A REMOTE CONTROLLER FOR HOME AND OFFICE APPLIANCES BY TELEPHONE

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ABSTRACT

This paper describes the design and development of a phone -based remote controller for home and office automation. The circuit is designed based on the Turkish telephone standards and connected to the telephone network just like any normal telephone sets. Any tone dialing Dual Tone Multiple Frequency (DTMF) telephone set or hand -held tone dialer may be used to send commands to the control unit, and remotely control, a wide range of mains appliances in homes and offices. The designed circuit can also detect user identification number for prevent non-authorized use of the control unit. The feedback signal informs to the user about the results of commands.

1. INTRODUCTION:

In this modern age the field of automation has advanced rapidly and become an integral part of homes and offices. As a result, all sorts of technological advances have been used to have a better environment. Information exchange between homes and offices or vice-versa makes many aspects of daily life easier and more convenient [1]. The purpose of this remote controller may be enumerated as follows:

1-To find a solution for some prevailing problems.

The equipment which is supposed to be left either on or off when one is away from home or office such as security alarms, electrical oven, iron etc. may be controlled remotely.

2-From the convenience point of view.

The user can easily operate appliances at home in a very convenient manner while he is in the office. For example, the user may turn on the oven just before coming home so that it heats up while he is on the way and this enable him to start cooking immediatly.

3-From the economic point of view.

With the advances in telecommunications, telephone lines have reached the most remote places. It would be a pity to use this expensive investment for the purpose of only verbal communication[1]. On the contrary the already available lines can be used without further infra structural investment for educational, cultural and control purposes. This availability of telephone lines drastically reduces the cost of implementing such a system. When one is away from home and he remembers something which has to be done, he will either have to go back or ask some one else to do the job. Both of them are time and energy consuming. Earlier works on this topic involved the usage of a personal computer (PC) [2]. A PC may not always be available, in any case it is expensive solution. Considering this the presented solution is more attractive.

2. THE FUNDAMENTAL PRINCIPAL OF SYSTEM:

As it is shown in figure 1, the function of this remote controller is to control the power supplied to remote location via telephone line. The remote controller is placed next to the local telephone set. The system is based on (DTMF) telephone system. The controller makes use of the telephone keypad as input device to direct data and instructional commands [3-4]. The received commands are detected and sent to driver of load.

2.1 DTMF Telephone System.

In this system the telephone numbers are sent by audio tones. Two different frequency in voice band indicate any digit of keypad. Telephone sets use the DTMF method for sending numbers. Pressing one of the keys in DTMF keypad causes to generate two tones in the voice band (300-3000 Hz). The block diagram of DTMF generator used in telephone set is shown in figure 2. The DTMF tones for telephone keypad are shown in table 1. For detecting of a valid pair tones in DTMF receiver, each tone pair should be separated by a valid pause[5]. Table 1 shows the established Bell system standards.

Low group tones : 697,770,852,941 Hz.
High group tones : 1209,1336,1477,1633 Hz.
Frequency tolerance f(1.5 %+2 Hz)
Amplitude range : -24 dbm<a<+6dbm 600 ohm

Pause duration   : 40 ms or longer
Pause duration   : 40 ms or longer

F HZ Low	F HZ High	NO	Q_4	Q3	Q_2	Q_1
697	1209	1	0	0	0	1
697	1336	2	0	0	1	0
697	1477	3	0	0	1	1
770	1209	4	0	1	0	0
770	1336	5	0	1	0	1
770	1477	6	0	1	1	0
852	1209	7	0	1	1	1
852	1477	8	1	0	0	0
941	1477	9	1	0	0	1
852	1336	0	1	0	1	0
941	1209	*	1	0	1	1
941	1477	#	1	1	0	0
697	1633	A	1	1	0	1
770	1633	B	1	1	1	0
852	1633	C	1	1	1	1
941	1633	D	0	0	0	0

