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**Advances in Applied Science Research, 2011, 2 (4):410-416**

# Microcontroller Based IR Remote Control Signal Decoder for Home Application

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## ABSTRACT

*The present paper describes a design and implementation of an infrared (IR) remote control signal decoder which can be used for various home control applications. For a demonstration we have designed remote controlled fan regulator and ON-OFF power supply switch. The entire system is based on microcontroller that makes the control system smarter and easy to modify for other applications. It enables the user to operate or control a fan regulator and operate the mains power switch from about 10 meters away. The control setting and output AC voltage of fan regulator has been observed.*

**Key words:** IR decoder, AVR, Microcontroller, AC dimmer.

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## INTRODUCTION

Today, electronics is used in home appliances for wide purposes including the motor regulation of a washing machine, the control of a vacuum cleaner, the light dimming of a lamp or the heating in a coffee machine etc. This pervasion increases rapidly because appliances require enhanced features, easy to built and modify as electronics based solutions become cheaper and more sophisticated. Within this evolution, the microcontrollers (MCU) progressively replace analog controllers and discrete solutions even in low cost applications.

They are more flexible, often need less components and provide faster time to market. With an analog IC, the designer is limited to a fixed function frozen inside the device. Remote control facilitates variety of operation around the home or office from a distance such as fan regulators and mains power supply. It provides a system that is easy to understand and also to operate, a system that would be cheap and affordable, reliable and easy to maintain the system of remote control and offers long durability. It adds more comfort to everyday living by removing the inconvenience of having to move around to operate a fan regulator. The first remote control, called "lazy bones" was developed in 1950 by Zenith Electronics Corporation (then known as Zenith Radio Corporation). The device was developed quickly, and it was called "Zenith Space Command", the remote went into production in the fall of 1956, becoming the first practical wireless remote control device [1]. Mahmud Shehu AHMED and team introduced remote controlled mains power supply in 2007 and fan regulator in 2006 [2, 3]. Their design was based on some analog and digital components which were less compact and required to design dedicated infrared remote transmitter, besides the system was less flexible to modify for other control applications.

This demanded the development of a microcontroller based embedded system for home automation. The system has been developed and implemented as described in this paper is capable to control a fan regulator and operate the mains power supply from distance of about 10 meters.

## DEVICE HARDWARE DESIGN

The full functional block diagram of a device is shown in fig.1.The device consist of blocks namely IR transmitter, IR receiver, microcontroller as decoder, driver circuit. IR sensor module receives the IR pulses sent form remote and converts it to corresponding electric pulses. These electric pulses are given to microcontroller that decodes it to corresponding data byte using zero crossing detector and on chip timer and interrupt. These data bytes are used to take further control decisions. The control output signals are given to driver circuit, which drives the actual device.

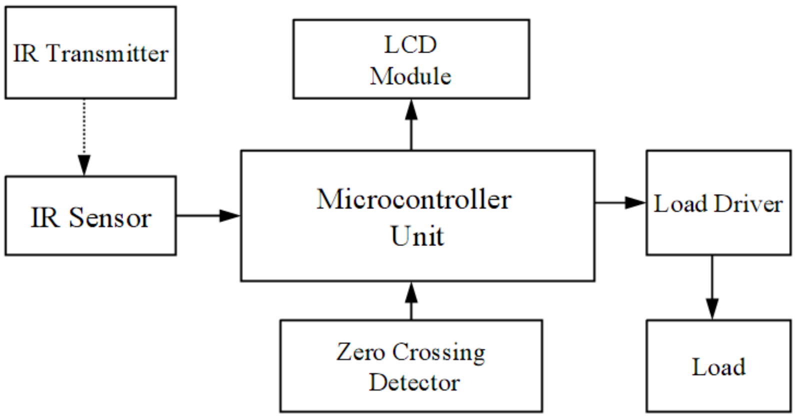


**Fig.1. Hardware Block Diagram**

### *IR remote transmitter*

In present system we have used Sony IR remote which use 12-bit SIRC protocol as shown in fig.2a [4]. The code starts with a header of 2.4ms followed by 7-bit command and 5-bit device address in which least significant bits (LSB) are transmitted first. Then the Commands are repeated every 45ms for as long as the key on the remote control is held down. The address and commands exist of logical ones and zeros. A space of 600µS or 1T and a pulse of 1200 µS or 2T form logical one. A logical zero is formed by a space of 600 µS and pulse of 600µS as shown in fig.2b.

