R09114 - MOBILE CONTROLLED SMART DEVICE FOR MULTIPLE DEVICE REGULATION

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ABSTRACT

Engineering is all about exploring our environment to its maximum and the application of such observations in improving the standards of living. This paper would provide the engineering graduates a better insight into the utilities of mobile communication and would help them to study its application in regulating any device from any location in the world. It makes use of the very basic fundamentals of electronics and communication engineering, the dual tone multi-frequency (DTMF) receiver that is interfaced with the ISP microcontroller 89c51RD2, to regulate any device using electronic relays. The greatest advantage of the system is it is password protected and it uses only a serial port for its programming and so would help the engineering graduates to make their own device regulating system without much hassle.

Keywords: Dual Tone Multi Frequency, In-System Programmer, SPDT Relay.

1. Introduction

The advancement of technology and rise in economy of the country has also brought with it, a daily life of stress and overloading of work. This paper discusses one such application of wireless communication that would not only help in making our lives hassle free but also assist students if the technical field grasp the fundamentals of mobile communication as well is microcontrollers in a better way, other than the conventional classroom study.

The paper includes the dual tone multi-frequency circuit, which acts as a receiver for the frequency sent through mobile communication. The frequencies received by the mobile phone at the receiver end our converted into digital form using the DTMF IC. This digital output is provided as an input to the controller, which decides, through programming, which relay on the relay card is to be switched on. Accordingly, the device connected to the corresponding relay switches on and off. Of course, there are several interfacing issues, which have been thoroughly discussed and taken care of.

The DTMF circuit gets its input from the mobile phone, which acts as the receiver. The input is provided by the headpiece, which is connected to the input pin of the IC. The frequencies of a particular digit on the phone are converted into their corresponding binary numbers, in the form of 1's and 0's, which is represented by a HIGH voltage and a LOW voltage, respectively. This is produced at the output of the DTMF card.

This output produced is given to the microcontroller, which is an in-system programmable (ISP), which means there is no requirement of the programmer. Now, that is advantageous as the cost of the setup is reduced. The ISP used, is programmed using RS-232 protocol. It can use the serial port of the computer to program our controller. Also this facility is ensured as we are using a reprogrammable microcontroller, so that we can change the codes for controlling each device as and when desired. Now, since the controller works on a very low voltage and, the output obtained as a HGH or LOW, lies in the same low voltage range, the connected device has to be driven using a RELAY CARD. It consists of relays, output of which are connected to the device, which has to be controlled. So now the output obtained at the controller pins is amplified and it drives the relay, which in turn drives the device ON and OFF.

In the fast moving world as of today, our wisdom lies in exploring new ways to handle tasks which are of less importance and save time and money both. By

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using the above device, we can operate typically any appliance, from any part of the world. This device finds application in vast areas such as our homes, offices, etc. it also helps to study the frequency modulation and concepts like FSK in electronics and communication trade. Hence, the importance of this paper lies in the exploring the various platforms in which it finds its applications.

2. Block Diagram

The functional block diagram of the system is described below.

It shows the three basic blocks of the system along with the input and the output. The input is through the headpiece of the mobile phone kept as the receiver phone. One of the wires of the input is at the common ground with the battery, while the other is connected at the input pin of the DTMF IC.

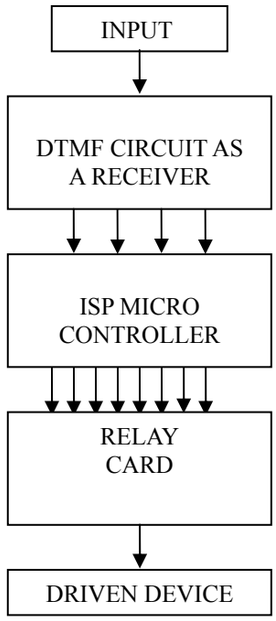

Fig 1 Functional block diagram

One of the wires of the input is at the common ground with the battery, while the other is connected at the input pin of the DTMF IC. It provides a 4-bit output, which is given to the controller. The controller program converts it into an 8-bit output such that only one output pin is enabled with a particular combination of the input bits.

The output of the ISP controller is provided at the input of the relay card, which drives the devices connected to it. The electronic relays switch ON when they receive a HIGH voltage, and vice versa. This way the device is operated.

3. DTMF Receiver

Dual-Tone Multi-Frequency (DTMF) is perhaps the most widely known method of Multi Frequency Shift Keying (MSFK) data transmission technique. DTMF was developed by Bell Labs to be used in the telephone system. Most telephones today uses DTMF dialing (or "tone" dialing). The DTMF standards define the overlaying of two pure sinusoidal waves by additive combination.

$$x(t) = A \cos(\varpi_1 t) + B \cos(\varpi_h t + \varphi) \quad (1)$$

Where ϖ_l and ϖ_h are the low and high frequencies of the sine waves being used, A and B are the amplitude of the signals and φ is the initial phase shifts [8].

