION GATE (HT12E)	Input pins for address A0-A7 setting They can be externally set to VDD or VSS.
AD8-AD11	I	NMOS TRANSMISSION GATE (HT12E)	Input pins for address/data AD8-AD11 setting They can be externally set to VDD or VSS (only for the HT12E).
D2-D11	I	CMOS IN Pull-High	Input pins for data D2-D11 setting and transmission enable, active low They can be externally set to VSS or left open (see Note).
DOUT	O	CMOS OUT	Encoder data serial transmission output
LMB	I	CMOS IN Pull-High	Latch/Momentary transmission format selection pin: Latch: Floating or VDD Momentary: VSS
$\overline{TE}$	I	CMOS IN Pull-High	Transmission enable, active low (see Note).
OSC1	I	OSCILLATOR 1	Oscillator input pin
OSC2	O	OSCILLATOR 1	Oscillator output pin
X1	I	OSCILLATOR 2	455KHz resonator oscillator input
X2	O	OSCILLATOR 2	455KHz resonator oscillator output
VSS	I	—	Negative power supply (GND)
VDD	I	—	Positive power supply

Table 3.2 Pin Description Of HT 12E

### 3.2.7 ELECTRICAL CHARACTER

HT12A/B/C		(Ta=25°C)					
Symbol	Parameter	Test Condition		Min.	Typ.	Max.	Unit
		VDD	Condition				
VDD	Operating Voltage	—	—	2.4	3	5	V
ISTR	Stand by Current	3V	Oscillator stops.	—	0.1	1	μA
		5V		—	0.1	1	μA
IDD	Operating Current	3V	No load FOSC=455KHz	—	200	400	μA
		5V		—	400	800	μA
IDOUT	Output Drive Current	5V	V <sub>OH</sub> =0.9V <sub>DD</sub> (Source)	-1	-1.6	—	mA
			V <sub>OL</sub> =0.1V <sub>DD</sub> (Sink)	2	3.2	—	mA
V <sub>IH</sub>	"H" Input Voltage	—	—	0.8V <sub>DD</sub>	—	V <sub>DD</sub>	V
V <sub>IL</sub>	"L" Input Voltage	—	—	0	—	0.2V <sub>DD</sub>	V
R <sub>DATA</sub>	D2-D11 Pull-High Resistance	5V	V <sub>DATA</sub> =0V	—	150	300	KΩ

Table 3.3 Electrical Characteristics Of HT12E

### 3.2.8 FUNCTIONAL DESCRIPTION

#### OPERATION

The  $2^{12}$  series of encoders begins a 4 word transmission cycle upon receipt of a transmission enable (TE for the HT12E or D2~D11 for the HT12A/B/C, active low). This cycle will repeat itself as long as the transmission enable (TE or D2~D11) is held low. Once the transmission enable returns high the encoder output completes its final cycle and then stops as shown in Fig.3.5 for the HT12E.

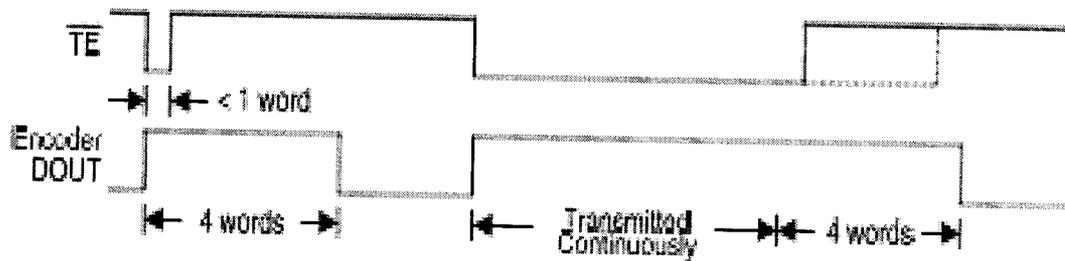


Fig 3.8 Transmission Timing For HT 12E

### 3.2.9 ADDRESS/DATA WAVEFORM

Each programmable address/data pin can be externally set to one of the following two logic states as shown below

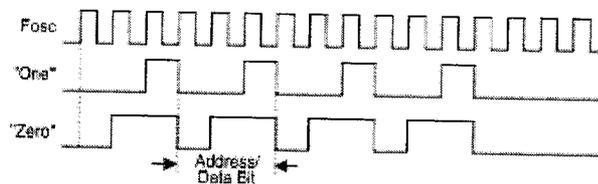


Fig 3.9 Address/Data Bit Waveform For HT 12E

### ADDRESS/DATA PROGRAMMING (PRESET)

The status of each address/data pin can be individually pre-set to logic "high" or "low". If a transmission enable signal is applied, the encoder scans and transmits the status of the 12 bits

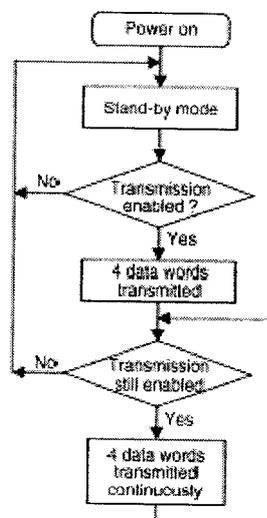
of address/data serially in the order A0 to AD11 for the HT12E encoder and A0 to D11 for the HT12A/B/C encoder. During information transmission these bits are transmitted with a preceding synchronization bit. But if the trigger signal is not applied, the chip enters the stand-by mode and consumes a reduced current which is less than 1mA for a supply voltage of 5V. Usual applications preset the address pins with individual security codes by the DIP switches or PCB wiring, while the data is selected by the push button or electronic switches.

The transmitted information is as shown:

<b>Pilot &amp; Sync.</b>	A0	A1	A2	A3	A4	A5	A6	A7	AD8	AD9	AD10	AD11
	1	0	1	0	0	0	1	1	1	1	1	0

**Table 3.4 Encoder Transmission Sequence**

### 3.2.10 HT 12E PROCESS FLOW CHART



**Fig 3.10 Encoder Control Flow**

## OSCILLATOR FREQ VS SUPPLY VOLTAGE

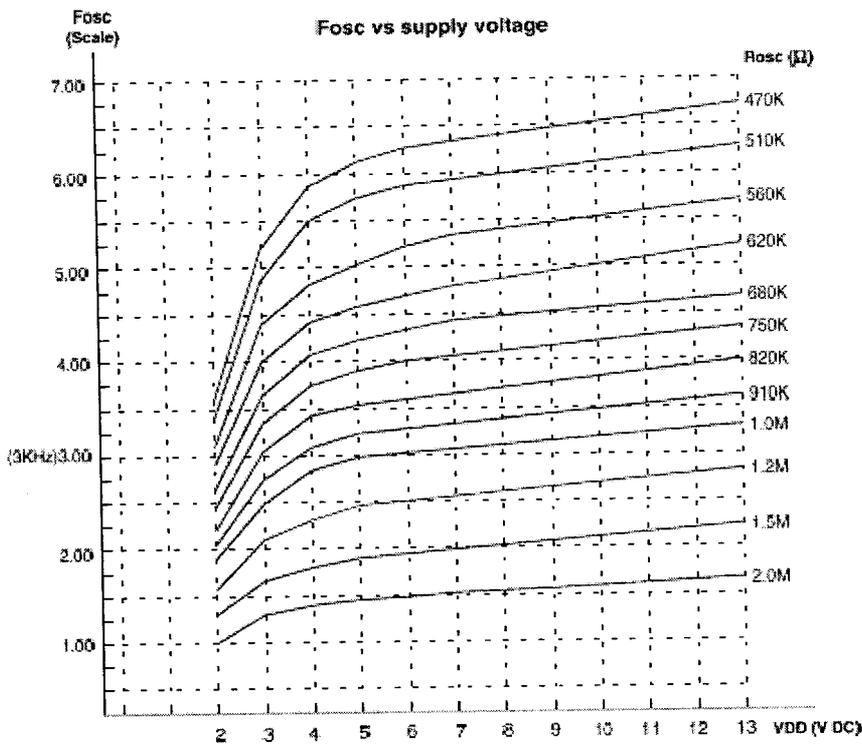


Fig 3.11 The Recommended Oscillator Frequency Is  $F_{OSCD}$  (Decoder) =  $F_{OSCE}$  (Encoder)

### 3.3 RF TRANSMITTER

The third section of PC module is the RF transmitter. The serialized encoded data from the encoder is transmitted to the RF transmitter for the modulation of the encoded signal. Explanation of the RF transmitter is given below.

The STT-433 is ideal for remote control applications where low cost and longer range is required. The transmitter operates from a 1.5-12V supply, making it ideal for battery-powered applications. The transmitter employs a SAW-stabilized oscillator, ensuring accurate frequency control for best range performance. Output power and harmonic emissions are easy to control, making FCC and ETSI compliance easy. The manufacturing-friendly SIP style package and low-cost make the STT-433 suitable for high volume applications.

### **3.3.1 OPERATION**

OOK(On Off Keying) modulation is a binary form of amplitude modulation. When a logical 0 (data line low) is being sent, the transmitter is off, fully suppressing the carrier. In this state, the transmitter current is very low, less than 1mA. When a logical 1 is being sent, the carrier is fully on. In this state, the module current consumption is at its highest, about 11mA with a 3V power supply.

OOK is the modulation method of choice for remote control applications where power consumption and cost are the primary factors. Because OOK transmitters draw no power when they transmit a 0, they exhibit significantly better power consumption than FSK transmitters.

#### **Data Rate**

The oscillator start-up time is on the order of 40uSec, which limits the maximum data rate to 4.8 kbit/sec.

#### **SAW stabilized oscillator**

The transmitter is basically a negative resistance LC oscillator whose center frequency is tightly controlled by a SAW resonator. SAW (Surface Acoustic Wave) resonators are fundamental frequency devices that resonate at frequencies much higher than crystals.

### **3.3.2 FEATURES**

- 433.92 MHz Frequency
- Low Cost
- 1.5-12V operation
- 11mA current consumption at 3V
- Small size
- 4 dBm output power at 3V.

### 3.3.3 PIN DIAGRAM:

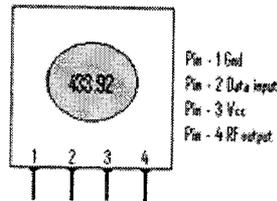
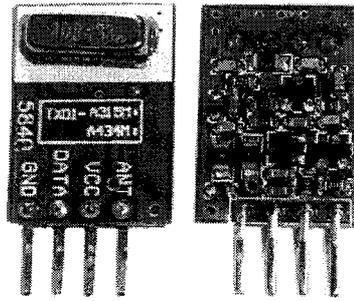


Fig 3.12 Pin Diagram Of ST-433

### 3.3.4 GENERAL CHARACTERISTICS

The following table depicts the technical specifications of the transmitter module.

Modulation:ASK

Parameter	Symbol	Min	Typ.	Max	Unit
Operating Voltage	Vcc	1.5	3.0	12	Volts DC
Operating Current Data = VCC	Icc	-	11mA @3V 59mA @5V	-	mA
Operating Current Data = GND	Icc	-	100	-	uA
Frequency Accuracy	TOL fc	-75	0	+75	Khz
Center Frequency	Fc	-	433	-	Mhz
RF Output Power		-	4 dBm@3V (2 mW) 16 dBm@5V (39 mW)		dBm / mW
Data Rate		200	1K	3K	BPS
Temperature		-20		+60	Deg. C
Power up delay			20		ms

Table 3.5 General Characteristics Of RF Transmitter

Robo module

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### 3.3.5 ENCODER WITH RF TRANSMITTER

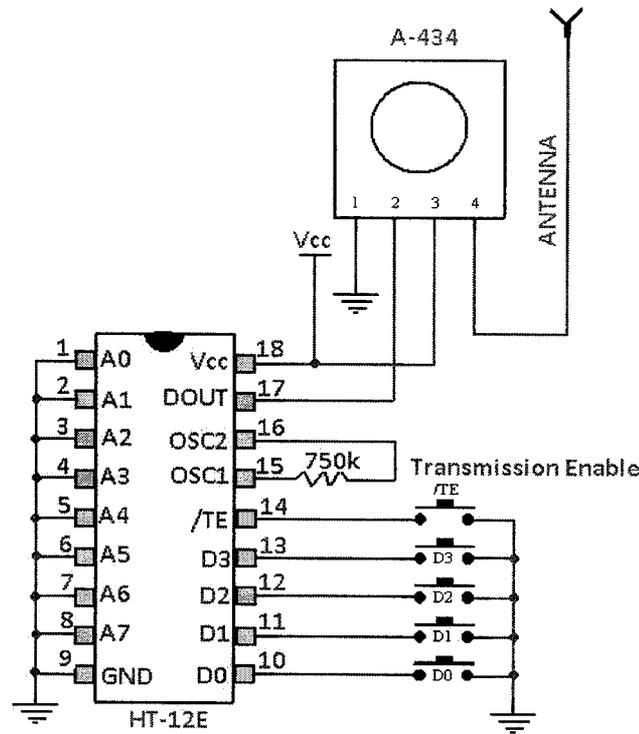


Fig 3.13 Interface Of Encoder With RF Transmitter

## ROBO MODULE

### 4.1 ROBO MODULE

In robo module, the RF receiver is used to receive the modulated data which is transmitted by the RF transmitter. Explanation of the RF receiver is given below.

#### 4.1.1 RF RECEIVER

The STR-433 is ideal for short-range remote control applications where cost is a primary concern. The receiver module requires no external RF components except for the antenna. It generates virtually no emissions, making FCC and ETSI approvals easy. The super-regenerative design exhibits exceptional sensitivity at a very low cost. The manufacturing-friendly SIP style package and low-cost make the STR-433 suitable for high volume applications.