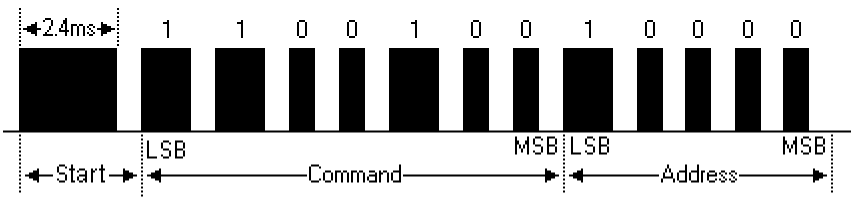


***Figure 2a***

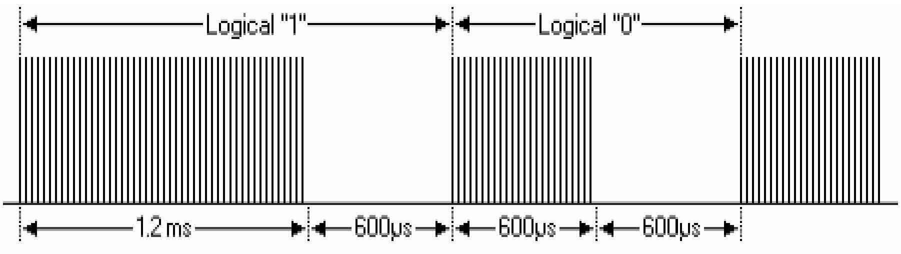


***Figure 2b***
**Fig. 2.IR transmitter protocol**

***Zero crossing detector***

Zero crossing detector generates pulses for every zero crossing of the input AC signal. These pulses are fed to the microcontroller interrupt pin through the opto-coupler. The opto - coupler is used for the isolation of the high voltage AC to the low voltage DC supply at the microcontroller side. The microcontroller was interrupted for every zero crossing which triggers the TRIAC as per the user need.The circuit diagram of system is shown in fig.3.