DTMF provides low power dissipation and high reliability. The MT8870C, DTMF transceiver employs a microprocessor interface that allows precise control of transmitter and receiver functions. By collecting data at specific time intervals and sending it to the controller to take decisions is used to turn on or off a switch or control unit. Such information transfers hardly sums up to a few bytes and hence low data rates would suffice for such implementations [1].

The receiver is a dual tone multi frequency circuit which receives a particular frequency and converts it into the corresponding 4-bit binary digit which is represented by the HIGH and LOW voltage. It consists of a bandsplit filter, which separates the high and low group tones, followed by a digital counter which verifies the frequency and duration of the received tones before passing the corresponding code to the output bus. Both these sections are incorporated in the form of an integrated circuit (IC) MT8870 [4].

The separation of the low-group and high group tones is achieved by applying the DTMF signal to the inputs of the sixth-order switched capacitor bandpass filters, the bandwidths of which correspond to the low and high group frequencies. The filter portion consists of notches at 350 and 440 Hz for exceptional dial tone rejection. Each filter output is followed by a single order switched capacitor filter which smoothes the signal prior to limiting. Limiting is performed by high-gain comparators, which are provided with hysteresis to

prevent detection of unwanted low-level signals.

A decoder that uses digital counting techniques to detect and decode all 16 DTMF tone-pairs into a 4- bit code follows the filter. When the detector recognizes the presence of two valid tones (this is referred to as the "signal condition" in some industry specifications) the "Early Steering" (ESt) output will go to an active state. Any subsequent loss of signal condition will cause ESt to assume an inactive state.

Before registration of a decoded tone pair, the receiver checks for a valid signal duration (referred to as character recognition condition). This check is performed by an external RC time constant driven by ESt.

The provided signal condition is maintained for a valid period, Vc reaches the threshold of the steering logic to register the tone pair, latching its corresponding 4-bit code into the output latch. The contents of the output latch are made available on the 4-bit output bus by raising the three state control input (TOE) to logic HIGH.

Each of the 16 symbols is assigned a particular 4-bit code, which is obtained at the output of the circuit and can be verified by placing LED's at the output. They glow when they receive a HIGH.

Table1. Functional Decode Table

Digit	TOE	INH	Est	Q4	Q3	Q2	Q1
Any	L	X	H	Z	Z	Z	Z
1	H	X	H	0	0	0	1
2	H	X	H	0	0	1	0
3	H	X	H	0	0	1	1
4	H	X	H	0	1	0	0
5	H	X	H	0	1	0	1
6	H	X	H	0	1	1	0
7	H	X	H	0	1	1	1
8	H	X	H	1	0	0	0
9	H	X	H	1	0	0	1
0	H	X	H	1	0	1	0
*	H	X	H	1	0	1	1
#	H	X	H	1	1	0	0
A	H	L	H	1	1	0	1
B	H	L	H	1	1	1	0
C	H	L	H	1	1	1	1
D	H	L	H	0	0	0	0
A	H	H	L	Undetected, the output code will remain the same as the previous code.			
B	H	H	L				
C	H	H	L				
D	H	H	L				

L=Logic low, H=Logic High, Z= High Impedance, X= Don't Care.

The internal clock is completed with the addition of an external 3.579545 MHz, which is connected at the required pin.

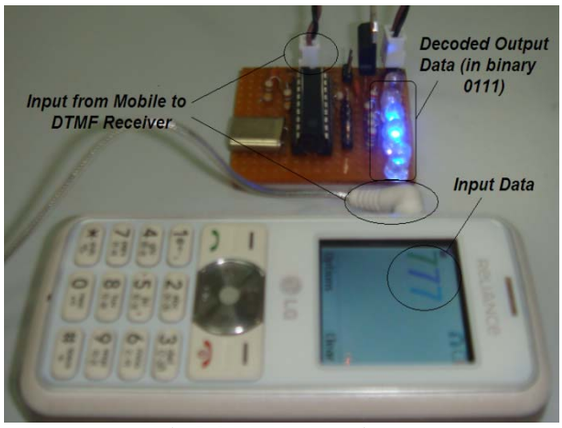

Fig 2 A DTMF Receiver

3.1 Differential Input Configuration

At the input of the IC, there is a differential-input operational amplifier as well as a bias source (VRef), which is used to bias the inputs at, mid-rail.

