# "REMOTE CONTROL OF DEVICES USING CELLPHONES"

*Report of the project carried out at Siddaganga Institute of Technology, Tumkur*

*submitted in partial fulfillment of the requirements for the award of degree*

*Of*

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*In*

ELECTRONICS AND COMMUNICATION

*Of*

VISVESWARIAH TECHNOLOGICAL UNIVERSITY, BELGAUM

*Submitted by*


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## SIDDAGANGA INSTITUTE OF TECHNOLOGY

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**DEPARTMENT OF ELECTRONICS & COMMUNICATION**

# Certificate

*Certified that the project work entitled*

## “REMOTE CONTROL OF DEVICES USING CELLPHONES”

*is a bonafide work carried out by* SHUHAB-U-TARIQ *in partial fulfillment for the award of degree of Bachelor of Engineering in Electronics and Communication of Visveswaraiah Technological University, Belgaum during the academic year 2006-2007. It is certified that all the corrections/suggestions indicated for internal assessment have been incorporated in the report deposited in the department library. The project report has been approved as it satisfies the academic requirements in respect of project work prescribed for the Bachelor of Engineering degree.*

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# ABSTRACT

Telephone is one of the most common and useful consumer electronic gadgets in the world today. It incorporates both Communication & Digital Electronics fields.

As the device is so much popular and part of everyday activities, many add-on circuits are constructed to make it still a more feature rich instrument, and one such add-on feature is this system which allows user to switch ON/OFF loads from remote end. It finds applications in homes, offices and even in industries.

It is a telephone operated device control circuit which enables switching ‘ON’ and ‘OFF’ of appliances through telephone lines. It can be used to switch appliances from any distance, overcoming the limited range of infra-red and radio remote control.

Basically this system performs the following operations:

- It senses the “real” telephone ring.
- Automatically switches the call to this system, after predefined rings.
- Switches ON/OFF the load depends upon the key pressed by the caller.

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# CHAPTER 1

# INTRODUCTION

The system is connected to the telephone lines in parallel to the user's telephone-set. Whenever the call comes, it detects it and starts counting the number of rings. If the rings are equal to pre-defined number, say five, it simply means user is not present and the system has to attend the call. So the system switches the call to this unit, so that it can detect the commands send by caller. Depends upon the key pressed by the caller, the respective load goes ON/OFF or latches.

## 1.1 Block Diagram and its Explanation

The Block Diagram, as shown in Fig 1.1, of this system is explained in these blocks: RC Coupling, Ring Detector, Schmitt Trigger, Ring Counter, Switching Unit, DTMF Decoder, BCD to Binary Converter, Latch Unit, Driver Unit and finally Power Supply. Let us see the details of each part in the following explanation.

### 1.1.1 RC NETWORK:

This is nothing but a resistor, capacitor & diode combination across the Telephone line to match the impedance & reduce input voltage to required level.

### 1.1.2 RING DETECTOR:

The ringing signal of 75 Vrms, 15 Hz from the Telephone line is simultaneously given to Telephone Set and this Ring Detector block. This block identifies that the call is coming to the Telephone Set, and thus alerts this system. The output of this block is given to Schmitt Trigger for conversion.

### 1.1.3 SCHMITT TRIGGER:

This block converts ring signal [which is AC voltage of about 75Vrms, with ringing tone duration of 0.4 sec ON – 0.2 OFF] into digital pulses for further processing. This is required as rest of the system needs digital pulses for manipulation and taking appropriate decisions. The output of this block is given to Ring Counter.

### 1.1.4 RING COUNTER:

This block counts the number of ringing pulses, so that after predefined rings [say 5 rings] this system must lift the cradle automatically to attend the incoming call. The output of this block is given to Switching Unit for decision making step.

### 1.1.5 SWITCHING UNIT:

This block takes the information, the number of rings, from Ring Counter block and decides whether to attend the call automatically or leave it for humans hanging around Telephone Set. The number of rings crosses the predefined rings [say 5 rings] this block concludes that there are NO humans to attend the call, hence lifts the call for itself.

