REMOTE CONTROLLED SMARTHOME OVER PSTN

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Abstract: *The concept of remote controlled has become increasingly widespread nowadays due to the need to improve domestic comfort. This project presents the realization of such a system. Smarthome involves interconnecting multiple systems that together lead to the realization of remote command and control for electronic equipment and appliances found in a home or company office. Smarthome over PSTN is such a system, a remote control system that involves the use of fixed switched telephone network to achieve the interaction between the user and the controlled equipment. The whole project was based on the command and control unit - integrated type, a microcontroller.*

Key words: *smarthome, PSTN, DTMF, microcontroller, optocoupler, integrated*

1. THE REMOTE CONTROL CONCEPT - INTRODUCTION

The first remote control tendencies were represented by Nikola Tesla's attempts in 1898 to remote control vehicles or vessels.

Remote control concept was initially considered a difficult area to address, but with the spread of electricity in all homes has become a challenge for researchers and also a need to improve the comfort of their homes.

Smarthome idea complements the concept of automated home (Home Automation), control of the decision being made by human factor from a considerable distance from the ordered items.

2. PUBLIC SWITCHED TELEPHONE NETWORK (PSTN)

PSTN-Public Switching Telecommunication Network is the Public Switched Telephone Network - the largest telecommunications network comprising a total of approximately 1000 million subscribers [9].

This network is used mainly for telephone communications services.
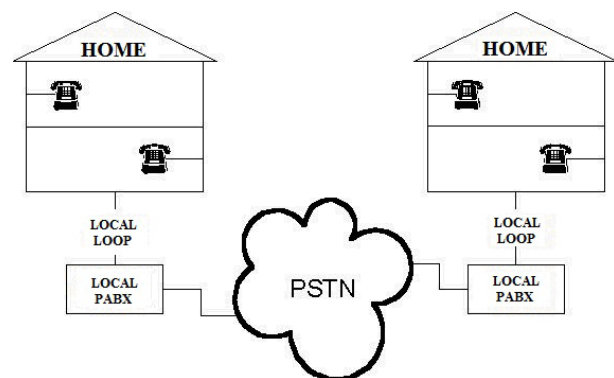

Fig. 1 – PSTN

The main features of the telephone network are:
- subscribers access to analog phone line;
- links and communications are performed in telephone baseband (0.3 - 3.4 kHz);
- switching can be achieved both analog (electromechanical PBX) and digital (electronic PBX) - (64 kbps channels);
- signaling in the network can be done in two methods, "Pulse" and "Tone". Method "pulse" involves interrupting the supply voltage fox example 3 times for number 3, and for the 'Tone' are used DTMF tones.

Table 1. DTMF Frequency

F_{high} / F_{low}	1209Hz	1336Hz	1477Hz
697Hz	1	2	3
770Hz	4	5	6
852Hz	7	8	9
941Hz	*	0	#

DTMF - Dual Tone Multi Frequency. With these tones are transmitted information from the user to the telephone PBX when the user wants to make a phone call, so the number you wish to call is transmitted digit by digit to PBX as specific signals for each key.

These tones are signals that are included in the telephone baseband (0.3 - 3.4 kHz), so they can be sent during a call, as in the submitted project.

3. DESIGN OF THE DIAGRAM AND FUNCTIONAL BLOCKS

The system is designed to be connected in parallel to the telephone line, so it does not interfere in any way with the usual calls.
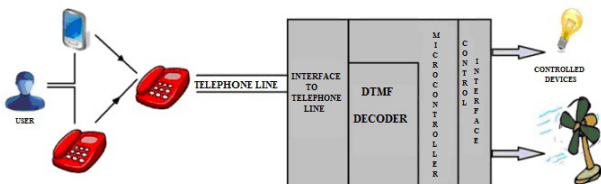

Fig. 2 – Block diagram

The entire assembly is connected to the telephone line through the optocoupler block, whose role is to isolate two independent entities, and adapting the signals in telephone line to the requirements of microcontroller unit.

Signals that appears during the ringing, are counted by the microcontroller and after reaching a pre-established number of bursts, the microcontroller connects the entire circuit to the telephone line, so it answers the call.