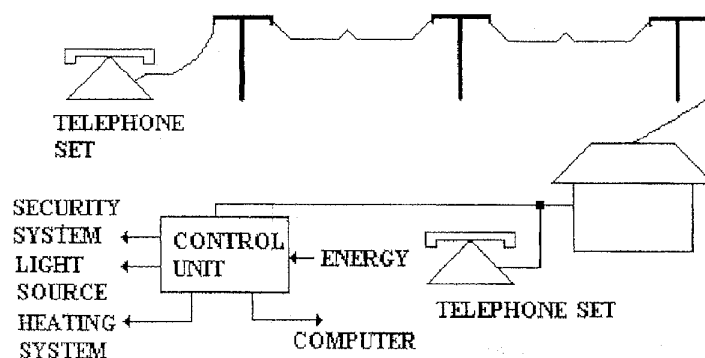Table1- Functional Decode Table

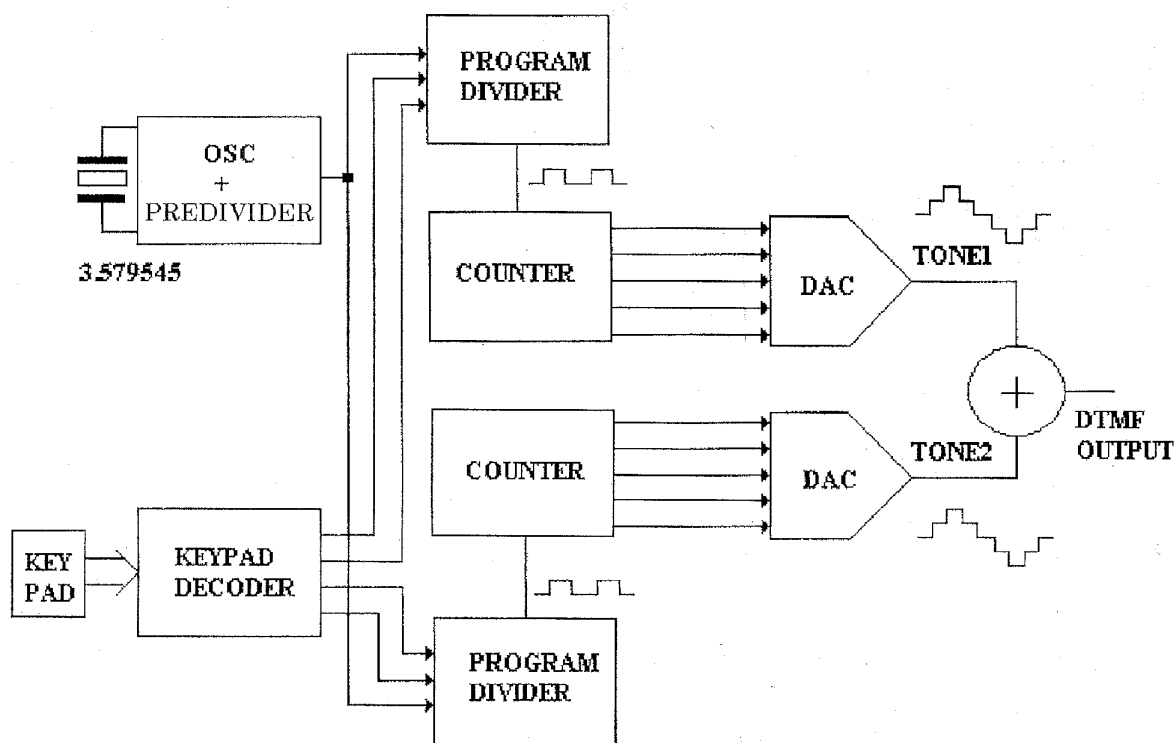Figure 1- Remote Control by Telephone

Figure 2- Block Diagram of DTMF Generator in Telephone Set

The task of DTMF receiver is to detect the presence of a valid tone pair on a telephone line or other transmission medium.   The presence of a valid tone pairs indicate a single digit. The output of the DTMF receiver is binary code as shown in table 1.

An internal structure of DTMF receiver is shown in figure 3. This integrated circuit is a complete DTMF receiver, integrating both band pass filter and digital decoder function. The filter section uses switched capacitor techniques to detect all DTMF tone pairs and decode them into four bit binary code.

