**Информатика и вычислительная техника. Текст 1.**

**GSM-BASED ELECTRONIC INTERFACE FOR**

**REMOTE CONTROL OF ELECTRICAL**

**APPLIANCES**

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***ABSTRACT***

The human mind always needs information of interest to control systems of his/her choice. In this age of electronic systems, it is important to be able to control and acquire information from everywhere. Remote management of several home and office appliances is a subject of growing interest and in recent years we have seen many systems providing such controls. In this work, a phone based home/office remote controller interface equipped with power to turn ON/OFF and receive STATUS of electrical appliances remotely located was developed. A method for control using the Dual Tone Multi-Frequency Decoder (DTMF) tone generated when the user pushes the mobile phone keypad buttons connected to a remote mobile system is presented.

Keywords: Remote controller interface, GSM, DTMF, appliances and electronic systems

**1.0 INTRODUCTION**

The desire of man to control an object that is remotely located to him has been for many ages. However, the technology that meets the perfect desire in this respect has not been obtained, though there is increasing improvement in technology that struggles to meet this need in terms of accuracy, speed, ease of operation and limitless operation point.

The introduction of the Global System for Mobile Communication (GSM) and particularly the use of hand-held mobile phones brought the innovation of distance communication at remote location. Based on this, research is currently on-going to utilize this facility for remote control of systems and appliances; take for instance, a man on a journey inside his car suddenly remembers that he left the Air conditioner ON when it was supposed to be OFF. The normal condition is to drive back and switch OFF. But with the GSM mobile phone in the hand, one looks on how the same could be used to effect control at any point

and time.

This work presents how to design an electronic interface compatible with the GSM handset operation that

can enable remote control of electrical appliances. It reveals how to develop an interface between the

GSM and electrical appliances suitable for several models of mobile phones that enable a two way system

of practical communication between the GSM and remote electrical appliances.

The remaining sections are arranged as follows. Section 2 presents methods adopted in GSM controls,

section 3 presents the system development, section 4 describes the design stage of the work, section 5

highlights components of the proposed system and section 6 presents the conclusion.

**Информатика и вычислительная техника. Текст 2.**

**2.0 METHODS ADOPTED IN GSM CONTROLS**

Method of controls rest on the input and output standard of mobile phones common to all phones. There

are basic outputs and inputs of every mobile phone. Inputs like the keypads and microphones are the basic

inputs. The outputs are the speakers, backlights, vibrations and sounds. The basic inputs and outputs can

be used with appropriate transducers. This work takes advantage of the keypad tone discussed below:

**2.1 Keypad Tone**

There is an interesting feature on the keypad of the handset. The keypad has tones, each with unique

frequency and hence sounds. Once a call is acknowledged by the receiving phone, the speakers of the two

phones (the transmitter and the receiver) are automatically activated to receive keypad tones when the

buttons of any of the phones is depressed. Every phone irrespective of manufacturer has twelve (12)

keypads. The twelve keypads are Key 0 to 9, asterisk (\*) and the hash (#). These tones are automatically

transmitted and received as the keypad tones. With independent frequency and twelve in number, each

button could be used to transmit command to the control equipment. Thus several independent commands

could be generated using this approach. With the trend in technology, where microcontroller has gained

wide appreciation, the controls are not limited to twelve (12). The keypad tone is a frequency array in

matrix form as indicated in the Table 1 below. The address of any number is given by two frequencies,

the row and column frequencies. By so doing, every number of the keypad can be located on the matrix

table.

Table 1: Frequency matrix of the Keypad of Phones

**3.0 SYSTEM DEVELOPMENT**

The keypad tone is used to generate the necessary command that will activate electromagnetic or solid

state relays for switching ON and OFF and the accessing of the STATUS of several appliances. The tones

received through the earpiece will be converted to binary number that each represents using a standard

Integrated Circuit (IC) chip called Dual Tone Multi-Frequency Decoder (DTMF). The binary numbers are

fed into BCD-to-Decimal decoder. The output decimal is fed into a microcontroller that serves three

purposes outlined as follows:

**Информатика и вычислительная техника. Текст 3.**

**3.1 Dual Tone Multi-Frequency Signaling (DTMF)**

Dual-tone multi-frequency signaling (DTMF) is used for telecommunication signaling over telephone

lines in the voice-frequency band between telephone handsets and other communications devices and the

switching center. The multiple tones are the reason for calling the system multi-frequency. These tones

are then decoded by the switching center to determine which key was pressed. Table 2 shows the

frequencies generated on each key press.

This work takes advantage of the DTMF keypad tone since it is used to control multiple devices and it is

a standard for all mobile phones. In this work, signals produced by the DTMF were converted to voltages

via a customized circuitry that can control about any device.

Table 2: The keypad numbers and their corresponding frequencies

**4.0 DESIGN PROCEDURE**

In the design stage of this work, special attention is put on the critical condition that makes the component

and the module operate efficiently. All components and their functions for the purpose of this work are well discussed. The major problem accosted in engineering design is how to fully and correctly specify

the requirements of the design.

**4.1 Multiple Units GSM Controlled Devices**

The multiple units GSM controlled devices system design process involves the following:

1. Full analysis of the system specification.

2. Hardware design

The hardware tasks include the definition and analysis of suitable circuit components used in achieving

the circuit design of the multiple units GSM controlled devices, and the circuits necessary for taking

electrical signals as inputs, activating, deactivating and getting feedback from electrical appliances. The

first task is getting DTMF Integrated Circuit to receive the signals from the keypad of the mobile phone.

