Abstract

The human mind always needs information of interest to control system of his/her choice. In the age of electronic systems, it is important to be able to control and acquire information from everywhere. Although many methods to remotely control systems have been devised, the methods have the problems such as the need for special devices and software to control the system. This paper suggests a method of controlling devices using DTMF (Dual Tone Multi Frequency) tone generated when the user pushes mobile phone keypad buttons or when connected to remote mobile system. This system suggested consists of mobile phones normally registered in communication service and a system that can receive a call from another phone; also the mobile phone can be selected irrespective of the mobile phone model and mobile phone carrier. Here, we are developing a system with a PIC 16F877A Micro controller to control four relays that act as switch for four separate devices.
Circuit Explanation

The whole project can be divided into four sections

- Power Supply Unit
- DTMF Decoder Unit
- Microcontroller Unit
- Relay Unit

4.1 Power Supply Unit

The working of each unit needs a proper power supply. We require 5V DC and 12V DC supplies from the normal 230V, 50Hz AC supply.

4.1.1 Introduction

Starting with an AC voltage, a steady dc voltage is obtained by rectifying the ac voltage, then filtering to a dc level, and finally, regulating to obtain a desired fixed dc voltage. The regulation is usually obtained from an IC voltage regulator unit, which takes a dc voltage and provides a somewhat lower dc voltage, which remains the same even if the input dc voltage varies, or the output load connected to the dc voltage changes.

The AC voltage, typically 230V rms, is connected to a transformer, which steps that ac voltage down to the level for the desired dc output. A diode rectifier then provides a full-wave rectified voltage that is initially filtered by a simple capacitor filter to produce a dc voltage. This resulting dc voltage usually has some ripple or ac voltage variation. A regulator circuit can use this dc input to provide a dc voltage that not only has much less ripple voltage but also remains the same dc value even if the input dc voltage varies somewhat, or the load connected to the output dc voltage changes. This voltage regulation is usually obtained by using voltage regulator IC units.

4.1.2 Working Principle

4.1.2.1 Transformer

The potential transformer will step down the power supply voltage (0-230V) to (0-6V) level. Then the secondary of the potential transformer will be connected to the precision rectifier, which is constructed with the help of op amp. The advantages of using precision rectifier are it will give peak voltage output as DC; rest of the circuits will give only RMS output.

4.1.2.2 bridge rectifier

When four diodes are connected as shown in the circuit diagram, Fig 4.1, it is called as bridge rectifier. The input to the circuit is applied to the diagonally opposite
corners of the network, and the output is taken from the remaining two corners. Let us assume that the transformer is working properly and there is a positive potential, at point A and a negative potential at point B. The positive potential at point A will forward bias D3 and reverse bias D4. The negative potential at point B will forward bias D1 and reverse D2. At this time D3 and D1 are forward biased and will allow current to pass through them; D4 and D2 are reverse biased and will block current ow. One-half cycle later the polarity across the secondary of the transformer reverses, forward biasing D2 and D4 and reverse biasing D1 and D3. Since current flows through the load during both half cycles of the applied voltage, this bridge rectifier is a full-wave rectifier.

One advantage of a bridge rectifier over a conventional full-wave rectifier is that with a given transformer the bridge rectifier produces a voltage output that is nearly twice that of the conventional full-wave circuit.

4.1.2.3 Voltage Regulators

Voltage regulators comprise a class of widely used ICs. Regulator IC units contain the circuitry for reference source, comparator amplifier, control device, and overload protection all in a single IC. Although the internal construction of the IC is somewhat different from that described for discrete voltage regulator circuits, the external operation is much the same. IC units provide regulation of either a fixed positive voltage, a fixed negative voltage, or an adjustable set voltage. A power supply can be built using a transformer connected to the ac supply line to step the ac voltage to desired amplitude, then rectifying that ac voltage, filtering with a capacitor and RC filter, if desired, and finally regulating the dc voltage using an IC regulator. The regulators can be selected for operation with load currents from hundreds of milli amperes to tens of amperes, corresponding to power ratings from milli watts to tens of watts.