2.2 Filter Section.

Separation of low-group and   high-group tones is achieved by applying the   DTMF to the input of two sixth-order switched capacitor band pass filters, the bandwidth of which corresponds to the low and high group frequencies.   Each filter output is followed by a single   order switched capacitor filter section   which   smoothes the signals prior to limiting. Limiting is performed by high -gain comparators, which are provided with hysteresis to prevent detection of unwanted low-level signals.   Figure 4 shows the filter response.
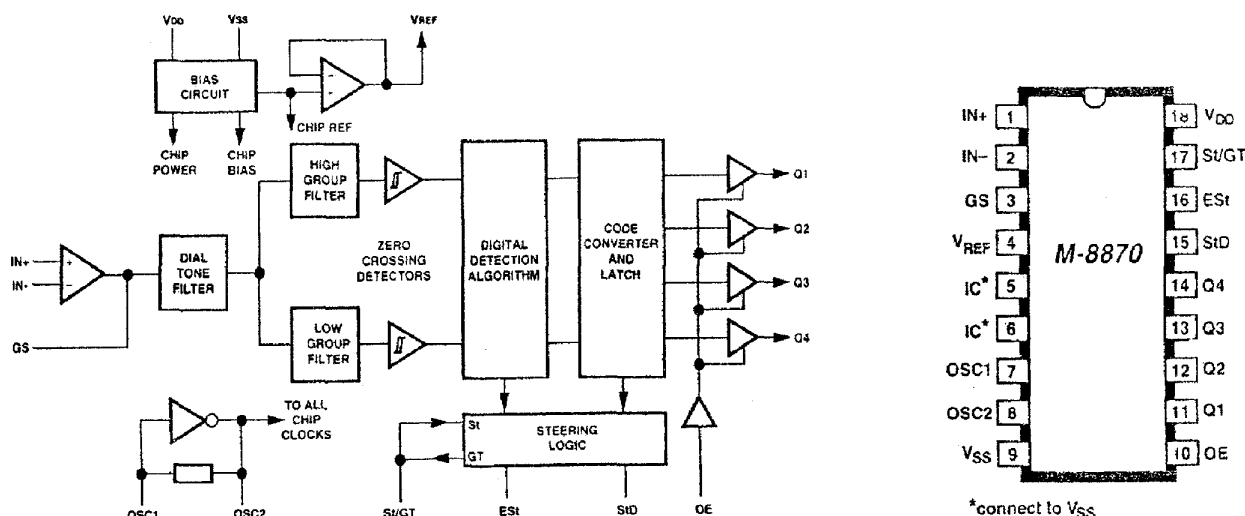

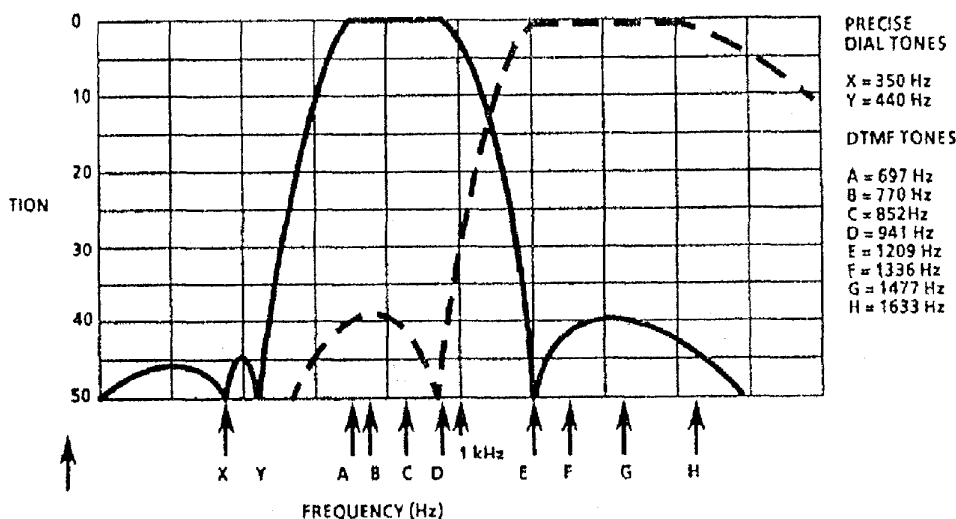Figure 3- Internal Structure of DTMF Receiver