### 4.1.2 Operation

The STR-433 uses a super-regenerative AM detector to demodulate the incoming AM carrier. A super regenerative detector is a gain stage with positive feedback greater than unity so that it oscillates. An RC-time constant is included in the gain stage so that when the gain stage oscillates, the gain will be lowered over time proportional to the RC time constant until the oscillation eventually dies. When the oscillation dies, the current draw of the gain stage decreases, charging the RC circuit, increasing the gain, and ultimately the oscillation starts again. In this way, the oscillation of the gain stage is turned on and off at a rate set by the RC time constant. This rate is chosen to be super-audible but much lower than the main oscillation rate. Detection is accomplished by measuring the emitter current of the gain stage. Any RF input signal at the frequency of the main oscillation will aid the main oscillation in restarting. If the amplitude of the RF input increases, the main oscillation will stay on for a longer period of time, and the emitter current will be higher. Therefore, we can detect the original base-band signal by simply low-pass filtering the emitter current. The average emitter current is not very linear as a function of the RF input level. It exhibits a  $1/\ln$  response because of the exponentially rising nature of oscillator start-up. The steep slope of a logarithm near zero results in high sensitivity to small input signals.

### DATA SLICER

The data slicer converts the base-band analog signal from the super-regenerative detector to a CMOS/TTL compatible output. Because the data slicer is AC coupled to the audio output, there is a minimum data rate. AC coupling also limits the minimum and maximum pulse width. Typically, data is encoded on the transmit side using pulse-width modulation (PWM) or non-return-to-zero (NRZ). The most common source for NRZ data is from a UART embedded in a micro-controller. Applications that use NRZ data encoding typically involve microcontrollers.

The most common source for PWM data is from a remote control IC such as the HC-12E from Holtek or ST14 CODEC from Sunrom Technologies. Data is sent as a constant rate square-wave. The duty cycle of that square wave will generally be either 33% (a zero) or 66% (a one).

The data slicer on the STR-433 is optimized for use with PWM encoded data, though it will work with NRZ data if certain encoding rules are followed.

## **POWER SUPPLY**

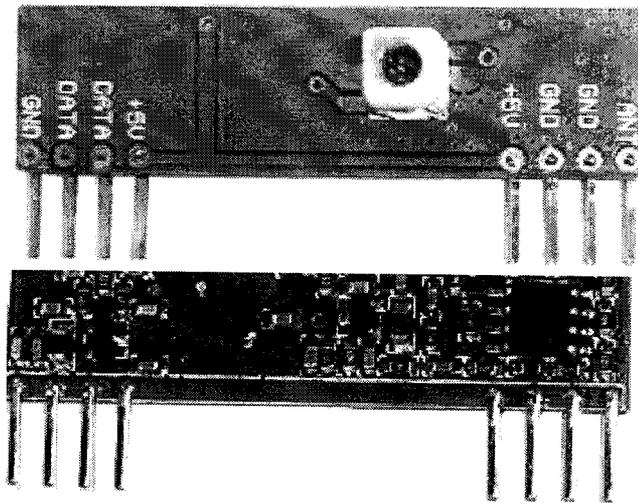
The STR-433 is designed to operate from a 5V power supply. It is crucial that this power supply be very quiet. The power supply should be bypassed using a 0.1uF low-ESR ceramic capacitor and a 4.7uF tantalum capacitor. These capacitors should be placed as close to the power pins as possible. The STR-433 is designed for continuous duty operation. From the time power is applied, it can take up to 750mSec for the data output to become valid.

## **ANTENNA INPUT**

It will support most antenna types, including printed antennas integrated directly onto the PCB and simple single core wire of about 17cm. The performance of the different antennas varies. Any time a trace is longer than 1/8th the wavelength of the frequency it is carrying, it should be a 50 ohm micro strip.

### **4.1.3 FEATURES**

- Low Cost
- 5V operation
- 3.5mA current drain
- No External Parts are required
- Receiver Frequency: 433.92 MHZ
- Typical sensitivity: -105dBm
- IF Frequency: 1MHz



#### 4.1.4 PIN DIAGRAM

STR-433 is used as a RF receiver. The STR-433 are excellent for applications requiring short-range remote controls.

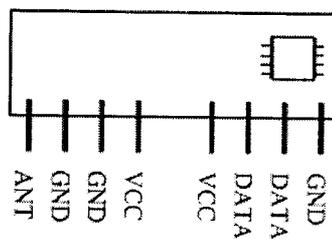


Fig 4.1 Pin Diagram Of RF Receiver

#### 4.1.5 GENERAL CHARACTERISTIC

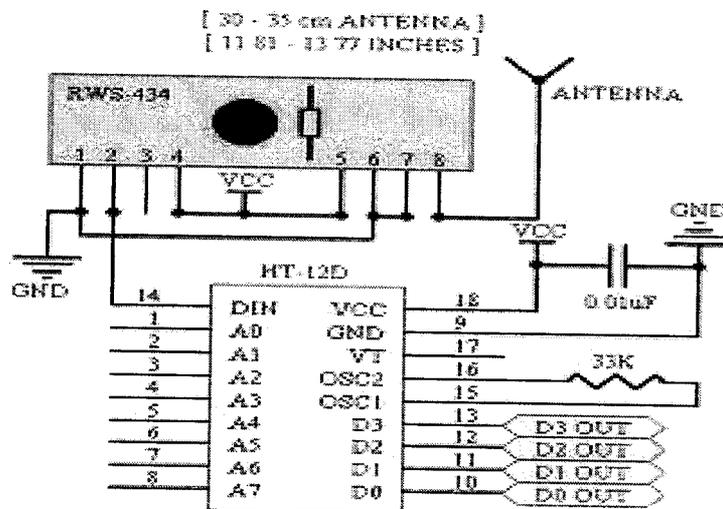
The following table depicts the technical specifications of the receiver module. With reference to the above table, the receiver module could be effectively used by maintaining the allowable range of signal specifications and also by maintaining the optimum operating conditions specified for efficient working.

Parameter	Symbol	Min	Typ.	Max	Unit
Operating Voltage	Vcc	4.5	5.0	5.5	VDC
Operating Current	Icc	-	3.5	4.5	mA
Reception Bandwidth	BW rx	-	1.0	-	MHz
Center Frequency	Fc	-	433.92	-	MHz
Sensitivity	-	-	-105	-	dBm
Max Data Rate	-	300	1k	3K	Kbit/s
Turn On Time	-	-	25	-	ms
Operating Temperature	T op	-10	-	+60	°C

**Table 4.1 General Characteristics Of RF Receiver**

Also the sensitivity of the receiver in dB is found to be quite approximate for efficiency in reconstructing a signal from the transmitter at a vicinity of the receiver.

#### 4.1.6 DECODER WITH RF RECEIVER



**Fig 4.2 Circuit Diagram Of Rf Receiver**

## **4.2 DECODER (2<sup>12</sup> SERIES)**

The second section of the Robo module is the decoder. The main purpose of its installation in the reception circuitry is for the conversion of serial input to parallel form. Explanation of the decoder is given below

The decoder IC that is made use of is the HT 12D IC from HOLTEK. The main purpose of its installation in the reception circuitry is for the conversion of serial input to parallel form and ensures error free reception by comparing the redundancy of data generated by the encoder.

### **4.2.1 FEATURES**

- Operating voltage: 2.4V~12V
- Low power and high noise immunity CMOS technology
- Low stand-by current
- Capable of decoding 12 bits of information
- Pairs with HOLTEK's 212 series of encoders
- Binary address setting
- Three times of receiving check
- Minimal external components
- A built-in oscillator with only a 5% resistor
- A valid transmission indicator

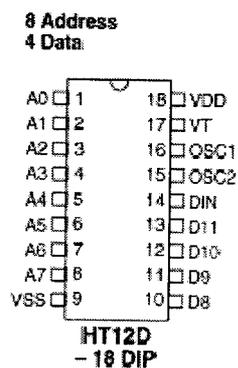
### **4.2.2 APPLICATIONS**

- Burglar alarm system
- Smoke and fire alarm system
- Garage door controllers
- Car door controllers
- Car alarm system
- Security system
- Cordless telephones
- Other remote control systems

### 4.2.3 GENERAL DESCRIPTION

The 212 decoders are a series of CMOS LSIs for remote control system applications. They are paired with HOLTEK's 212 series of encoders (refer to the encoder/decoder cross reference table). For proper operation a pair of encoder/decoder with the same number of addresses and data format should be chosen.

The decoders receive serial addresses and data from a programmed 212 series of encoders that are transmitted by a carrier using an RF or an IR transmission medium. They compare the serial input data three times continuously with their local addresses. If no error or unmatched codes have been found, the input data codes are decoded and then transferred to the output pins. The VT pin also goes high to indicate a valid transmission. The 212 series of decoders is capable of decoding information that consists of N bits of address and 12-N bits of data. Of this series, the HT12D is arranged to provide 8 address bits and 4 data bits, and the HT12F is used to decode 12 bits of address information.



**Fig 4.3 Pin Diagram Of HT 12D**

### SELECTION TABLE

Function Item	Address No.	Data		VT	Oscillator	Trigger	Package
		No.	Type				
HT12D	8	4	L.	√	RC oscillator	DIN active "Hi"	18 DIP/20 SOP
HT12F	12	0	—	√	RC oscillator	DIN active "Hi"	18 DIP/20 SOP

**Table 4.2 Selection Table Of HT 12D**

## 4.2.4 BLOCK DIAGRAM

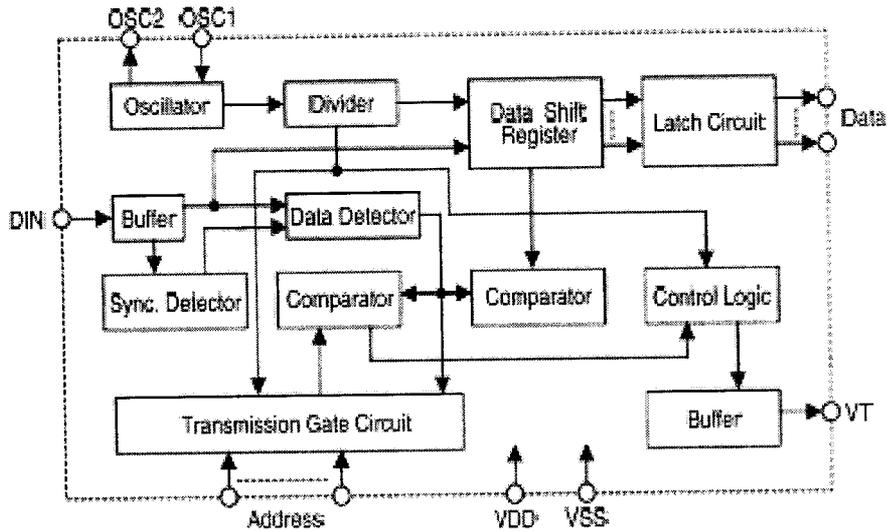


Fig 4.4 Block Diagram Of HT 12D

## 4.2.5 ELECTRICAL CHARACTERISTICS

Symbol	Parameter	Test Condition		Min.	Typ.	Max.	Unit
		V <sub>DD</sub>	Condition				
V <sub>DD</sub>	Operating Voltage	—	—	2.4	5	12	V
I <sub>STB</sub>	Stand-by Current	5V	Oscillator stops.	—	0.1	1	μA
		12V		—	2	4	μA
I <sub>DD</sub>	Operating Current	5V	No load F <sub>OSC</sub> =150KHz	—	200	400	μA
I <sub>O</sub>	Data Output Source Current (D8-D11)	5V	V <sub>OH</sub> =4.5V	-1	-1.6	—	mA
	Data Output Sink Current (D8-D11)	5V	V <sub>OL</sub> =0.5V	1	1.6	—	mA
I <sub>VT</sub>	VT Output Source Current	5V	V <sub>OH</sub> =4.5V	-1	-1.6	—	mA
	VT Output Sink Current		V <sub>OL</sub> =0.5V	1	1.6	—	mA
V <sub>IH</sub>	"H" Input Voltage	5V	—	3.5	—	5	V
V <sub>IL</sub>	"L" Input Voltage	5V	—	0	—	1	V
F <sub>OSC</sub>	Oscillator Frequency	5V	R <sub>OSC</sub> =51KΩ	—	150	—	KHz

Table 4.3 Electrical Characteristics Of HT 12D

### 4.2.6 PIN DESCRIPTION

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

**Table 4.4 Pin Description Of HT 12D**

### OUTPUT TYPE

Of the 212 series of decoders, the HT12F has no data output pin but its VT pin can be used as a momentary data output. The HT12D, on the other hand, provides 4 latch type data pins whose data remain unchanged until new data are received.

Part No.	Data Pins	Address Pins	Output Type	Operating Voltage
HT12D	4	8	Latch	2.4V-12V
HT12F	0	12	---	2.4V-12V

**Table 4.5 Output Type Of HT 12D**

### 4.2.7 FUNCTIONAL DESCRIPTION

#### OPERATION

The 212 series of decoders provides various combinations of addresses and data pins in different packages so as to pair with the 212 series of encoders. The decoders receive data that are transmitted by an encoder and interpret the first N bits of code period as addresses and the last 12-N bits as data, where N is the address code number. A signal on the DIN pin activates the

oscillator which in turn decodes the incoming address and data. The decoders will then check the received address three times continuously. If the received address codes all match the contents of the decoder's local address, the 12-N bits of data are decoded to activate the output pins and the VT pin is set high to indicate a valid transmission. This will last unless the address code is incorrect or no signal is received. The output of the VT pin is high only when the transmission is valid. Otherwise it is always low.