The second task is writing of a suitable program used by the Micro-controller, which performs the right

selection function to switch ON/OFF and check STATUS of the electrical devices. The hardware or

circuit is clearly divided into some major divisions, which are:

1. The Dual Tone Multi Frequency (DTMF) Signaling (HT9170B)

2. The Micro-controller (PIC18F4550)

3. BCD Decade converter (4028B)

4. The Driver and Switching state

5. The Circuit Power Supply

**Информатика и вычислительная техника. Текст 4.**

**4.2 BLOCK DIAGRAM**

The block diagram (Figure 1) shows the flow of communication between the hardware devices but does

not specify how the components communicate. The operator uses the transmitting mobile phone to call

the phone number of the receiving mobile phone this operation incurs variable cost since the use of the

service provider which differ according to the network provider involved, immediately the receiving

mobile phone receives the signal it sends it to the DTMF which operates in binary form, the binary output

of the DTMF is then sent to the decade converter which converts the binary output of the DTMF into a

form that the micro-controller can use. This enables multiple devices to be ON/OFF and their STATUS

can be checked at a time as determined by the user. The driver is used to drive the relays at the switching

state to switch ON/OFF the load. More on the operation of this work is discussed in the subsequent

sections below.

***Figure 1*** *The operational block diagram*

**4.2.1 Transmitting Mobile Station**

The naming convention “Transmitting Mobile Station” has been chosen for the Mobile phone with the

person that intends to control one or more devices at a remote location. The person who wants to switch

ON/OFF and get STATUS of any device at the remote location dials the number of the Remote Station.

The call to the Mobile Station can be via any Network Provider and their tariffs apply.

**4.2.2 Receiving Mobile Station (Base Station)**

The naming convention used for the phone that is in the remote location, attached to the circuitry is

“Receiving Mobile Station”. In this design, we take advantage of the Automatic Answer that is activated

with the insertion of an Earphone. The mobile phone on the receiver side picks up the phone

automatically after 5 seconds (timing can be specified), and then makes the tones available to the DTMF

tone decoder IC through the headphone jack of the phone. This can be used with any model of mobile

phone the only major challenge is that the pin connections of the earphones may differ and so the right

earphone must be used.

**4.2.3 DTMF Decoder (HT9170D)**

The DTMF decoder decodes DTMF signals which are audible sound that can be heard when the keys are

depressed on the telephone keypad. The DTMF decoder converts the received tones to their respective

binary values and then outputs them. Its internal architecture consists of a band split filter section which

separates the low and the high tone of the received tone pair, followed by a digital decode(counting)

section which verifies both the frequency and duration of the received tones before passing resultant 4-bit

code to the output bus.

**Информатика и вычислительная техника. Текст 5.**

The IC HT9170D usually has its pin out connection as shown in the Figure 4. This connection is the

standard which the design for this work adhered to in all specifications.

*Fig4: Drawing of the pin connection of the DTMF*

**4.2.4 BCD-to- Decimal Decoder (HEF4028B IC)**

The BCD Decade Converter (HEF4028B IC) is a 4-bit BCD to decimal decoder. The outputs are fully

buffered for best performance. When used as a BCD to decimal decoder a 1-2-4-8 BCD code applied to

inputs A0 to A3 causes the selected output to be HIGH while the other nine outputs will be LOW. The

4028 converter decodes a 4-bit BCD code from the DTMF to a decimal which only allows for one output

to be high at a time while the others low. As a BCD to decade converter, it will only respond to input

value from 0 to 9. The Figure 5 shows the Decade converter and the pin connection.

*Figure 5 BCD Decade converter (4028B) and pin connection.*

**4.2.5 Micro-Controller (PIC18F4550)**

The micro-controller is a microprocessor with provisions for input and output embedded in it. It consists

of timers, Analog to Digital Converters (ADCs), Universal Synchronous Asynchronous Receiver

Transmitter (USART), etc. It is an 8-bit microcontroller with flash program memory and Electrically

Erasable Programmable Read Only Memory (EEPROM), it contains 83-instructions which includes byteoperations, bits-operations and branching. It has five 8-bits ports which can be bit-wise or byte-wise

addressed. The pin connection of the PIC18F4550 is shown in Figure 6.

***Figure 6****: The pin connection of the Micro-controller (PIC18F4550)*

The three major features of the design as previously stated are:

1. Receives instructions on pin 2,3,4,5 and 33, decodes them to give device address and command, then

sends corresponding signals to the driver of the power circuit.

2. Ensures dual independent operation action – device ON or OFF.

3. Provides a feedback STATUS of any device under control whether ON or OFF.

The design parameters and steps are outlined as follows:

1. Read and store received key values in a First-In-First-Out (FIFO) buffer

2. All commands ends with key “5” to execute the last four digits stored in the FIFO buffer.

3. Decode the first three digits to device address and the fourth digit to a command to be executed.

**4.2.5.1 Design for switch ON, OFF and STATUS**

For individual control of the devices, three digits address are allocated to them. A forth digit is added to

determine which command is to be executed on the device. Then, the system uses a 5-digit instruction

code as shown below in the Figure 7:

*Figure 7: Instruction code format for a device*