The fixed voltage regulator has an unregulated dc input voltage, Vi, applied to one input terminal, a regulated output dc voltage, Vo, from a second terminal, with the third terminal connected to ground. For a selected regulator, IC device specifications list a voltage range over which the input voltage can vary to maintain a regulated output voltage over a range of load current. The specifications also list the amount of output voltage change resulting from a change in load current (load regulation) or in input voltage (line regulation).

In The series 78 regulators provide fixed regulated voltages from 5V to 24 V shows how one such IC, a 7812, is connected to provide voltage regulation with output from this unit of +12VDC. An unregulated input voltage Vi is filtered by capacitor C1 and connected to the ICs IN terminal. The ICs OUT terminal provides a regulated +5V which is filtered by capacitor C2 (mostly for any high-frequency noise). The third IC terminal is connected to ground (GND). While the input voltage may vary over some permissible voltage range, and the output load may vary over some acceptable range, the output voltage remains constant within specified voltage variation limits. These limitations are spelled out in the manufacturers specification sheets.

Power Supplies Used
4.2 DTMF Decoder Unit

DTMF is a generic communication term for touch tone (a Registered Trademark of AT andT). DTMF is an example of a multi frequency shift keying (MFSK) system. The tones produced when dialing on the keypad on the phone could be used to represent the digits, and a separate tone is used for each digit. However, there is always a chance that a random sound will be on the same frequency which will trip up the system. It was suggested that if two tones were used to represent a digit, the likelihood of a false signal occurring is ruled out. This is the basis of using dual tone in DTMF communication. DTMF dialing uses a keypad with 12/16 buttons. Each key pressed on the phone generates two tones of specific frequencies, so a voice or a random signal cannot imitate the tones. One tone is generated from a high frequency group of tones and the other from low frequency group.

The frequencies generated on pressing different phone keys are shown in the Table.

Each row and column of the keypad corresponds to a certain tone and creates a specific frequency. Each button lies at the intersection of the two tones as shown in Table. When a button is pressed, both the row and column tones are generated by the telephone instrument. These two tones will be unique and different from tones of other keys. So, whenever we say that there is a low and high frequency associated with a button, it is actually the sum of two waves is transmitted.

This is a full DTMF receiver that integrates both band split filter and decoder functions into a single 18-pin DIP or SOIC package. Manufactured using state of the art CMOS process technology, the M-8870 offers low power consumption and precise data handling. Its filter section uses switched capacitor technology for both the low and high group filters and for dial tone rejection. Its decoder uses digital counting techniques to detect and decode all 16 DTMF tone pairs into 4 bit code external component count is minimized by provision of a on chip differential input amplifier, clock generator, and latched tri-state interface bus. Minimal external components required include a low cost 3.579545 MHz color burst crystal, a timing resistor, and timing capacitor. The new M-8870-02 provides a power down option which, when enabled, drops consumption too less than .5 mw. The 02 versions can also inhibit the decoding of the fourth column digits. DTMF is the generic name for pushbutton telephone signaling equivalent to the bell systems touch-tone. Dual tone multi frequency (DTMF) signaling is quickly replacing dial-pulse signaling in telephone banking or electronic mail systems, in which the user can select options from a menu by sending signals from a telephone.

4.2.1 DTMF Standards:

The DTMF tone-signaling standard is also known as touch tone or MFPB (Multi-frequency push button). Bell labs for use by ATand T in the dial-pulse-signaling standard developed
touch-tone. Each administration has defined its own DTMF specifications. They are all very similar to the CCITT standard, varying by small amounts in the guard bands allowed in frequency, power twist and talk-off. Two tones are used to generate a DTMF digit. One tone is chosen out of four row tones, and the other is chosen out of four column tones. Two of eight tones can be combined so as to generate sixteen different DTMF digits. Of these sixteen keys shown in the figure, twelve are the familiar keys of a touch-tone keypad and four are reserved for future uses.

### 4.2.2 Decoder Description

The decoder used is M-8870. M-8870 includes a band split filter that separates the high and low tones of the received pair, and a digital decoder that verifies both the frequency and duration of the received tones before parsing the resulting 4-bit code to the output bus. The M-8870 decoder uses a digital counting technique to determine the frequencies of the limited tones and to verify that they correspond to standard DTMF frequencies. A complex averaging algorithm is used to protect against tone simulation by extraneous signals (such as voice) while tolerating small frequency variations. The algorithm ensures an optimum combination of immunity to talk-off and tolerance to interfering signals (third tones) and noise. When the detector recognizes the simultaneous presence of two valid tones (known as signal condition), it raises the Early Steering flag (ES). Any subsequent loss of signal condition will cause ES to fall.