### DECODER TIMING

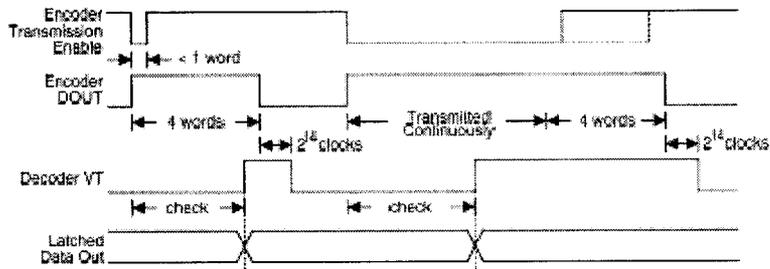


Fig 4.5 Reception Timing For HT 12D

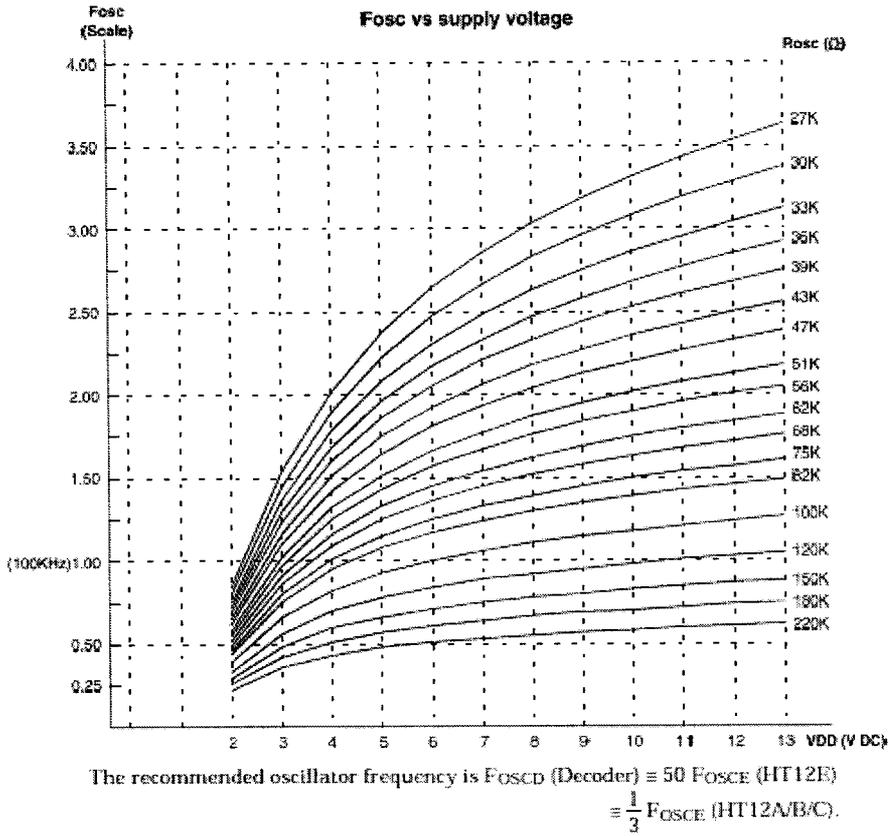
### ADDRESS/DATA SEQUENCE

The following table provides a address/data sequence for various models of the 212 series of decoders. A correct device should be chosen according to the requirements of individual addresses and data.

HOLTEK Part No.	Address/Data Bits											
	0	1	2	3	4	5	6	7	8	9	10	11
HT12D	A0	A1	A2	A3	A4	A5	A6	A7	D8	D9	D10	D11
HT12F	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11

Table 4.6 Decoder Reception Sequence

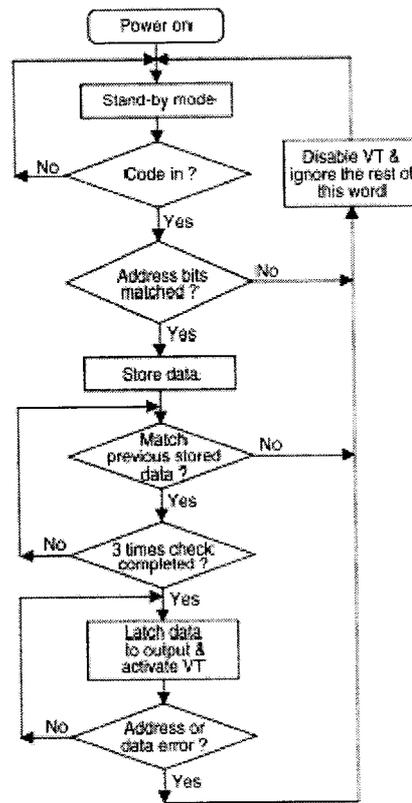
## OSCILLATOR FREQ Vs SUPPLY VOLTAGE



**Fig 4.6 Osc.Freq. For Different  $R_{osc}$**

### 4.2.8 FLOW CHART

The oscillator is disabled in the stand-by state and activated when a logic “high” signal applies to the DIN pin. That is to say, the DIN should be kept low if there is no signal input.

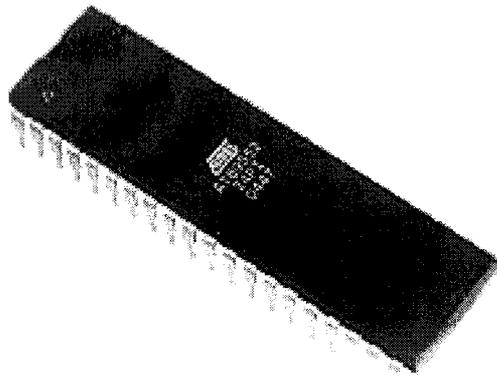


**Fig 4.7 Decoder Control Flow**

### 4.3 MICROCONTROLLER

The third main section of the Robo model is the Microcontroller. A microcontroller consists of a powerful CPU tightly coupled with memory (RAM,ROM, or EPROM), various I/O features such as Serial ports, parallel ports, timers/counter, interrupt controller, data acquisition interfaces, analog to digital converter (ADC), Digital to Analog (DAC) converter, everything integrated on to a Single Silicon Chip.

The microcontroller IC that is made use of is the AT89S52 from Atmel. The Microcontroller AT89S52 is interfaced with the DC motor relay circuit. The working of DC motor is controlled by the microcontroller.



## **PURPOSE OF USING AT89S52**

The AT89S52 is a low-power, high-performance CMOS 8-bit microcomputer with 4K bytes of flash programmable and Erasable Read Only Memory (EPROM). The device is manufactured using Atmel's high density nonvolatile memory technology and is compatible with the industry standard MCS-51™ instruction set and pinout. 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 AT89S52 is a powerful microcomputer which provides control applications. Brief Description of microcontroller is given below.

## **AT89S52 MICROCONTROLLER**

### **4.3.1 FEATURES OF ATMEL**

- Compatible with MCS®-51 Products
- 8K Bytes of In-System Programmable (ISP) Flash Memory
- Endurance: 10,000 Write/Erase Cycles
- 4.0V to 5.5V Operating Range
- Fully Static Operation: 0 Hz to 33 MHz
- Three-level Program Memory Lock
- 256 x 8-bit Internal RAM
- 32 Programmable I/O Lines

- Three 16-bit Timer/Counters
- Eight Interrupt Sources
- Full Duplex UART Serial Channel

## **DESCRIPTION**

The AT89S52 is a low-power, high-performance CMOS 8-bit microcontroller with 8K bytes of in-system programmable Flash memory. The device is manufactured using Atmel's high-density nonvolatile memory technology and is compatible with the industry-standard 80C51 instruction set and pinout.

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 in-system programmable Flash on a monolithic chip, the Atmel AT89S52 is a powerful microcontroller which provides a highly-flexible and cost-effective solution to many embedded control applications.

The AT89S52 provides the following standard features: 8K bytes of Flash, 256 bytes of RAM, 32 I/O lines, Watchdog timer, two data pointers, 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 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 interrupt or hardware reset.

### 4.3.2 BLOCK DIAGRAM

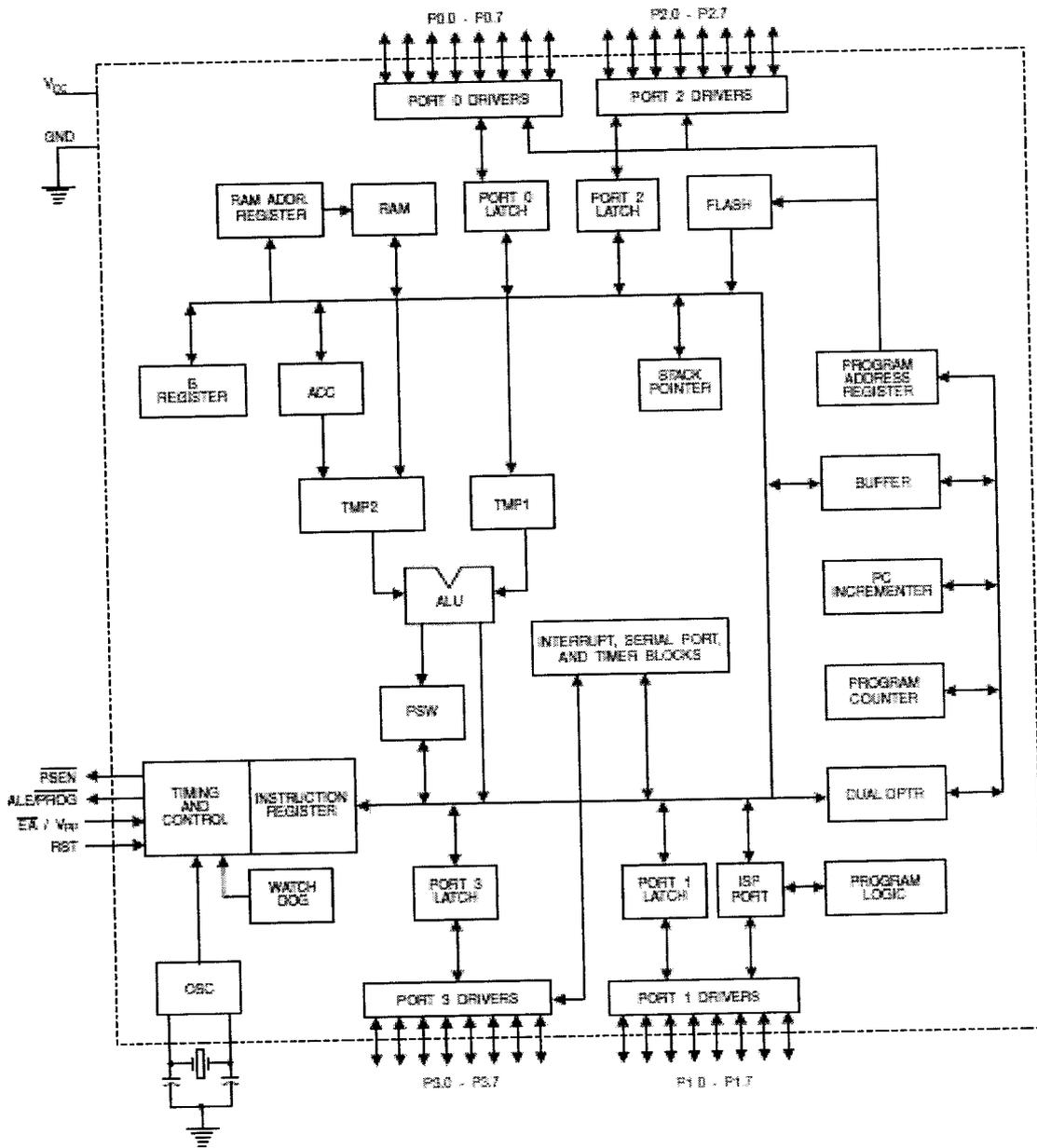


Fig 4.8 Block Diagram Of AT89S52

### 4.3.3 PIN CONFIGURATIONS

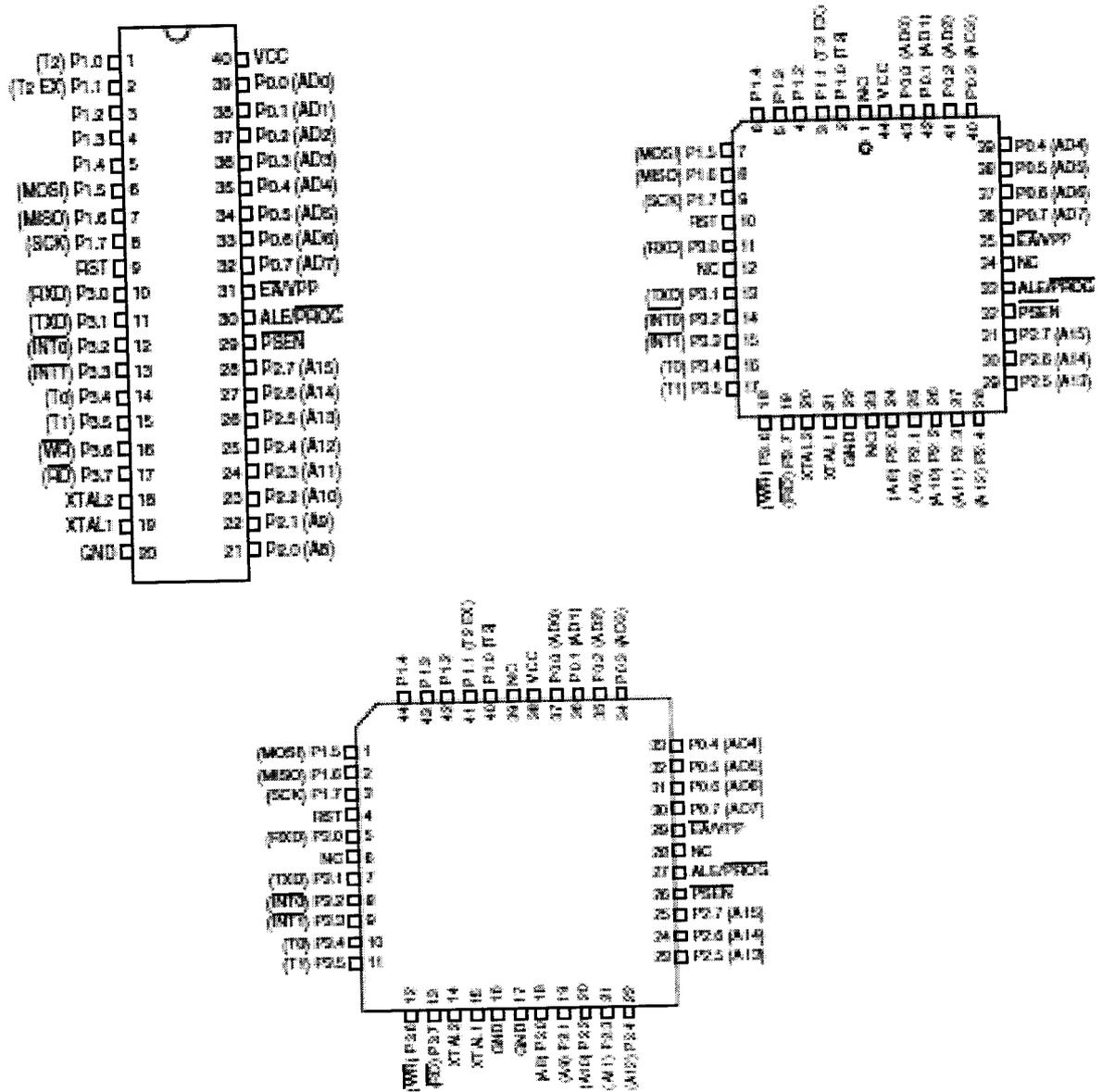


Fig 4.9 Pin Configurations Of AT8952

## PIN DESCRIPTION

**VCC** Supply voltage.

**GND** Ground.

**Port 0** Port 0 is an 8-bit open drain bidirectional 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 bidirectional 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 2** Port 2 is an 8-bit bidirectional 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 bidirectional 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 receives some control signals for Flash programming and verification.