Figure 4- Filter Response

3. THE FUNDAMENTAL PRINCIPAL OF REMOTE CONTROLLER DESIGN:

- The control unit is connected to telephone network just like any telephone set.
- The controller is designed to interface with telephone line. Isolation through an opto-coupler, surge protection circuitry and matching transformer are necessary to conform with the Turkish Telecom requirements.
- For automatic line connection, ring detector and ring counter are necessary.
- Reset and preset of ring counter, generates acknowledge tone after completing each command.
- For preventing non-authorized use of the control unit, a passcode is necessary.
- For local use, a selection mode must be found.
- After completing control operation, transaction must be ended automatically after a certain time.

4. BLOCK DIAGRAM OF REMOTE CONTROLLER:

The block diagram of remote controller is shown in figure 5. This block consists of four main features.

1. Telephone line interface,
2. DTMF receiver and digital circuit,
3. Driver and feedback circuit,
4. Power supply.

4.1 Telephone Line Interface.

This section consists of two parts. The first one detects ring signals, that enable the unit to answer the call at the right moment, and the other is to receive and transmit tones via the telephone line.

In telephone systems a ringing signal is sent to the called telephone to alert the called party [2]. The ringer signal voltage is 75-90 volt and it's frequency is 25 Hz. For automatic line connection, this ringer signal is used. As shown in figure 6, the first step in the line interface is ring detector. This circuit responds to alternating ring signals. The ring counter detects the ringing tones and enables the transaction timer circuit when the preset count is reached [3]. The answering time is dependent on a transaction timer that switches on a digital circuit via a matching transformer to telephone line.
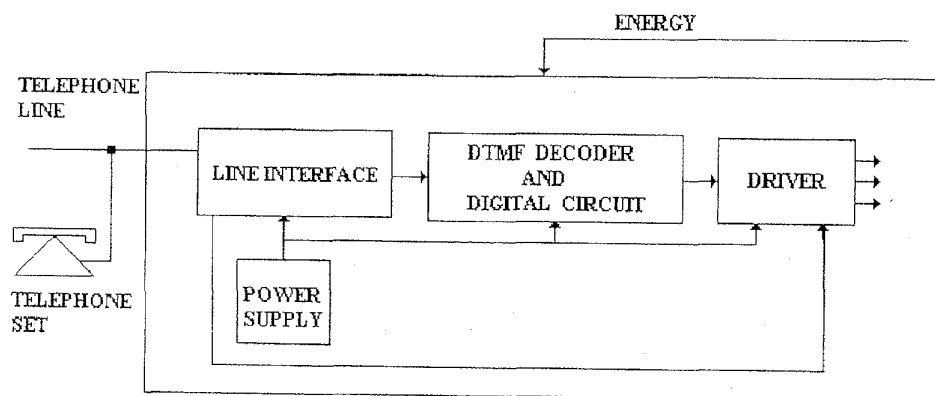

Figure 5- The Block Diagram of Remote Control
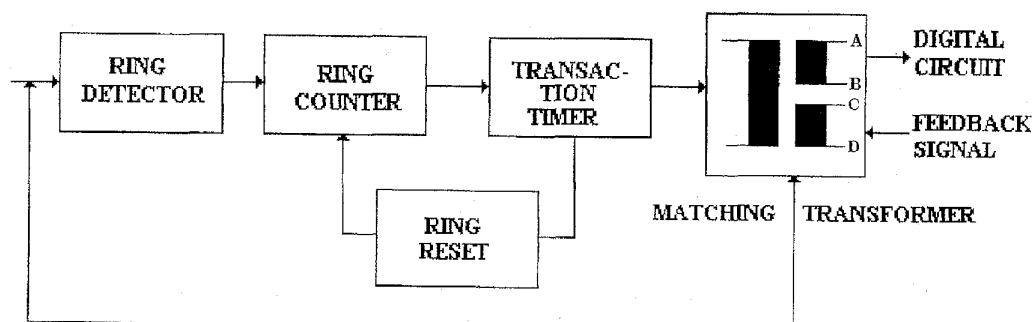

