Safe and Secure PIC Based Remote Control Application for Intelligent Home

Yavuz EROL[1], Hasan H. BALIK[2*], Serkan INAL[1] and Duygu KARABULUT[1]

[1] University of Firat, Faculty of Engineering, Department of Electrical and Electronics Eng. Elazig/ TURKEY
[2]Beykent University, Faculty of Engineering and Architect, Department of Electronics and Communication Engineering, Istanbul/ TURKEY

*

Summary
In this paper, secure PIC based remote control system for intelligent houses has been presented. With this implemented system, it is possible to safely control electricity operated domestic devices by the help of public or mobile phones from any places all over the world. Developed remote control device has been optically and electrically isolated to secure the system. In addition the system implemented and introduced in this paper has pin-check algorithm in order to enlarge security.

Key words:
Intelligent home, DTMF, PIC microcontroller, telephone line.

1. Introduction

Recently home automation product for intelligent home is increasingly getting very common. By the help of intelligent home technologies that increased comfort, greater safety and security, life has been becoming easier [1]. With this system, home appliance can be controlled from any places in the world [2, 3, 4]. Domestic devices such as lamb, oven, air conditioner, heater and computer can be easily controlled remotely. To remote control of home appliance by telephones which offer easy usage, has been investigated [5, 6, 7].

In this paper, pin-check supported safe, secure and easy use remote control PIC microcontroller, which has RISC architecture, based design has been introduced. Electrical operated domestic devices have been controlled by public or mobile phones using DTMF signals using this system.

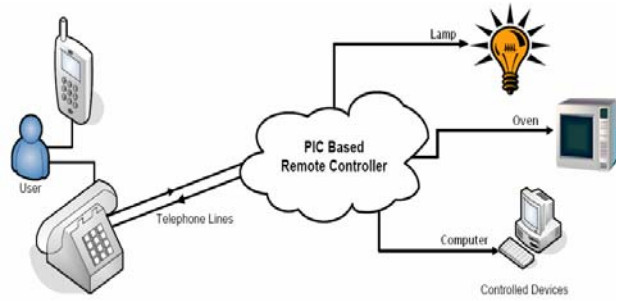


Fig. 1 Block diagram of remote controller system.

The main principle of offered system operation has been shown in Figure 1. The central unit of this system is PIC based remote control circuit which will be called as controller. This controller detects the number of ringing, then decodes DTMF signal and then checks pin numbers which are entered. When the pin numbers have been entered correctly, the controller gives to right to control devices. Both pin numbers and orders to control appliance have been transmitted via telephone line or electromagnetic waves as DTMF signal.

2. Features of Telephone Line

Every phone on the standard public telephone network is connected to the phone-exchange office with two pair copper line. Any two people communicate each other by the help of switching unit in the phone-exchange office. There are two methods to sent phone numbers to the switchboard: first one is dial pulse system, other is multi frequency system. The phone, of which key pad information is sent by audio tone, is used to remote control devices. This is also called Dual Tone Multi Frequency (DTMF) and every button on the key pad has different frequency. Therefore, when the button is pressed, its relevant frequency is sent to the switchboard. These button identification signals are transmitted via telephone line with voice signal.

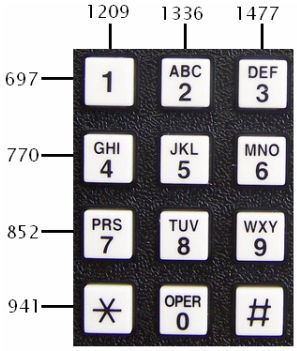


Fig. 2 Keypad with 12 keys and frequencies (Hz).

Manuscript received May 5, 2007
Manuscript revised May 20, 2007

DTMF codes are decoded by appropriate DTMF decoder and then button information is found [8]. Key pad and DTMF signal frequencies are shown in Figure 2.

3. PIC Microcontroller

PIC16F84A is one of the most popular microcontrollers which are commonly used. This microcontroller is based on RISC architecture and has 18 legs with 13 input/output ports. Legs' connections of the PIC microcontroller used are shown in Figure 3 [9].

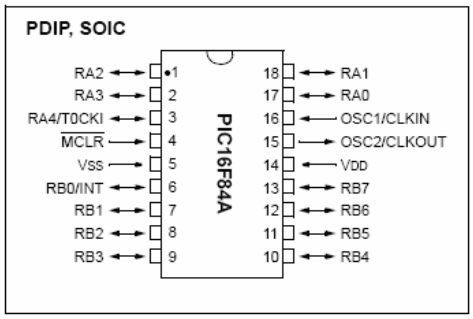


Fig. 3 Pin diagrams.

It is possible to process data with PIC16F84A microcontroller of which oscillator frequency can reach up to 10 MHz. There are two main reasons to choose PIC16F84A for remote control applications. First one is to be cheap. The last one is to have enough ports.