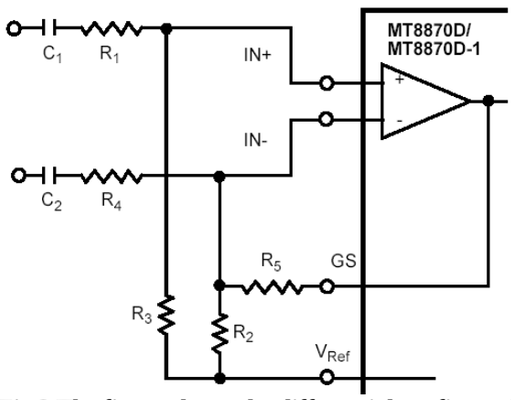

Fig 3 The figure shows the differential configuration, which permits the adjustment of gain with the feedback resistor R5.

R3= (R2 R5)/(R2 + R5) (2)

Voltage Gain (Av diff) =R5/R1 (3)

Input Impedance
(Zin diff) = 2√((R1^2)+((1/2∏fC)^2)) (4)

So we can conclude from the above equations that there is a provision for connection of a feedback

resistor to the op-amp output (GS) for adjustment of gain. In a single-ended configuration, the input pins are connected with the op-amp connected for unity gain and VRef biasing the input at 1/2VDD.

3.2 Input Signal Ground

The circuit designed above is a single ended input configuration, which may not work if the grounding is not done properly. The effect on the circuit of an efficient grounding system has a major impact on its proper working. The preferred scheme for two-wire single-ended input connections is to take the ground return directly to the reference point of the input amplifier. As we know that the first stage of the DTMF IC is an amplifier, this grounding technique would prove best for its proper functioning.

The reference point on a single-ended input is not always easy to find. We have to look for the point from which the input voltage must be developed in order for the amplifier gain to act on it alone. In this way, no extra signals are introduced in series with the wanted signal by means of common impedance.

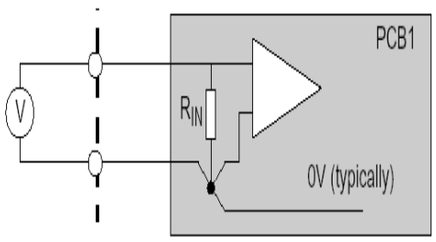

Fig 4 Diagrammatic representation of grounding technique.

4. ISP Microcontroller

The In- System Programmer we are using is an 8051 series controller. It is 89C51RD2RFN, by NXP.

The most advantageous of its properties is its capability of being programmed using a serial or a parallel port. Hence, it provides a huge flexibility in its operation. We can use the device as desired for various operations by changing the program stored in it and using a serial port to program the controller.

The controller has three 8-bit bi-directional input/output ports that are equally well used for transmission and receiving of data during programming. The pins are multiplexed. The programming interface accepts either a high-voltage (12-volt) or a low-voltage (VCC) program enable signal. The low-voltage programming mode provides a convenient way to program the 89C51 inside the user's system, while the high-voltage programming mode is compatible with conventional third party Flash or EPROM programmers.

Every code byte in the Flash array can be written and using the appropriate combination of control signals can erase the entire array. The write operation cycle is self timed and once initiated, will automatically time itself to completion.

4.1 Programming the Microcontroller

For successfully giving the directions to the controller for accomplishing a task, we need to program it. To program the 89C51, we take the following steps.

1. Input the desired memory location on the address lines.
2. Input the appropriate data byte on the data lines.
3. Activate the correct combination of control signals.
4. Raise EA/VPP to 12V for the high-voltage programming mode.
5. Pulse ALE/PROG once to program a byte in the Flash array or the lock bits. The byte-write cycle is self-timed and typically takes no more than 1.5 ms.

Repeat steps 1 through 5, changing the address and data for the entire array or until the end of the object file is reached.

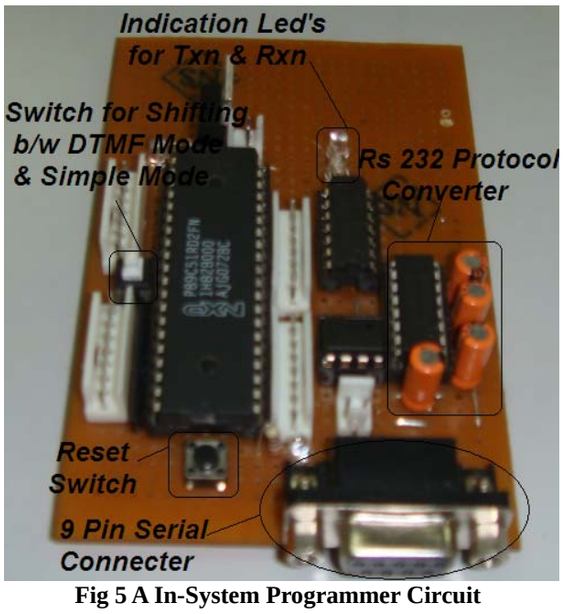

Fig 5 A In-System Programmer Circuit

The functionality of the system depends mainly on the program that is stored in the controller. Here, the controller is programmed for enabling a particular output

pin when it receives an input signal of a particular bit code.