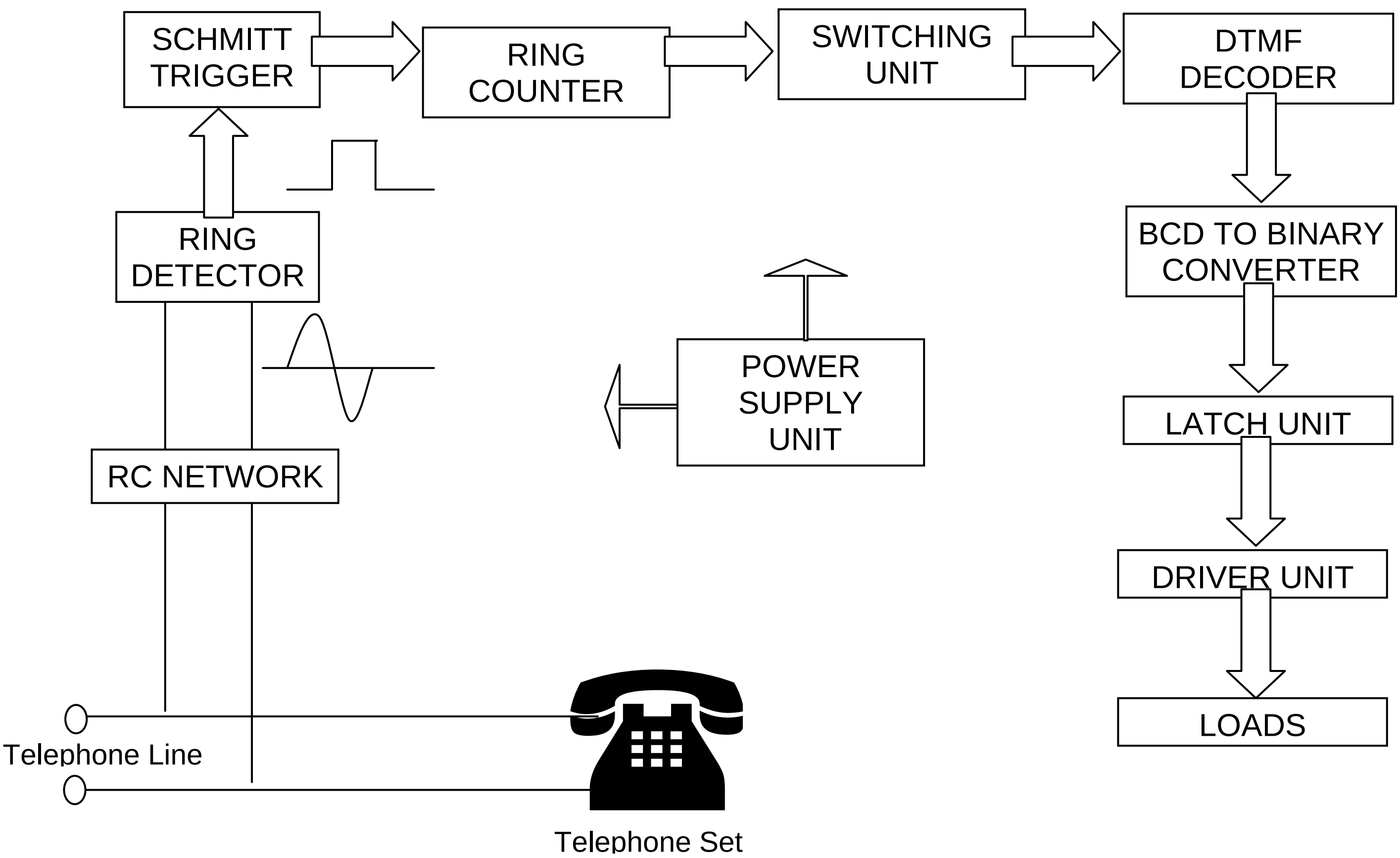



Fig 1.1 BLOCK DIAGRAM OF TELEREMOTE

### 1.1.6 DTMF DECODER:

This block acts as Demultiplexer and receives the command [key pressed] sent by caller, decodes Dual Tone Multiple Frequency coded commands into BCD form and fed to next block for further processing.

### 1.1.7 BCD TO BINARY CONVERTER:

This block converts the BCD [Binary Coded Decimal] form commands into Binary form and thus gets eight output points for manipulation.

### 1.1.8 LATCH UNIT:

This block latches the condition of the load to any one form: ON or OFF. This is basically a Flip Flop, which changes to High or Low state whenever any trigger pulse is given.

### 1.1.9 DRIVER UNIT:

This block drives the low impedance relay with the help of high current and high voltage Darlington transistor pair.

### 1.1.10 LOAD:

To this system user can connect any mains operated loads, depend upon one’s requirement. For example home user can connect Lights, Washing Machine, Air-conditioner, Fan as loads and Industrial users can connect Motors, Security Cameras, Lights,

### 1.1.11 POWER SUPPLY:

This Power Supply Unit provides all necessary working voltages to circuits gathered to make this project.

# CHAPTER 2

# RC NETWORK, RING DETECTOR & SCHMITT-TRIGGER SECTION

The first section comprises of three blocks: RC Network, Ring Detector and Schmitt Trigger. The RC Network & Ring Detector detects the incoming ring tone signals, which is in AC form, reduces it and fed to Schmitt Trigger. The job of the Schmitt Trigger is to convert that AC signals into digital pulses. For Ring Detection, old and simple RC network with bridge rectifier is used. And popular 555 Timer IC is used to construct the Schmitt Trigger circuit.

The **RC NETWORK** is nothing but a series connection of passive components, Resistor [R] and Capacitor [C]. The resistor limits the current and capacitor blocks DC and allows only AC components. In this system, it is necessary to block -48V DC supplied to Telephone Set from Exchange and allows 75Vrms, 17Hz AC ringing signals to pass through. So this RC network is constructed such that, it blocks -48V DC using rectifier diodes and allows [after minimizing] ringing signals to pass through the Schmitt Trigger.

The basic function of the **SCHMITT TRIGGER** circuit is to convert/generate a chain of square wave from any regular or irregular signal input. The triggering pulse generator produces a series of square waves using AC signals of ring tones fed by RC Network, and acts like a clock signal generator to the further section. Here the square waves generated by the Trigger pulse generator are fed to the Counter as a clock pulse.

Digital circuits often require a source of accurately defined pulses. The requirement is generally for a single pulse of given duration (i.e. a ‘one shot’) or for a continuous train of pulses of given frequency and duty cycle. Rather than attempt to produce an arrangement of standard logic gates to meet these requirements, it is usually simpler and more cost-effective to make use of one of the range of versatile integrated circuits known collectively as ‘timers’. The greater level of accuracy and stability with long Monostable periods is possible only with timer IC. The **555-TIMER** is a neat mixture of analog circuitry but its applications are virtually limitless in the world of digital pulse generation. These devices can usually be configured for wither Monostable or Astable operation and require only a few external components in order to determine their operational parameters.

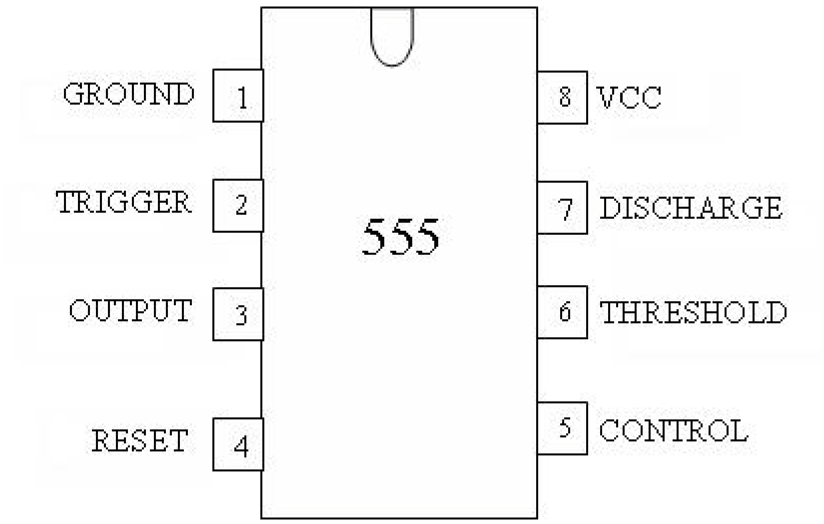



Fig: 2.1 IC-555 Timer

The timer comprises two operational amplifiers (used as comparators) together with an RS Bistable element. In addition, an inverting output buffer is incorporated so that a considerable current can be sourced or sunk to/from a load. A single transistor switch “Qd” is also provided as a means of rapidly discharging the external timing capacitor.

The standard 555 timer is housed in an 8-pin DIL package and operates from supply rail voltages of between 4.5V and 15V. This encompasses the normal range for TTL devices and thus the device is ideally suited for use in conjunction with TTL circuitry.

