SMART HOME

Project Report submitted in partial fulfillment of the requirement

for the Degree of

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in

Electronics and Communication Engineering

under the Supervision of

Mr. VIKAS HASTIR

By

SWATI CHAUHAN	081110
BINDIA HANDA	081114
ABHISHEK SRIVASTAVA	081118

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, WAKNAGHAT, SOLAN – 173234, HIMACHAL PRADESH

Certificate

This is to certify that project report entitled "**Smart Home**", submitted by Swati Chauhan, Bindia Handa, Abhishek Srivastava in partial fulfillment for the award of degree of Bachelor of Technology in Electronics and Communication Engineering to Jaypee University of Information Technology, Waknaghat, Solan has been carried out under my supervision.

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

Vikas

Date: **Mr. Vikas Hastir**

Designation

Acknowledgement

A project of such a comprehensive coverage and modern ideology cannot be prepared without help from numerous sources.

We gratefully acknowledge the generous guidance of our project guide **Mr. VIKAS HASTIR**. He inspired, guided, assisted us at all stages of this project work. We owe him a great debt of gratitude for without his support, this work wouldn't have been accomplished, indeed. We just have no words to express our obligations for this learned and noble scholar.

We are equally indebted to all the staff members of Electronics Department of our University. This project work has been greatly assisted by the cooperation of Project lab staff that provided full support and facilities.

We have tried to produce the very best out of our endeavor.

Swati Chauhan (081110)

Bindia Handa (081114)

Abhishek Srivastava (081118)

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Abstract

In this project we access the electrical devices using the frequency signals (wireless) using a **AT89C51** micro controller. The device control program is stored in the memory of the microcontroller to control the devices through the input switches.

Mainly the system consists of two modules i.e. Transmitter (Tx) module & Receiver (Rx) module. At the Tx side switches are connected and at the Rx side devices are connected. The radio frequency that is being used here is **434MHz** . The TRX -434 RF transmitter module uses a digital modulation technique called **ASK (Amplitude Shift Keying)** or on-off keying. The RX-434 radio receiver module receives the ASK signal from TRX-434. Here **HT12E** & **HT12D** have been used as encoder and decoder respectively. The encoder converts the parallel inputs (from the remote switches) into serial set of signals. These signals are serially transferred through RF to the reception point. The transmitted signals are received by the receiver module placed away from the source of transmission. The transmission occurs at the rate of 1Kbps - 10Kbps. The transmitted data is received by an RF receiver operating at the same frequency as that of the transmitter. The decoder is used after the RF receiver to decode the serial format and retrieve the original signals as outputs. The HT12D decoder demodulates the received address and the data bits. The system allows one way communication between two nodes, namely, transmission and reception.

5V supply for microcontroller & HT12D is obtained from the **Voltage supply** unit. Initially 230 V AC supply is reduced to (0-12V) with the help of a step down transformer having a capacity of 500mA.

Such smart homes can also help the elderly and disabled with assisted living, patient monitoring and emergency response. It can be easily installed in existing home without adding any additional wires/switches.

CHAPTER 1 INTRODUCTION

1.1 Overview

The Delta Centre (2005) in Norway describes a Smart Home technology as "a collective term for information and communication technology (ICT) as used in houses, were the various components are communicating via a local network. The technology can be used to monitor, warn and carry out functions according to selected criteria."

Smart Home includes the digital home, intelligent home, connected home, and networked home. Smart House includes consideration of the interface with the user and the user's needs. With conventional installations every action must be actively triggered by the user i.e. to turn the light on, a manual switch must be activated. These systems are operated by a remote control, often through one command from the user resulting in one response from the system. The technology can be used to monitor, warn and perform actions according to chosen criteria.

The Smart House will control and monitor the essential services we use daily. Home automation for the elderly and disabled can provide increased quality of life for persons who might otherwise require caregivers or institutional care. There will inevitably be occasions where the house system needs to report a problem or other information to a responsible body, other than the householder. For example, police, medical services or utility providers. These applications may be included in the future improvement.

Nowadays, wireless communication is preferred over wired communication. A lot of research is being done on wireless communication. Radio waves are commonly used for long range communications with high power transmitter. Infrared is commonly used for short range LOS communications. Almost all consumer electronics items are operated using a remote control. Only this way, this technology came into the hands of common man. Every person knows how to operate devices using remote control but very rare persons actually know how this technology works. In our project, we will try to demonstrate the remote control technology sending digital inputs through RF spectrum, microcontroller's interfaces with various peripherals.

1.2 Desk Research

For the implementation of Smart Home various domestic network technologies are available based on Device interconnection, Control & automation sets and Data nets as follows:

- Device interconnection:
  - Bluetooth
  - IrDA
  - ZigBee
- Control and automation nets:
  - INSTEON
  - Universal Powerline Bus
  - X10
  - ZigBee
  - Z-Wave
- Data nets:
  - Ethernet
  - Homeplug
  - WiFi

There have been many attempts to standardize the forms of hardware, electronic and communication interfaces needed to construct a Smart Home system. Some standards use additional communication and control wiring, some embed signals in the existing power circuit of the house, some use radio frequency (RF) signals, and some use a combination of several methods. Control wiring is hardest to retrofit into an existing house. Some appliances include USB that is used to control it and connect it to a domotics network.

Besides the upcoming standardization of Smart Home hardware, there is also the issue of the control software. In older systems, the control of each home automation system needed to be done separately, and there was thus no central control system.

Medium	Advantages	Disadvantages
Signal cables (twisted pair)	High capacity. Few disturbances. Long range.	Expensive to draw cables in existing buildings. Visible cables may be perceived as not aesthetic.
Bluetooth	Receivers have to be installed in all rooms.	Limited to the room in which the receiver is placed.
Radio signals	Little or no cable drawing. Easy to move units.	Walls and installations in the building reduce the range. This may be solved by repeating units, passing on the signals. Any batteries must be changed. Users with body-worn transmitter may be hard to localise.
230V Cable net (powerline)	Utilises the cabling for 230V. May imply simple installation. Easy to move units between existing socket points.	Noise on the net must be filtered away yielding additional costs. Need for filters between apartments in the same building. Slow/low capacity.
IR (infrared light)	Easy to localise the origin of the triggered alarm. Receivers have to be installed in all rooms where the system is to be used.	Limited to the room in which the receiver is placed.

Table 1 Mediums for transfer of signals

1.3 Literature Survey

Wireless communications can be via Radio frequency communication, Microwave communication, Infrared (IR). Applications may involve point-to-point communication, point-to-multipoint communication, broadcasting, cellular networks and other wireless networks.

The radio frequency that is being used in this project is **434MHz** . The TRX -434 RF transmitter module uses a digital modulation technique called **ASK** (Amplitude Shift Keying) or on-off keying.The RX-434 radio receiver module receives the ASK signal from TRX-434.

In ASK, it is necessary to transmit data in serial fashion. The data to be send by the transmitter has to be compatible with the receiver and this very function is done using microcontroller in this project. It makes different codes for different switches pressed and transmits it serially which makes it very much compatible with RF receivers.

1.4 Technology Considerations

When designing a home control technology three main requirements must be taken into account:

a. Ease-of-use

b. Reliability

c. Low cost

Ease-of-use: When designing a wireless home control technology for the mass-market it is very important to realize that it is the average homeowner or a semi-skilled installer who typically installs the system. The technology must provide simple intuitive installation and require no network management by the user during the lifetime of the installation. Finally the technology must be designed to support horizontal applications; enabling different product types from various vendors to seamless communicate with each other and use each other features.

Reliability: Robust and reliable RF communication is crucial in order to allow the home control system to handle sensitive operations. For example, if the home owner instructs the central door locking application to lock and arm the alarm system, he or she must be guaranteed that the instruction is registered and executed. Furthermore, as RF operates on a shared medium, and RF is sensitive to changes in the environment, protocol algorithms must be applied to make the RF link as reliable as a wired system. The implementation of this robustness includes features such as frame acknowledgment, collision avoidance, random back off algorithms, retransmission, and routing, to achieve reliable links and full home network coverage.

Low Cost: In order to have a true mass-market technology the physical wireless platform must have a very low cost. The right tradeoffs between technology choice and cost must be taken without compromising the reliability of the network. As many home control products are both developed and manufactured in low salary countries it is important to supply a hardware(HW) and software (SW) platform, which can be integrated without having significant RF and mesh network knowledge. This can be accomplished by supplying a ready-to-use and pre-tested HW module and a well-tested protocol stack, which provides a simple and intuitive interface between the protocol SW and the application SW. Home control products already exist today, including wireless control and monitoring of lighting, thermostats, movement sensors, air conditioning, using ready-to-use RF platforms containing both hardware and software.

The RF platform contains microprocessor, memory, RF transceiver, RF front-end and system crystal. The SW protocol assures that the products can communicate with each other in a standardized way. To meet the complex design requirements of simultaneously achieving low cost, ease-of-use and high reliability the entire wireless platform development process from protocol and module specification to final production must be taken into account.

1.5 Organisation of the Report

This report has been divided into various chapters. Brief description of these chapters is given below:

Chapter 1 gives the general introduction of the project. It contains the literature survey to obtain information regarding this project. It covers the desk research and objective behind this project.

Chapter 2 reflects the hardware of project covering basic architecture, RF transmitter & receiver module.

Chapter 3 gives an insight into modulation & demodulation techniques used.

Chapter 4 gives an insight into the software used to program the microcontroller.

Chapter 5 describes the process of preparing PCB layouts for hardware circuit simplification.

CHAPTER 2 HARDWARE DESCRIPTION

2.1 Architecture of Smart Home

In order to understand the potential of the technology, we will describe the different elements, which standards are relevant to Smart Home. In general the components are divided into:

- Sensors: To monitor and submit messages in case of changes.
- Actuators: To perform a physical action.
- Controllers: To make choices based on programmed rules and occurrences.
- Central unit: To render possible programming of units in the system.
- Networks: Allow communication between the units and control unit.
- Interface: To ease users communication with the system.

Sensors monitor and measure activities in the surroundings. Actuators perform physical actions. Several of the components of Environmental Control Systems are actuators. Controllers make choices based on programmed rules and occurrences. Controllers are microprocessors often built-in with sensors and actuators. They receive and process values from the sensor or other controllers. All units in modern, decentralized bus systems have their own microprocessors (micro controller). Thus in principle no controlling central unit is necessary to manage the system after having programmed it. In practical terms however, a central unit it is useful for the re-programming, maintenance and changes in the system. Some units are delivered with their own central units, whilst others use a PC with additional software. In residential homes the programming and re-programming of the system must be simple and intuitive. A good user interface, documentation of the system and training of the staff are important factors for the system to be used in an efficient way. Residential homes often have one or two "super users" responsible for the reprogramming of units, which is password protected programming. In residential homes or institutions with a staff room, a PC will receive all the alarms.

Such solutions can be combined with cordless telephones, for instance through using PCs during daytime and cordless telephones or cell phones during night time for the receiving of alarms.