The number of square wave bursts in Romanian PBX signaling is 25 bursts/ring. At this point comes into play DTMF decoder with the sole purpose of converting signals specific to telephone line into binary signal that is recognized by the microcontroller.
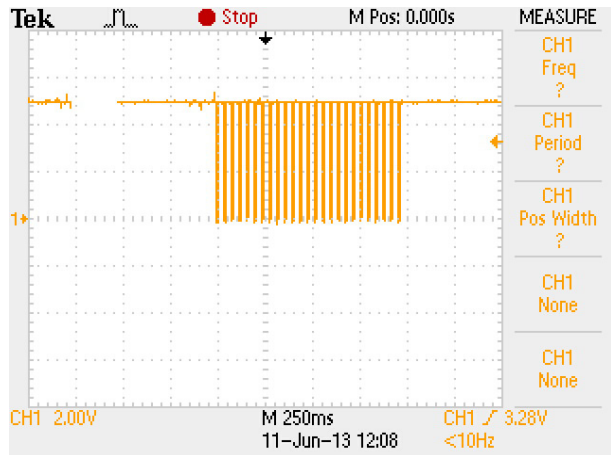

Fig. 3 – Oscilloscope capture for one ring – 25 bursts

The software requires to the caller to enter a password to have access in the system (1990*) after which he can command the device.

The control of devices is via a power block.

The entire activity of the system is coordinated and developed around embedded computing unit - PIC16F84 microcontroller.

3.1 Optocoupler block and interface between the system and the telephone line

The interface that realize the connection between the system and the telephone line is composed of two parts, one that helps adaptation of the control signals occurred on the line and the needs of microcontroller and other part, the physical closing circuit that realize responding to the call.

The first part, one containing an optocoupler (4N25) has the main purpose optical isolation between the proposed circuit and the phone line so there is no interference between these two entities.
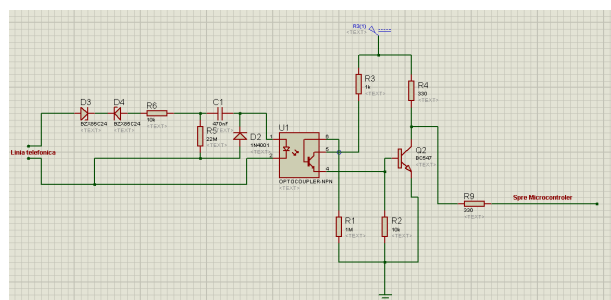

Fig. 4 – Interface between circuit and telephone line

The actual coupling part is represented by a line relay controlled by 5Vdc which is coupled to the controller output. After the controller has decided that the system must be connected to the telephone line, after a preset number of call bursts, it applies on pin RA1 – the logic value 1 - analogical 5VDC, thus coupling the system to the telephone network.
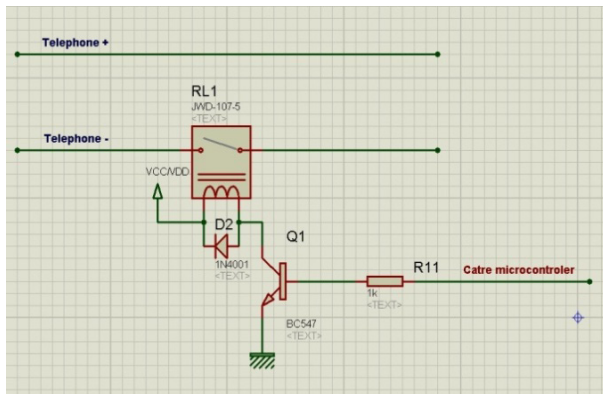

Fig. 5 – Line relay

3.2 DTMF decoder block

The design of DTMF decoder diagram was largely based on the specific application for integrated circuit MT8870.
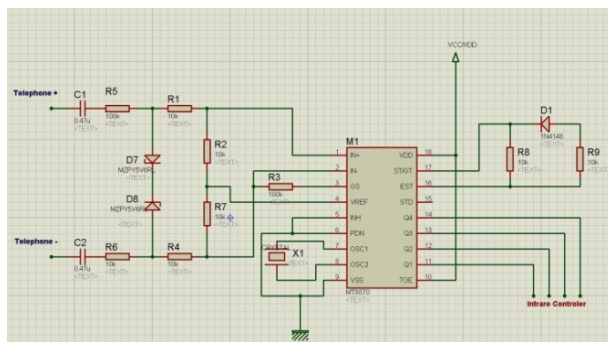

Fig. 6 – DTMF decoder

Block thus created is an interface between the telephone line and the microcontroller. This circuit realize the conversion of the analogical DTMF signal in four bits digital signal that is needed for the microcontroller input.