Before a decoded tone pair is registered, the receiver checks for valid signal duration (referred to as character recognition-condition). This check is performed by an external RC time constant driven by ES. Logic high on ES causes VC (block diagram) to rise as the capacitor discharges. Provided that signal condition is maintained (ES remains high) for the validation period (tGTF), VC reaches the threshold (VTSt) of the steering logic to register the tone pair, thus latching its corresponding 4-bit code (see DC Characteristics in Data Sheet) into the output latch. At this point, the GT output is activated and drives VC to VDD. GT continues to drive high as long as ES remains high. Finally, after a short delay to allow the output latch to settle, the delayed steering output flag (StD) goes high, signaling that a received tone pair has been registered. The contents of the output latch are made available on the 4-bit output bus by raising the three-state control input (OE) to logic high. The steering circuit works in reverse to validate the inter digit pause between signals. Thus, as well as rejecting signals too short to be considered valid, the receiver will tolerate signal interruptions (dropouts) too short to be considered a valid pause. This capability, together with the ability to select the steering time constants externally, allows the designer to tailor performance to meet a wide variety of system requirements.

### 4.2.3 Functional description

The M-8870 operating functions include a band split filter that separates the high and low tones of the received pair, and a digital decoder that verifies both the frequency and duration of the received tones before passing the resulting 4-bit code to the output bus.

### 4.2.3.1 Filter
The low and high group tones are separated by applying the dual tone signal to the inputs of two 9th order switched capacitor band pass filters with bandwidths that corresponds to the bands enclosing the low and high group tones. The filter also incorporates notches at 350 and 440Hz, providing excellent dial tone rejection. A single order switched capacitor section that smoothes the signals prior to limiting follows each filter output. High gain comparator provided with hysteresis to prevent detection of unwanted low-level signals and noise performs signal limiting. The comparator outputs provide full rail logic swings at the frequencies of the incoming tones.

4.2.3.2 Decoder

The M-8870 decoder uses a digital counting technique to determine the frequencies of the limited tones and to verify that they correspond to standard DTMF frequencies. Complex averaging algorithm is used to protect against tone simulation by extraneous signals while tolerating small frequency variations the algorithm ensures an optimal combination of immunity to talk o and tolerance to interfacing signals and noise. When the detector recognizes the simultaneous presence of two valid tones, it raises the early steering ag (EST). Any subsequent loss of signal condition will cause EST to fall.

4.2.3.3 DTMF Clock Circuit

The internal clock circuit is completed with the addition of a standard 3.579545 MHz color burst crystal. The crystal can be connected to a single M-8870 or to a series of M-8870s. a single crystal can be used to connect a series of M-8870 by coupling the oscillator output of each M-8870 through a 30pF capacitor to the oscillator input of the next M-8870.

4.2.3.4 differential Input Configuration

The input arrangement of the MT8870D provides a differential input operational amplifier as a bias source (VRef ) which is used to bias the inputs at mid-rail. Provision is made for the 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 as shown with the op-amp connected for unity gain and VRef biasing circuit the input at 1/2VDD.Gain adjustment is possible by changing the resistance value R5.