2.2 RF Transmitter & Receiver Modules

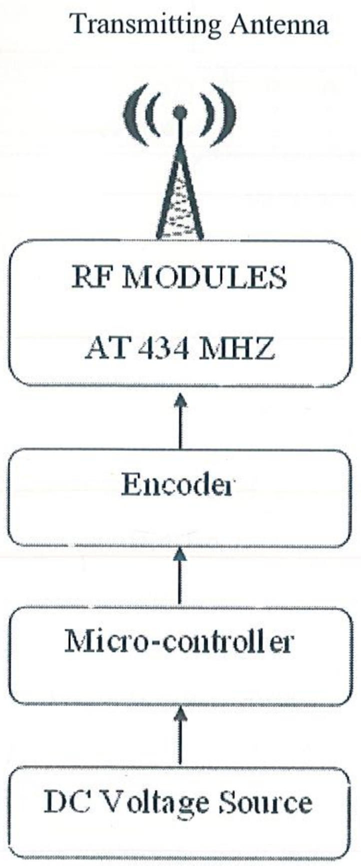

Figure 1 Transmitter Module

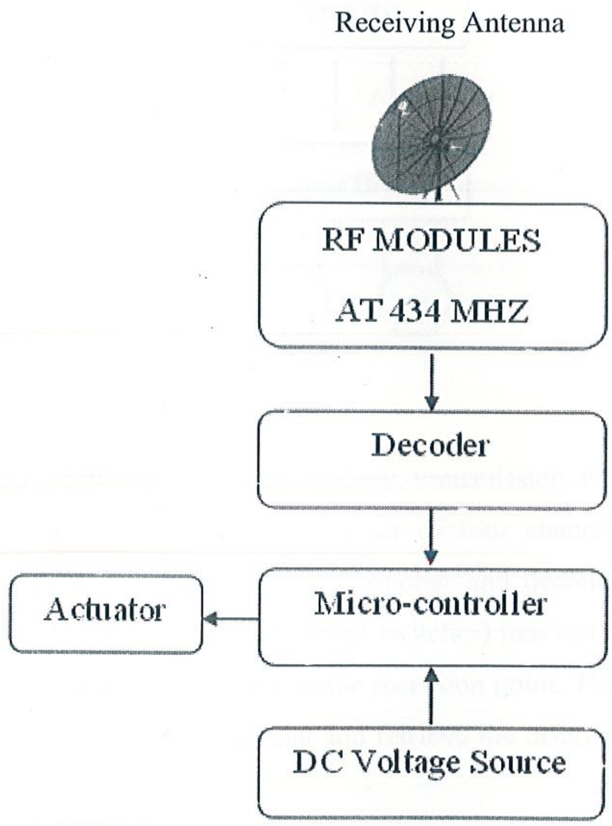

Figure 2 Receiver Module

This radio frequency (RF) transmission system employs Amplitude Shift Keying (ASK) with transmitter/receiver (Tx/Rx) pair operating at 434 MHz. The transmitter module takes serial input and transmits these signals through RF. The transmitted signals are received by the receiver module placed away from the source of transmission.

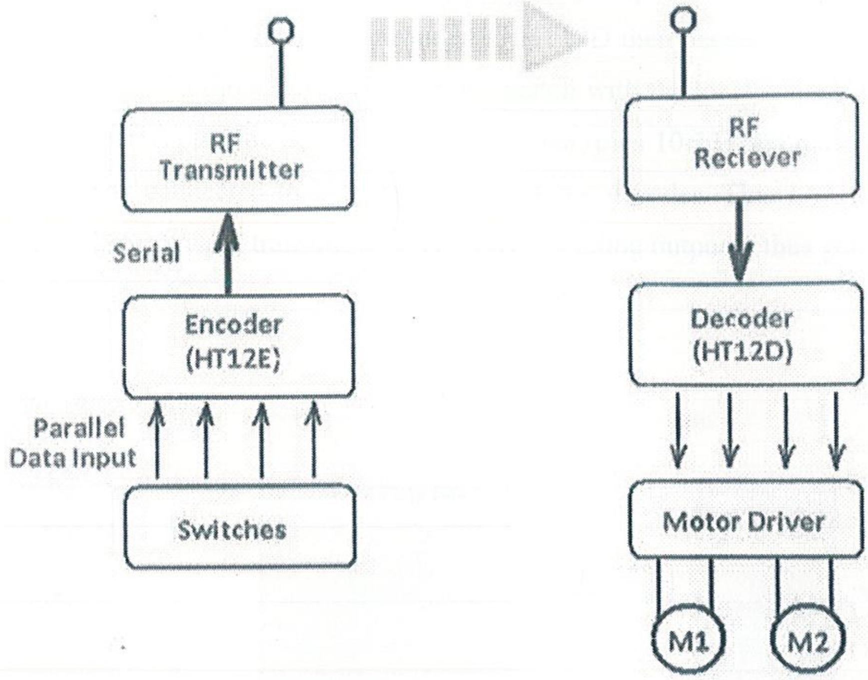

Figure 3 RF module - visualization

The system allows one way communication between two nodes, namely, transmission and reception. The RF module has been used in conjunction with a set of four channel encoder/decoder ICs. Here HT12E & HT12D have been used as encoder and decoder respectively. The encoder converts the parallel inputs (from the remote switches) into serial set of signals. These signals are serially transferred through RF to the reception point. The decoder is used after the RF receiver to decode the serial format and retrieve the original signals as outputs.

Encoder IC (HT12E) receives parallel data in the form of address bits and control bits. The control signals from remote switches along with 8 address bits constitute a set of 12 parallel signals. The encoder HT12E encodes these parallel signals into serial bits. Transmission is enabled by providing ground to pin14 which is active low. The control signals are given at pins 10-13 of HT12E. The serial data is fed to the RF transmitter through pin17 of HT12E.

When signal is received by receiver, it is given to DIN pin (pin14) of HT12D. On reception of signal, oscillator of HT12D gets activated. IC HT12D then decodes the serial data and checks the address bits three times. If these bits match with the local address pins (pins 1-8) of HT12D, then it puts the data bits on its data pins (pins 10-13) and makes the VT pin high. An LED is connected to VT pin (pin17) of the decoder. This LED works as an indicator to indicate a valid transmission. The corresponding output is thus generated at the data pins of decoder IC.

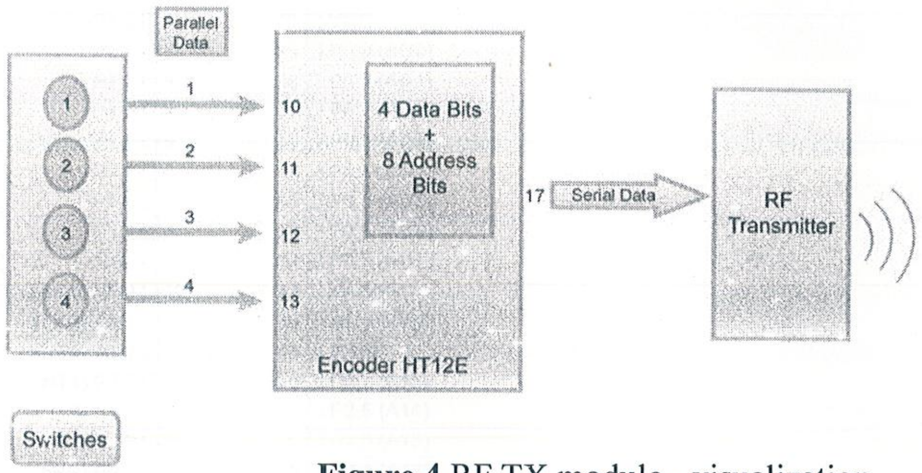

Figure 4 RF TX module - visualization

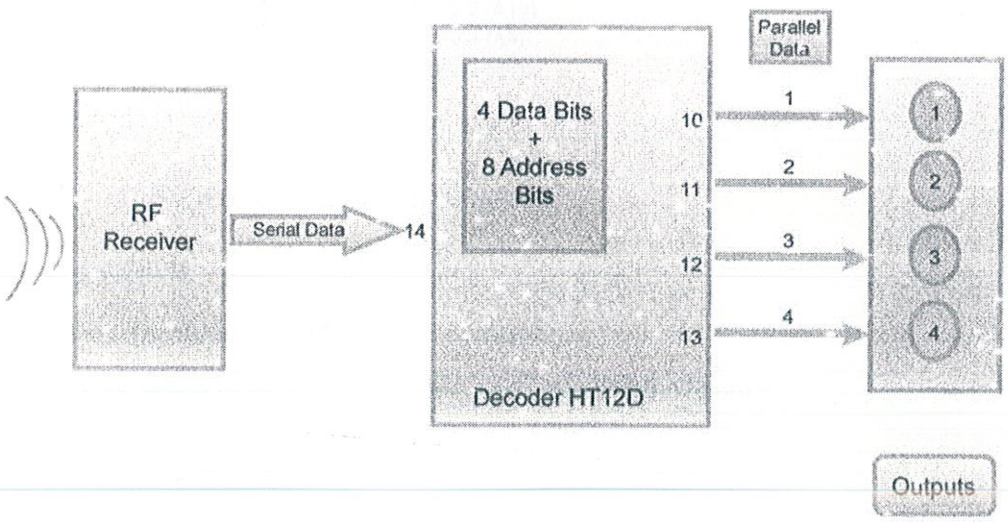

Figure 5 RF RX module - visualization

2.3 Microcontroller & IC description

The microcontrollers used in the coding and encoding of data at the transmitter and receiver end requires various ICs of the 8051 family and HT12D and HT12E. The IC of 8051 family used in the circuit implementation is 89C51.

2.3.1 89C51 IC

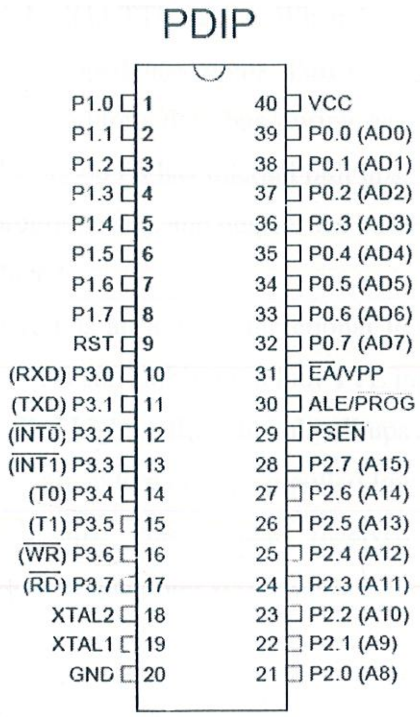

Figure 6 89C51 pin diagram

Features:

- 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

Pin description:

Port 0

Port 0 is an 8-bit open-drain bi-directional I/O port. As an output port, each pin can sink eight TTL inputs. When 1s are written to port 0 pins, the pins can be used as high impedance inputs. Port 0 may also be configured to be the multiplexed low order address/data bus during accesses to external program and data memory. In this mode P0 has internal pull ups. Port 0 also receives the code bytes during Flash programming, and outputs the code bytes during program verification.

Port 1

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

Port 2

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

2 also receives the high-order address bits and some control signals during Flash programming and verification.

Port 3

Port 3 is an 8-bit bi-directional I/O port with internal pull ups. The Port 3 output buffers can sink/source four TTL inputs. When 1s are written to Port 3 pins they are pulled high by the internal pull ups and can be used as inputs. As inputs, Port 3 pins that are externally being pulled low will source current (IIL) because of the pull ups.

RST

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

ALE/PROG

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

PSEN

Program Store Enable is the read strobe to external program memory. When the AT89C51 is executing code from external program memory, PSEN is activated twice each machine cycle, except that two PSEN activations are skipped during each access to external data memory.

EA/VPP

External Access Enable. EA must be strapped to GND in order to enable the device to fetch code from external program memory locations starting at 0000H up to FFFFH. Note, however, that if lock bit 1 is programmed, EA will be internally latched on reset. EA should be strapped to VCC for internal program executions. This pin also receives the 12-volt programming enable voltage (VPP) during Flash programming, for parts that require 12-volt VPP.

XTAL1

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

XTAL2

Output from the inverting oscillator amplifier.