4. Specifications of Remote Controller System

Remote controller system designed is connected parallel to telephone line and electrically operated home appliances can be controlled by using telephone from any places all over the world. Anybody who has GSM and public phone can access the controller by calling the phone number to which PIC based remote controller is connected. At the fist stage, opto-counter unit counts the number of rings. When the number of rings has reached to specified number, the controller opens the line and waits the user to enter the pin-number. The pin-number must be at least 4 digits long for the security reasons. If there is no pin-number entered in 15 second, the controller closes the line automatically. This feature has been put into the system introduced in this paper to not to keep the telephone line busy for unwanted reasons or for miss calls.

PIC based controller detects the pin-number weather right or wrong. If wrong pin-number is entered, the controller waits till the right pin-number is entered. When the right pin-number is entered, it can be reached to device controlling stage by pressing "*" button. At this stage, system waits orders and process the orders entered. To finalize the process "#" must be entered. Both pin-number and orders are transmitted as DTMF signal and therefore have very secure structure.

In Figure 4, complete circuit schema is shown.

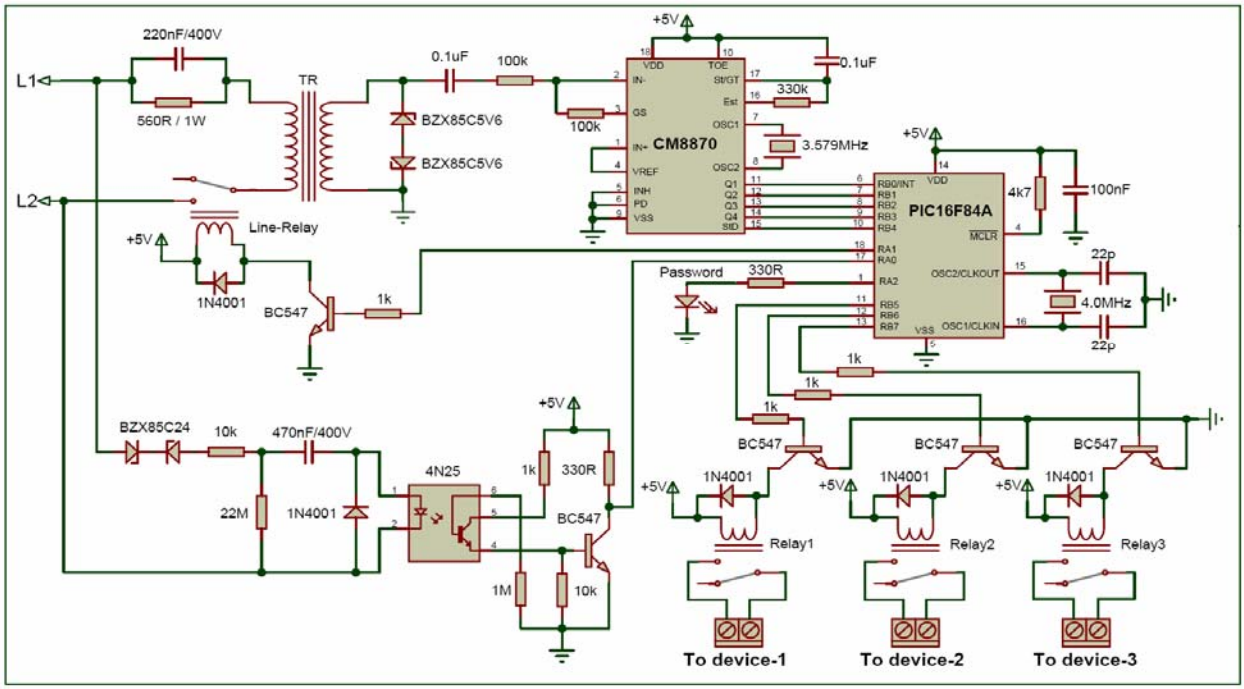


Fig. 4 Complete Circuit Schema.

The remote control system shown in Figure 4 consists of four different units. These are opto-counter unit, magnetic isolation unit, DTMF decoder unit and relay driver unit. These units have been designed not to give any unwanted effects on telephone line. Each unit has been given in detail below.

4.1.1 Opto-Counter Unit

Optic isolation unit shown in Figure 5 has been designed to detect number of rings. When the input of the circuit is exited by high amplitude sinusoidal ring signal, 0-5 V square wave signal appears at the output port. The output port of the optic isolation circuit is connected to RA0 pin of the PIC based microcontroller. 16 pulses appear at the output for every ring. PIC based controller counts the pulses to determine the number of rings. When the number of rings specified is reached, the controller opens the telephone line. For example, controller counts 128 pulses for 8 rings. 4N25 opto-coupler integrated circuit provides the optic isolation between the PIC circuit and telephone line.

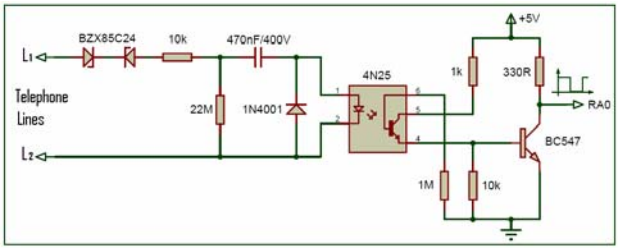


Fig. 5 Optical isolation circuit.