**RST** Reset input. A high on this pin for two machine cycles while the oscillator is running resets the device. This pin drives high for 98 oscillator periods after the Watchdog times out. The DISRTO bit in SFR AUXR (address 8EH) can be used to disable this feature. In the default state of bit DISRTO, the RESET HIGH out feature is enabled.

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

**PSEN** Program Store Enable (PSEN) is the read strobe to external program memory. When the AT89S52 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.

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

**XTAL2** Output from the inverting oscillator amplifier.

## **PROGRAMMING THE FLASH – PARALLEL MODE**

The AT89S52 is shipped with the on-chip Flash memory array ready to be programmed. The programming interface needs a high-voltage (12-volt) program enable signal and is compatible with conventional third-party Flash or EPROM programmers. The AT89S52 code memory array is programmed byte-by-byte

## **PROGRAMMING ALGORITHM**

Before programming the AT89S52, the address, data, and control signals should be set up according to the “Flash Programming .To program the AT89S52, take the following steps:

1. Input the desired memory location on the address lines.
2. Input the appropriate data byte on the data lines.
3. Activate the correct combination of control signals.
4. Raise EA/VPP to 12V.
5. Pulse ALE/PROG once to program a byte in the Flash array or the lock bits.

The byte-write cycle is self-timed and typically takes no more than 50  $\mu$ s. Repeat steps 1 through 5, changing the address and data for the entire array or until the end of the object file is reached.

## **DATA POLLING**

The AT89S52 features Data Polling to indicate the end of a byte write cycle. During a write cycle, an attempted read of the last byte written will result in the complement of the written data on P0.7. Once the write cycle has been completed, true data is valid on all outputs, and the next cycle may begin. Data Polling may begin any time after a write cycle has been initiated.

## **READY/BUSY**

The progress of byte programming can also be monitored by the RDY/BSY output signal. P3.0 is pulled low after ALE goes high during programming to indicate BUSY. P3.0 is pulled high again when programming is done to indicate READY.

## **PROGRAM VERIFY**

If lock bits LB1 and LB2 have not been programmed, the programmed code data can be read back via the address and data lines for verification. **The status of the individual lock bits can be verified directly by reading them back. Reading the Signature Bytes:** The signature bytes are read by the same procedure as a normal verification of locations 000H, 100H, and 200H, except that P3.6 and P3.7 must be pulled to a logic low. The values returned are as follows. (000H) = 1EH indicates manufactured by Atmel (100H) = 52H indicates AT89S52 (200H) = 06H.

## **CHIP ERASE**

In the parallel programming mode, a chip erase operation is initiated by using the proper combination of control signals and by pulsing ALE/PROG low for duration of 200 ns - 500 ns. In the serial programming mode, a chip erase operation is initiated by issuing the Chip Erase instruction. In this mode, chip erase is self-timed and takes about 500 ms. During chip erase, a serial read from any address location will return 00H at the data output.

## **PROGRAMMING THE FLASH – SERIAL MODE**

The Code memory array can be programmed using the serial ISP interface while RST is pulled to VCC. The serial interface consists of pins SCK, MOSI (input) and MISO (output). After RST is set high, the Programming Enable instruction needs to be executed first before other operations can be executed. Before a reprogramming sequence can occur, a Chip Erase operation is required. The Chip Erase operation turns the content of every memory location in the Code array into FFH. Either an external system clock can be supplied at pin XTAL1 or a crystal needs to be connected across pins XTAL1 and XTAL2. The maximum serial clock (SCK)

frequency should be less than 1/16 of the crystal frequency. With a 33 MHz oscillator clock, the maximum SCK frequency is 2 MHz.

## **SERIAL PROGRAMMING ALGORITHM**

To program and verify the AT89S52 in the serial programming mode, the following sequence is recommended:

1. Power-up sequence:
  - a. Apply power between VCC and GND pins.
  - b. Set RST pin to “H”. If a crystal is not connected across pins XTAL1 and XTAL2, apply a 3 MHz to 33 MHz clock to XTAL1 pin and wait for at least 10 milliseconds.
2. Enable serial programming by sending the Programming Enable serial instruction to pin MOSI/P1.5. The frequency of the shift clock supplied at pin SCK/P1.7 needs to be less than the CPU clock at XTAL1 divided by 16.
3. The Code array is programmed one byte at a time in either the Byte or Page mode. The write cycle is self-timed and typically takes less than 0.5 ms at 5V.
4. Any memory location can be verified by using the Read instruction which returns the content at the selected address at serial output MISO/P1.6.
5. At the end of a programming session, RST can be set low to commence normal device operation.

Power-off sequence (if needed):

1. Set XTAL1 to “L” (if a crystal is not used).
2. Set RST to “L”.
3. Turn VCC power off.

## **DATA POLLING**

The Data Polling feature is also available in the serial mode. In this mode, during a write cycle an attempted read of the last byte written will result in the complement of the MSB of the serial output byte on MISO.

## **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. These interrupts are all shown in Figure 13-1. 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 13-1 shows that bit position IE.6 is unimplemented. User software should not write a 1 to this bit position, since it 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.

## **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. Either a quartz crystal or ceramic resonator may be used. To drive the device from an external clock source, XTAL2 should be left unconnected while XTAL1 is driven. 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.

## **IDLE MODE**

In idle mode, the CPU puts itself to sleep while all the on-chip peripherals remain active. The mode is invoked by software. The content of the on-chip RAM and all the special functions registers remain unchanged during this mode. The idle mode can be terminated by any enabled interrupt or by a hardware reset. Note that when idle mode is terminated by a hardware reset, the device normally resumes program execution from where it left off, up to two machine cycles before the internal reset algorithm takes control. On-chip hardware inhibits access to internal RAM in this event, but access to the port pins is not inhibited. To eliminate the possibility of an unexpected write to a port pin when idle mode is terminated by a reset, the instruction following the one that invokes idle mode should not write to a port pin or to external memory.

## **POWER-DOWN MODE**

In the Power-down mode, the oscillator is stopped, and the instruction that invokes Power-down is the last instruction executed. The on-chip RAM and Special Function Registers retain their values until the Power-down mode is terminated. Exit from Power-down mode can be initiated either by a hardware reset or by an enabled external interrupt. Reset redefines the SFRs but does not change the on-chip RAM. The reset should not be activated before VCC is

restored to its normal operating level and must be held active long enough to allow the oscillator to restart and stabilize.

#### 4.4 RELAY CIRCUIT

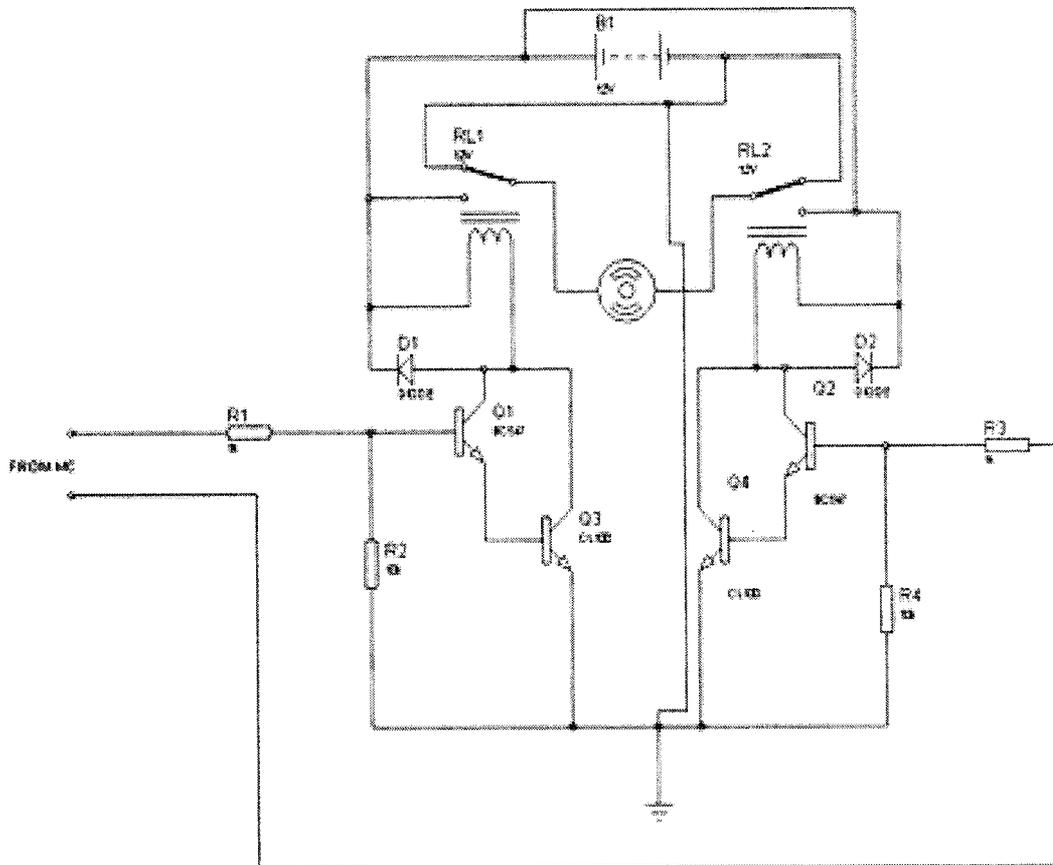


Fig 4.10 Circuit Diagram Of Relay Circuit

#### CIRCUIT DIAGRAM DESCRIPTION

The circuit is designed to control the motor in the forward and reverse direction. The circuit consists of a relay. The relay ON and OFF is controlled by the switch transistor.

The relay is nothing, but an electromagnetic switch device which consists of three pins. They are common, normally closed and Normally Opened. The common pin of relay is connected to positive and negative terminal of the motor through snubber circuit.

The relay is connected in the collector terminal of the transistor. When high pulse signals is given to base of the transistor, the transistor conduct and shorts the collector and emitter terminal and zero signals are given to base of the transistor so the relay is turned OFF state. When low pulse is given to the base of the transistor, the transistor conduct and the relay is turned ON.

The series combination of resistor and capacitor is called as snubber circuit. When the relay is turn ON and turn OFF continuously, the back emf may fault the relays. So the back emf is grounded through the snubber circuit.

1. When relay is in the ON state, the motor is running in the forward direction.
2. When relay is in the OFF state, the motor is running in the reverse direction.

The DC motor operates at 12 V through relay.

#### **4.5 PICK AND PLACE MECHANISM OF ROBO MODEL**

The mechanical part of the Robo model is the pick and place mechanism. The Pick and Place mechanism of the robot consists of three arms. The first arm is the raising and lowering arm. The second arm is the bending arm. The third arm is the holding arm for carrying the object. Each of the three arm has the limiting switch for the limit to which the arm should lift or bend.

<b>OPERATION</b>	<b>DATA BITS (MSB BITS)</b>
PICK	1 1 0 1
PLACE	1 0 1 1
STOP	1 1 1 0

## Video requirements

---

## MOVEMENT CONTROL OF ROBO MODEL

The movement of the robot is made in four ways. They are

1. Forward
2. Reverse
3. Right
4. Left

The movement of the robot is controlled by the data bits from the Microcontroller.

Data bits for the direction of movement of vehicle is given below

OPERATION	DATA BITS (LSB BITS)
Forward	1 1 1 0
Reverse	1 1 0 1
Right	1 0 1 0
Left	0 1 1 1

## VIDEO REQUIREMENTS

### 5.1 TV TUNER CARD

The fourth main section of the PC module is the TV Tuner card. A **TV tuner card** is a computer component that allows television signals to be received by a computer. Most TV tuners also function as video capture cards, allowing them to record television programs onto a hard drive.

#### DESCRIPTION

A TV tuner card is a computer component that allows television signals to be received by a computer. Most TV tuners also function as video capture cards, allowing them to record television programs onto a hard disk.

## VIDEO CAPTURE

Video capture cards are a class of video capture devices designed to plug directly into expansion slots in personal computers and servers. Models from many manufacturers are available; all comply with one of the popular host bus standards including PCI, newer PCI Express (PCIe) or AGP bus interfaces.

These cards typically include one or more software drivers to expose the cards' features, via various operating systems, to software applications that further process the video for specific purposes. As a class, the cards are used to capture baseband analog composite video, S-Video, and, in models equipped with tuners, RF modulated video. Some specialized cards support digital video via digital video delivery standards including Serial Digital Interface (SDI) and, more recently, the emerging **HDMI standard**. These models often support both standard definition (SD) and high definition (HD) variants.

While most PCI and PCI-Express capture devices are dedicated to that purpose, AGP capture devices are usually included with the graphics adapted on the board as an all-in-one package. Unlike video editing cards, these cards tend to not have dedicated hardware for processing video beyond the analog-to-digital conversion. Most, but not all, video capture cards also support one or more channels of audio. New technologies allow PCI-Express and HD-SDI to be implemented on video capture cards at lower costs than before.

There are many applications for video capture cards including converting a live analog source into some type of analog or digital media, (such as a VHS tape to a DVD), archiving, video editing, scheduled recording (such as a DVR), television tuning, or video surveillance. The cards may have significantly different designs to optimally support each of these functions.

One of the most popular applications for video capture cards is to capture video and audio for live Internet video streaming. The live stream can also be simultaneously archived and formatted for video on demand. The capture cards used for this purpose are typically purchased, installed, and configured in host PC systems by hobbyists or systems integrators. Some care is required to select suitable host systems for video encoding, particularly HD applications which are more affected by CPU performance, number of CPU cores, and certain motherboard characteristics that heavily influence capture performance.