2.3.2 HT12D IC

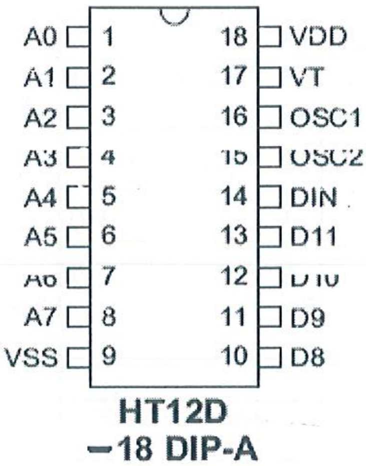

Figure 7 HT12D pin diagram

Features:

- Operating voltage
- 2.4V~12V for the HT12E
- Low power and high noise immunity CMOS
- Low standby current: 0.1_A (typ.) at
- VDD=5V
- HT12A with a 38kHz carrier for infrared
- transmission medium
- Minimum transmission word
- Four words for the HT12E
- One word for the HT12A
- Built-in oscillator needs only 5% resistor
- Data code has positive polarity

Pin description:

Pin Name	I/O	Internal Connection	Description
A0~A11 (HT12F)	I	NMOS Transmission Gate	Input pins for address A0~A11 setting These pins can be externally set to VSS or left open.
A0~A7 (HT12D)			Input pins for address A0~A7 setting These pins can be externally set to VSS or left open.
D8~D11 (HT12D)	O	CMOS OUT	Output data pins, power-on state is low.
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	—	—	Negative power supply, ground
VDD	—	—	Positive power supply

Table 2 HT12D pin description

2.3.3 HT12E IC

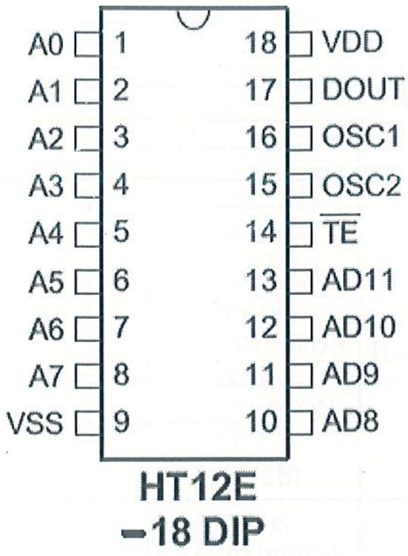

Figure 8 HT12E pin description

Features:

- Operating voltage 2.4V~12V
- Low power and high noise immunity
- Low standby current: 0.1_A (typ.) at VDD=5V
- HT12A with a 38kHz carrier for infrared transmission medium
- Minimum transmission word Four words for the HT12E, One word for the HT12A
- Built-in oscillator needs only 5% resistor
- Data code has positive polarity

Pin description:

Pin Name	I/O	Internal Connection	Description
A0~A7	I	CMOS IN Pull-high (HT12A) NMOS TRANSMISSION GATE PROTECTION DIODE (HT12E)	Input pins for address A0~A7 setting These pins can be externally set to VSS or left open
AD8~AD11	I	NMOS TRANSMISSION GATE PROTECTION DIODE (HT12E)	Input pins for address/data AD8~AD11 setting These pins can be externally set to VSS or left open
D8~D11	I	CMOS IN Pull-high	Input pins for data D8~D11 setting and transmission enable, active low These pins should be externally set to VSS or left open (see Note)
DOUT	O	CMOS OUT	Encoder data serial transmission output
L/MB	I	CMOS IN Pull-high	Latch/Momentary transmission format selection pin: Latch: Floating or VDD Momentary: VSS

Table 3 HT12E pin description

2.4 Circuit Description

2.4.1 Transmitter Circuit

The microcontroller reads the input data from the switches S1 through S4. Port 3 provides read data to the encoder IC HT12E at pins 10 through 13. The microcontroller is programmed to control the input and output data.

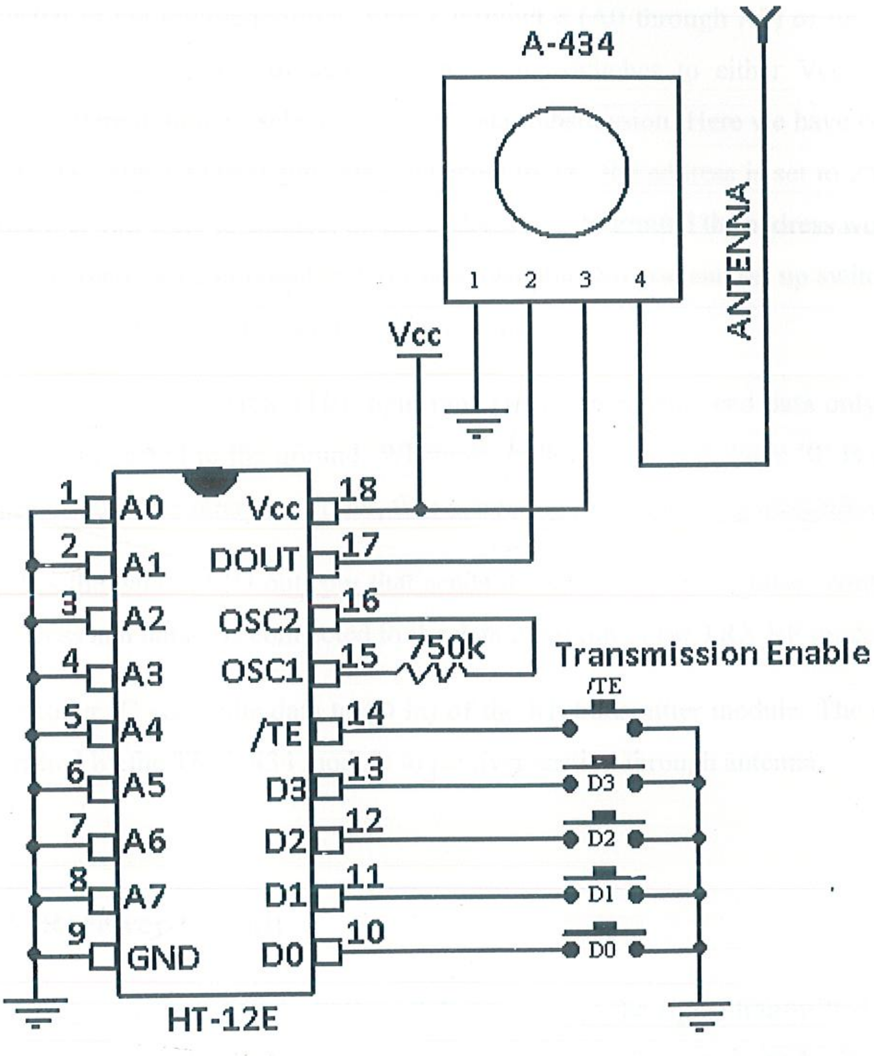

Figure 9 Transmitter circuit

When the push button switches (S1 through S4) are open, logic '0' is constantly fed to the respective port pins to the microcontroller. When any of the buttons is pressed, logic '1' is fed to the respective port pin of the microcontroller,

The device control program stored in the memory of the microcontroller activates and executes as per the functions defined in the program for respective input switches. Data input AD8 through AD11 (pins 10 through 13) HT12E are connected to the microcontroller. Pins 1 through 8 (A0 through A7) of the IC are address inputs. Shorting of address pins using switches to either Vcc or Gnd enables different address selections of for data transmission. Here we have connect them to 5V. Since address pins are connected to 5V, the address is set to 255d (in decimal). If you were to connect all the address pins to ground the address would be 00d. Thus there are 256 possible addresses available. So you can set up switches to control one or more of the encoder address pins.

Pin 14 is a transmit–enable (TE) input pin. The encoder will send data only when pin 14 is connected to the ground. Whenever button is pressed, logic '0' is sent to this pin through the microcontroller, thus activating it and enabling transmission.

Pin 17 is the data out (D out) pin that sends the serial stream of pulses containing the address and data it is connected to the data input pin of the TRX RF module.

The encoder IC sends the data to (D in) of the RF transmitter module. The data is transmitted by the TRX- 434 module to receiver section through antenna.

2.4.2 Receiver Circuit

The RF receiver circuit (RX- 434) module can receive the signal transmitted by the transmitter from a distance of upto 9 metres (30 feet). The range can be increased up to 30 metres using a good antenna. D out pin of RX-434 module is connected to the D in pin of decoder IC (HT12D). D in pin receives the address and data bits serially from the RF module. Decoder separates data and address from the received information. It accepts data only if the received address matches with the assigned to the encoder address (HT12E). The HT12D decoder receives serial addresses and data from the encoder that are transmitted by a carrier signal over the RF medium.

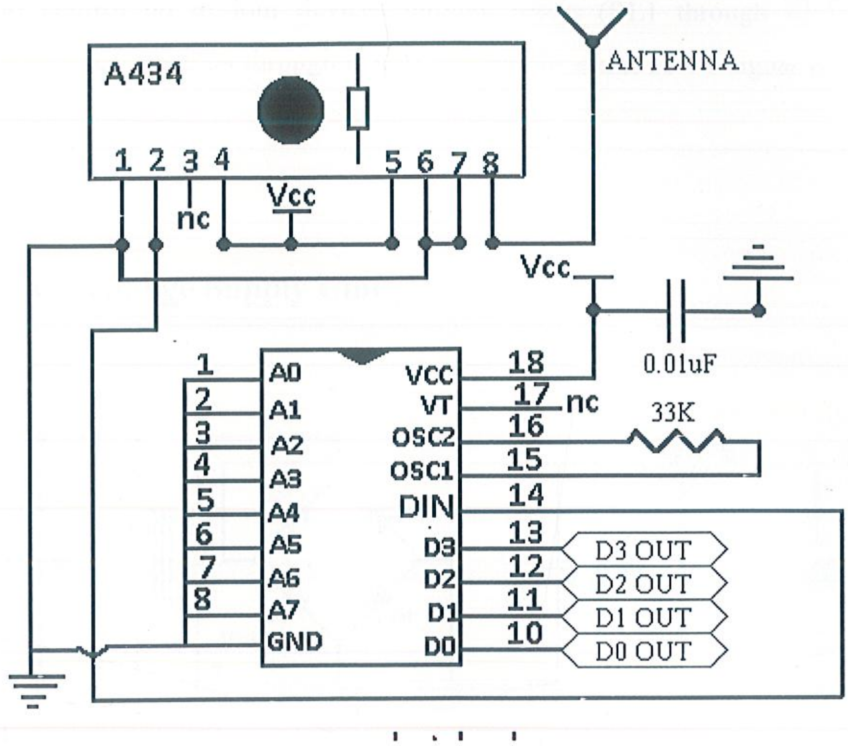

Figure 10 Receiver circuit

The decoder compares the serial input data three times continuously with its local address. If no error or unmatched codes are found, the input data codes are decoded and transferred to the output pins. The HT12D provides four latch type data pins whose data remains unchanged until new data is received.

The select inputs can be connected to either Vcc or VT pin (pin 17) for latch or momentary operation. Jumper switch (JS) is used to select between latch or momentary operation. When latch mode is selected, data present at the output pins is latched. When the momentary mode is selected, the data presented at output pins is available as long as VT pin remains active high. As soon as VT pin becomes active low, the respective relay de-energies.

The latched output data from the multiplexer is fed to the relay driver IC ULN2003, to control up to four devices through relays (RL1 through RL4). VT pin is connected to LED4 through IC6 to indicate the status of VT signal when it is active high.

2.4.3 Voltage Supply Unit

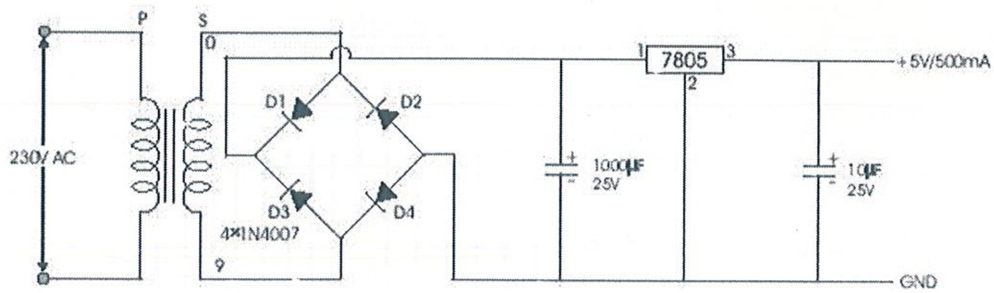

Figure 11 Voltage Supply Unit

5V supply is obtained from the +5V supply unit for microcontroller and digital ICs. Initially 230 V AC supply is reduced to (0-9V) with the help of a step down transformer having a capacity of 500mA.