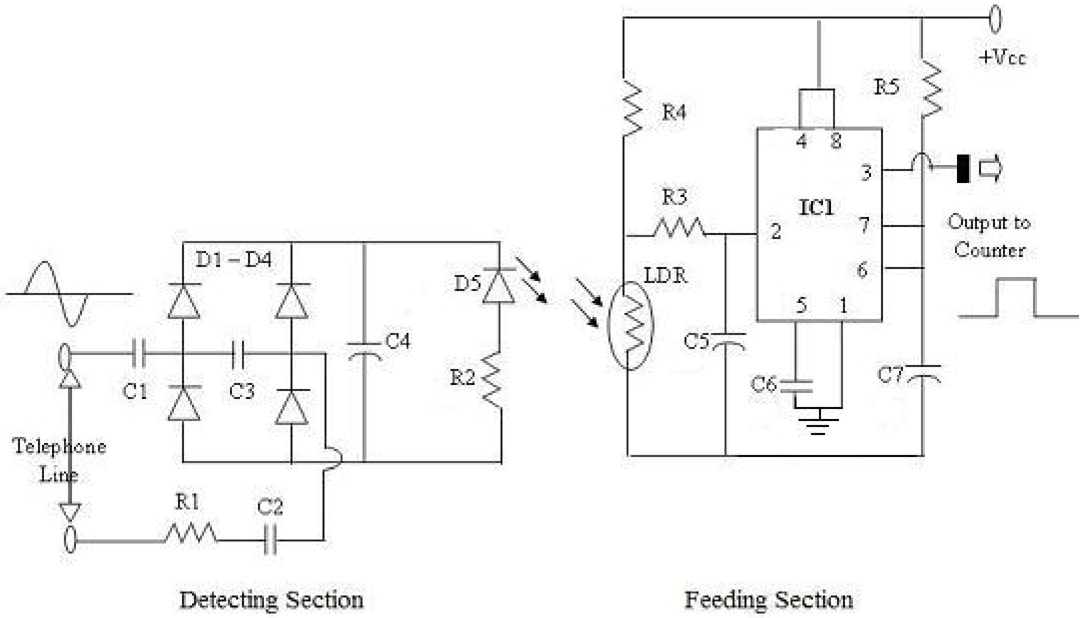



Fig: 2.2 Circuit diagram of Ring Detector & Schmit Trigger Section

## Parts List:

| | | |
|---|---|---|
| IC1 | 555 Timer IC | 1 |
| R1-R3 | 1 K Ohm ¼ Watt | 3 |
| R4 | 33k Ohm ¼ Watt | 1 |
| R5 | 10K Ohm ¼ Watt | 1 |
| LDR | Light Sensor | 1 |
| D1 – D4 | 1N4007 Rectifier Diodes | 4 |
| D5 | Indicator LED | 1 |
| CAPACITORS | | |
| C1,C2 | 0.3 µf Ceramic Disc type | 2 |
| C3,C6 | 0.1µF Ceramic Disc type | 2 |
| C4 | 100 µF/25V Electrolytic | 1 |
| C5 | 1 µF/25V Electrolytic | 1 |
| C7 | 10 µF/25V Electrolytic | 1 |

# 2.1 Circuit Description

## 2.1.1 RING DETECTOR:

The combination of passive components with bridge rectifier acts as ring detector. It is constructed such that the fluctuating AC's distortions should not false trigger the Schmitt trigger circuit. The idea is to isolate the detecting section from the feeding section. This is achieved by using LED-LDR pair combination to transfer the ringing signal.

The -48V DC is blocked by rectifier diodes D1 to D4 and ringing signal of 75V, 15-17 Hz is minimised by R & C components and fed to an Indicator LED D5. The resistor R2 is current limiting one. The LED D5 blinks with respect to ringing signals.

The LDR [Light Dependent Resistor], whose resistance varies with respect to the light falls on it, changes its internal resistance and hence produces the triggering pulse across the pin-2 of Schmitt Trigger IC.

## 2.1.2 SCHMITT TRIGGER:

An electronic circuit that generates square waves using positive feedback is known as a Multivibrator. This switching circuit is basically a two stage amplifier and operates in two states (ON and OFF) controlled by external circuit conditions. There are three types of Multivibrator: Astable or Free Running Multivibrator, Monostable or One Shot Multivibrator and Bistable or Flip-flop Multivibrator.

An oscillator circuit which generates square wave of its own (i.e. without external triggering) is known as Astable or Free Running Multivibrator. The outputted square pulse is not stable in nature. It switches back and forth from one state to the other. And the switching time is determined by the external components (i.e. RC constant). These pulse trains are used to ON/OFF or trigger the connected external circuits. The normal 555 IC Astable Multivibrator can be used readily to drive a relay (operating current must be less than 150mA).

The circuit diagram of Fig.2.3 shows how the timer IC 555 can be used as an Astable pulse generator. In this mode the circuit provides very constant output frequency. The triggering pulse fed from Ring Dectector's output is fed to trigger input pin-2. The threshold input is connected to the trigger input. Two external resistances R1, R2 and a capacitor C is used in the circuit (Fig: 2.3). This circuit has no stable state. The circuit changes its state automatically. Hence the operation is also called Free Running non-sinusoidal oscillator.

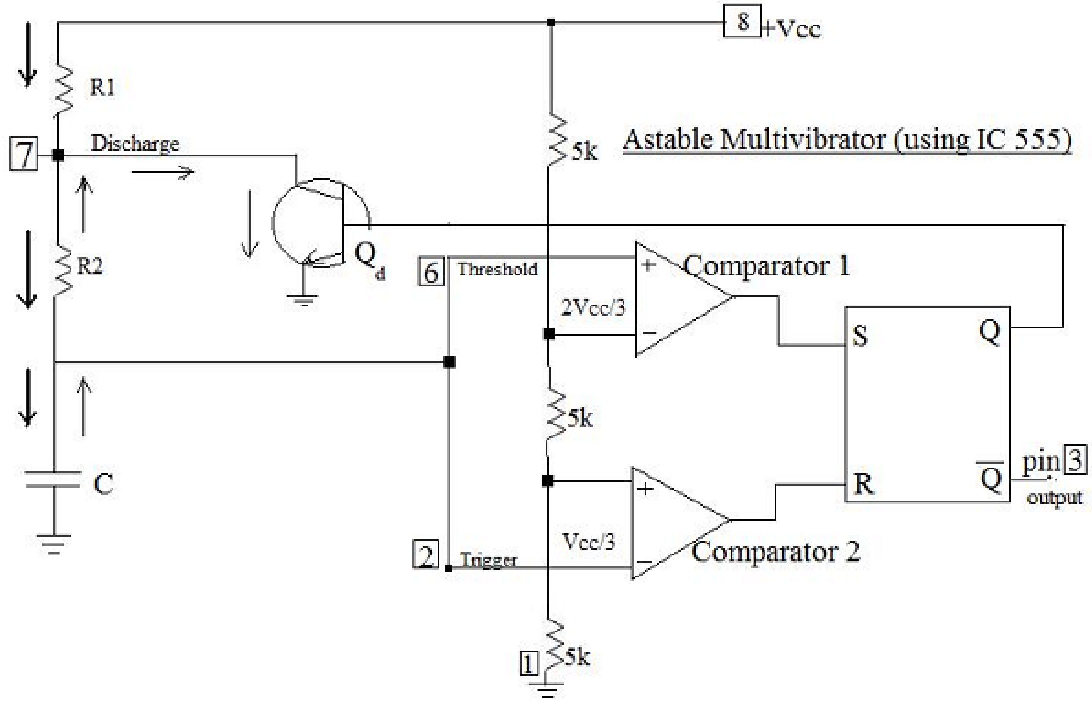



Fig: 2.3 IC-555 timer in Astable Multivibrator mode

When the flip-flop is set, Q is high which drives the transistor Qd in saturation and the capacitor gets discharged. Now the capacitor voltage is nothing but the trigger voltage, so while discharging when it becomes less than Vcc/3, comparator-2 output goes high. This resets the flip-flop, hence Q goes low and notQ goes high.