USB capture devices can be another low price, easy to setup, and compatible option. Popular devices include the Pinnacle Dazzle (\$50-80), the EasyCAP or EzCap (\$10-20), and the Hauppauge HD PVR (\$200).

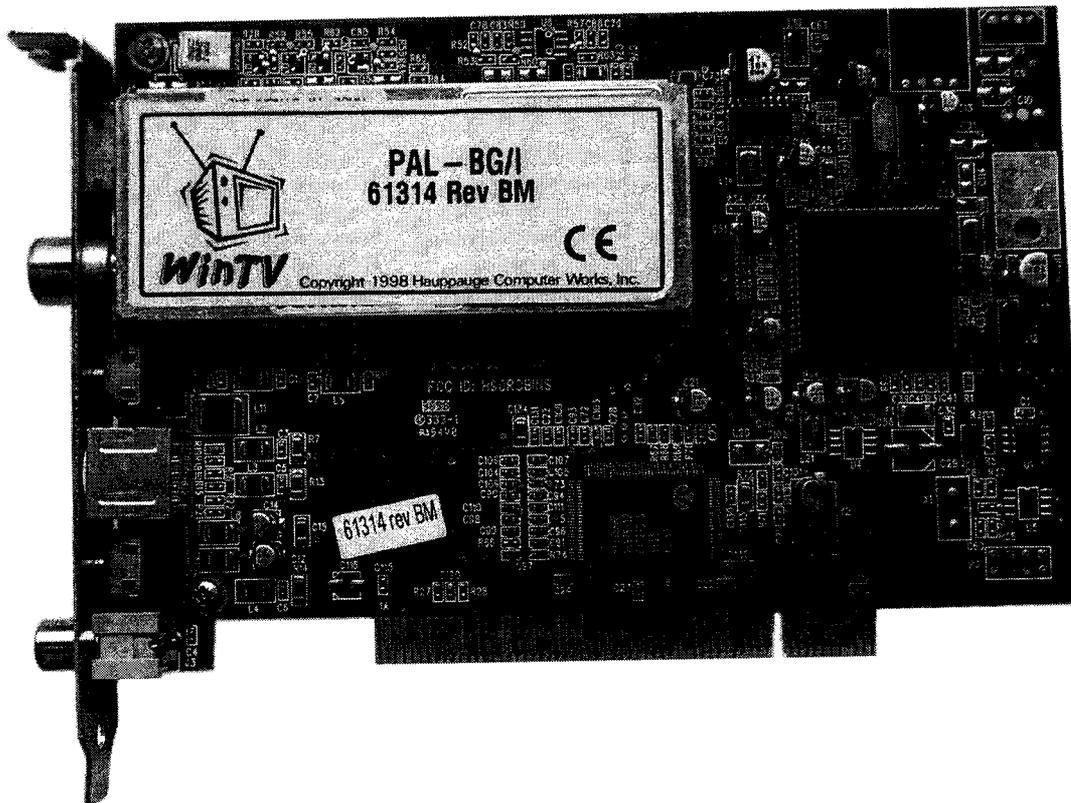


Fig 5.1 TV Tuner Card

## 5.2 WIRELESS CAMERA SETUP

### FEATURES

- Wireless transmission and reception
- Small size
- Light weight
- Low power consumption
- High sensitivity

- Easy installation & operation
- Easy to conceal

## OPERATION INSTRUCTIONS

1. Twist the receiver antenna into the receiver.
2. Connect the receiver to the monitor with AV cable.
3. Plug the DC 9V 500MA adaptor into the power jack of the receiver.
4. Insert the DC 8V 200MA adaptor into the power jack of the camera.
5. Adjust the frequency controller on the receiver to the required position.
6. Adjust the lens of the camera to the best position, mount the camera with the screw.

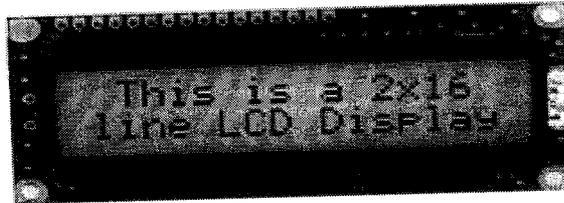
## SPECIFICATIONS

Image pickup device:	1/3 ¼ inches
TV system:	PAL/CCIR NTSC/EIA
Definition:	380 TV lines
Scan frequency:	PAL/CCIR : 50HZ NTSC/EIA : 60HZ
Output power:	50mw 200mw
Output frequency:	900 MHZ 1200 MHZ
Power supply:	DC +6v – 12v

### 5.3 LCD DISPLAY

LCD's also are used as numerical indicators, especially in digital watches where their much smaller current needs than LED displays (microamperes compared with millamperes) prolong battery life. Liquid crystals are organic (carbon) compounds, which exhibit both solid and liquid properties.

A 'cell' with transparent metallic conductors, called electrodes, on opposite faces, containing a liquid crystal, and on which light falls, goes 'dark' when a voltage is applied across the electrodes. The effect is due to molecular rearrangement within the liquid crystal.



The LCD display used in this project consists of 2 rows. Each row consists of maximum 16 characters. So using this display only maximum of 32 characters can be displayed.

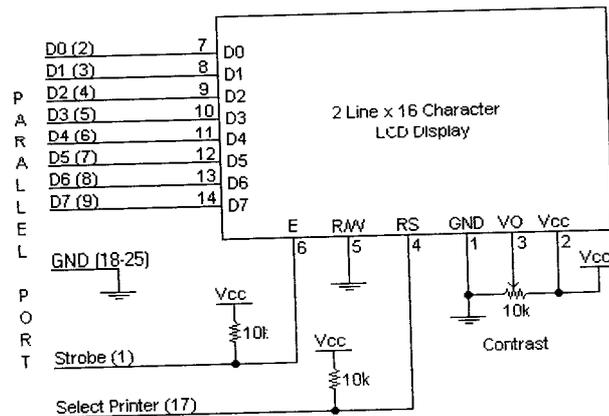


Fig 5.2 Pin Diagram Of JHD659-162A LCD

## CIRCUIT DESCRIPTION

Above is the quite simple schematic. The LCD panel's *Enable* and *Register Select* is connected to the Control Port. The Control Port is an open collector / open drain output. While most Parallel Ports have internal pull-up resistors, there are a few which don't. Therefore by incorporating the two 10K external pull up resistors, the circuit is more portable for a wider range of computers, some of which may have no internal pull up resistors.

We make no effort to place the Data bus into reverse direction. Therefore we hard wire the *R/W* line of the LCD panel, into write mode. This will cause no bus conflicts on the data lines. As a result we cannot read back the LCD's internal Busy Flag which tells us if the LCD has accepted and finished processing the last instruction. This problem is overcome by inserting known delays into our program. The 10k Potentiometer controls the contrast of the LCD panel. Nothing fancy here. As with all the examples, I've left the power supply out. You can use a bench power supply set to 5v or use an onboard +5 regulator. Remember a few de-coupling capacitors, especially if you have trouble with the circuit working properly.

## APPLICATIONS

- Display content : 16 x 2 characters
- Lcd type : STN Y/G, STN BLUE, STN GREY, FSTN
- Controller : ks0066 or equal
- Operating temperature : Normal (0-50C); Wide (20 – 70C)
- Power supply : 5.0V
- Viewing angle : 6H; 12H

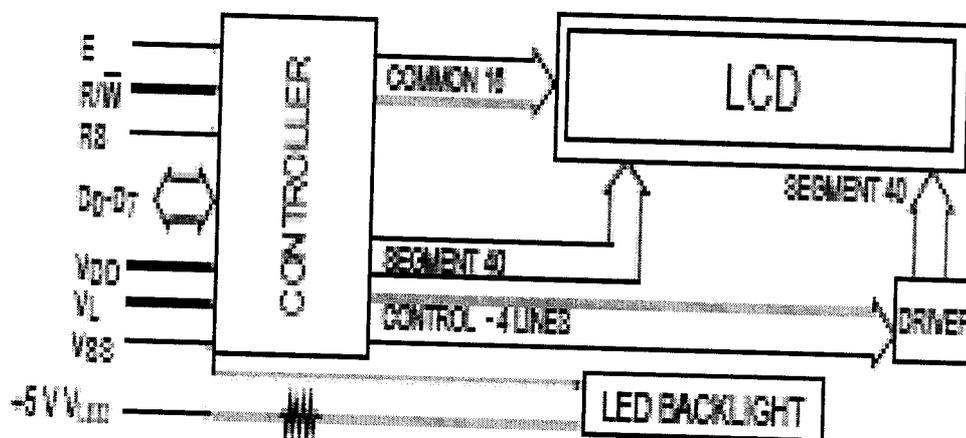


Fig 5.3 Microcontroller With JHD659-162A LCD

Software module

---

## SOFTWARE MODULE

### 6.1 MICROCONTROLLER CODING

The Microcontroller AT89S52 has been programmed using C language. The coding enables us to control the robot in all the four directions and to Pick and Place the certain required object.

#### AT89S52 CODING

```
#include<AT89X52.h>

sbit rx0=P1^0;

sbit rx1=P1^1;

sbit rx2=P1^2;

sbit rx3=P1^3;

sbit rs=P2^0;//connect to lcd output port

sbit rw=P2^1;//connect to lcd output port

sbit en=P2^2;//connect to lcd output port

sbit pickup=P2^3;

sbit pickdown=P2^4;

sbit pick=P2^5;

sbit place=P2^6;

sbit buzzer=P2^7;

sbit m1p=P3^4;

sbit m1n=P3^5;

sbit m2p=P3^6;

sbit m2n=P3^7;

void lcd_init();

void lcd_command(unsigned char);
```

```

void lcd_data(unsigned char);
void lcd_display(unsigned char*);
void lcd_delay(unsigned int);
unsigned char receive=0X00;
void main()
{
    P0=0X00;
    P1=0XFF;
    P2=0X00;
    P3=0X00;
    lcd_init();
    lcd_command(0X80);
    lcd_display("PICK AND PLACE");
    lcd_command(0XC0);
    lcd_display("  ROBOT  ");
    buzzer=0;
    lcd_delay(5000);
    buzzer=1;
    while(1)
    {
        receive=P1;
        if(receive==0XF0)
        {
            buzzer=0;
            lcd_delay(5000);
        }
    }
}

```

```
buzzer=1;
pickup=0;
pickdown=0;
pick=0;
place=0;
m1p=0;
m1n=0;
m2p=0;
m2n=0;
lcd_command(0XC0);
lcd_display("STOP  ");
}
else if(receive==0XF1)
{
    buzzer=0;
    lcd_delay(5000);
    buzzer=1;
    pickup=0;
    pickdown=0;
    pick=0;
    place=0;
    m1p=1;
    m1n=0;
    m2p=0;
    m2n=1;
}
```

```
        lcd_command(0XC0);  
        lcd_display("FRONT  ");  
    }
```

```
else if(receive==0XF2)
```

```
{  
    buzzer=0;  
    lcd_delay(5000);  
    buzzer=1;  
    pickup=0;  
    pickdown=0;  
    pick=0;  
    place=0;  
    m1p=0;  
    m1n=1;  
    m2p=1;  
    m2n=0;  
    lcd_command(0XC0);  
    lcd_display("BACK  ");  
}
```

```
else if(receive==0XF3)
```

```
{  
    buzzer=0;  
    lcd_delay(5000);  
    buzzer=1;
```

```

pickup=0;

pickdown=0;

pick=0;

place=0;

m1p=0;

m1n=0;

m2p=0;

m2n=1;

lcd_command(0XC0);

lcd_display("LEFT  ");

}

else if(receive==0XF4)

{

    buzzer=0;

    lcd_delay(5000);

    buzzer=1;

    pickup=0;

    pickdown=0;

    pick=0;

    place=0;

    m1p=1;

    m1n=0;

    m2p=0;

    m2n=0;

```

```

        lcd_command(0XC0);
        lcd_display("RIGHT ");
    }
else if(receive==0XF5)
{
    buzzer=0;
    lcd_delay(5000);
    buzzer=1;
    pickup=0;
    pickdown=0;
    pick=0;
    place=0;
    m1p=0;
    m1n=0;
    m2p=0;
    m2n=0;
    pick=1;
    place=0;
    lcd_command(0XC0);
    lcd_display("PICK ");
}

else if(receive==0XF6)
{
    buzzer=0;

```

```
    lcd_delay(5000);  
  
    buzzer=1;  
  
    pickup=0;  
  
    pickdown=0;  
  
    pick=0;  
  
    place=0;  
  
    m1p=0;  
  
    m1n=0;  
  
    m2p=0;  
  
    m2n=0;  
  
    pick=0;  
  
    place=1;  
  
    lcd_command(0XC0);  
  
    lcd_display("PLACE  ");  
  
}
```

```
else if(receive==0XF7)
```

```
{  
  
    buzzer=0;  
  
    lcd_delay(5000);  
  
    buzzer=1;  
  
    pickup=0;  
  
    pickdown=0;  
  
    pick=0;  
  
    place=0;  
  
}
```

```
    m1p=0;

    m1n=0;

    m2p=0;

    m2n=0;

    pickup=1;

    pickdown=0;

    lcd_command(0XC0);

    lcd_display("PICK UP ");
}

else if(receive==0XF8)
{

    buzzer=0;

    lcd_delay(5000);

    buzzer=1;

    pickup=0;

    pickdown=0;

    pick=0;

    place=0;

    m1p=0;

    m1n=0;

    m2p=0;

    m2n=0;

    pickup=0;

    pickdown=1;
```

```

        lcd_command(0XC0);

        lcd_display("PICK DOWN ");
    }
else if(receive==0XF9)
{
    buzzer=0;

    lcd_delay(5000);

    buzzer=1;

    pickup=0;

    pickdown=0;

    pick=0;

    place=0;

    m1p=0;

    m1n=0;

    m2p=0;

    m2n=0;

    lcd_command(0XC0);

    lcd_display("BREAK ");
}

    receive=0X00;
}
}
void lcd_init()
{