This low voltage is rectified with the help of bridge rectifier. The ripples are minimized with the help of capacitor filter to get a smooth DC supply. The rating of the chosen capacitor filter is 1000µF.

The regulated DC voltage is obtained by using a regulator IC 7805. Another capacitor filter of rating 10µF is connected at the output of regulator IC to eliminate the voltage oscillations at the output due to the large voltage oscillations at the input of the regulator.

2.4.4 Microcontroller Board

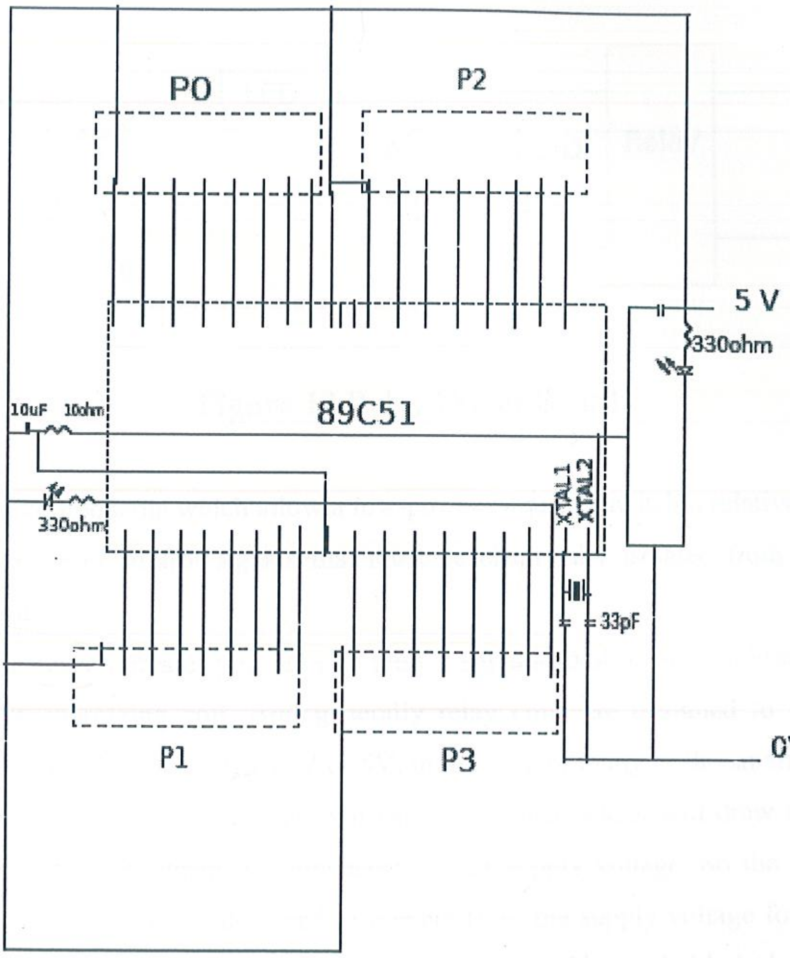

Figure 11 Microcontroller Board

The AT89C51 is a low-power, high-performance CMOS 8-bit microcomputer with 4K 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 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 AT89C51 is a powerful microcomputer which provides a highly flexible and cost effective solution to many embedded control applications.

2.4.3 Relay Driver Board

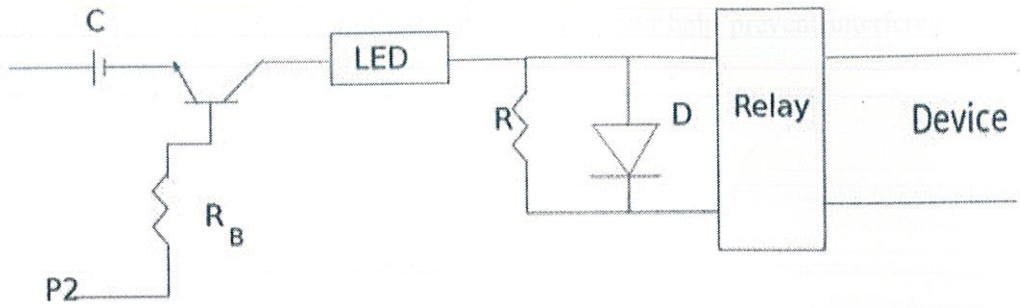

Figure 12 Relay Driver Board

Relays are components which allow a low-power circuit to switch a relatively high current on and off, or to control signals that must be electrically isolated from the controlling circuit itself.

To make a relay operate, you have to pass a suitable pull-in and 'holding current (DC) through its energizing coil. And generally relay coils are designed to operate from a particular supply voltage often 12V or 5V, in the case of many of the small relays used for electronics work. In each case the coil has a resistance which will draw the right pull-in and holding currents when it's connected to that supply voltage. So the basic idea is to choose a relay with a coil designed to operate from the supply voltage for control circuit (and with contacts capable of switching), and then provide a suitable 'relay driver' circuit so that your low-power circuitry can control the current through the relay's coil.

It uses an NPN transistor to control the coil current. All the low-power circuitry has to do is provide enough base current to turn the transistor on and off. NPN transistor is being used to control a relay with a 12V coil, operating from a +12V supply. Series base resistor is used to set the base current for transistor, so that the transistor is driven into saturation (fully turned on) when the relay is to be energized. That way, the transistor will have minimal voltage drop, and hence dissipate very little power — as well as delivering most of the12V to the relay coil. A power diode is connected across the relay coil, to protect the transistor from damage due to the back-EMF pulse generated in the relay coil's inductance when Q1 turns off.

It is a good idea to fit the supply line of the relay/driver stage with a reasonably high value of bypass capacitor (say 100uF), to absorb the current transients when the relay turns on and off. This will ensure more reliable operation, and help prevent interference with the operation of your control circuitry.

CHAPTER 3 MODULATION PROCESS

3.1 Amplitude Shift Keying

Amplitude shift keying - ASK - is a modulation process, which imparts to a sinusoid two or more discrete amplitude levels. These are related to the number of levels adopted by the digital message. For a binary message sequence there are two levels, one of which is typically zero. Thus the modulated waveform consists of bursts of a sinusoid. Figure 11 illustrates a binary ASK signal (lower), together with the binary sequence which initiated it (upper). Neither signal has been bandlimited.

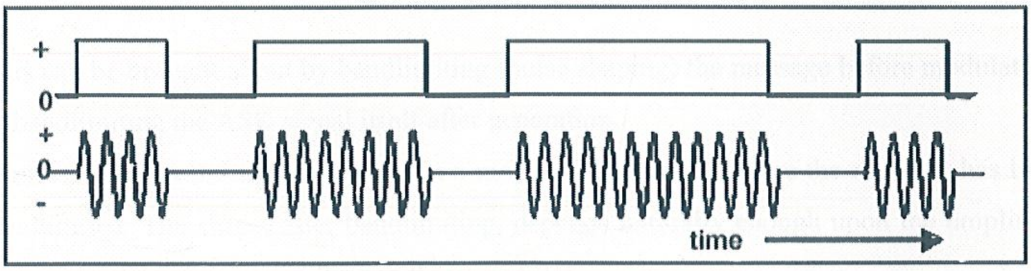

Figure 13 ASK modulation

There are sharp discontinuities shown at the transition points. These result in the signal having an unnecessarily wide bandwidth. Bandlimiting is generally introduced before transmission, in which case these discontinuities would be 'rounded off'. The bandlimiting may be applied to the digital message, or the modulated signal itself. The data rate is often made a sub-multiple of the carrier frequency. This has been done in the waveform of Figure 11.

One of the disadvantages of ASK, compared with FSK and PSK, for example, is that it has not got a constant envelope. This makes its processing (eg, power amplification) more difficult, since linearity becomes an important factor. However, it does make for ease of demodulation with an envelope detector.

As already indicated, the sharp discontinuities in the ASK waveform of Figure 11 imply a wide bandwidth. A significant reduction can be accepted before errors at the receiver increase unacceptably.

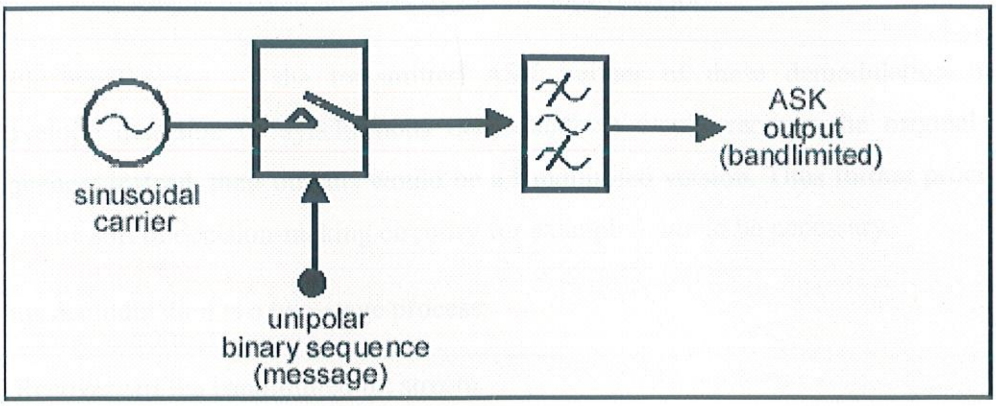

Figure 14ASK generation method

This can be brought about by bandlimiting (pulse shaping) the message before modulation, or bandlimiting the ASK signal itself after generation.

Figure 13 shows the signals present in a model of Figure 12, where the message has been bandlimited. The shape, after bandlimiting, depends naturally enough upon the amplitude and phase characteristics of the bandlimiting filter.

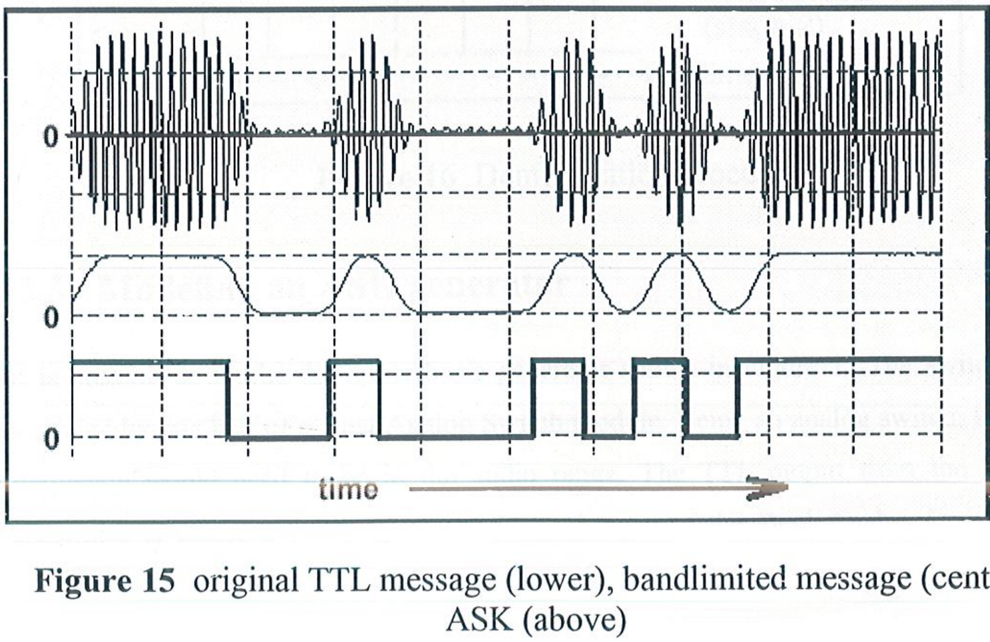

Figure 15 original TTL message (lower), bandlimited message (center), ASK (above)

3.2 Intro to De-Modulation

It is apparent from Figures 11 and 14 that the ASK signal has a well defined envelope. Thus it is amenable to demodulation by an envelope detector.