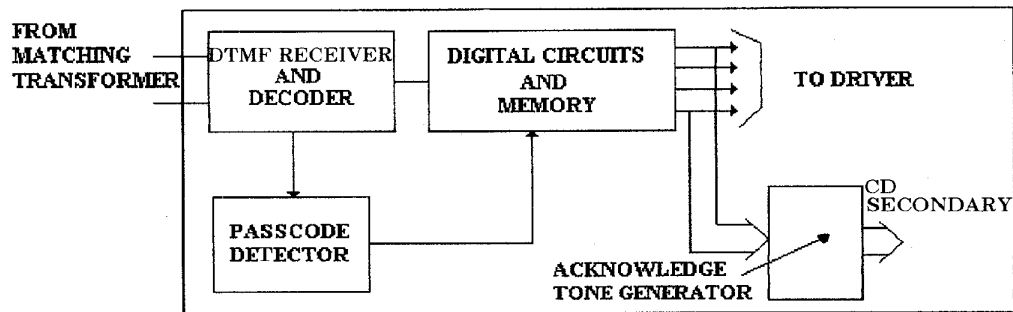Figure 6- The Block Diagram of Line Interface

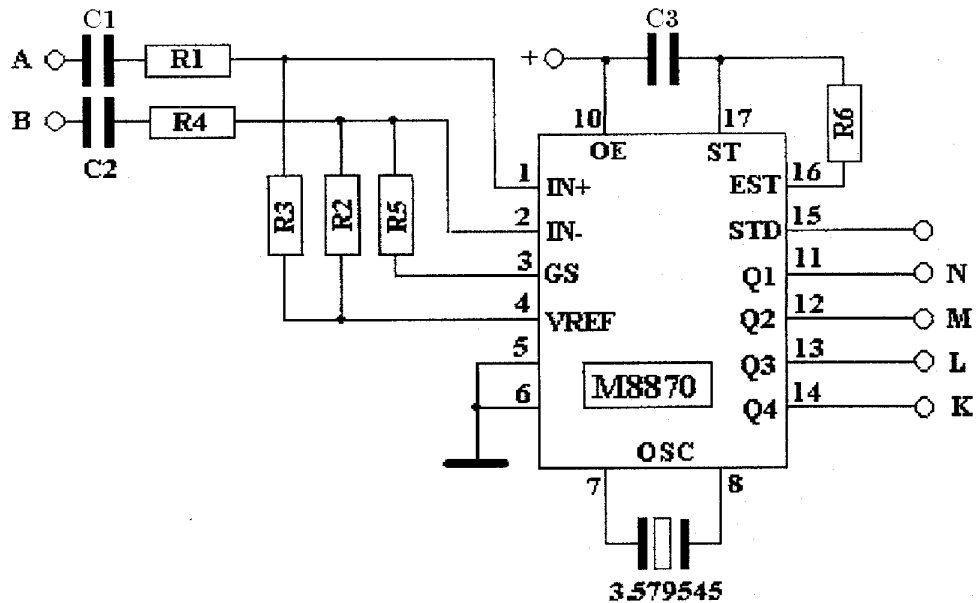Figure 7- The Block Diyagram of Digital Circuit.
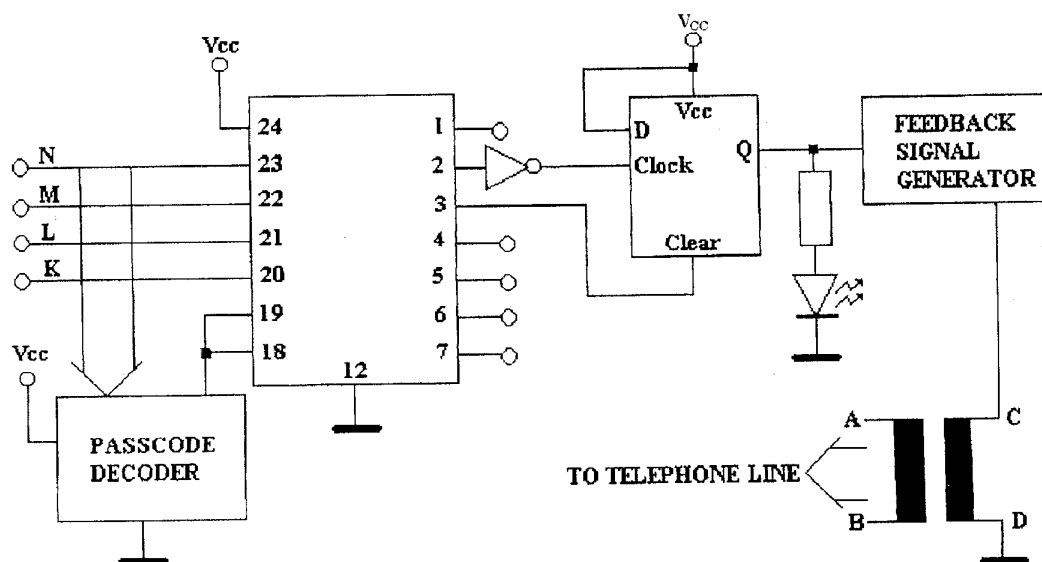