The low Q makes transistor Qd OFF. Thus capacitor starts charging through the resistances R1, R2 and Vcc. The charging path is shown by thick arrows in Fig.2.3.

As total resistance in the charging path is (R1+R2), the charging time constant is (R1+R2)C.

Now the capacitor voltage is also the threshold voltage. While charging, capacitor voltage increases, i.e. the threshold voltage increases. When it exceeds 2Vcc/3, then comparator-1 output goes high,which sets the flip-flop. The flip-flop output Q becomes high and output at Pin.3, i.e. notQ becomes low.

High Q drives transistor Qd in saturation and capacitor starts discharging through resistance R2 and transistor Qd. This path is shown by dotted arrows. Thus the discharging time constant is R2*C.

When capacitor voltage becomes less than Vcc/3, comparator-2 output goes high,resetting the flip-flop. Thereafter the entire cycle is repeated until the circuit receives the ringing signals.

Thus when capacitor is charging, output is high, while when its discharging, the output is low. The output at Pin.3 is a rectangular wave. The capacitor voltage is exponentially rising and falling. Generally the charging time constant is greater than the discharging time constant, hence at the output, the waveform is not symmetric.

The charging and discharging time for the capacitor is given by,

Ton = Charging Time = 0.693(R1+R2)C

Toff = Discharging Time = 0.693(R2)C

Hence, time for one complete cycle becomes,

T = Ton + Toff = 0.693(R1+R2)C + 0.693(R2)C

= 0.693(R1 + 2R2)C

Frequency of Oscillations,

f = 1/T = 1 / 0.693(R1+2R2)C = 1.44 / (R1+2R2)C Hz.

# CHAPTER 3

# RING COUNTER CUM SWITCHING UNIT

This Section counts the number of rings and lifts the cradle automatically after pre-defined number of rings, say five The commonly available decade counter IC 4017 is used to count the number of rings. And it is configured to count upto 4 pulses and on fifth pulse it latches itself. The triggering action is actually carried out by relay driver circuit, which is comprised by two Darlington transistors with a relay.

On several occasions counting is required, but manual counting becomes time-consuming and inaccurate when objects to be connected are very large in number or they pass through in quick succession. In such situations the counters using electronic circuits are more reliable than human counters. A counter can also be used effectively to count time intervals [as in shutter time in camera]. A counter with suitable connectivity can even work as a stopwatch, or as a frequency counter. Basically, a digital frequency counter counts the number of pulses/second which gives the frequency directly in Hz. With a circuit modification and external transducers, one can convert a counter to a digital thermometer, flow meter, tachometer, voltmeter, stopwatch, frequency counter etc.

**4017 DECADE COUNTER:** The well-known CMOS IC type 4017 is a decade counter, which offers an excellent means of sequentially scanning small matrices. However, it may also be used as a programmable frequency divider. It has clock input to trigger the counter, clear pin is to clear the counter. Active low clock enable pin enables the counter and carry out pin triggers the next decade counter after reaching its maximum counting limit. There are 10 binary outputs which can be used independently or used to drive any display panel. The working voltage of this decade IC is 4 to 18 Voltage and bears maximum clock frequency of 2 Mega Hertz at its clock input pin.

**POWER DRIVING CIRCUITS:** In many applications, a relay will require some form of interface to the circuit to which it is connected. Often such an interface consists of nothing more than a single transistor. Almost any n-p-n transistor with a current gain of 50 or more can be used in the circuit. However, it is important to ensure that it is operated within its maximum collector current ($I_{C(max)}$) rating. The coil resistance of relay and preferred transistors are as follows: 50 ohm to 200 ohm - T1P31 (or equivalent), 200 Ohm to 400 Ohm - BC142 (or equivalent), 400 Ohm to 1.2 K Ohm - BC108 (or equivalent). The circuit requires an input current of about 0.5 mA when operated from a 5V source. In some applications it may be desirable to increase the sensitivity of the circuit, in which case a Darlington driver stage can be used. A Darlington driver based on two (discrete) n-p-n devices requires a current of only a mere 40μA at 5V in order to operate the relay. This circuit can be used with relays having coil resistance as low as about 200 ohm and will also operate reliable with an input current of as little as 40μA.

**RELAY:** The traditional method of switching current through a load, which requires isolation from the controlling circuit, involves the use of an electromechanical relay. Such devices offer a simple, low-cost solution to the problem of maintaining adequate isolation between the controlling circuit and the potentially lethal voltages associated with an a.c. main supply. The coils, which provide the necessary magnetic flux to operate a relay, are available for operation on a variety of voltages between 5V and 115V d.c. and 12V to 250V a.c. at currents of between 5 mA and 100 mA.