With bandlimiting of the transmitted ASK neither of these demodulation methods (envelope detection or synchronous demodulation) would recover the original binary sequence; instead, their outputs would be a bandlimited version. Thus further processing - by some sort of decision-making circuitry for example - would be necessary.

Thus demodulation is a two-stage process:

1. Recovery of the bandlimited bit stream

2. Regeneration of the binary bit stream

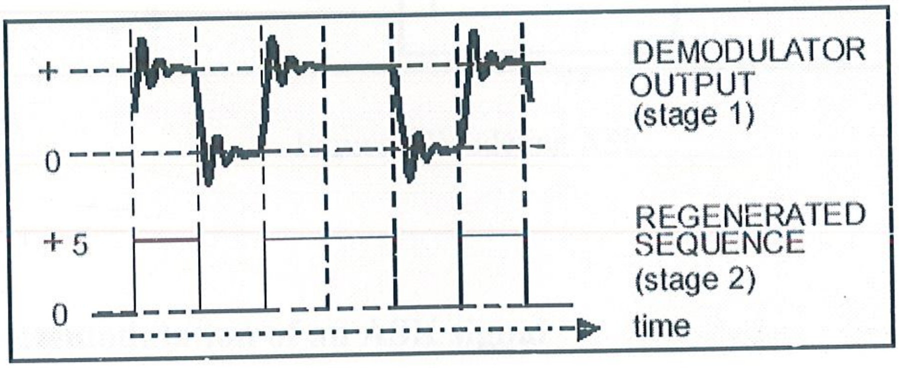

Figure 16 Demodulation process

3.3 Modeling an ASK generator

It is possible to model the rather basic generator shown in Figure 12.The switch can be modeled by one half of a Dual Analog Switch module. Being an analog switch, the carrier frequency would need to be in the audio range. The TTL output from the Sequence Generator is connected directly to the Control input of the Dual Analog Switch. For a synchronous carrier and message use the 8.333 kHz TTL sample clock (filtered by a Tuneable LPF) and the 2.083 kHz sinusoidal message from the Master Signals module.

If you need the Tuneable LPF for bandlimiting of the ASK, use the sinusoidal output from an Audio Oscillator as the carrier. For a synchronized message as above, tune the oscillator close to 8.333 kHz, and lock it there with the sample clock connected to its SYNCH input.

This arrangement is shown modeled in Figure 15.

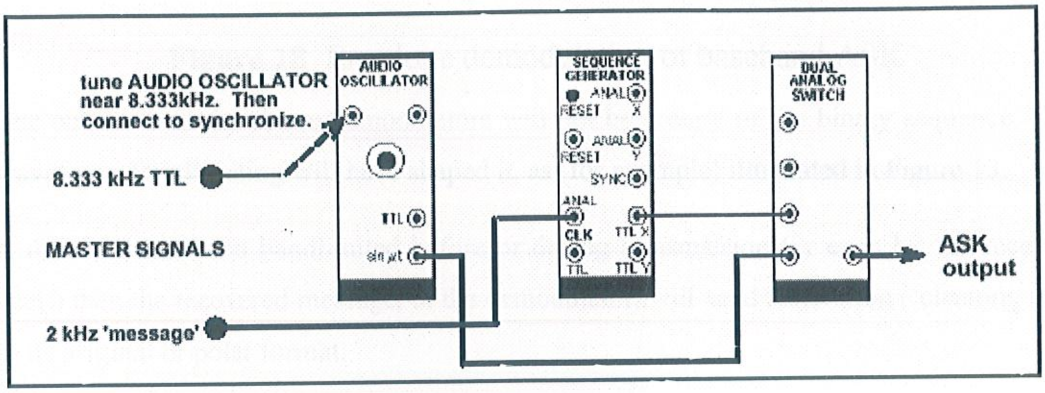

Figure 17 Modeling ASK

3.4 Demodulation of an ASK signal

Having a very definite envelope, an envelope detector can be used as the first step in recovering the original sequence. Further processing can be employed to regenerate the true binary waveform. Figure 16 is a model for envelope recovery from a baseband ASK signal.

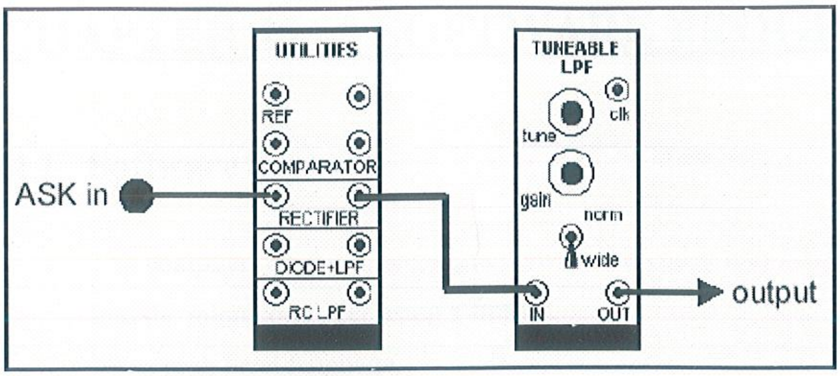

Figure 18 Envelope demodulation of baseband ASK

The output from the above demodulators will not be a copy of the binary sequence TTL waveform. Bandlimiting will have shaped it, as (for example) illustrated in Figure 13.

If the ASK has been bandlimited before or during transmission (or even by the receiver itself) then the recovered message, in the demodulator, will need restoration ('cleaning up') to its original bi-polar format.

Some sort of decision device is then required to regenerate the original binary sequence. This could be done with a COMPARATOR.

CHAPTER 4 SOFTWARE PROGRAMMING

4.1 Software

- The compilers of these languages convert the codes into HEX file which is burnt into the microcontroller using a Burner.
- It is a high level language.
- It is easy to understand and work with it.
- The compiler is used to covert High Level Language into Machine Language.

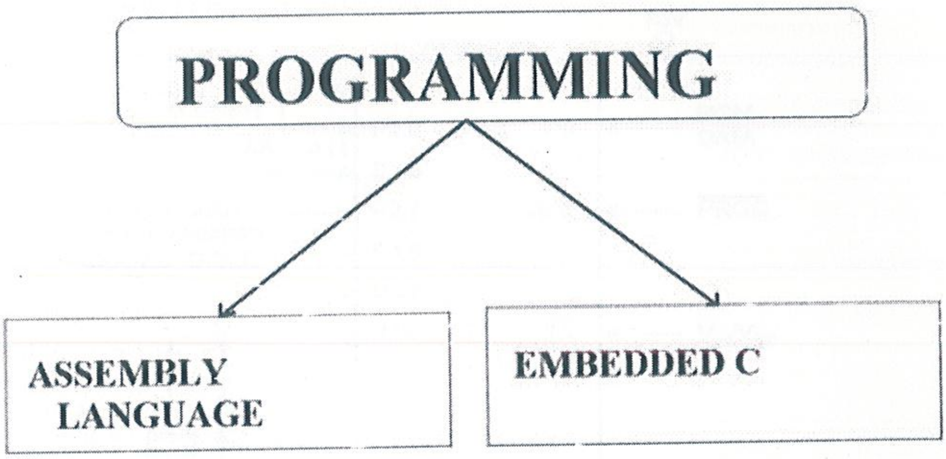

Figure 19 Types of Programming language

The software flowchart programmed in the microcontroller of the transmitter section is shown in fig. It is written in Assembly language and compiled using ASM51 software to generate the hex code. The hex program can be burnt into the AT89C51 microcontroller by using any standard program available in the market.

The software program is designed to accept the input from the user as well as control the devices.

4.2 Programming the Flash

The AT89C51 is normally shipped with the on-chip Flash memory array in the erased state (that is, contents = FFH) and ready to be programmed. The programming interface accepts either a high-voltage (12-volt) or a low-voltage (VCC) program enable signal. The low voltage programming mode provides a convenient way to program the AT89C51 inside the user's system, while the high-voltage programming mode is compatible with conventional third party Flash or EPROM programmers. The AT89C51 is shipped with either the high-voltage or low-voltage programming mode enabled. The AT89C51 code memory array is programmed byte by byte in either programming mode.

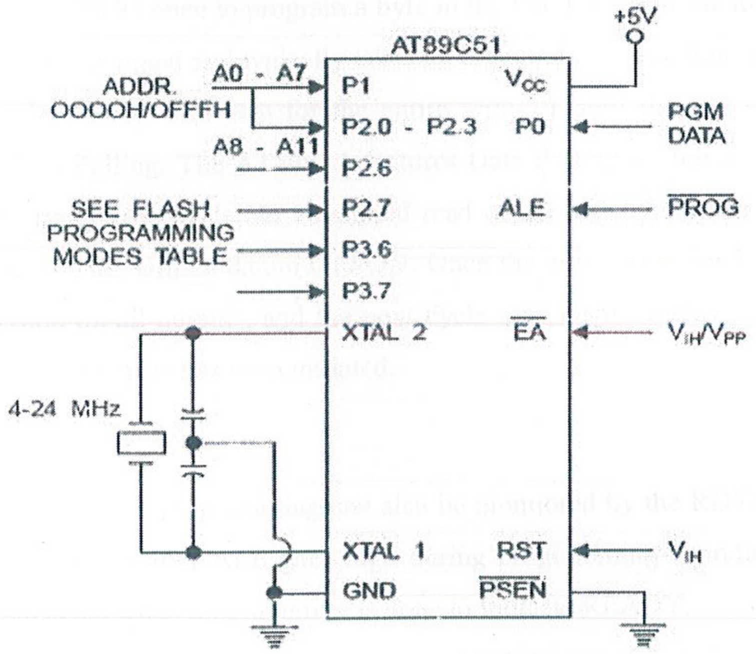

Figure 20 Initialization for programming

To program any non-blank byte in the on-chip Flash Memory, the entire memory must be erased using the Chip Erase Mode.

Programming Algorithm: Before programming the AT89C51, the address, data and control signals should be set up according to the Flash programming mode table and Figures.

To program the AT89C51, 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 12 V for the high-voltage programming mode.

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 1.5 ms. 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 AT89C51 features Data Polling to indicate the end of a write cycle. During a write cycle, an attempted read of the last byte written will result in the complement of the written datum on PO.7. Once the write cycle has been completed, true data are 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. P3.4 is pulled low after ALE goes high during programming to indicate BUSY. P3.4 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 lock bits cannot be verified directly. Verification of the lock bits is achieved by observing that their features are enabled.

Chip Erase:

The entire Flash array is erased electrically by using the proper combination of control signals and by holding ALE/PROG low for 10 ms. The code array is written with all "1"s. The chip erase operation must be executed before the code memory can be re-programmed.

Reading the Signature Bytes:

The signature bytes are read by the same procedure as a normal verification of locations 030H, 031H, and 032H, except that P3.6 and P3.7 must be pulled to a logic low. The values returned are as follows:

(030H) = 1EH indicates manufactured by Atmel

(031H) = 51H indicates 89C51

(032H) = FFH indicates 12 V programming

(032H) = 05H indicates 5 V programming.

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. The only exit from power down is a hardware reset. Reset redefines the SFRs but does not change the onchip 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.