4.3 Microcontroller Unit

PIC16F874A/877A devices are available in 40-pin and 44-pin packages. The operating frequency of PIC 16F877A is DC-20MHz.it has 8K flash program memory, 368 bytes of data memory, and 256 bytes of EEPROM Data Memory. It has four input output ports and three timers. PIC 16F877A is available in 40- pin PDIP, 44- pin PLCC, 44-pin TQFP and 44-pinQFN packages. The PIC16F87XA devices have a 13-bit program counter capable of addressing an 8K word x 14 bit program memory space. The PIC16F876A/877A devices have 8K words x 14 bits of Flash program memory. The data memory is partitioned into multiple banks which contain the General Purpose Registers and the Special Function Registers. Bits RP1 (Status<6>) and RP0 (Status<5>) are the bank select
bits. Each bank extends up to 7Fh (128 bytes). The lower locations of each bank are reserved for the Special Function Registers. Above the Special Function Registers are General Purpose Registers, implemented as static RAM. All implemented banks contain Special Function Registers. Some frequently used Special Function Registers from one bank may be mirrored in another bank for code reduction and quicker access. The Status register of the PIC16F877A contains the arithmetic status of the ALU, the Reset status and the bank select bits for data memory. The Status register can be the destination for any instruction, as with any other register. The Program Counter (PC) is 13 bits wide. The low byte comes from the PCL register which is a readable and writable register. The upper bits (PC<12:8>) are not readable. The PIC16F87XA family has an 8-level deep x 13-bit wide hardware stack. The stack space is not part of either program or data space and the stack pointer is not Readable or writable. The PC is Pushed onto the stack.

4.4 Relay Unit

A relay is an electrically operated switch. Current owing through the coil of the relay creates a magnetic field which attracts a lever and changes the switch contacts. The coil current can be on or off so relays have two switch positions and they are double throw (changeover) switches. Relays allow one circuit to switch a second circuit which can be completely separate from the rst. For example a low voltage battery circuit can use a relay to switch a 230V AC mains circuit. There is no electrical connection inside the relay between the two circuits; the link is magnetic and mechanical.

The coil of a relay passes a relatively large current, typically 30mA for a 12V relay, but it can be as much as 100mA for relays designed to operate from lower voltages. Most ICs (chips) cannot provide this current and a transistor is usually used to amplify the small IC current to the larger value required for the relay coil. The maximum output current for the popular 555 timer IC is 200mA so these devices can supply relay coils directly without amplification.

Relays are usually SPDT or DPDT but they can have many more sets of switch contacts, for example relays with 4 sets of changeover contacts are readily available. Most relays are designed for PCB mounting but you can solder wires directly to the pins providing you take care to avoid melting the plastic case of the relay.

The relay's switch connections are usually labeled COM, NC and NO:

- **COM = Common**, always connect to this, it is the moving part of the switch.
- **NC = Normally Closed**, COM is connected to this when the relay coil is off.
- **NO = Normally Open**, COM is connected to this when the relay coil is on.
4.4.1 Circuit Description

This circuit is designed to control the load. The load may be motor or any other load. The load is turned ON and OFF through relay. The relay ON and OFF is controlled by the pair of switching transistors (BC 547). The relay is connected in the Q2 transistor collector terminal. A Relay is nothing but electromagnetic switching device which consists of three pins. They are Common, Normally close (NC) and normally open (NO).

The relay common pin is connected to supply voltage. The normally open (NO) pin connected to load. When high pulse signal is given to base of the Q1 transistors, the transistor is conducting and shorts the collector and emitter terminal and zero signals is given to base of the Q2 transistor. So the relay is turned OFF state.

When low pulse is given to base of transistor Q1 transistor, the transistor is turned OFF. Now 12v is given to base of Q2 transistor so the transistor is conducting and relay is turned ON. Hence the common terminal and NO terminal of relay are shorted. Now load gets the supply voltage through relay.

4.4.2 Snubber Circuit

Snubbers are frequently used in electrical systems with an inductive load where the sudden interruption of current often leads to a sharp rise in voltage across the device creating the interruption. This sharp rise in voltage is a transient and can damage and lead to failure of the controlling device. A spark is likely to be generated (arching), which can cause electromagnetic interference in other circuits. The snubber prevents this undesired voltage by conducting transient current around the device.