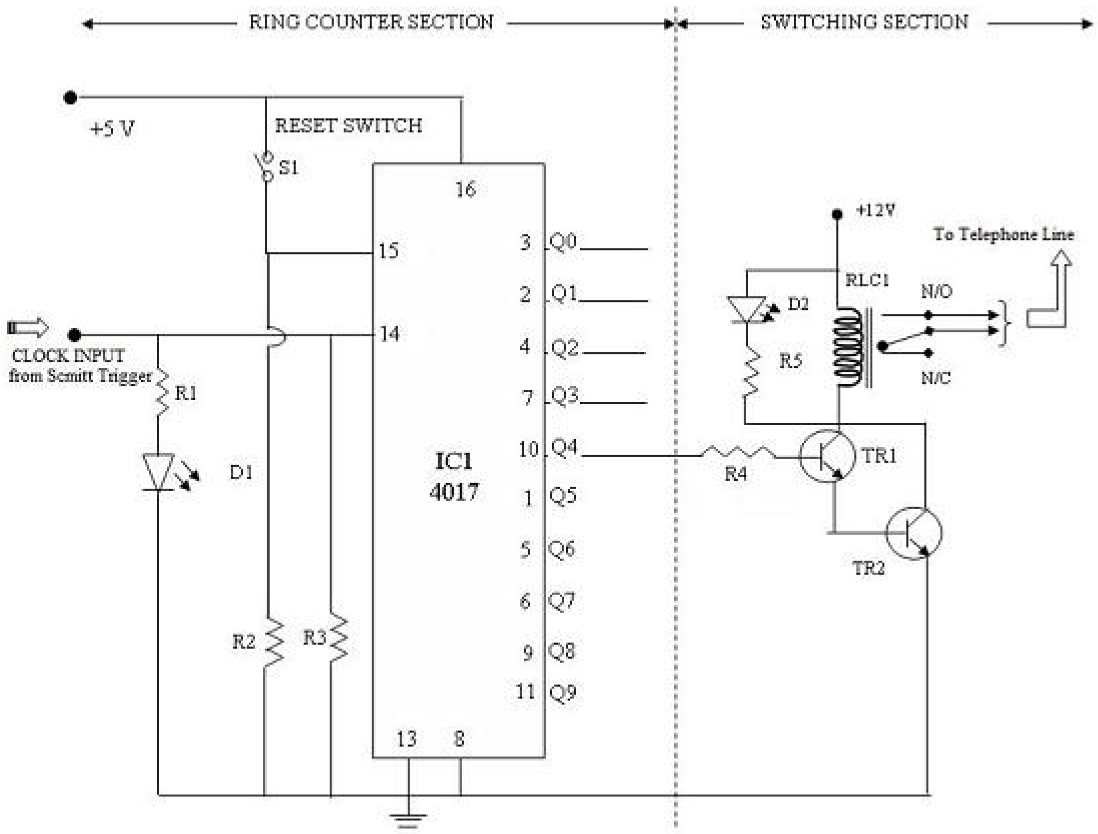



Fig: 3.1 Circuit Diagram of Ring Counter cum Switching & Controlling unit

## Parts List:

| | | |
|---|---|---|
| **SEMICONDUCTORS** | | |
| IC1 | 4017 CMOS Decade Counter IC | 1 |
| **RESISTORS** | | |
| R1 & R5 | 470 Ohms ¼ Watt Carbon Resistor | 2 |
| R2- R4 | 22 K Ohms ¼ Watt Carbon Resistor | 3 |
| **MISCELLANEOUS** | | |
| S1 | Reset Switch [push-to-ON] | 1 |
| RLC1 | 12 V, 700 Ohm DPDT Reed Relays | 1 |
| D1 & D2 | Red Indicator LEDs | 2 |

## 3.1 Circuit Description

The presented unit contains two stages: Ring Counter and Switching & Controlling Section.

### 3.1.1 RING COUNTER:

The clock pulse is fed to the counter at pin-14, CLOCK input pin. As the Active Low Clock Enable pin-13 is connected to ground, the counter starts counting the inputted pulses. For first clock pulse output at pin-3 [Q0] goes high. The second clock pulse makes the output of pin-2 [Q1] go high. This process goes on for 10 outputs [i.e., up to Q9] in sequential order. After $10^{th}$ pulse reset pin-15 must be made high to restart the counter.

But this system is designed to count four rings and then lift the telephone to attend the phone automatically. So, only five outputs are used, viz., Q0, Q1, Q2, Q3 & Q4 with respect to pins-3, 2, 4, 7 & 10. The fifth output, i.e., High at Q4, is fed to Switching & Controlling Section for switching action. That simply means when ring counter senses fifth pulse at its CLOCK pin, IC1's pin 10 goes High. This in turn drives the Switching section into saturation.

### 3.1.2 SWITCHING & CONTROLLING SECTION:

The High pulse at Q4 output through R4 makes the driver transistors TR1 & TR2 into saturation region. This TR1 & TR2 pair makes Darlington pair, and hence drives two low impedance relays very easily. This stage is necessary, as Ring Counter IC1's output is not strong enough to activate the relay.

As the Darlington pair transistors enter the saturation region, relay RLC1 gets energized. This action makes N/O [Normally Open] pin with Pole short and hence provides Command signals a path to this system.  The Relay RLC1 is connected in series of Telephone Line. This section works on +12Volts, and hence provides the required voltage to the relays by specially designed power supply unit.

# CHAPTER 4

# DTMF DECODER AND BCD TO BINARY CONVERTER MODULE

This Section decodes the DTMF form Command signal sent by caller and converts it into eight bit binary output signals such that four loads can be controlled independently.

Before going in deep on actual circuit & its explanation, let us have details of the terms & components used in this section.

## 4.1 DTMF

The telephone is the most extraordinary element of the telecommunication systems. A telephone works on the principle of varying the line current in proportional to sound. The transducer which converts sound waves to an electrical signal is called a microphone, and the one which does the reverse function is called a speaker/earphone. Signaling is the most critical function of any telecommunication system. Normally alternating voltages of low value are used for signaling or ringing, as commonly referred. In modern telephones, the rotary dial has been replaced by pushbutton matrix dial. These telephones use ICs to generate the DC pulses. The pulse dialing is slower and susceptible to noise. It takes over 10 seconds to dial a 6-digit number. The is very slow as compared to the processing speed of modern electronic exchanges. Besides it has the following limitations: The subscriber can signal only up to the exchange, and end to end or subscriber to subscriber signaling is not possible. Only ten codes, i.e. from 0 to 9, are possible. Time required to dial each digit is different. To overcome these limitations, modern telecommunication uses two distinct tones, which correspond to a particular number. This is called the Dual Tone Multi Frequency [DTMF] dialing. If one dials, say, number ‘5’, then two tones of 770 Hz and 1336 Hz is transmitted. These tones are sensed and decoded by the exchange and converted to the dialed digit, which is digit ‘5’ in this case. The column pertaining to tone 1633 Hz is used for special facilities like flash, pause etc.

HIGH FREQUENCY GROUP / LOW FREQUENCY GROUP

| | 1209Hz | 1336Hz | 1447Hz | 1663Hz |
|---|---|---|---|---|
| 697Hz | 1 | 2 | 3 | A |
| 770Hz | 4 | 5 | 6 | B |
| 852Hz | 7 | 8 | 9 | C |
| 941Hz | * | 0 | # | D |

Fig: 4.1 Frequency Assignments for Various Keys

## 4.2 DTMF DECODER MT8870 IC

Each digit in DTMF (dual tone multi-frequency) code corresponds to a combination of two discrete frequencies, one each from a low and high group of frequencies, which are generated when any switch on a dialer key-pad is pressed. Such a key-pad along with the frequencies associated with each row and column. The key-pad is used in conjunction with a dialer IC such as UM9214 or UM9215 to generate the pair of frequencies as mentioned.

The DTMF signals transmitted over the telephone lines can be received and decoded using a DTMF receiver/decoder IC such as MT8870 produced by Mitel or Zarlinks. The decoded outputs can be suitably used along with certain additional circuitry to design a Call-Line-Identification-Product unit [popularly known as CLIP]. The four hexadecimal output obtained from the DTMF receiver/decoder IC corresponding to each digit on the telephone key-pad together with the associated dual-tone frequencies can be put-it in a table form for easy reference.

The DTMF digits transmitted over the telephone lines would have a nominal width of 50 ms followed by a pause (no signal) of similar duration between consecutive digits. Thus, ten consecutive digits would be transmitted in one second. Note that the DTMF codes for the CLIP service are transmitted in between the handset is On-Cradle.

Hence it is essential to detect On-Cradle and Off-Cradle status of called subscriber as well as the ringing signal.