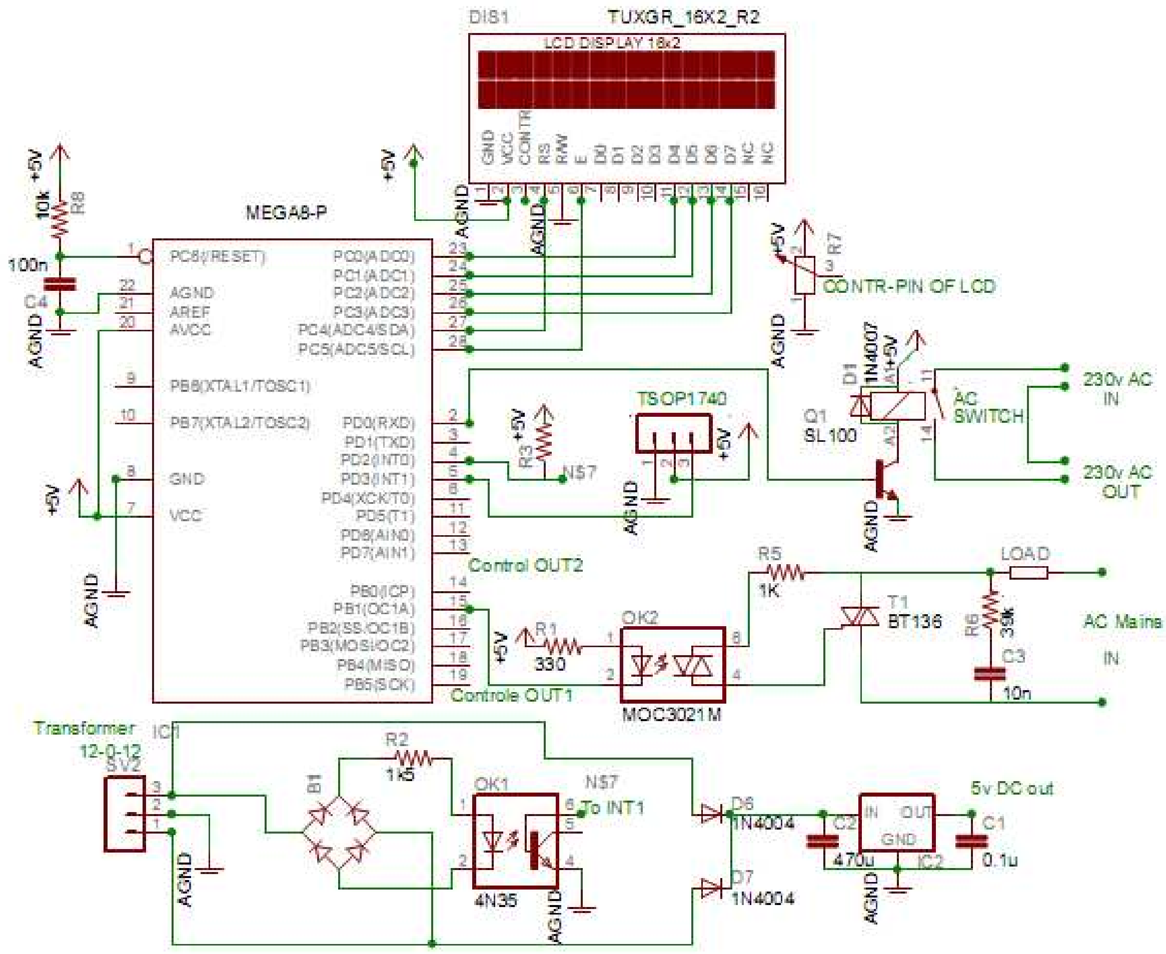


**Fig.3.Circuit diagram of system**

***Microcontroller unit as decoder***

The system circuit diagram shown in fig.3 has been designed around the ATMEL AVR Atmega8 microcontroller. The microcontroller's on-chip peripherals like programmable I/O port, Timer and External Rest, RC-oscillator, EEPROM, Power On Reset (POR) are being used to lower the cost and to increase the efficiency and reliability. This makes AVR microcontroller a better choice for such embedded systems. MCU uses calibrated 8 MHz internal RC oscillator. TSOP-1740 receiver module is used to receive the IR signal form transmitter. This sensor module demodulates the received IR signal that is compatible to microcontroller. Microcontroller decodes the demodulated frame from sensor module to corresponding command and address data byte. This decoded data bytes are then used to take actual control decision. In present system to increase or decries output AC voltage the function keys used are 'Volume +' and 'Volume -' on IR remote transmitter and to ON-OFF AC mains switch 'Power' function key is used. The corresponding decoded command bytes are 19, 20, and 21 respectively.

***Load Driver***

The power control device used here is a triac BT136 being least expensive power switch to operate directly on the 110/240V mains. Thus it is the optimal switch for most of the low-cost power applications operating online. It can withstand a maximum load current typically 5A. Phase angle control technique is employed to control the load power [5]. The output power is controlled by the phase delay of the triac drive. This delay is referred to the zero crossing of the line voltage detected by Zero crossing detector circuit. The control output from microcontroller port pin is given to opto-coupler MOC3031M to trigger the triac. The triac is driven in quadrants QII and QIII with 60 mA gate current with 100uS pulse width. This pulse width is sufficiently long to insure the triac gets latched at the end of the pulse.

Changing operation from 50Hz to 60Hz can be achieved by making simple modifications to the MCU EPROM/ROM table defining the triac conduction angle versus power level. Automatic selection of the 50Hz/ 60Hz tables could be done.