```

```

    lcd_command(0X38);//2 lines & 5X7 matrix
    lcd_delay(500);
    lcd_command(0X01);//clear display screen
    lcd_delay(500);
    lcd_command(0X06);//shift cursor to right
    lcd_delay(500);
    lcd_command(0X0C);//display on cursor off
    lcd_delay(500);
    lcd_command(0X80);//1st line
    lcd_delay(500);
}

```

```

void lcd_command(unsigned char x)

```

```

{
    P0=x;
    rs=0;
    rw=0;
    en=1;
    lcd_delay(500);
    en=0;
}

```

```

void lcd_data(unsigned char y)

```

```

{
    P0=y;
    rs=1;
    rw=0;
}

```

```

        en=1;
        lcd_delay(500);
        en=0;
    }
void lcd_display(unsigned char *z)
{
    while(*z!='\0')
    {
        lcd_data(*z);
        lcd_delay(500);
        z++;
    }
}
void lcd_delay(unsigned int i)
{
    unsigned int j=0;
    for(j=0;j<i;j++);
}

```

### **AT89C2051 CODING**

```

#include<REG2051.h>
sbit tx0=P1^0;
sbit tx1=P1^1;
sbit tx2=P1^2;
sbit tx3=P1^3;

```

```
unsigned char receive=0X00;
```

```
void main()
```

```
{
```

```
    P1=0X00;
```

```
    TMOD=0X20;
```

```
    SCON=0X50;
```

```
    TH1=0XFD;
```

```
    TR1=1;
```

```
    TI=0;
```

```
    SBUF='S';
```

```
    while(TI==0);
```

```
    TI=0;
```

```
    while(1)
```

```
    {
```

```
        RI=0;
```

```
        while(RI==0);
```

```
        receive=SBUF;
```

```
        RI=0;
```

```
        if(receive=='S')
```

```
        {
```

```
            P1=0XF0;
```

```
        }
```

```
        if(receive=='F')
```

```
        {
```

```
            P1=0XF1;
```

```
}  
  
if(receive=='B')  
{  
    P1=0XF2;  
}  
  
if(receive=='L')  
{  
    P1=0XF3;  
}  
  
if(receive=='R')  
{  
    P1=0XF4;  
}  
  
if(receive=='P')  
{  
    P1=0XF5;  
}  
  
if(receive=='O')  
{  
    P1=0XF6;  
}  
  
if(receive=='U')  
{  
    P1=0XF7;  
}
```

```
if(receive=='Y')
{
    P1=0XF8;
}
if(receive==' '||receive=='0')
{
    P1=0XF9;
}
}
}
```

## 6.2 VB PROGRAM

The robot model is controlled by the pc which consists of the vb installed in it priory. This is the screen by which the robot is controlled

### VB CODING

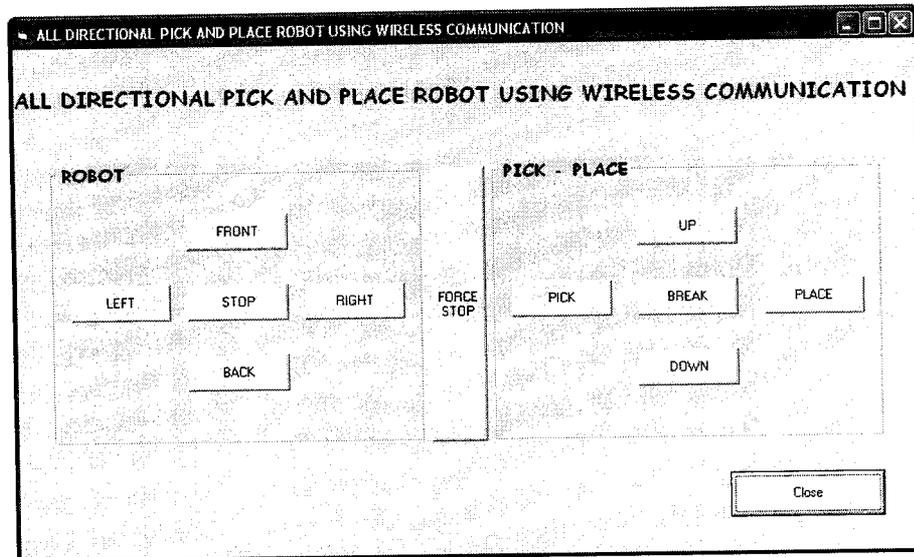


Fig 6.1 Display Screen Of PC

```
Private Sub Command1_Click()
```

```
MSComm1.Output = "F"
```

```
End Sub
```

```
Private Sub Command10_Click()
```

```
MSComm1.Output = "U"
```

```
End Sub
```

```
Private Sub Command11_Click()
```

```
MSComm1.Output = "0"
```

```
End Sub
```

```
Private Sub Command12_Click()
```

```
MSComm1.Output = " "
```

```
End Sub
```

```
Private Sub Command2_Click()
```

```
Unload Me
```

```
End
```

```
End Sub
```

```
Private Sub Command3_Click()
```

```
MSComm1.Output = "B"
```

```
End Sub
```

```
Private Sub Command4_Click()
```

```
MSComm1.Output = "L"
```

```
End Sub
```

```
Private Sub Command5_Click()
```

```
MSComm1.Output = "R"
```

```
End Sub
```

```
Private Sub Command6_Click()
```

```
MSComm1.Output = "P"
```

```
End Sub
```

```
Private Sub Command7_Click()
```

```
MSComm1.Output = "O"
```

End Sub

Private Sub Command8\_Click()

MSComm1.Output = "S"

End Sub

Private Sub Command9\_Click()

MSComm1.Output = "Y"

End Sub

Private Sub Form\_Load()

MSComm1.PortOpen = True

Timer1.Enabled = True

End Sub

Private Sub Timer1\_Timer()

Timer1.Enabled = False

Debug.Print MSComm1.Input

Timer1.Enabled = True

End Sub

Conclusion

---

## CONCLUSION

This robot is utilized for pick the thing in one place and places those things in required places. Some industrial works are harmful for humans this robot is mainly utilized for reduce the risk process and consuming time and avoid labors. Human are tired for tough work such as assembly line, fabric handling etc. this robot does all those things it mainly reduces the manual work our robot is designed at low cost as well as high efficient one. This project is to give the way for providing bigger effective robot for industrial applications. In this project, we have powered the robot with recharging battery. The cost of the recharging battery is low.

All the movements of the robot are stored in a data base in the pc for reference. We have used visual basic as the front end and ms access as the back end for the data base. This application helps the management of the industry to have an overall view of all the operations in the industry.

### 7.1 FUTURE ENHANCEMENT

- Compatible with MCS-51™ Products
- 4K Bytes of In-System Reprogrammable Flash Memory
- Fully Static Operation: 0 Hz to 24 MHz
- Three-level Program Memory Lock
- 128 x 8-bit Internal RAM
- 32 Programmable I/O Lines
- Two 16-bit Timer/Counters
- Six Interrupt Sources
- Programmable Serial Channel
- Low-power Idle and Power-down Modes

## **FEATURES OF THE MECHANICAL DESIGN**

- Two motors for running the wheels of the robot.
- Two motors for the movement of robotic arm.
- Movement up and down
- Movement of jaw open and close
- Wireless Camera on top of the assembly
- Rectangular metal box as the base
- A Belt around wheels, in order to save on the usage of hardware.

## **FUTURE APPLICATION**

- Coal mining
- Military Operation
- Fire fighting Operation
- Undersea Robots
- Garbage Collection and Waste Disposal Operation.

## References

---

## REFERENCES

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4. Felice Balarin , Yosinori Watanabe , Harry Hsieh , Luciano Lavagno , Claudio Passerone , Alberto Sangiovanni-Vincentelli, *Metropolis: An Integrated Electronic System Design Environment*, *Computer*, v.36 n.4, p.45-52, April 2003 [doi>10.1109/MC.2003.1193228]
5. Massimo Baleani , Frank Gennari , Yunjian Jiang , Yatish Patel , Robert K. Brayton , Alberto Sangiovanni-Vincentelli, *HW/SW partitioning and code generation of embedded control applications on a reconfigurable architecture platform*, *Proceedings of the tenth international symposium on Hardware/software codesign*, May 06-08, 2002, Estes Park, Colorado [doi>10.1145/774789.774820]

## Appendices

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# KA78XX/KA78XXA

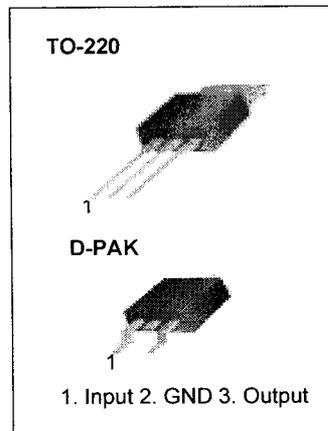
## 3-Terminal 1A Positive Voltage Regulator

### Features

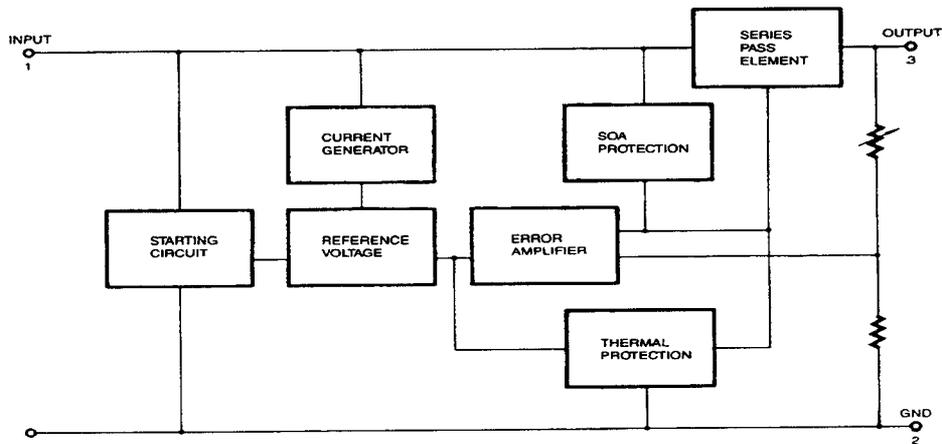
- Output Current up to 1A
- Output Voltages of 5, 6, 8, 9, 10, 12, 15, 18, 24V
- Thermal Overload Protection
- Short Circuit Protection
- Output Transistor Safe Operating Area Protection

### Description

The KA78XX/KA78XXA series of three-terminal positive regulator are available in the TO-220/D-PAK package and with several fixed output voltages, making them useful in a wide range of applications. Each type employs internal current limiting, thermal shut down and safe operating area protection, making it essentially indestructible. If adequate heat sinking is provided, they can deliver over 1A output current. Although designed primarily as fixed voltage regulators, these devices can be used with external components to obtain adjustable voltages and currents.



### Internal Block Diagram



Rev. 1.0.0

## Absolute Maximum Ratings

Parameter	Symbol	Value	Unit
Input Voltage (for $V_O = 5V$ to $18V$ ) (for $V_O = 24V$ )	$V_I$	35	V
	$V_I$	40	V
Thermal Resistance Junction-Cases (TO-220)	$R_{\theta JC}$	5	$^{\circ}C/W$
Thermal Resistance Junction-Air (TO-220)	$R_{\theta JA}$	65	$^{\circ}C/W$
Operating Temperature Range (KA78XX/A/R)	TOPR	0 ~ +125	$^{\circ}C$
Storage Temperature Range	TSTG	-65 ~ +150	$^{\circ}C$

## Electrical Characteristics (KA7805/KA7805R)

(Refer to test circuit,  $0^{\circ}C < T_J < 125^{\circ}C$ ,  $I_O = 500mA$ ,  $V_I = 10V$ ,  $C_I = 0.33\mu F$ ,  $C_O = 0.1\mu F$ , unless otherwise specified)

Parameter	Symbol	Conditions	KA7805			Unit	
			Min.	Typ.	Max.		
Output Voltage	$V_O$	$T_J = +25^{\circ}C$	4.8	5.0	5.2	V	
		$5.0mA \leq I_O \leq 1.0A$ , $P_O \leq 15W$ $V_I = 7V$ to $20V$	4.75	5.0	5.25		
Line Regulation (Note1)	Regline	$T_J = +25^{\circ}C$	$V_O = 7V$ to $25V$	-	4.0	100	mV
			$V_I = 8V$ to $12V$	-	1.6	50	
Load Regulation (Note1)	Regload	$T_J = +25^{\circ}C$	$I_O = 5.0mA$ to $1.5A$	-	9	100	mV
			$I_O = 250mA$ to $750mA$	-	4	50	
Quiescent Current	$I_Q$	$T_J = +25^{\circ}C$	-	5.0	8.0	mA	
Quiescent Current Change	$\Delta I_Q$	$I_O = 5mA$ to $1.0A$	-	0.03	0.5	mA	
		$V_I = 7V$ to $25V$	-	0.3	1.3		
Output Voltage Drift	$\Delta V_O / \Delta T$	$I_O = 5mA$	-	-0.8	-	mV/ $^{\circ}C$	
Output Noise Voltage	$V_N$	$f = 10Hz$ to $100KHz$ , $T_A = +25^{\circ}C$	-	42	-	$\mu V/V_O$	
Ripple Rejection	RR	$f = 120Hz$ $V_O = 8V$ to $18V$	62	73	-	dB	
Dropout Voltage	$V_{Drop}$	$I_O = 1A$ , $T_J = +25^{\circ}C$	-	2	-	V	
Output Resistance	$r_O$	$f = 1KHz$	-	15	-	$m\Omega$	
Short Circuit Current	$I_{SC}$	$V_I = 35V$ , $T_A = +25^{\circ}C$	-	230	-	mA	
Peak Current	$I_{PK}$	$T_J = +25^{\circ}C$	-	2.2	-	A	

### Note:

1. Load and line regulation are specified at constant junction temperature. Changes in  $V_O$  due to heating effects must be taken into account separately. Pulse testing with low duty is used.