The program logic is to select particular codes as reset and use the other pins to control the ON and OFF of corresponding relays. The system is reset or the device is turned off when the reset frequency is received. Here, the code for digit 4(1010) and 5(1011) has been used as reset.

Now when the input at Port1 is either 0010(2H) or 0011(3H) then the output would be such as to enable tone of the pins of the output ports, hence switching ON the relay connected to the port, in turn, driving the devices ON.

5. Relay Card

A relay is an electrical switch that opens and closes under the control of another electrical circuit. In the original form, the switch is operated by an electromagnet to open or close one or many sets of contacts. Because a relay is able to control an output circuit of higher power than the input circuit, it can be considered to be, in a broad sense, a form of an electrical amplifier

When a current flows through the coil, the resulting magnetic field attracts an armature that is mechanically linked to a moving contact. The movement either makes or breaks a connection with a fixed contact. When the current to the coil is switched off, the armature is returned by a force approximately half as strong as the magnetic force to its relaxed position.

Usually this is a spring, but gravity is also used commonly in industrial motor starters. Most relays are manufactured to operate quickly. In a low voltage application, this is to reduce noise. In a high voltage or high current application, this is to reduce arcing.

The relay being used here is a BONA series SPDT, 6V relay with a 2A current rating. . SPDT stands for Single Pole Double Throw. In this type of relay there is a common terminal connects to either of two others. Including two for the coil, such a relay has five terminals in total. By analogy with the functions of the original electromagnetic device, a solid-state relay is made with a thyristor or other solid-state switching device. To achieve electrical isolation an optocoupler can be used which is a light-emitting diode (LED) coupled with a photo transistor.

If the coil is energized with DC, a diode is frequently installed across the coil, to dissipate the energy from the collapsing magnetic field at deactivation, which would otherwise generate a spike of voltage and might cause damage to circuit components. Some automotive relays already include that diode inside the relay case. Alternatively a contact protection network, consisting of a capacitor and resistor in series, may absorb the surge. If the coil is designed to be energized with AC, a small copper ring can be crimped to the end of the solenoid. This "shading ring" creates a small out-of-phase current, which increases the minimum pull on the armature during the AC cycle.

The current rating at the output ports of the microcontroller is not sufficient to drive a relay for this we need to make the output ports compatible for driving the relay, which can be done by using integrated circuit (IC) ULN2803. It contains eight darlington transistors with common emitters and integral suppression diodes for inductive loads. Each darlington features a peak load current rating of 600mA (500mA continuous) and can withstand at least 50V in the off state. Outputs can be paralleled for higher current capabilities [4].

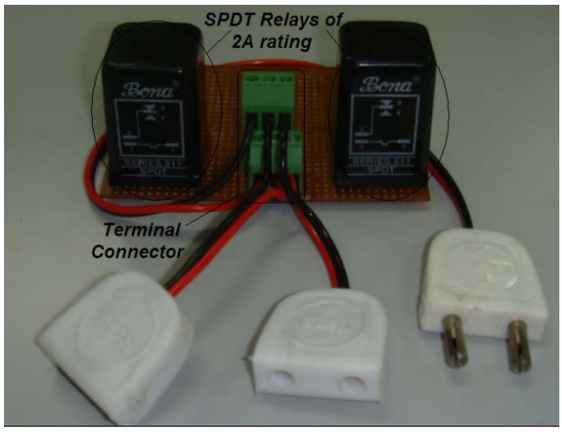

Fig 6 A two relay, Relay Card used to drive a device

For practical examination of the paper, we have used two relays to form a relay card, which has a plug and play output that can be connected to any device of the available specifications.

6. Flow Chart

In today's world, protection should be kept in mind while designing a system, so that authorization to the valid users only will be provided to avoid the miss use of the system. For the same a password protected option is added to the system to make it capable of the making decisions by its own to which it should allow to access it.

This thing is explained with the help of flow chart how the brain (microcontroller) is making the decisions to choose the authorized user as well as how

the respective relays are switched ON and OFF with respect to the predefined keys.