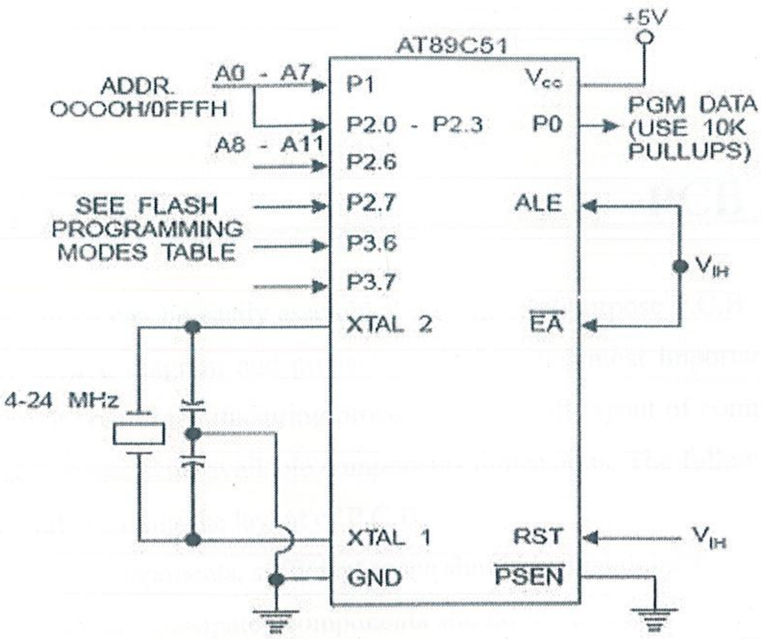

Figure 21 Programming Flash

Program Memory Lock Bits

On the chip are three lock bits which can be left unprogrammed (U) or can be programmed (P) to obtain the additional features listed in the table .When lock bit 1 is programmed, the logic level at the EA pin is sampled and latched during reset. If the device is powered up without a reset, the latch initializes to a random value, and holds that value until reset is activated. It is necessary that the latched value of EA be in agreement with the current logic level at that pin in order for the device to function properly.

CHAPTER 5 PCB LAYOUT

The entire circuit can be easily assembled on a general purpose P.C.B. board respectively. Layout of desired diagram and preparation is first and most important operation in any printed circuit board manufacturing process. First of all layout of component side is to be made in accordance with available components dimensions. The following points are to be observed while forming the layout of P.C.B.

1. Between two components, sufficient space should be maintained.
2. High voltage/max dissipated components should be mounted at sufficient distance from semiconductor and electrolytic capacitors.
3. The most important points are that the components layout is making proper compromise with copperside circuit layout. Printed circuit board (P.C.B.s) is used to avoid most of all the disadvantages of conventional breadboard. These also avoid the use of thin wires for connecting the components; they are small in size and efficient inperformance.

5.1 Preparing Circuit Layout

First of all the actual size circuit layout is to bedrawn on the copper side of the copper clad board. Then enamel paint is applied on the tracks of connection with the help of a shade brush. We have to apply the paints surrounding the point at which the connection is to be made. It avoids the disconnection between the leg of the component and circuit track. After completion of painting work, it is allowed to dry.

DRILLING After completion of painting work, holes 1/23inch(1mm) diameter are drilled at desired points where we have to fix the components.

ETCHING The removal of excess of copper on the plate apart from the printed circuit is known as etching. From this process the copper clad board with printed circuit is placed in the solution of FeCl with 3-4 drops of HCL in it and is kept so for about 10 to 15 minutes and is taken out when all the excess copper is removed from the P.C.B.

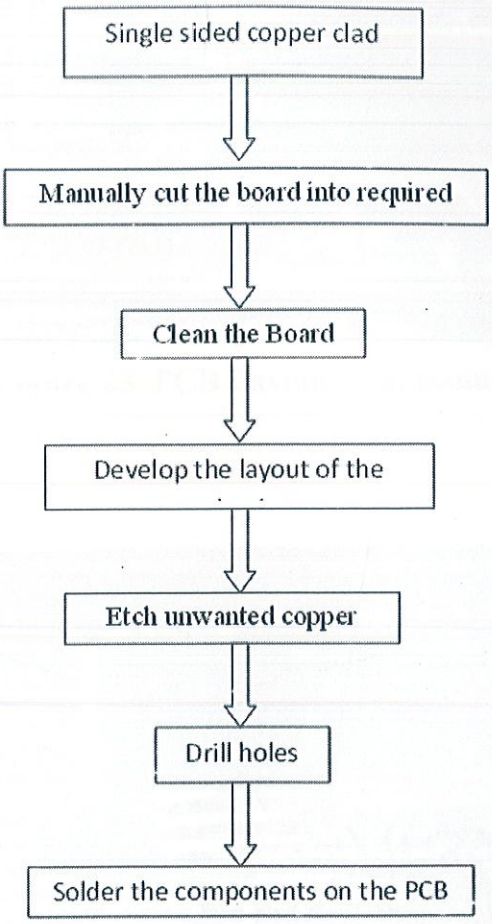

Figure 22 Flowchart for Preparing P.C.B

SOLDERING Soldering is process of joining two metallic conductors, where two metal conductors are to be join or fused is heated with a device called soldering iron and then as allow of tin and lead called solder is applied which melts and converse the joint. The solder cools and solidifies quickly to ensure is good and durable connection between the jointed metal converting the joint solder also present oxidation.

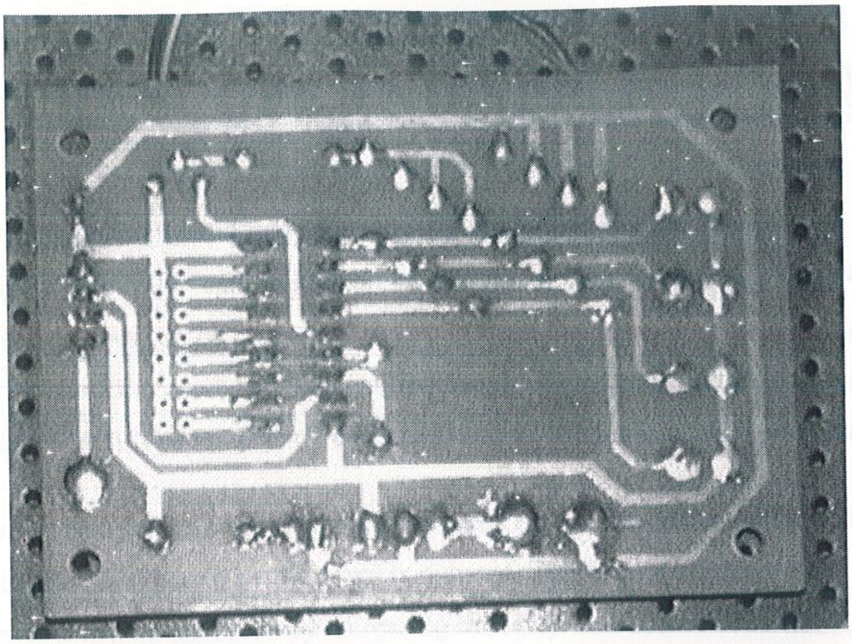

Figure 23 PCB Layout of Transmitter

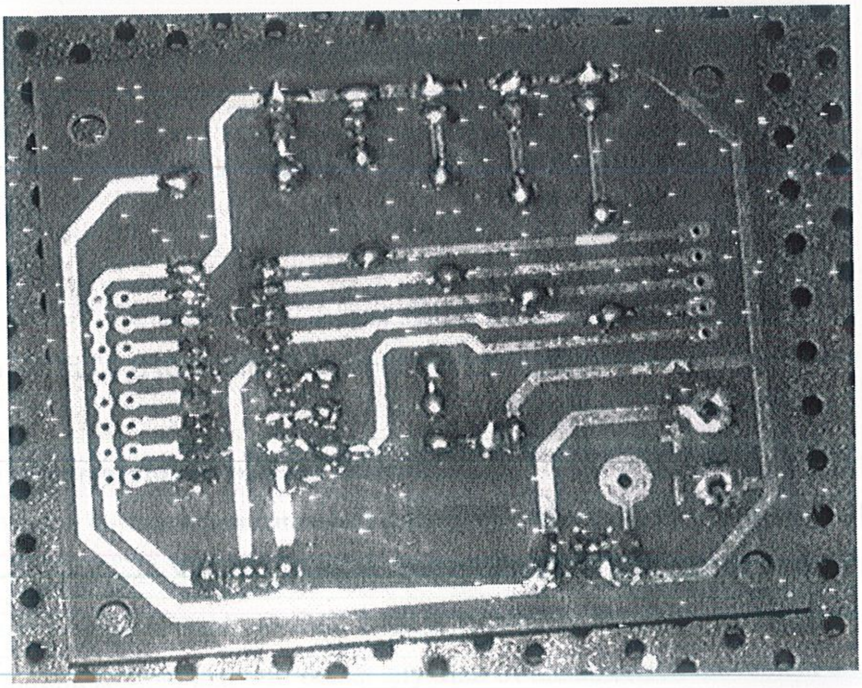

Figure 24 PCB Layout of Receiver

FUTURE SCOPE AND APPLICATIONS

The system is small, simple and good for wireless equipment control. The microcontroller based equipment controller can switch on or off up to four devices by user with the transmitter. The devices can be controlled remotely from the distance up to 30 metres from the transmitter. The RF receiver module can receive the signal transmitted from a distance up to 9 metres (30feet). The range can be increased up to 30 metres using a good antenna.

The electrical devices can be controlled using wireless equipment control without the use of wires. The messiness caused by the wires is reduced. This is cost-effective also. The number of devices can be increased by increasing the relay. The source code can also be written in embedded C language which makes error detecting in the code easier.

APPLICATIONS:

1. Heating, Ventilation and Air Conditioning (HVAC)

Due to the wireless network many devices execute simple tasks like lighting, access control, air controlling, all this application can be developed using low-end, low-cost microcontrollers.

2. Lighting

Smart Home can be used to control household electric lights.

3. Control and integration of security systems

With Smart Home, the consumer can select and watch cameras live from an Internet source to their home or business. Security cameras can be controlled, allowing the user to observe activity around a house or business right from a Monitor or touch panel. Security systems can include motion sensors that will detect any kind of unauthorized movement and notify the user through the security system or via cell phone.

4. Other systems

Using special hardware, almost any household appliance can be monitored and controlled automatically or remotely, including:

- Coffeemaker
- Garage door
- Pet feeding and watering
- Plant watering
- Pool pump(s) and heater, Hot tub and Spa.

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5. William C. Mann (ed.) Smart technology for aging, disability and independence : the state of the science, John Wiley and Sons, 2005.