## Electrical Characteristics (KA7806/KA7806R)

(Refer to test circuit ,  $0^{\circ}\text{C} < T_J < 125^{\circ}\text{C}$ ,  $I_O = 500\text{mA}$ ,  $V_I = 11\text{V}$ ,  $C_I = 0.33\mu\text{F}$ ,  $C_O = 0.1\mu\text{F}$ , unless otherwise specified)

Parameter	Symbol	Conditions	KA7806			Unit	
			Min.	Typ.	Max.		
Output Voltage	$V_O$	$T_J = +25^{\circ}\text{C}$	5.75	6.0	6.25	V	
		$5.0\text{mA} \leq I_O \leq 1.0\text{A}$ , $P_O \leq 15\text{W}$ $V_I = 8.0\text{V to } 21\text{V}$	5.7	6.0	6.3		
Line Regulation (Note1)	Regline	$T_J = +25^{\circ}\text{C}$	$V_I = 8\text{V to } 25\text{V}$	-	5	120	mV
			$V_I = 9\text{V to } 13\text{V}$	-	1.5	60	
Load Regulation (Note1)	Regload	$T_J = +25^{\circ}\text{C}$	$I_O = 5\text{mA to } 1.5\text{A}$	-	9	120	mV
			$I_O = 250\text{mA to } 750\text{mA}$	-	3	60	
Quiescent Current	$I_Q$	$T_J = +25^{\circ}\text{C}$	-	5.0	8.0	mA	
Quiescent Current Change	$\Delta I_Q$	$I_O = 5\text{mA to } 1\text{A}$	-	-	0.5	mA	
		$V_I = 8\text{V to } 25\text{V}$	-	-	1.3		
Output Voltage Drift	$\Delta V_O / \Delta T$	$I_O = 5\text{mA}$	-	-0.8	-	mV/ $^{\circ}\text{C}$	
Output Noise Voltage	$V_N$	$f = 10\text{Hz to } 100\text{kHz}$ , $T_A = +25^{\circ}\text{C}$	-	45	-	$\mu\text{V}/V_O$	
Ripple Rejection	RR	$f = 120\text{Hz}$ $V_I = 9\text{V to } 19\text{V}$	59	75	-	dB	
Dropout Voltage	$V_{\text{Drop}}$	$I_O = 1\text{A}$ , $T_J = +25^{\circ}\text{C}$	-	2	-	V	
Output Resistance	$r_O$	$f = 1\text{kHz}$	-	19	-	$\text{m}\Omega$	
Short Circuit Current	ISC	$V_I = 35\text{V}$ , $T_A = +25^{\circ}\text{C}$	-	250	-	mA	
Peak Current	$I_{\text{PK}}$	$T_J = +25^{\circ}\text{C}$	-	2.2	-	A	

### Note:

1. Load and line regulation are specified at constant junction temperature. Changes in  $V_O$  due to heating effects must be taken into account separately. Pulse testing with low duty is used.

## Electrical Characteristics (KA7808/KA7808R)

(Refer to test circuit,  $0^{\circ}\text{C} < T_J < 125^{\circ}\text{C}$ ,  $I_O = 500\text{mA}$ ,  $V_I = 14\text{V}$ ,  $C_I = 0.33\mu\text{F}$ ,  $C_O = 0.1\mu\text{F}$ , unless otherwise specified)

Parameter	Symbol	Conditions	KA7808			Unit	
			Min.	Typ.	Max.		
Output Voltage	$V_O$	$T_J = +25^{\circ}\text{C}$	7.7	8.0	8.3	V	
		$5.0\text{mA} \leq I_O \leq 1.0\text{A}$ , $P_O \leq 15\text{W}$ $V_I = 10.5\text{V to } 23\text{V}$	7.6	8.0	8.4		
Line Regulation (Note1)	Regline	$T_J = +25^{\circ}\text{C}$	$V_I = 10.5\text{V to } 25\text{V}$	-	5.0	160	mV
			$V_I = 11.5\text{V to } 17\text{V}$	-	2.0	80	
Load Regulation (Note1)	Regload	$T_J = +25^{\circ}\text{C}$	$I_O = 5.0\text{mA to } 1.5\text{A}$	-	10	160	mV
			$I_O = 250\text{mA to } 750\text{mA}$	-	5.0	80	
Quiescent Current	$I_Q$	$T_J = +25^{\circ}\text{C}$	-	5.0	8.0	mA	
Quiescent Current Change	$\Delta I_Q$	$I_O = 5\text{mA to } 1.0\text{A}$	-	0.05	0.5	mA	
		$V_I = 10.5\text{V to } 25\text{V}$	-	0.5	1.0		
Output Voltage Drift	$\Delta V_O / \Delta T$	$I_O = 5\text{mA}$	-	-0.8	-	mV/ $^{\circ}\text{C}$	
Output Noise Voltage	$V_N$	$f = 10\text{Hz to } 100\text{kHz}$ , $T_A = +25^{\circ}\text{C}$	-	52	-	$\mu\text{V}/V_O$	
Ripple Rejection	RR	$f = 120\text{Hz}$ , $V_I = 11.5\text{V to } 21.5\text{V}$	56	73	-	dB	
Dropout Voltage	$V_{\text{Drop}}$	$I_O = 1\text{A}$ , $T_J = +25^{\circ}\text{C}$	-	2	-	V	
Output Resistance	$r_O$	$f = 1\text{kHz}$	-	17	-	$\text{m}\Omega$	
Short Circuit Current	$I_{\text{SC}}$	$V_I = 35\text{V}$ , $T_A = +25^{\circ}\text{C}$	-	230	-	mA	
Peak Current	$I_{\text{PK}}$	$T_J = +25^{\circ}\text{C}$	-	2.2	-	A	

### Note:

1. Load and line regulation are specified at constant junction temperature. Changes in  $V_O$  due to heating effects must be taken into account separately. Pulse testing with low duty is used.

## Electrical Characteristics (KA7809/KA7809R)

(Refer to test circuit,  $0^{\circ}\text{C} < T_J < 125^{\circ}\text{C}$ ,  $I_O = 500\text{mA}$ ,  $V_I = 15\text{V}$ ,  $C_I = 0.33\mu\text{F}$ ,  $C_O = 0.1\mu\text{F}$ , unless otherwise specified)

Parameter	Symbol	Conditions	KA7809			Unit	
			Min.	Typ.	Max.		
Output Voltage	V <sub>O</sub>	T <sub>J</sub> = +25 °C	8.65	9	9.35	V	
		5.0mA ≤ I <sub>O</sub> ≤ 1.0A, P <sub>O</sub> ≤ 15W V <sub>I</sub> = 11.5V to 24V	8.6	9	9.4		
Line Regulation (Note1)	Regline	T <sub>J</sub> = +25 °C	V <sub>I</sub> = 11.5V to 25V	-	6	180	mV
			V <sub>I</sub> = 12V to 17V	-	2	90	
Load Regulation (Note1)	Regload	T <sub>J</sub> = +25 °C	I <sub>O</sub> = 5mA to 1.5A	-	12	180	mV
			I <sub>O</sub> = 250mA to 750mA	-	4	90	
Quiescent Current	I <sub>Q</sub>	T <sub>J</sub> = +25 °C	-	5.0	8.0	mA	
Quiescent Current Change	ΔI <sub>Q</sub>	I <sub>O</sub> = 5mA to 1.0A	-	-	0.5	mA	
		V <sub>I</sub> = 11.5V to 26V	-	-	1.3		
Output Voltage Drift	ΔV <sub>O</sub> /ΔT	I <sub>O</sub> = 5mA	-	-1	-	mV/°C	
Output Noise Voltage	V <sub>N</sub>	f = 10Hz to 100KHz, T <sub>A</sub> = +25 °C	-	58	-	μV/V <sub>O</sub>	
Ripple Rejection	RR	f = 120Hz V <sub>I</sub> = 13V to 23V	56	71	-	dB	
Dropout Voltage	V <sub>Drop</sub>	I <sub>O</sub> = 1A, T <sub>J</sub> = +25 °C	-	2	-	V	
Output Resistance	r <sub>O</sub>	f = 1KHz	-	17	-	mΩ	
Short Circuit Current	I <sub>SC</sub>	V <sub>I</sub> = 35V, T <sub>A</sub> = +25 °C	-	250	-	mA	
Peak Current	I <sub>PK</sub>	T <sub>J</sub> = +25 °C	-	2.2	-	A	

### Note:

1. Load and line regulation are specified at constant junction temperature. Changes in V<sub>O</sub> due to heating effects must be taken into account separately. Pulse testing with low duty is used.

## Electrical Characteristics (KA7810)

(Refer to test circuit ,  $0^{\circ}\text{C} < T_J < 125^{\circ}\text{C}$ ,  $I_O = 500\text{mA}$ ,  $V_I = 16\text{V}$ ,  $C_I = 0.33\mu\text{F}$ ,  $C_O = 0.1\mu\text{F}$ , unless otherwise specified)

Parameter	Symbol	Conditions	KA7810			Unit	
			Min.	Typ.	Max.		
Output Voltage	$V_O$	$T_J = +25^{\circ}\text{C}$	9.6	10	10.4	V	
		$5.0\text{mA} \leq I_O \leq 1.0\text{A}$ , $P_O \leq 15\text{W}$ $V_I = 12.5\text{V to } 25\text{V}$	9.5	10	10.5		
Line Regulation (Note1)	Regline	$T_J = +25^{\circ}\text{C}$	$V_I = 12.5\text{V to } 25\text{V}$	-	10	200	mV
			$V_I = 13\text{V to } 25\text{V}$	-	3	100	
Load Regulation (Note1)	Regload	$T_J = +25^{\circ}\text{C}$	$I_O = 5\text{mA to } 1.5\text{A}$	-	12	200	mV
			$I_O = 250\text{mA to } 750\text{mA}$	-	4	400	
Quiescent Current	$I_Q$	$T_J = +25^{\circ}\text{C}$	-	5.1	8.0	mA	
Quiescent Current Change	$\Delta I_Q$	$I_O = 5\text{mA to } 1.0\text{A}$	-	-	0.5	mA	
		$V_I = 12.5\text{V to } 29\text{V}$	-	-	1.0		
Output Voltage Drift	$\Delta V_O / \Delta T$	$I_O = 5\text{mA}$	-	-1	-	mV/ $^{\circ}\text{C}$	
Output Noise Voltage	$V_N$	$f = 10\text{Hz to } 100\text{KHz}$ , $T_A = +25^{\circ}\text{C}$	-	58	-	$\mu\text{V}/V_O$	
Ripple Rejection	RR	$f = 120\text{Hz}$ $V_I = 13\text{V to } 23\text{V}$	56	71	-	dB	
Dropout Voltage	$V_{\text{Drop}}$	$I_O = 1\text{A}$ , $T_J = +25^{\circ}\text{C}$	-	2	-	V	
Output Resistance	$r_O$	$f = 1\text{KHz}$	-	17	-	$\text{m}\Omega$	
Short Circuit Current	$I_{\text{SC}}$	$V_I = 35\text{V}$ , $T_A = +25^{\circ}\text{C}$	-	250	-	mA	
Peak Current	$I_{\text{PK}}$	$T_J = +25^{\circ}\text{C}$	-	2.2	-	A	

**Note:**

1. Load and line regulation are specified at constant junction temperature. Changes in  $V_O$  due to heating effects must be taken into account separately. Pulse testing with low duty is used.

## Electrical Characteristics (KA7812/KA7812R)

(Refer to test circuit,  $0^{\circ}\text{C} < T_J < 125^{\circ}\text{C}$ ,  $I_O = 500\text{mA}$ ,  $V_I = 19\text{V}$ ,  $C_I = 0.33\mu\text{F}$ ,  $C_O = 0.1\mu\text{F}$ , unless otherwise specified)

Parameter	Symbol	Conditions	KA7812/KA7812R			Unit	
			Min.	Typ.	Max.		
Output Voltage	V <sub>O</sub>	T <sub>J</sub> = +25 °C	11.5	12	12.5	V	
		5.0mA ≤ I <sub>O</sub> ≤ 1.0A, P <sub>O</sub> ≤ 15W V <sub>I</sub> = 14.5V to 27V	11.4	12	12.6		
Line Regulation (Note1)	Regline	T <sub>J</sub> = +25 °C	V <sub>I</sub> = 14.5V to 30V	-	10	240	mV
			V <sub>I</sub> = 16V to 22V	-	3.0	120	
Load Regulation (Note1)	Regload	T <sub>J</sub> = +25 °C	I <sub>O</sub> = 5mA to 1.5A	-	11	240	mV
			I <sub>O</sub> = 250mA to 750mA	-	5.0	120	
Quiescent Current	I <sub>Q</sub>	T <sub>J</sub> = +25 °C	-	5.1	8.0	mA	
Quiescent Current Change	ΔI <sub>Q</sub>	I <sub>O</sub> = 5mA to 1.0A	-	0.1	0.5	mA	
		V <sub>I</sub> = 14.5V to 30V	-	0.5	1.0		
Output Voltage Drift	ΔV <sub>O</sub> /ΔT	I <sub>O</sub> = 5mA	-	-1	-	mV/°C	
Output Noise Voltage	V <sub>N</sub>	f = 10Hz to 100kHz, T <sub>A</sub> = +25 °C	-	76	-	μV/V <sub>O</sub>	
Ripple Rejection	RR	f = 120Hz V <sub>I</sub> = 15V to 25V	55	71	-	dB	
Dropout Voltage	V <sub>Drop</sub>	I <sub>O</sub> = 1A, T <sub>J</sub> = +25 °C	-	2	-	V	
Output Resistance	r <sub>O</sub>	f = 1KHz	-	18	-	mΩ	
Short Circuit Current	I <sub>SC</sub>	V <sub>I</sub> = 35V, T <sub>A</sub> = +25 °C	-	230	-	mA	
Peak Current	I <sub>PK</sub>	T <sub>J</sub> = +25 °C	-	2.2	-	A	

### Note:

1. Load and line regulation are specified at constant junction temperature. Changes in V<sub>O</sub> due to heating effects must be taken into account separately. Pulse testing with low duty is used.