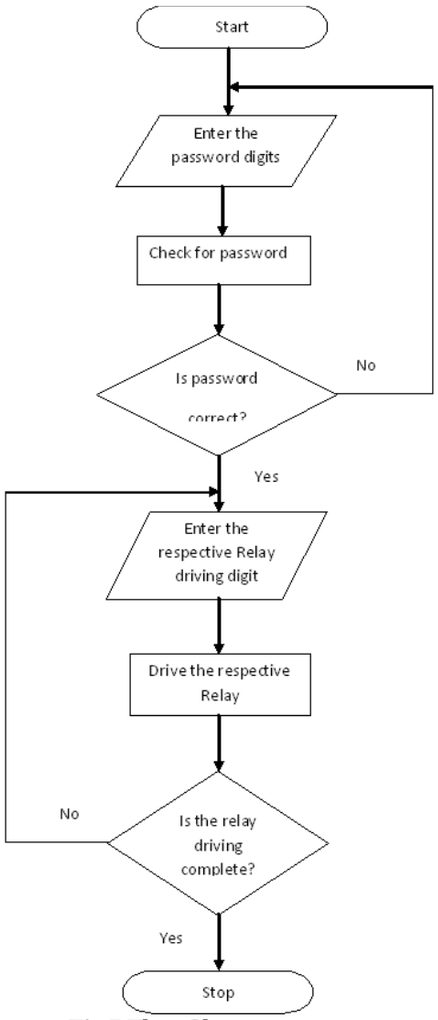

Fig 7 Flow Chart

7. Applications

New applications emerge that require portable, connected, and low-cost systems, capable of dealing with a multitude of tasks of high complexity.

The new applications impose severe constraints on performance, cost, and power dissipation of contemporary and future circuits and systems. To meet such specifications, innovative solutions are required at all levels of system design abstraction. In addition, understanding the various diverse technologies that co-exist in modern highly integrated systems becomes an important tool to achieve true system-wide optimization [2].

Keeping this in mind, this paper is an attempt not only to establish the engineering values in students and to enable them to get a better insight into the implementation of the engineering concepts but also to bring out an innovative design that can be utilized to make our day-to-day life comfortable.

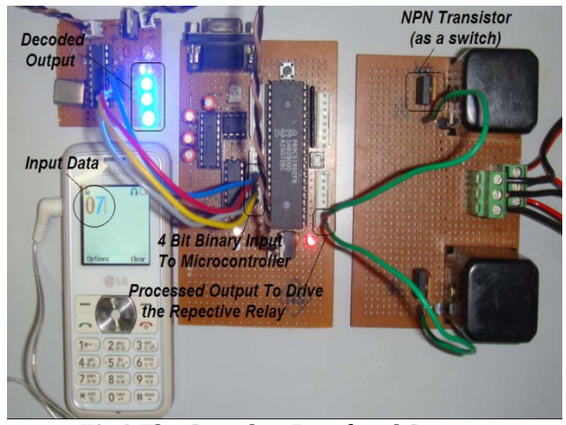

Fig 8 The Complete Interfaced System

Engineering graduates need to be imbued with the knowledge of electronic design, analysis and software development. Furthermore, they have to be familiar with electronic components such as receivers, motors, logic devices, microprocessors and microcontrollers and many others. This paper reports a project based learning initiative where different circuit designs are interfaced with each other to bring out valuable products for research, education and entertainment purposes [1].

This interface consumes low power and works on high frequency, and hence is economical and cost effective. It finds application in the commercial industry as well as the education field.

8. Disadvantage

As the two sides of a coin the device has its own disadvantages. Major one of them being that to operate the device you have to make a call on the telecom receiver kept at that place. This adds to the cost of operation that may not suit to some people, but then again this drawback does not hold a stronger ground as compared to the facilities provided by the device.

Furthermore, the telecom industry has itself

given us a good solution to this problem by lowering down the call rate to a very comfortable level.

In these days personal computers are mostly replaced by the laptops, and for the programming it uses the serial port, which is hardly available in today's laptop.

9. Conclusion

Base on the analysis, following conclusions was drawn:

1. We can perform enormous operations and research work by bringing together various circuits and providing them with decision-making capability by interfacing it with microcontrollers can result into development of new products.
2. There is a huge difference between theoretical study and practical implementation of concepts and this paper would help to bridge the gulf between the domains.
3. We can use the above circuit for the automation purposes of homes and even for the industrial based applications as well by interfacing it with PLC's.
4. Unregulated power supply can result into improper decoded binary data by the DTMF module, since proper regulated power supply is advisable for the DTMF module to achieve the better results.

10. References

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