DTMF Signal Output Codes

| Digit | Low Group (Hz) | High Group (Hz) | Row | Col. | Hexadecimal O/P Q1 Q2 Q3 Q4 |
|---|---|---|---|---|---|
| 1 | 697 | 1209 | 1 | 1 | 0 0 0 1 |
| 2 | 697 | 1336 | 1 | 2 | 0 0 1 0 |
| 3 | 697 | 1477 | 1 | 3 | 0 0 1 1 |
| 4 | 770 | 1209 | 2 | 1 | 0 1 0 0 |
| 5 | 770 | 1336 | 2 | 2 | 0 1 0 1 |
| 6 | 770 | 1477 | 2 | 3 | 0 1 1 0 |
| 7 | 852 | 1209 | 3 | 1 | 0 1 1 1 |
| 8 | 852 | 1336 | 3 | 2 | 1 0 0 0 |
| 9 | 852 | 1477 | 3 | 3 | 1 0 0 1 |
| 0 | 941 | 1336 | 4 | 1 | 1 0 1 0 |
| • | 941 | 1209 | 4 | 2 | 1 0 1 1 |
| # | 941 | 1477 | 4 | 3 | 1 1 0 0 |
| A | 697 | 1633 | 2 | 4 | 1 1 0 1 |
| B | 770 | 1633 | 2 | 4 | 1 1 1 0 |
| C | 852 | 1633 | 3 | 4 | 1 1 1 1 |

Fig: 4.2 DTMF to Hexa decimal Conversion

The On-Cradle and Off-Cradle status of the handset can be detected, based on the voltage state, before the start of ringing (which is between 40 and 52V DC approximately). The voltage drops to 10 to 12V DC on lifting of the handset from the cradle. The ringing status can be detected with the use of either a coactively coupled rectifier bridge or an AC Opto-coupler (or even a DC Opto-coupler with an external diode shunted in anti-parallel across the internal diode of the Opto-coupler together with a current limiting series resistor).

The end of calling-number can be detected from the knowledge of inter-digital pause. A time-out e.g. 150 ms or so, can be fixed for this purpose. This is termed as inter-digit time-out (IDT). For the purpose of calculation of IDT, as also for shifting of the consecutive digits, one can make use of active high DSO (delayed steering output) signal from pin 15 of IC8870.

## 4.3 DEMULTIPLEXER IC-74154

A De-Multiplexer is a logic circuit that demultiplexes one input data line to more than one data output lines. Which output line is active again depends upon the logic status of the control lines. A generalized demultiplexer has one data input, (n) data output lines and (m) control lines with $2^m = n$. A demultiplexer without a data input line is the Decoder. In a decoder, one of the output lines is active at a time depending upon the status of the control bits. This 24- pin demultiplexer IC 74154 can be configured to accept Binary Coded Decimal Numbers at input pins and gives out the corresponding binary number at output pins. The working voltage of IC is 5 Volts, propagation delay is 6 nano seconds and maximum toggle speed is 40 Mega Hertz.

## 4.4 HEXBUFFER/CONVERTER[NON-INVERTER]IC4049

Buffers does not affect the logical state of a digital signal (i.e. logic 1 input results into logic 1 output where as logic 0 input results into logic 0 output). Buffers are normally used to provide extra current drive at the output, but can also be used to regularise the logic present at an interface. And Inverters are used to complement the logical state (i.e. logic 1 input results into logic 0 output and vice versa). Also Inverters are used to provide extra current drive and, like buffers, are used in interfacing applications. This 16-pin DIL packaged IC 4049 acts as Buffer as-well-as a Converter**.** The input signals may be of 2.5 to 5V digital TTL compatible or DC analogue the IC gives 5V constant signal output [TTL compatible]. The IC acts as buffer and provides isolation to the main circuit from varying input signals. The working voltage of IC is 4 to 16 Volts and propagation delay is 30 nanoseconds. It consumes 0.01 mill Watt power with noise immunity of 3.7 V and toggle speed of 3 Megahertz**.**