## Electrical Characteristics (KA7815)

(Refer to test circuit,  $0^{\circ}\text{C} < T_J < 125^{\circ}\text{C}$ ,  $I_O = 500\text{mA}$ ,  $V_I = 23\text{V}$ ,  $C_I = 0.33\mu\text{F}$ ,  $C_O = 0.1\mu\text{F}$ , unless otherwise specified)

Parameter	Symbol	Conditions	KA7815			Unit	
			Min.	Typ.	Max.		
Output Voltage	V <sub>O</sub>	T <sub>J</sub> = +25 °C	14.4	15	15.6	V	
		5.0mA ≤ I <sub>O</sub> ≤ 1.0A, P <sub>O</sub> ≤ 15W V <sub>I</sub> = 17.5V to 30V	14.25	15	15.75		
Line Regulation (Note1)	Regline	T <sub>J</sub> = +25 °C	V <sub>I</sub> = 17.5V to 30V	-	11	300	mV
			V <sub>I</sub> = 20V to 26V	-	3	150	
Load Regulation (Note1)	Regload	T <sub>J</sub> = +25 °C	I <sub>O</sub> = 5mA to 1.5A	-	12	300	mV
			I <sub>O</sub> = 250mA to 750mA	-	4	150	
Quiescent Current	I <sub>Q</sub>	T <sub>J</sub> = +25 °C	-	5.2	8.0	mA	
Quiescent Current Change	ΔI <sub>Q</sub>	I <sub>O</sub> = 5mA to 1.0A	-	-	0.5	mA	
		V <sub>I</sub> = 17.5V to 30V	-	-	1.0		
Output Voltage Drift	ΔV <sub>O</sub> /ΔT	I <sub>O</sub> = 5mA	-	-1	-	mV/°C	
Output Noise Voltage	V <sub>N</sub>	f = 10Hz to 100KHz, T <sub>A</sub> = +25 °C	-	90	-	μV/V <sub>O</sub>	
Ripple Rejection	RR	f = 120Hz V <sub>I</sub> = 18.5V to 28.5V	54	70	-	dB	
Dropout Voltage	V <sub>Drop</sub>	I <sub>O</sub> = 1A, T <sub>J</sub> = +25 °C	-	2	-	V	
Output Resistance	r <sub>O</sub>	f = 1KHz	-	19	-	mΩ	
Short Circuit Current	I <sub>SC</sub>	V <sub>I</sub> = 35V, T <sub>A</sub> = +25 °C	-	250	-	mA	
Peak Current	I <sub>PK</sub>	T <sub>J</sub> = +25 °C	-	2.2	-	A	

### Note:

1. Load and line regulation are specified at constant junction temperature. Changes in V<sub>O</sub> due to heating effects must be taken into account separately. Pulse testing with low duty is used.

## Electrical Characteristics (KA7818)

(Refer to test circuit,  $0^{\circ}\text{C} < T_J < 125^{\circ}\text{C}$ ,  $I_O = 500\text{mA}$ ,  $V_I = 27\text{V}$ ,  $C_I = 0.33\mu\text{F}$ ,  $C_O = 0.1\mu\text{F}$ , unless otherwise specified)

Parameter	Symbol	Conditions	KA7818			Unit	
			Min.	Typ.	Max.		
Output Voltage	$V_O$	$T_J = +25^{\circ}\text{C}$	17.3	18	18.7	V	
		$5.0\text{mA} \leq I_O \leq 1.0\text{A}$ , $P_O \leq 15\text{W}$ $V_I = 21\text{V to } 33\text{V}$	17.1	18	18.9		
Line Regulation (Note1)	Regline	$T_J = +25^{\circ}\text{C}$	$V_I = 21\text{V to } 33\text{V}$	-	15	360	mV
			$V_I = 24\text{V to } 30\text{V}$	-	5	180	
Load Regulation (Note1)	Regload	$T_J = +25^{\circ}\text{C}$	$I_O = 5\text{mA to } 1.5\text{A}$	-	15	360	mV
			$I_O = 250\text{mA to } 750\text{mA}$	-	5.0	180	
Quiescent Current	$I_Q$	$T_J = +25^{\circ}\text{C}$	-	5.2	8.0	mA	
Quiescent Current Change	$\Delta I_Q$	$I_O = 5\text{mA to } 1.0\text{A}$	-	-	0.5	mA	
		$V_I = 21\text{V to } 33\text{V}$	-	-	1		
Output Voltage Drift	$\Delta V_O / \Delta T$	$I_O = 5\text{mA}$	-	-1	-	mV/ $^{\circ}\text{C}$	
Output Noise Voltage	$V_N$	$f = 10\text{Hz to } 100\text{KHz}$ , $T_A = +25^{\circ}\text{C}$	-	110	-	$\mu\text{V}/V_O$	
Ripple Rejection	RR	$f = 120\text{Hz}$ $V_I = 22\text{V to } 32\text{V}$	53	69	-	dB	
Dropout Voltage	$V_{\text{Drop}}$	$I_O = 1\text{A}$ , $T_J = +25^{\circ}\text{C}$	-	2	-	V	
Output Resistance	$r_O$	$f = 1\text{KHz}$	-	22	-	$\text{m}\Omega$	
Short Circuit Current	ISC	$V_I = 35\text{V}$ , $T_A = +25^{\circ}\text{C}$	-	250	-	mA	
Peak Current	IPK	$T_J = +25^{\circ}\text{C}$	-	2.2	-	A	

### Note:

1. Load and line regulation are specified at constant junction temperature. Changes in  $V_O$  due to heating effects must be taken into account separately. Pulse testing with low duty is used.

## Electrical Characteristics (KA7824)

(Refer to test circuit,  $0^{\circ}\text{C} < T_J < 125^{\circ}\text{C}$ ,  $I_O = 500\text{mA}$ ,  $V_I = 33\text{V}$ ,  $C_I = 0.33\mu\text{F}$ ,  $C_O = 0.1\mu\text{F}$ , unless otherwise specified)

Parameter	Symbol	Conditions	KA7824			Unit	
			Min.	Typ.	Max.		
Output Voltage	$V_O$	$T_J = +25^{\circ}\text{C}$	23	24	25	V	
		$5.0\text{mA} \leq I_O \leq 1.0\text{A}$ , $P_O \leq 15\text{W}$ $V_I = 27\text{V to } 38\text{V}$	22.8	24	25.25		
Line Regulation (Note1)	Regline	$T_J = +25^{\circ}\text{C}$	$V_I = 27\text{V to } 38\text{V}$	-	17	480	mV
			$V_I = 30\text{V to } 36\text{V}$	-	6	240	
Load Regulation (Note1)	Regload	$T_J = +25^{\circ}\text{C}$	$I_O = 5\text{mA to } 1.5\text{A}$	-	15	480	mV
			$I_O = 250\text{mA to } 750\text{mA}$	-	5.0	240	
Quiescent Current	$I_Q$	$T_J = +25^{\circ}\text{C}$	-	5.2	8.0	mA	
Quiescent Current Change	$\Delta I_Q$	$I_O = 5\text{mA to } 1.0\text{A}$	-	0.1	0.5	mA	
		$V_I = 27\text{V to } 38\text{V}$	-	0.5	1		
Output Voltage Drift	$\Delta V_O / \Delta T$	$I_O = 5\text{mA}$	-	-1.5	-	mV/ $^{\circ}\text{C}$	
Output Noise Voltage	$V_N$	$f = 10\text{Hz to } 100\text{KHz}$ , $T_A = +25^{\circ}\text{C}$	-	60	-	$\mu\text{V}/V_O$	
Ripple Rejection	RR	$f = 120\text{Hz}$ $V_I = 28\text{V to } 38\text{V}$	50	67	-	dB	
Dropout Voltage	$V_{\text{Drop}}$	$I_O = 1\text{A}$ , $T_J = +25^{\circ}\text{C}$	-	2	-	V	
Output Resistance	$r_O$	$f = 1\text{KHz}$	-	28	-	$\text{m}\Omega$	
Short Circuit Current	$I_{\text{SC}}$	$V_I = 35\text{V}$ , $T_A = +25^{\circ}\text{C}$	-	230	-	mA	
Peak Current	$I_{\text{PK}}$	$T_J = +25^{\circ}\text{C}$	-	2.2	-	A	

### Note:

1. Load and line regulation are specified at constant junction temperature. Changes in  $V_O$  due to heating effects must be taken into account separately. Pulse testing with low duty is used.

## Electrical Characteristics (KA7805A)

(Refer to the test circuits.  $0^{\circ}\text{C} < T_J < +125^{\circ}\text{C}$ ,  $I_O = 1\text{A}$ ,  $V_I = 10\text{V}$ ,  $C_I = 0.33\mu\text{F}$ ,  $C_O = 0.1\mu\text{F}$ , unless otherwise specified)

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit	
Output Voltage	$V_O$	$T_J = +25^{\circ}\text{C}$	4.9	5	5.1	V	
		$I_O = 5\text{mA to } 1\text{A}$ , $P_O \leq 15\text{W}$ $V_I = 7.5\text{V to } 20\text{V}$	4.8	5	5.2		
Line Regulation (Note1)	Regline	$V_I = 7.5\text{V to } 25\text{V}$ $I_O = 500\text{mA}$	-	5	50	mV	
		$V_I = 8\text{V to } 12\text{V}$	-	3	50		
		$T_J = +25^{\circ}\text{C}$	$V_I = 7.3\text{V to } 20\text{V}$	-	5		50
			$V_I = 8\text{V to } 12\text{V}$	-	1.5		25
Load Regulation (Note1)	Regload	$T_J = +25^{\circ}\text{C}$ $I_O = 5\text{mA to } 1.5\text{A}$	-	9	100	mV	
		$I_O = 5\text{mA to } 1\text{A}$	-	9	100		
		$I_O = 250\text{mA to } 750\text{mA}$	-	4	50		
Quiescent Current	$I_Q$	$T_J = +25^{\circ}\text{C}$	-	5.0	6.0	mA	
Quiescent Current Change	$\Delta I_Q$	$I_O = 5\text{mA to } 1\text{A}$	-	-	0.5	mA	
		$V_I = 8\text{V to } 25\text{V}$ , $I_O = 500\text{mA}$	-	-	0.8		
		$V_I = 7.5\text{V to } 20\text{V}$ , $T_J = +25^{\circ}\text{C}$	-	-	0.8		
Output Voltage Drift	$\Delta V/\Delta T$	$I_O = 5\text{mA}$	-	-0.8	-	mV/ $^{\circ}\text{C}$	
Output Noise Voltage	$V_N$	$f = 10\text{Hz to } 100\text{KHz}$ $T_A = +25^{\circ}\text{C}$	-	10	-	$\mu\text{V}/V_O$	
Ripple Rejection	RR	$f = 120\text{Hz}$ , $I_O = 500\text{mA}$ $V_I = 8\text{V to } 18\text{V}$	-	68	-	dB	
Dropout Voltage	$V_{\text{Drop}}$	$I_O = 1\text{A}$ , $T_J = +25^{\circ}\text{C}$	-	2	-	V	
Output Resistance	$r_O$	$f = 1\text{KHz}$	-	17	-	$\text{m}\Omega$	
Short Circuit Current	ISC	$V_I = 35\text{V}$ , $T_A = +25^{\circ}\text{C}$	-	250	-	mA	
Peak Current	IPK	$T_J = +25^{\circ}\text{C}$	-	2.2	-	A	

### Note:

1. Load and line regulation are specified at constant junction temperature. Change in  $V_O$  due to heating effects must be taken into account separately. Pulse testing with low duty is used.

## Electrical Characteristics (KA7806A)

(Refer to the test circuits.  $0^{\circ}\text{C} < T_J < +125^{\circ}\text{C}$ ,  $I_O = 1\text{A}$ ,  $V_I = 11\text{V}$ ,  $C_I = 0.33\mu\text{F}$ ,  $C_O = 0.1\mu\text{F}$ , unless otherwise specified)

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit	
Output Voltage	V <sub>O</sub>	T <sub>J</sub> = +25 °C	5.58	6	6.12	V	
		I <sub>O</sub> = 5mA to 1A, P <sub>O</sub> ≤ 15W V <sub>I</sub> = 8.6V to 21V	5.76	6	6.24		
Line Regulation (Note1)	Regline	V <sub>I</sub> = 8.6V to 25V I <sub>O</sub> = 500mA	-	5	60	mV	
		V <sub>I</sub> = 9V to 13V	-	3	60		
		T <sub>J</sub> = +25 °C	V <sub>I</sub> = 8.3V to 21V	-	5		60
			V <sub>I</sub> = 9V to 13V	-	1.5		30
Load Regulation (Note1)	Regload	T <sub>J</sub> = +25 °C I <sub>O</sub> = 5mA to 1.5A	-	9	100	mV	
		I <sub>O</sub> = 5mA to 1A	-	4	100		
		I <sub>O</sub> = 250mA to 750mA	-	5.0	50		
Quiescent Current	I <sub>Q</sub>	T <sub>J</sub> = +25 °C	-	4.3	6.0	mA	
Quiescent Current Change	ΔI <sub>Q</sub>	I <sub>O</sub> = 5mA to 1A	-	-	0.5	mA	
		V <sub>I</sub> = 9V to 25V, I <sub>O</sub> = 500mA	-	-	0.8		
		V <sub>I</sub> = 8.5V to 21V, T <sub>J</sub> = +25 °C	-	-	0.8		
Output Voltage Drift	ΔV/ΔT	I <sub>O</sub> = 5mA	-	-0.8	-	mV/°C	
Output Noise Voltage	V <sub>N</sub>	f = 10Hz to 100KHz T <sub>A</sub> = +25 °C	-	10	-	μV/V <sub>O</sub>	
Ripple Rejection	RR	f = 120Hz, I <sub>O</sub> = 500mA V <sub>I</sub> = 9V to 19V	-	65	-	dB	
Dropout Voltage	V <sub>Drop</sub>	I <sub>O</sub> = 1A, T <sub>J</sub> = +25 °C	-	2	-	V	
Output Resistance	r <sub>O</sub>	f = 1KHz	-	17	-	mΩ	
Short Circuit Current	I <sub>SC</sub>	V <sub>I</sub> = 35V, T <sub>A</sub> = +25 °C	-	250	-	mA	
Peak Current	I <sub>PK</sub>	T <sub>J</sub> = +25 °C	-	2.2	-	A	

### Note:

1. Load and line regulation are specified at constant junction temperature. Change in V<sub>O</sub> due to heating effects must be taken into account separately. Pulse testing with low duty is used.