Appendix A : Source Code

Interfacing Microcontroller for device access system:

Input P1.0 –P1.3

Output P2.0 –P2.3

```
ORG 0000H
        LJMP 005CH
        DEC R6
        CJNE R6,#0FFH,01H
        DEC R7
        MOV A,R7
        ORL A,R6
        CLR C
        SUBB A,0F0H
        LCALL 003EH ⇦RAM
        JZ 04H
        JC 02H
        CLR A
        MOV A,#01H
        MOV R0,#96H
        MOV R1,#02H
        DJNZ R0,0FEH
        DJNZ R1,0FCH
        LCALL 0036H ⇦RAM
        JNZ 0F3H
        MOV R0,#0FFH
        CLR A
        MOV @R0,A
        DJNZ R0,0FDH
        MOV 81H,#23H
        MOV 20H,#00H
```

```
MOV 0A0H,#00H
ACALL 126H
MOV 21H,#00H
MOV C,94H
MOV A,21H
MOV 0E0H,C
MOV 21H,A
MOV C,93H ⇦ P1.3
MOV A,21H
MOV 0E1H,C
MOV 21H,A
MOV C,92H ⇦ P1.2
MOV A,21H
MOV 0E2H,C                      } Read From Port 1
MOV 21H,A
MOV C,91H  ⇦P1.1
MOV A,21H
MOV 0E3H,C
MOV 21H,A
MOV C,90H ⇦P1.0
MOV 04H,C
JC 03H
LJMP 009CH
LJMP 009FH
LJMP 006DH
MOV A,21H
CJNE A,#01H,02H
SJMP 03H
LJMP 00BFH
MOV C,0A0H
MOV 04H,C
```

```
JNC 03H
LJMP 00B7H
SETB 0A0H
LJMP 00B9H
CLR 0A0H
MOV R6,#0E8H
MOV R7,#03H
ACALL 04EH
MOV A,21H
CJNE A,#02H,02H
SJMP 03H
LJMP 00DFH
MOV C,0A1H ⇦ P2.0
MOV 04H,C
LJMP 00D7H
SETB 0A1H ⇦P2.1
LJMP 00D9H
MOV 04H,C
JNC 03H
LJMP 00F7H
SETB 0A2H ⇦P2.2
LJMP 00F9H
MOV R7,#03H
SJMP 03H
LJMP 011FH
MOV C,0A3H
MOV 04H,C
JNC 03H
LJMP 0117H
SETB 0A3H ⇦ P2.3
LJMP 0119H
```

Write to Port 2 (applies to the lines from MOV C,0A1H to LJMP 0119H)

```
CLR 0A3H
MOV R6,#0E8H
MOV R7,#03H
ACALL 04EH
LJMP 006DH
CLR 0AFH
SJMP 0FEH
MOV 22H,#01H
MOV 0F0H,#05H
MOV A,22H
ACALL 042H
LJMP 014EH
SETB 0B7H
MOV R6,#0C8H
MOV R7,#00H
ACALL 04EH
CLR 0B7H
MOV R6,#0C8H
MOV R7,#00H
ACALL 04EH
INC 22H
MOV A,22H
JZ 03H
LJMP 0129H
END
```

Appendix B : Components

B.1 ENCODER

In digital circuits, the term 'multiplexing' is also sometimes used to refer to the process of encoding, which is basically the generation of a digital code to indicate which of several input lines is active. An encoder or multiplexer is therefore a digital IC that outputs a digital code based on which of its several digital inputs is enabled.

On the other hand, the term 'demultiplexing' in digital electronics is also used to refer to 'decoding', which is the process of activating one of several mutually-exclusive output lines, based on the digital code present at the binary-weighted inputs of the decoding circuit, or decoder. A decoder or demultiplexer is therefore a digital IC that accepts a digital code consisting of two or more bits at its inputs, and activates or enables one of its several digital output lines depending on the value of the code.

Multiplexing and demultiplexing are used in digital electronics to allow several chips to share common signal buses. In demultiplexers, for instance, the output lines may be used to enable memory chips that share a common data bus, ensuring that only one memory chip is enabled at a time in order to prevent data clashes between the chips.

B.2 DECODER

A decoder is a device which does the reverse of an encoder, undoing the encoding so that the original information can be retrieved. The same method used to encode is usually just reversed in order to decode.

In digital electronics, a decoder can take the form of a multiple-input, multiple-output logic circuit that converts coded inputs into coded outputs, where the input and output codes are different. e.g. n-to-2^n, binary-coded decimal decoders. Enable inputs must be on for the decoder to function, otherwise its outputs assume a single "disabled" output code word. Decoding is necessary in applications such as data multiplexing, 7 segment display and memory address decoding.

The example decoder circuit would be an AND gate because the output of an AND gate is "High" (1) only when all its inputs are "High." Such output is called as "active High output". If instead of AND gate, the NAND gate is connected the output will be "Low" (0) only when all its inputs are "High". Such output is called as "active low output".

A slightly more complex decoder would be the n-to-2^n type binary decoders. These types of decoders are combinational circuits that convert binary information from 'n' coded inputs to a maximum of 2^n unique outputs. We say a maximum of 2^n outputs because in case the 'n' bit coded information has unused bit combinations, the decoder may have less than 2^n outputs. We can have 2-to-4 decoder, 3-to-8 decoder or 4-to-16 decoder. We can form a 3-to-8 decoder from two 2-to-4 decoders (with enable signals).

Similarly, we can also form a 4-to-16 decoder by combining two 3-to-8 decoders. In this type of circuit design, the enable inputs of both 3-to-8 decoders originate from a 4th input, which acts as a selector between the two 3-to-8 decoders. This allows the 4th input to enable either the top or bottom decoder, which produces outputs of D (0) through D (7) for the first decoder, and D (8) through D (15) for the second decoder.

A decoder that contains enable inputs is also known as a decoder-demultiplexer. Thus, we have a 4-to-16 decoder produced by adding a 4th input shared among both decoders, producing 16 outputs.

B.3 RELAY

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

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

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

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

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

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

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

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

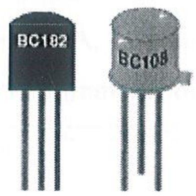
- COM = Common, always connect to this, it is the moving part of the switch.

- NC = Normally Closed, COM is connected to this when the relay coil is off.
- NO = Normally Open, COM is connected to this when the relay coil is on.
- Connect to COM and NO if you want the switched circuit to be on when the relay coil is on.

Connect to COM and NC if you want the switched circuit to be on when the relay coil is off.

B.4 TRANSISTOR

Transistors amplify current, for example they can be used to amplify the small output current from a logic IC so that it can operate a lamp, relay or other high current device. In many circuits a resistor is used to convert the changing current to a changing voltage, so the transistor is being used to amplify voltage.



A transistor may be used as a switch (either fully on with maximum current, or fully off with no current) and as an amplifier (always partly on). The amount of current amplification is called the current gain, symbol h_{FE}.

B.5 TRANSFORMER

A **transformer** is a device that transfers electrical energy from one circuit to another through inductively coupled conductors the transformer's coils. If a load is connected to the secondary, current will flow in the secondary winding, and electrical energy will be transferred from the primary circuit through the transformer to the load. In an ideal transformer, the induced voltage in the secondary winding (V_s) is in proportion to the primary voltage (V_p) and is given by the ratio of the number of turns in the secondary (N_s) to the number of turns in the primary (N_p) as follows:

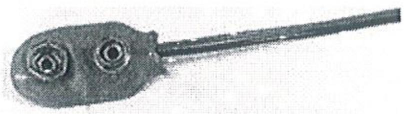
$$\frac{V_s}{V_p} = \frac{N_s}{N_p}$$

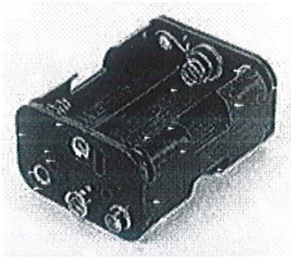
By appropriate selection of the ratio of turns, a transformer thus enables an alternating current (AC) voltage to be "stepped up" by making N_s greater than N_p, or "stepped down" by making N_s less than N_p. The windings are coils wound around a ferromagnetic core, air-core transformers being a notable exception.

Here we use a 12-0-12 transformer. 12-0-12 means that the voltage or the potential difference (p.d.) between each of the end terminal of the secondary winding and the mid-point of the secondary winding of the transformer is 12V. And, between the two ends of the secondary winding, you will get 12 + 12 = 24V. 500mA means the current delivery capability of the secondary winding of the transformer. Normally it is said in VA. In your case it would be 25 x 0.5 = 12VA. The ratings are arrived at based on the requirements of the loads that are to be connected to the transformer. The limiting criteria is the winding wire thickness and the insulation of the winding.

B.6 CONNECTORS

Battery clips and holders





The standard battery clip fits a 9V PP3 battery and many battery holders such as the 6 × AA cell holder shown. Battery holders are also available with wires attached, with pins for PCB mounting, or as a complete box with lid, switch and wires.

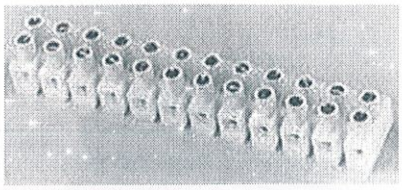
Many small electronic projects use a 9V PP3 battery but if you wish to use the project for long periods a better choice is a battery holder with 6 AA cells. This has the same voltage but a much longer battery life and it will work out cheaper in the long run.

Larger battery clips fit 9V PP9 batteries but these are rarely used now.

Terminal blocks and PCB terminals

Terminal blocks are usually supplied in 12-way lengths but they can be cut into smaller blocks with a sharp knife, large wire cutters or a junior hacksaw. They are sometimes called 'chocolate blocks' because of the way they can be easily cut to size.

PCB terminal block

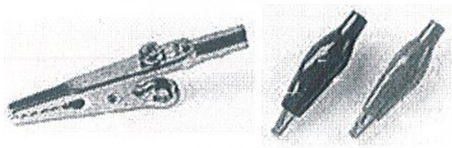


Terminal block

PCB mounting terminal blocks provide an easy way of making semi-permanent connections to PCBs. Many are designed to interlock to provide more connections.

Crocodile clips

The 'standard' crocodile clip has no cover and a screw contact. However, miniature insulated crocodile clips are more suitable for many purposes including test leads. They have a solder contact and lugs which fold down to grip the cable's insulation, increasing the strength of the joint. Remember to feed the cable through the plastic cover *before* soldering! Add and remove the cover by fully opening the clip, a piece of wood can be used to hold the jaws open.



Crocodile clips

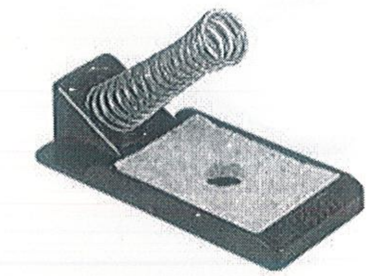
B.7 TOOLS REQUIRED FOR ELECTRONICS

Soldering iron

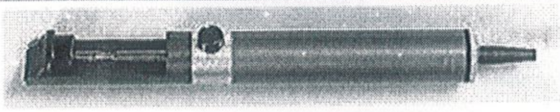
For electronics work the best type is one powered by mains electricity (230V in the UK), it should have a heatproof cable for safety. The iron's power rating should be 15 to 25W and it should be fitted with a small bit of 2 to 3mm diameter.

Soldering iron stand

You must have a safe place to put the iron when you are not holding it. The stand should include a sponge which can be dampened for cleaning the tip of the iron.



Desoldering pump (solder sucker)



A tool for removing solder when desoldering a joint to correct a mistake or replace a component.

Solder remover wick (copper braid)

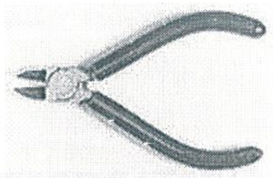
This is an alternative to the desoldering pump shown above.

Solder Wire

The best size for electronics is 22swg (swg = standard wire gauge).

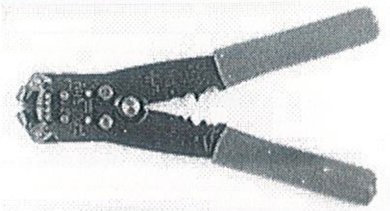
Side cutters

For trimming component leads close to the circuit board.



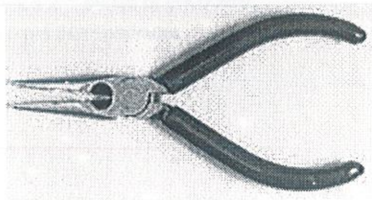
Wire strippers

Most designs include a cutter as well, but they are not suitable for trimming component leads.



Small pliers

Usually called 'snipe nose' pliers, these are for bending component leads etc. If you put a strong rubber band across the handles the pliers make a convenient holder for parts such as switches while you solder the contacts.



Small flat-blade screwdriver

For scraping away excess flux and dirt between tracks, as well as driving screws!