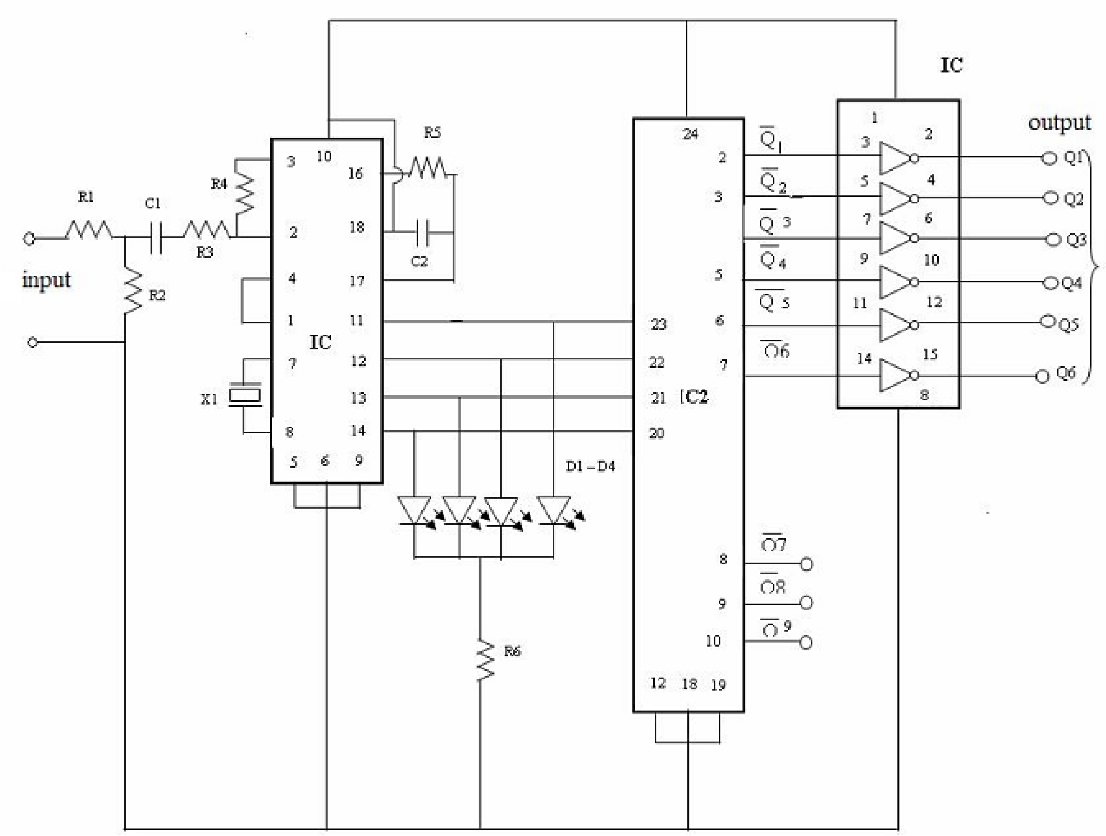



Fig: 4.3 Circuit Diagram of DTMF Decoder

## Parts List

| | | |
|---|---|---|
| IC1 | KT3170/MT8870, DTMF to BCD Converter IC | 1 |
| IC2 | 74154, 4-to-16-line De-multiplexer IC | 1 |
| IC3 | CD 4049 Buffer / Converter IC | 1 |
| R1& R2 | 22 K Ohms ¼ Watt Carbon Resistor | 2 |
| R3 | 10 K Ohms ¼ Watt Carbon Resistor | 1 |
| R4 | 1 M Ohms ¼ Watt Carbon Resistor | 1 |
| R5 | 330 Ohms ¼ Watt Carbon Resistor | 1 |
| R6 | 470 Ohms ¼ Watt Carbon Resistor | 1 |
| C1 & C2 | 0.1 µF CERAMIC DISC TYPE | 2 |
| X1 | 3.5795 M Hertz Crystal | 1 |
| D1 – D4 | Red Indicator LEDs | 4 |

## 4.5 Circuit Description

The circuit described here can be used to switch up to nine appliances (corresponding to the digits 1 through 9 of the telephone key-pad). The DTMF signals on telephone instrument are used as control signals. The digit ‘0’ in DTMF mode is used to toggle between the appliance mode and normal telephone operation mode. Thus the telephone can be used to switch ON or switch OFF the appliances also while being used for normal conversation. The circuit uses IC MT8870 (DTMF-to-BCD converter), 74154 (4-to-16-line demultiplexer), and six buffers [CD4049 IC]. The working of the circuit is as follows.

Once a call is established (after hearing ring-back tone), dial ‘0’ in DTMF mode. IC1 decodes this as ‘1010’ [LEDs D1 to D4 gives visual representation of this number], which is further demultiplexed by IC2 as output O10 (at pin 11) of IC2 (74154). The active low output of IC2, after inversion by an inverter gate of IC3 (CD4049), becomes logic 1. This is used to drive any load through relay. If digit ‘0’ is not dialled (in DTMF) after establishing the call, the ring continues and the telephone can be used for normal conversation. After selection of the appliance mode of operation, if digit ‘1’ is dialled, it is decoded by IC1 and its output is ‘0001’. This BCD code is then demultiplexed by 4-to-16-line demultiplexer IC2 whose corresponding output, after inversion by a CD4049 inverter gate, goes to logic 1 state. This pulse is used to drive a relay which can switch On or switch Off the appliance connected through its contacts. By dialling other digits in a similar way, other appliances can also be switched ‘On’ or ‘Off.’ This circuit is to be connected in parallel to the telephone instrument.

# CHAPTER 5

# LATCH & LOAD DRIVER SECTION

This section executes the command send by caller [decoded by DTMF Decoder section] by latching the load to previous state: ON/OFF. This section latches or locks the condition of the load to any one state using Flip-Flop/Bistable Multivibrator and drives the load using relay.

## 5.1 D flip-flop

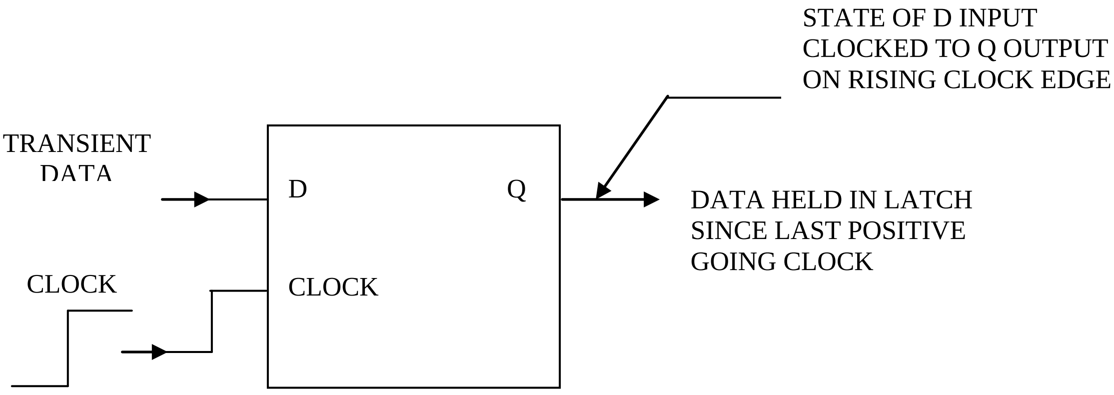



Fig: 5.1 D flip-flop

| Preset | Clear | Q |
|---|---|---|
| 0 | 0 | Indeterminate |
| 0 | 1 | 1 |
| 1 | 0 | 0 |
| 1 | 1 | Enables clocked operation |

The D-type bistable has two principle inputs; D (standing variously for data or delay) and CLOCK. The data input (logic 0 or logic 1) is clocked into the bistable such that the output state changes only when the clock changes state. Operation is thus said to be synchronous. Additional subsidiary inputs (which are invariably ‘active low’) are provided which can be used to directly set to reset the bistable. These are usually called PRESET (PR) and CLEAR (CLR).

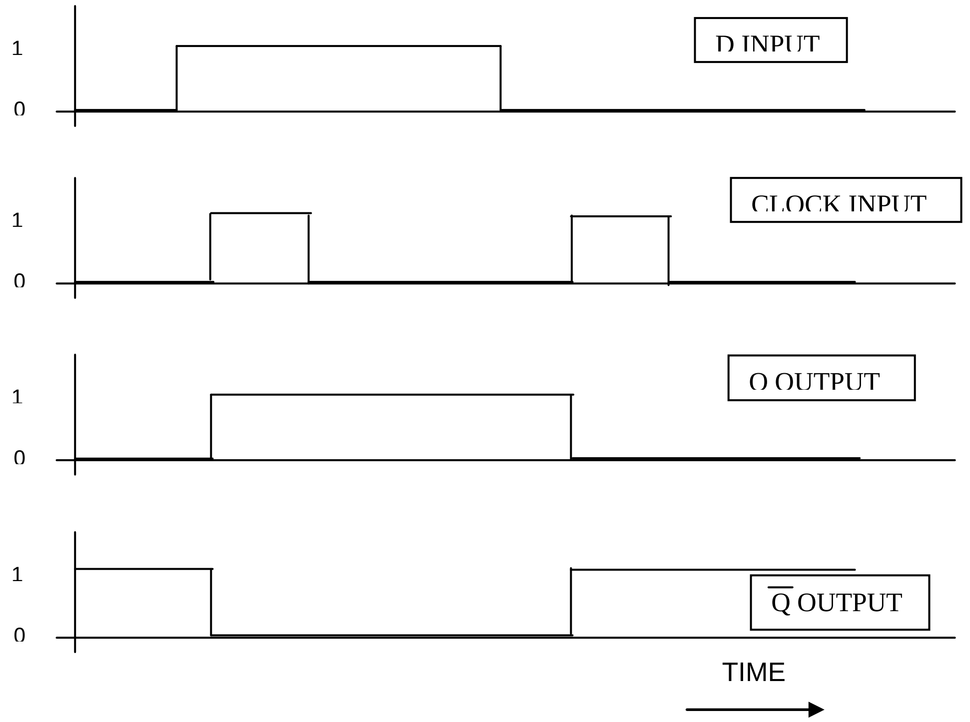



Fig: 5.2 Waveforms

Fig: 5.1 shows a typical application of a D-type bistable as a simple one-bit ‘data latch. The operation of the circuit is best explained by considering the timing diagram shown in Fig: 5.2. Here, the state of the D input is transferred to the Q output on each rising clock edge. The Q output remains unaffected by a falling clock edge. It should be noted that most common D-type bistables (e.g. 7474, 74174, 74175) are all clocked on the rising edge of the clock waveform.