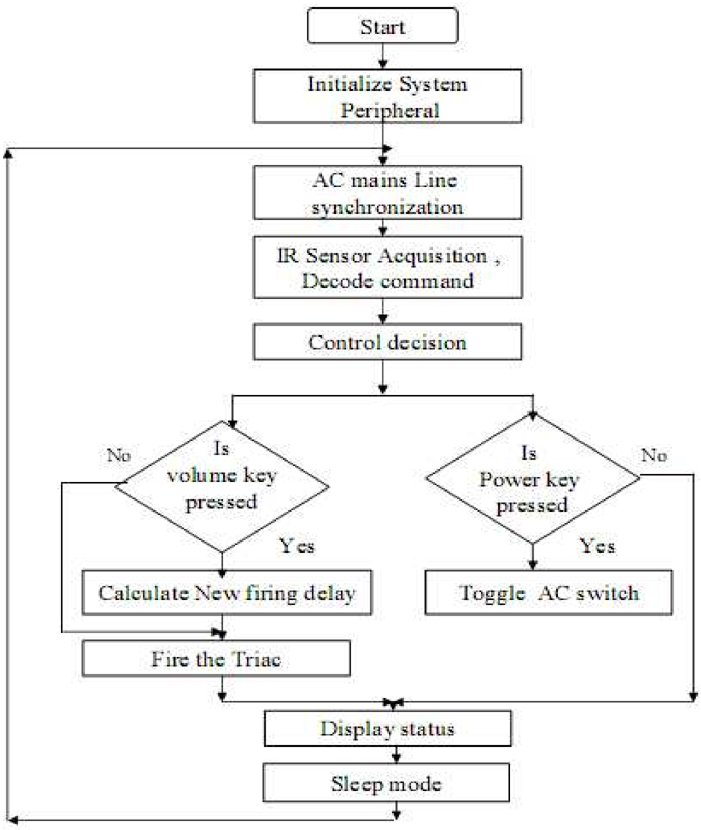


**Fig.4. The basic flow chart of the device software**

***The display circuit***

The device provides 10 steep speed controls from 0 to 9. The current speed is displayed on a liquid crystal display (LCD) module. The LCD module has on-board display controller, which relieves the main microcontroller from manually generating dot-matrix character display. The display unit is composed of 16 x 2 lines with 5x7 dot matrix alphanumeric. The LCD is configured in 4-bit mode with read-write control (WR) pin grounded. This configuration requires less number of I/O pins of microcontroller, typically 6 only. The circuit diagram shown in fig.3 reveals actual pin connections of LCD.

```
void main()
{
  uint8_t cmd;     //Command received from remote
  Initialize();
  while(1)
  {
    //Get Command For the Remote Control
    cmd=GetRemoteCmd(1);

    //Now process the command

    //UP Key
    if(cmd==RC_UP)
    {
      if(speed<9)
        speed++;  //increase speed
    }
    //DOWN Key
    if(cmd==RC_DOWN)
    {
      if(speed>0)
        speed--;     //decries speed
    }
    //Power Key
    if(cmd==RC_POWER)
    {
      if(fan_on)
      {
        POWER_LED_OFF();
        Ac_switch=0;   //Turn Off
      }
      else
      {
        POWER_LED_ON();
        Ac_swithc=1;   //Turn On
      }
    }

    Display(status);
   Sleep();
  }
```

**Fig.5. Main function in device software**

*The total memory usage for system is*
- *Program Memory - 248 words*
- *Data Memory - 13 bytes*

**SOFTWARE DESCRIPTION OF SYSTEM**

The firmware for the MCU is written in embedded–C language. Fig.4 shows the basic flow chart of the system software. When the device is powered-up, the initialization part of the device software configures various on-chip peripherals such as timers, interrupts, port etc. and initializes the externally interfaced LCD. This initialization sequence puts these resources into a known state.

Infrared receiver module is connected to interrupt-1 (INT1) that generate an interrupt when data stream detected transmitted by IR remote. The demodulated frame consists of Header, Command code (7-bit) which presents the actual button pressed on the remote control, and Device code (5-bit) which presents a TV, VCR, CD player etc. MCU on-chip 16-bit timer-1 is used to detect header, logic one and logic zero in demodulated data frame as the Header is 2.4ms in length, logic 1 is 1.8ms (1.2ms high + 0.6ms low), logic 0 is 1.2ms (0.6ms high + 0.6ms low). MCU decodes the demodulated frame from sensor module to corresponding command and address data byte.

Zero crossing detector is connected to INT0 (interrupt-0) of MCU. INT0 is setup as interrupt-on-change that sets interrupt-0 flag for every zero-crossing being detected.Microcontroller calculate delay by using the Timer1 and then activates the triac. At 50 Hz AC power line, one cycle is of 20 ms, half cycle is 10 ms. If the microcontroller delay 5ms before activates the triac on both sides, positive and negative, then the output power would have half of the power. The 10ms is divided into 10 steps for the power control by calculation then put it into preload time variable for Timer1. The conduction time of the triac can vary from 1ms (min firing angle $18^o$) to 9ms (max angle $162^o$) to a 50Hz application. The main function in device software is shown in fig.5.

## RESULTS AND DISCUSSION

100W load was connected to the dimmer channel and setting values to dimmer ware incremented. After each new value was set, the voltage at that channel's output was measured with a Fluke model 12 multimeter. In addition, the voltage supplied to the dimmer was measured at the mains outlet plugged into 226V. The observed data is given in table 1

**Table 1. Fan dimmer voltage test result**

| Timer Setting | Measured Voltage | Percentage full scale |
|---|---|---|
| 58916 | 25.92 | 11.0 |
| 59656 | 41.60 | 18.2 |
| 60259 | 72.8 | 32.2 |
| 60814 | 87.8 | 38.8 |
| 61370 | 116.4 | 51.5 |
| 61925 | 141.7 | 62.6 |
| 62481 | 162.2 | 71.1 |
| 63082 | 180.3 | 79.7 |
| 63823 | 207.0 | 91.6 |
| 65435 | 221.6 | 98.0 |

The results are presented graphically in fig.6.