4.1.2 Magnetic Isolation Unit

Magnetic isolation circuit shown in Figure 6 is used to provide electrical isolation between DTMF decoder and telephone line. The line transformer of which transform ratio is 1:1 isolates the system ground and telephone ground. Therefore DTMF decoder integrated circuit is not affected from electrical noises.

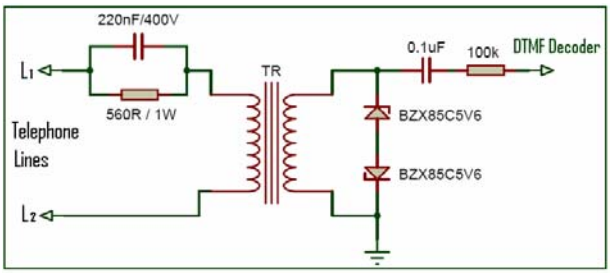
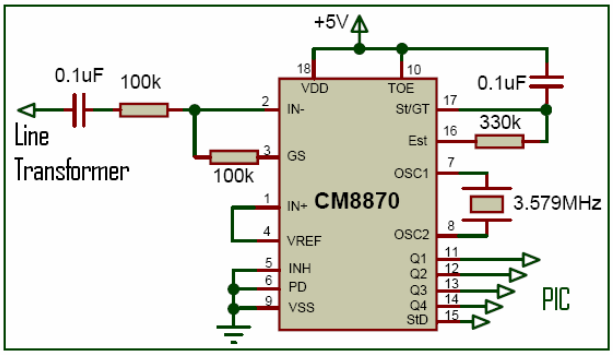


Fig. 6 Magnetic isolation circuit.

4.1.3 DTMF Decoder Unit

CM8870 DTMF decoder integrated circuit shown in Figure 7 decodes DTMF signal transmitted via telephone line and gives 4 bit digital information. Q1-Q4 outputs of the decoder integrated circuit are connected to RB0-RB3 inputs of the PIC microcontroller. Hence the button entered has been determined by the program written and loaded into the PIC microcontroller.



4.1.4 Relay Driver Unit

Relay Driver circuit shown in Figure 8 can remotely control 3 different electrically operated home appliances. Relay contacts are normally open and therefore devices are not working at the beginning. When proper order has been entered using telephone key pad, proper relays are exited by the PIC microcontroller. Therefore such as oven, lamb, heater or computer start working 1, 2 and 3 start (ON) relevant device and 4, 5 and 6 stop (OFF) devices respectively.

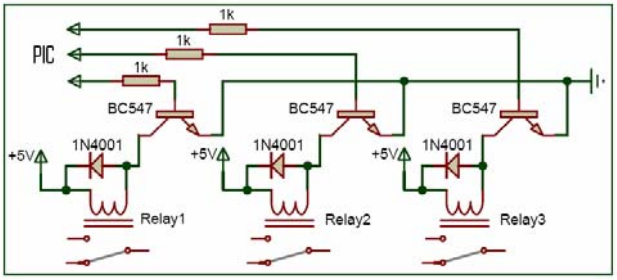


Fig 8 Relay driver circuit

5. Conclusions

Remote control system by telephone presented in this paper is based on PIC and has very secure structure. Designed circuit is isolated both optically and electrically; therefore it does not create any effect on telephone line. With pin-check system, non-authorized people can not connect to or use this system. In this application, secure, cheap and safe remote control system for intelligent houses has been presented.

References

[1] Nunes, R.J.C., Delgado, J.C.M, "An Internet application for home automation", MELECON Electrotechnical Conference, vol. 1, pp. 298 – 301, 2000.

[2] Malinowski, A., "Networked home automation projects", IECON '01, The 27th Annual Conference of the IEEE, vol. 3, pp. 1758 – 1762, 2001.

[3] Al-Ali, A.R.; Al-Rousan, M., "Java-based home automation system", IEEE Transactions on Consumer Electronics, vol. 50, Issue 2, pp. 498 – 504, 2004.

[4] Kwang Yeol Lee; Jae Weon Choi, "Remote-controlled home automation system via Bluetooth home network", SICE 2003, vol. 3, pp. 2824 – 2829, 2003.

[5] Koyuncu, B., "PC remote control of appliances by using telephone lines", IEEE Transactions on Consumer Electronics, vol 41, Issue 1, pp. 201 – 209, 1995.

[6] Schneider, S., Swanson, J., Peng-Yung Woo, "Remote telephone control system", IEEE Transactions on Consumer Electronics, vol 43, Issue 2, pp. 103 – 111, 1997.

[7] Zhi-Ming Lin, "A remote telephone-controlled home automation system", IEEE Southeastcon '98, pp. 148-152, 1998.

[8] CM8870C DTMF Decoder Datasheet, http://www.calmicro.com/products/data/pdf/ cm8870.pdf

[9] Microchip PIC16F84A Microcontroller Datasheet, http://ww1.microchip.com/downloads/en/devicedoc/35007b.pdf