Implementation Details

The circuit diagram for DTMF based remote control system was designed with MT8870 decoder and PIC 16F877A micro controller. First of all the entire circuit diagram was divided into three sub divisions decoder unit, micro controller unit and relay unit. After collecting all the components and proper verification, the decoder circuit was wired up on the breadboard. The input DTMF signal was connected to the DTMF decoder through a head set and simultaneously we could see the equivalent four bit binary coded output at the LED connected to it. We also verified that different input combinations at the input terminal could also produce the desired output. Then we started to test the working of relay unit with a breadboard model. Four 12V relays are used. The triggering of the relay for high and low logic input levels were checked and also verified that relay units can work in synchronization with the micro controller circuit. The main part left out was programming of PIC controller. We started studying micro C language with the help
of friends. At first the algorithm for our application was framed, and the corresponding program was written in micro C and simulated using PIC simulator. Then the program hex code was burned into the controller IC and verified the output. The output of the controller was seen to be delayed and the program was modified so as to overcome this difficulty. Converting these breadboard models into PCB was a great challenge for us. We started thinking about doing PCB fabrication ourselves rather than giving the task to experts in this field. We made use of instructions given by our guide and coordinator on PCB fabrication. The laboratory status explained us about the procedure of PCB fabrication. We designed the PCB layout of each circuit diagrams that are decoder, controller, relay and power supply unit even without using any software. The copper clad sheet was cleaned and the designed PCB layout was drown on it with permanent marker. Then it was put into ferric chloride solution for $\frac{1}{2}$ an hour. Then it was taken out from the solution and seen that the portion which are not touched by the marker was etched out. The holes were drilled at appropriate points by using the drilling machine in the mechanical workshop. Then the components were soldered on it and the final PCB was checked for proper working and found correct.

**Working**

In this project there are two mobile phones, one is used as remote and other is used as receiver. Using both of these mobile phones we can control the devices. Using remote mobile phone we can achieve control from distant places. From remote mobile phone user make a call to receiver mobile phone. The receiver phone will automatically attend that call. Then we can control devices using eight keys (key 1 to key 8)of the remote mobile phone. For the demonstration of the project, we used two lights and two fans as devices. The key"1" and key"2" are reserved for controlling first light. We when key 1 is pressed the corresponding DTMF tone is generated at receiver phone and is fed to DTMF decoder which generate four bit binary code of the number "1" which is" 0001" as shown in table. This code is processed by the controller and controls the rst relay leads rst device to turn ON. When key 2 is pressed, the earlier steps will repeated and finally turn OFF the first light. Then the key 3 is for switch ON first fan and key 4 is for switch O the first fan. Similarly key 5 and 6 are for controlling the second fan, key 7 and 8 are for controlling second light. The above operation performance is summerised in the table.

**Result**

Our aim was to control the home appliances remotely. To achieve this aim, we designed the circuit diagram as per our needs. Then selected each and every components as per the design. The project is completed successfully as our aim demands. The final working of the project is tested and verified. The figure shows the final model and status of the system for various commands from the user.
Conclusion

The DTMF signal generated by the mobile phone was successfully decoded. Using the decoded output and use of proper program for the microcontroller the system was used to control output of four relays. The output has been shown by an LED blink. The system is immune to external noise and ring tones of the receiver mobiles. There is a finite probability that the system turns ON and OFF due to ambient noises like voice, sound arising from door latches etc. But this effect has not practically wounded the working of the system as of time.

This project presents a method to control the domestic system using the DTMF tone generated by transmitting telephone instrument when the user pushes the keypad buttons of the mobile phone connected to the system. This control method uses the commercial mobile communication networks as the path of data transmission. This enables the user to control the system continuously by sending the mobile DTMF tone. The system has been implemented in the 2G communication network, so video data cannot be obtained.

Future Work

This product is aimed toward average consumers who wish to control household appliances remotely from their cell phones provided that the appliances are electrically controllable. Example of feasible appliances and applications under consideration include; enable/disable security systems, fans, lights, kitchen appliances, and heating/ventilation/air conditioning system. Right now we have designed the project for control of two devices but it can be designed for more number of devices. The system can be designed to have another mode of control i.e., by the use of SMS. Furthermore this system can be implemented in industrial applications where required personals can be notified of the status, providing the user to override under necessary circumstances. The use of a GSM modem can also incorporate additional security system. It can be further expanded with a voice interactive system facility. A feedback system can also be included which provides the state of a device (whether it is on/o) to the remote user. The system can also be designed over 3G and 4G networks which will be able to incorporate many additional features of feedback, video control and much more.

APPLICATIONS
Combinational Lock
Home Security System
Mobile/ Wireless Robot Control
Wireless radio control
Remote switches
Reporting accidental conditions