Appendix C : Data Sheets

HT12D/HT12F
2^{12} Series of Decoders

Features

- Operating voltage: 2.4V~12V
- Low power and high noise immunity CMOS technology
- Low standby current
- Capable of decoding 12 bits of information
- Binary address setting
- Received codes are checked 3 times
- Address/Data number combination
  - HT12D: 8 address bits and 4 data bits
  - HT12F: 12 address bits only
- Built-in oscillator needs only 5% resistor
- Valid transmission indicator
- Easy interface with an RF or an infrared transmission medium
- Minimal external components
- Pair with Holtek s 2^{12} series of encoders
- 18-pin DIP, 20-pin SOP package

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

General Description

The 2^{12} decoders are a series of CMOS LSIs for remote control system applications. They are paired with Holtek s 2^{12} series of encoders (refer to the encoder/de- coder cross reference table). For proper operation, a pair of encoder/decoder with the same number of ad- dresses and data format should be chosen.

The decoders receive serial addresses and data from a programmed 2^{12} series of encoders that are transmitted by a carrier using an RF or an IR transmission medium. They compare the serial input data three times continu- ously with their local addresses. If no error or un-matched codes are found, the input data codes are decoded and then transferred to the output pins. The VT pin also goes high to indicate a valid transmission.

The 2^{12} series of decoders are capable of decoding informations that consist of N bits of address and 12 N bits of data. Of this series, the HT12D is arranged to pro- vide 8 address bits and 4 data bits, and HT12F is used to decode 12 bits of address information.

HT12A/HT12E
2^{12} Series of Encoders

Features

- Operating voltage
  - 2.4V~5V for the HT12A
  - 2.4V~12V for the HT12E
- Low power and high noise immunity CMOS technology
- Low standby current: 0.1 A (typ.) at V_{DD}=5V
- HT12A with a 38kHz carrier for infrared transmission medium
- Minimum transmission word
  - Four words for the HT12E
  - One word for the HT12A
- Built-in oscillator needs only 5% resistor
- Data code has positive polarity
- Minimal external components
- HT12A/E: 18-pin DIP/20-pin SOP package

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

General Description

The 2^{12} encoders are a series of CMOS LSIs for remote control system applications. They are capable of encoding information which consists of N address bits and 12 N data bits. Each address/data input can be set to one of the two logic states. The programmed addresses/data are transmitted together with the header bits via an RF or an infrared transmission medium upon receipt of a trigger signal. The capability to select a $\overline{TE}$ trigger on the HT12E or a DATA trigger on the HT12A further enhances the application flexibility of the 2^{12} series of encoders. The HT12A additionally provides a 38kHz carrier for infrared systems.

Selection Table

Part No. \ Function	Address No.	Address/ Data No.	Data No.	Oscillator	Trigger	Package	Carrier Output	Negative Polarity
HT12A	8	0	4	455kHz resonator	D8~D11	18 DIP 20 SOP	38kHz	No
HT12E	8	4	0	RC oscillator	$\overline{TE}$	18 DIP 20 SOP	No	No

Note: Address/Data represents pins that can be address or data according to the decoder requirement.

1N4001 - 1N4007

Features

- Low forward voltage drop.
- High surge current capability.

General Purpose Rectifiers

Absolute Maximum Ratings*

T_A = 25°C unless otherwise noted

Symbol	Parameter	Value							Units
		4001	4002	4003	4004	4005	4006	4007	
V_{RRM}	Peak Repetitive Reverse Voltage	50	100	200	400	600	800	1000	V
$I_{F(AV)}$	Average Rectified Forward Current, .375 " lead length @ T_A = 75°C	1.0							A
I_{FSM}	Non-repetitive Peak Forward Surge Current 8.3 ms Single Half-Sine-Wave	30							A
T_{stg}	Storage Temperature Range	-55 to +175							°C
T_J	Operating Junction Temperature	-55 to +175							°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

Thermal Characteristics

Symbol	Parameter	Value	Units
P_D	Power Dissipation	3.0	W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	50	°C/W

Electrical Characteristics

T_A = 25°C unless otherwise noted

Symbol	Parameter	Device							Units
		4001	4002	4003	4004	4005	4006	4007	
V_F	Forward Voltage @ 1.0 A	1.1							V
I_{rr}	Maximum Full Load Reverse Current, Full Cycle T_A = 75°C	30							∝A
I_R	Reverse Current @ rated V_R T_A = 25°C T_A = 100°C	5.0 500							∝A ∝A
C_T	Total Capacitance V_R = 4.0 V, f = 1.0 MHz	15							pF

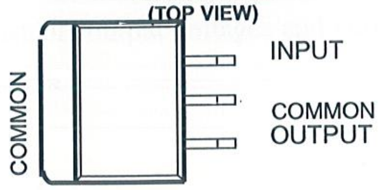
μA7800 SERIES POSITIVE-VOLTAGE REGULATORS

3-Terminal Regulators
Output Current up to 1.5 A
Internal Thermal-Overload Protection
High Power-Dissipation Capability
Internal Short-Circuit Current Limiting
Output Transistor Safe-Area Compensation

KC (TO-220) PACKAGE
(TOP VIEW)

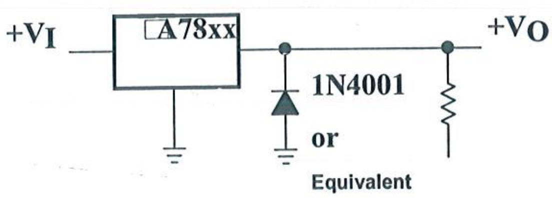
KCS (TO-220) PACKAGE (TOP VIEW)

KTE PACKAGE
(TOP VIEW)



Operation with a load common to a voltage of opposite polarity

In many cases, a regulator powers a load that is not connected to ground but, instead, is connected to a voltage source of opposite polarity (e.g., operational amplifiers, level-shifting circuits, etc.). In these cases, a clamp diode should be connected to the regulator output as shown in Figure 6. This protects the regulator from output polarity reversals during startup and short-circuit operation.



Description/ordering information

This series of fixed-voltage integrated-circuit voltage regulators is designed for a wide range of applications. These applications include on-card regulation for elimination of noise and distribution problems associated with single-point regulation. Each of these regulators can deliver up to 1.5 A of output current. The internal current-limiting and thermal-shutdown features of these regulators essentially make them immune to overload. In addition to use as fixed-voltage regulators, these devices can be used with external components to obtain adjustable output voltages and currents, and also can be used as the power-pass element in precision regulators.

ORDERING INFORMATION

T_J	V_O(NOM) (V)	PACKAGE †		ORDERABLE PART	TOP-SIDE
0°C to 125°C	5	POWER-FLEX (KTE)	Reel of 2000	∝A7805CKTER	∝A7805C
		TO-220 (KC)	Tube of 50	∝A7805CKC	∝A7805C
		TO-220, short shoulder (KCS)	Tube of 20	∝A7805CKCS	
	8	POWER-FLEX (KTE)	Reel of 2000	∝A7808CKTER	∝A7808C
		TO-220 (KC)	Tube of 50	∝A7808CKC	∝A7808C
		TO-220, short shoulder (KCS)	Tube of 20	∝A7808CKCS	
	10	POWER-FLEX (KTE)	Reel of 2000	∝A7810CKTER	∝A7810C
		TO-220 (KC)	Tube of 50	∝A7810CKC	∝A7810C
	12	POWER-FLEX (KTE)	Reel of 2000	∝A7812CKTER	∝A7812C
		TO-220 (KC)	Tube of 50	∝A7812CKC	∝A7812C
		TO-220, short shoulder (KCS)	Tube of 20	∝A7812CKCS	
	15	POWER-FLEX (KTE)	Reel of 2000	∝A7815CKTER	∝A7815C
		TO-220 (KC)	Tube of 50	∝A7815CKC	∝A7815C
		TO-220, short shoulder (KCS)	Tube of 20	∝A7815CKCS	
	24	POWER-FLEX (KTE)	Reel of 2000	∝A7824CKTER	∝A7824C
		TO-220 (KC)	Tube of 50	∝A7824CKC	∝A7824C

PCB Relay

G5LE

A Cubic, Single-pole 10-A Power Relay

- Subminiature "sugar cube" relay.
- Contact ratings of 10 A.
- Withstands impulses of up to 4,500 V.
- Two types of seal available: flux protection and plastic-sealed.
- UL class-B insulation certified, UL class-F available.
- Manufacturing facility in compliance with QS9000 automotive quality system standards.
- Ideal for applications in security equipment, household electrical appliances, garage door openers, and audio equipment.

Ordering Information

To Order: Select the part number and add the desired coil voltage rating, (e.g., G5LE-1-*DC12*).

Seal	Contact form	Model		
		Contact material		
		$AgSnO_2$	AgCdO	AgSnIn
Flux protection	SPDT	**G5LE-1**	**G5LE-1-ACD**	**G5LE-1-ASI**
	SPST-NO	**G5LE-1A**	**G5LE-1A-ACD**	**G5LE-1A-ASI**
Plastic-sealed	SPDT	**G5LE-14**	**G5LE-14-ACD**	**G5LE-14-ASI**
	SPST-NO	**G5LE-1A4**	**G5LE-1A4-ACD**	**G5LE-1A4-ASI**

MODEL NUMBER LEGEND

G5LE-□ □ □- □ -□
1 2 3 4 5

1. Number of Poles
1: 1 pole

2. Contact Form
None: SPDT
A: SPST-NO

3. Sealing
None: Flux-protection
4: Plastic-sealed

4. Contact Material
None: $AgSnO_2$
ACD: AgCdO
ASI: AgSnIn

5. Insulation Class
None: Class B insulation
CF: Class F insulation

Specifications

J COIL DATA

Rated voltage	3 VDC	5 VDC	6 VDC	9 VDC	12 VDC	24 VDC	48 VDC
Rated current	136.4 mA	79.4 mA	66.7 mA	45 mA	33.3 mA	16.7 mA	8.33 mA
Coil resistance	22.5 Ω	63 Ω	90 Ω	200 Ω	360 Ω	1,440 Ω	5,760 Ω
Must operate voltage	75% of rated voltage (max.)						
Must release voltage	10% of rated voltage (min.)						
Max. voltage	130% of rated voltage at 70°C (158°F), 170% of rated voltage at 23°C (73°F)						
Power consumption	Approx. 400 mW						

Note: 1. The rated current and coil resistance are measured at a coil temperature of 23°C (73°F) with a tolerance of ±10%.
2. 360 mW coil is available. Contact Omron for details.
3. VDE approved model available. Contact Omron for details.

J CONTACT DATA

Load		Resistive load (cosφ = 1)
Rated load		10 A at 120 VAC; 8 A at 30 VDC
Rated carry current		10 A
Max. switching voltage		250 VAC, 125 VDC
Max. switching current	AC	10 A
	DC	8 A
Max. switching capacity		1,200 VA, 240 W
Min. permissible load		100 mA at 5 VDC

J CHARACTERISTICS

Contact resistance		100 mΩ max.
Operate time		10 ms max.
Release time		5 ms max.
Bounce time	Operate	Approx. 0.6 ms
	Release	Approx. 7.2 ms
Max. switching frequency	Mechanical	18,000 operations/hr
	Electrical	1,800 operations/hr (under rated load)
Insulation resistance		100 MΩ min. (at 500 VDC)
Dielectric strength		750 VAC, 50/60 Hz for 1 min between contacts of same polarity 2,000 VAC, 50/60 Hz for 1 min between coil and contacts
Impulse withstand voltage		4,500 V between coil and contacts
Vibration resistance	Destruction	10 to 55 Hz, 1.5-mm double amplitude
	Malfunction	10 to 55 Hz, 1.5-mm double amplitude
Shock resistance	Destruction	1,000 m/s^2 (approx. 100G)
	Malfunction	100 m/s^2 (approx. 10G)
Life expectancy	Mechanical	10,000,000 operations min. (at 18,000 operations/hr)
	Electrical	100,000 operations min. (at 1,800 operations/hr)