The analogical DTMF signal is formed from the sum of two sinusoids, specific for each key and the output is a digital information represented by four bits, in accordance with the table bellow:

Table 2 – DTMF frequency and output[2]

Key	Low frequency [Hz]	High frequency [Hz]	DTMF decoder output			
			Q3	Q2	Q1	Q0
1	697	1209	0	0	0	1
2	697	1336	0	0	1	0
3	697	1477	0	0	1	1
4	770	1209	0	1	0	0
5	770	1336	0	1	0	1
6	770	1477	0	1	1	0
7	852	1209	0	1	1	1
8	852	1336	1	0	0	0
9	852	1477	1	0	0	1
0	941	1209	1	0	1	0
*	941	1336	1	0	1	1
#	941	1477	1	1	0	0

3.3 Microcontroller

Generally, a microcontroller is nowadays a complex electronic structure that has as purpose the control of a process in circuits and schematics where it is mounted. In a more general way to control a specific interactions with the environment without need of the human factor. In other words, the controller help automate the system in which it is included.
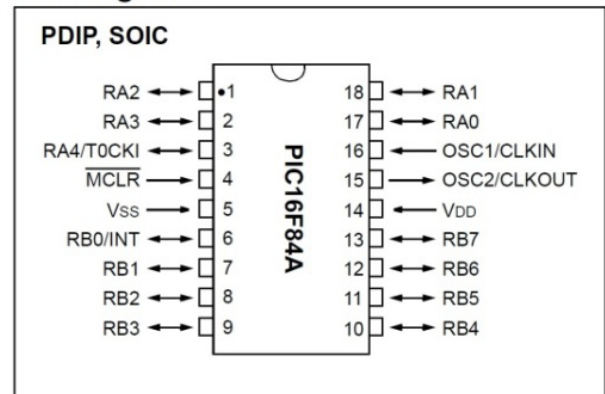

Fig. 7 – PIC16F84A microcontroller

For this project it was chosen an 8-bit microcontroller - PIC16F84A to be used as computing unit. This model is common in many applications and it's features are sufficient to perform properly the requirements of the project.

PIC16F84 has the following features: [3]
- 1KB program memory;
- 68 bytes of data RAM;
- 64 bytes of data EEROM;
- 14-bit wide instruction words;
- 8-bit wide data bytes;
- interrupt source;
- 13 input/output pins;

- 25 mA sink max. Per pin;

- WatchDog Timer;

- 200ns instruction cycle;

- 10.000 erase/write cycles;

- Low power consumption (< 2mA at 5V, 4MHz and < 15uA at 2V, 32kHz).

3.4 Power block

Power block is the block that realize the interface between the controller and the controlled household appliances.
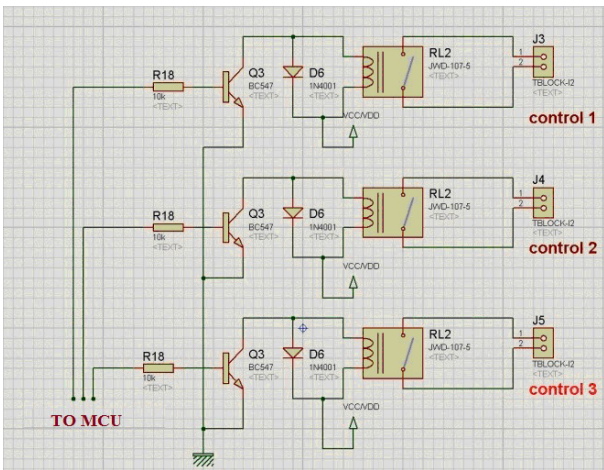

Fig. 8 – Power block

For implementation it was used 5VDC controlled relays whose switch withstands a current of 10A at a voltage of 250V. Voltage and current were chosen at these values because the project considers to control the power supply part of the controlled devices.

3.6 The software

To realize the code and compile it it was used "MPLAB IDE v8.70". Programming language is assembler (ASM). It was chosen this programming language because it is an intuitive programming language for the human factor and the result is optimized and very close to the machine code of the controller.

CONCLUSIONS

The remote control system via telephone line presented in this project is a secure system that allows increasing domestic comfort.

The circuit design is both magnetic and optical isolated from the telephone line and thus does not interfere in any way with it, their functionality is somewhat independently.

Using PIN verification before entering in command menu represents extra security against unauthorized access.

This project is an inexpensive and safe remote control for electrical equipment.

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