From table 1 it is observed that each channel of the dimmer output can take on any voltage between 11% and 98% of full scale and it can be used as transformer less variable power supply. The resolution for stepping voltage can be changed by adjusting the timer setting in microcontroller.

Keeping the microcontroller in Sleep mode the overall current draw has been reduced minimal level. And, using a minimal bias pulse to fire the triac further reduces current drawn. Together the power savings is more then 98% of the original triac bias current. At a cost of only 20% in increase power supply current for the microcontroller.This achieve a net reduction in the circuit current drawn over to 78%. The results in a significant savings in power dissipated in the transformer less variable power supply. This offer a system design involving much less expensive components.

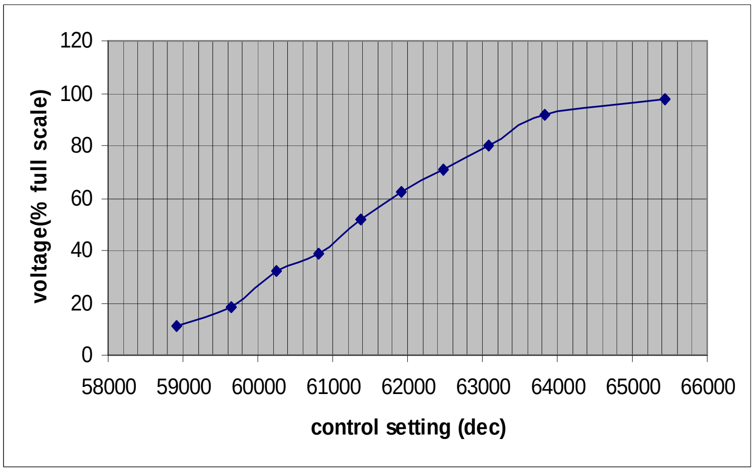


**Fig.6.Output voltage vs. control input**

## CONCLUSION

IR remote control signal decoder is implemented using microcontroller and its application is successfully demonstrated for home applications. The system is quite cheap, reliable and easy to operate. Due to use of MCU the work presented in this article can further be extended for web interfaced control application using Ethernet module like ENC28J60, RTL8019 etc.

## REFERENCES

[1] Ahmed M. S., Mohammed A. S., Onimole T. G., Attah P. O., *Leonardo Electronic Journal of Practices and Technologies*,9,p.55-62, **2006**.
[2] Mahmud S. A., Murtala B. Z. A., Kolo J.G., *Leonardo Journal of Sciences*, 11, p. 41-50, **2007**.
[3] Kolo J. G., Daudad U.S., *Leonardo Journal of Sciences*, 7, p. 175-186 **2008.**
[4] Bergmans S., Oisterwijk, Sony SIRC Protocol [online].
Available at: http://www.sbprojects.com/knowledge/ir/sirc.htm.
[5] Philips Semiconductors Application note, Power Control with Thyristors and Triacs [online]. Available at: http://www.fairchildsemi.com/an/AN/AN-3006.pdf
[6] Finney D., The Power Thyristor and its Applications, p. 35, Toronto, McGraw-Hill Book Company Limited, **1980.**
[7] Richard H.B.,Embedded C Programming and the Atmel AVR, Clifton Park, NY Thomson Delmar Learning, **2006**.
[8] Pranav Kumar Asthana, *Advances in Applied Science Research*, **2010**, 1 (2), pp. 84-91.
[9] Ochala, I. , Momoh, O. Y. and Gbaorun, F., *Advances in Applied Science Research*, **2011**, 2 (2),pp.28-37.
[10] Shahanaz Ayub, J.P.Saini, *Advances in Applied Science Research*, **2010**, 1(2), pp. 76-83.
[11] Ofoefule, Akuzuo U. , Nwankwo, Joseph I. and Ibeto, Cynthia N., *Advances in Applied Science Research*, **2010**, 1 (2),pp.1-8
[12] Nhivekar G.S., Mudholkar R.R., *Journal of Electrical and Electronics Engineering*, **2011**, 4(1), pp.139-142.