Figure 8- A Complete DTMF Receiver.

Figure 9- A Simple Application of Digital Circuit.

Matching transformer has two secondary(A-B) for DTMF receiver and' (C-D) for feedback signals. Another necessary section in this part is the ring counter reset circuit. The designed circuit will be interfaced to the telephone line. Therefore, isolation through an opto-coupler, surge protection circuitry and matching transformer are employed should be conform with Telecoms regulation conditions. For that reason using two opto-isolator is suitable. The first one is used between ring detector and ring counter and the other one is used for connecting the primary of matching transformer via telephone line.

5. DTMF RECEIVER AND DIGITAL CIRCUIT:

The main part of the remote controller is in this section. The received tones are transmitted here by line interface circuit via matching transformer. The block diagram of this section is shown in figure 7. As seen, this block consists of DTMF receiver, user passcode detection and memory elements. The output of this section is applied to driver. The received DTMF signals via secondary terminal (A-B) are capacitively coupled to decoder M8870. The external components that enable the M8870 to operate reliably are limited to four resistors, a capacitor and a quartz crystal. In this configuration, the input arrangement provides a differential-input operational amplifier as well as a bias source (v_c) which is used at the mid-rail. Provision is made for adjustment of gain. This configuration is shown in figure 8. The value of resistors and capacitors are:

$C_1 = C_2 = 10$ nf $R_1 = R_4 = R_5 = 100$ kohm
$R_3 = (R_2.R_5)/(R_2+R_5)$ voltage gain $= R_5/R_1$

The outputs of M 8870 are four bit code that applied to the digital circuit via the port line K,L,M,N. The digital circuit after the receiver is shown in figure 9 as a simple application. The four bit is coupled to 1 of 16 distributors (74 LS 154). For active mode the pins 18-19 of this Integrated circuit must be pulled down in ground potential. The active mode is dependent upon the passcode detection circuit. If the passcode is correct, the detection circuit sends a low potential to pin 18-19 of 74 LS 154. The output of distributor is sent to a D type Flip-Flop (F/F) memory element via an inverter. By pressing the '1' key from

DTMF keypad, it sends a high level potential and the LED as a load turns on. By pressing the key 2, the D type F/F receives a low level potential, resets input and Q goes to low. At the result of this, LED turns off.

6. RESULTS:

The remote controller given here is a digital circuit which may be constructed with the help of microprocessors and PLD's using fewer elements. With a minor modification, the system can be used in cars just as well as it is used in homes and offices. With the development of visual telephones, this system may also be used for educational purposes for children and for the convenience of elderly people. By elaborating upon this system and adding additional functions, it may be used for automation of household and office applications. For example; leaving message, receiving message without going home with a special access code. The home computer may be turned on and later data may be carried out through the telephone lines. In case of electric failure, system connects itself to the battery (included) and informs the caller.

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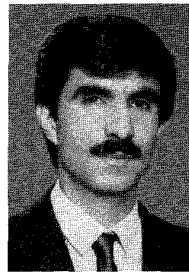
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