## 5.2 Decade counter IC 4013

This I.C consists of internally two D Flip-flops or latches. The flip-flops are used of signal latching or holding applications. It is a 14 pin, D.I.P package CMOS version I.C. It has a wide operating voltage range from 4V to 15 Volts. It is used in many digital circuits wherever the signal produced for a moment, by any circuit is to hold continuously. If once it is latched or hold a signal it can be brought to normal condition by resetting the I.C. It is also used as a memory-storing device.

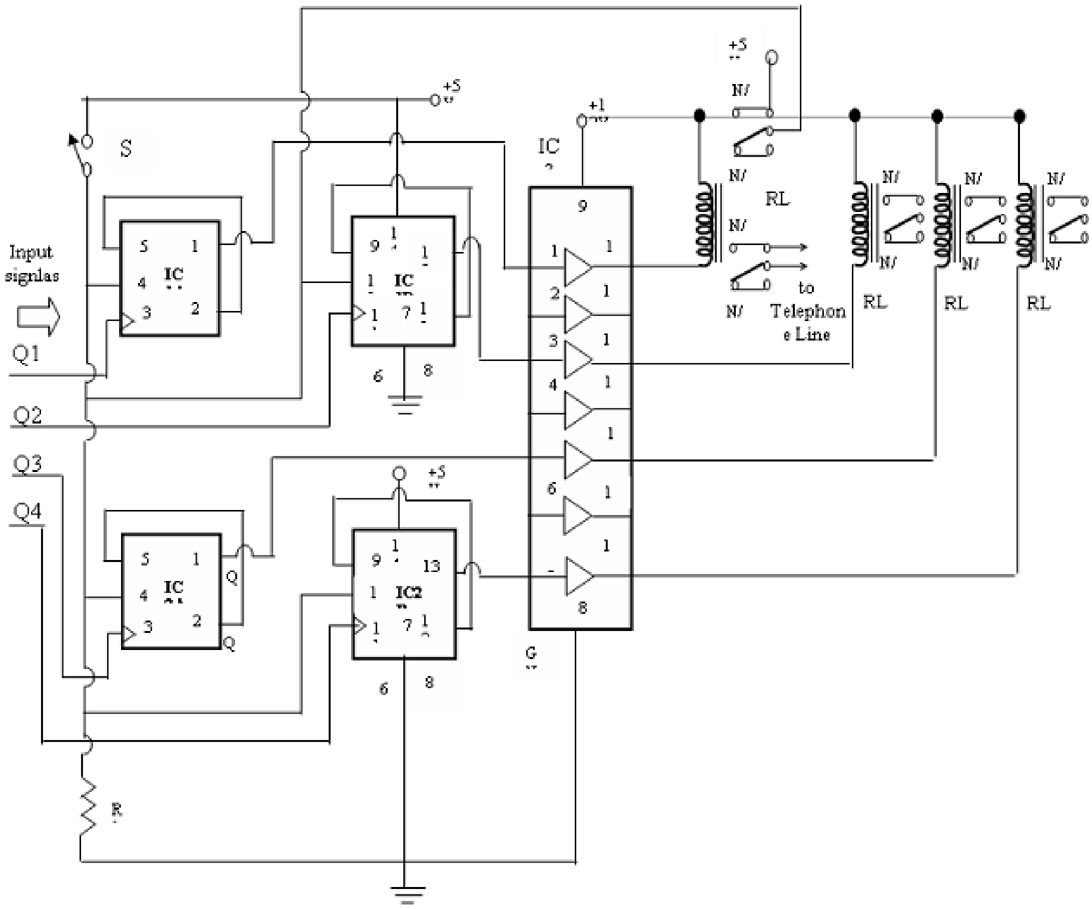



Fig: 5.3 Latch & Load Driver Section

## Parts List:

| | | |
|---|---|---|
| IC1 & IC2 | 4013 CMOS ICs | 2 |
| IC3 | 2003 Driver IC | 1 |
| R1 | 4.7 K Ohm, ¼ Watt Carbon Resistor | 1 |
| Sw1 | Push-to-ON Switch | 1 |
| RL1 – RL4 | Low Impedance Relays | 4 |

## 5.3 Circuit Description

The general circuit arrangement of the Latch IC follows:

The pin no. 7 & 14 are ground and Vcc points respectively. The pins from 1 to 6 are of first flip-flop and pins 8 to 13 are for flip-flop second. For the flip-flop the 'D' is the input [pin 5 & 9] to it and 'Q' [pin 1 & 13] & 'IN.Q' [pin 2 & 12] are output and inverted output terminals. The 'CLK' is the clock input [pin 3 & 11] to latch i.e. the input will be accepted only when the clock is high. The 'RST' is the reset terminal [pin 4 & 10], with a high signal to this terminal the latch is reset and output is made zero or low.

For latching operation, Q is shorted to D input and SET is connected to ground. The input is feed to CLK input and output is taken at Q terminal. This operation is also known as toggling condition. So the set pins 6 & 8 are connected to ground, pins 2 & 12 are shorted with pins 5 & 9 respectively. This Latch arrangement receives its clock input at pins 3 & 11 by DTMF Decoder section. Since the intended circuit is for FOUR DEVICE SYSTEM it uses three Latch ICs to receive seven command signals from DTMF Decoder section. For TWO DEVICE SYSTEM only one Latch IC is sufficient and as output loads increases this number of IC also increases.

The output of this Latch section is taken at pin 1 & 13 and fed to Driver section IC. This high voltage & high current driver IC [IC3] is used to drive the low impedance relays.

Whenever caller presses the command button [using his telephone Key Pad], the command is decoded into BCD and then to Binary. Thus one of the 8 binary digits goes HIGH and acts as Clock pulse to its respective Latch arrangement. The Latch then toggles its state and hence output pin goes to alternative state. This action in turn activate respective relay to go ON/OFF. Thus load will be either turned ON or OFF, depend upon the previous status.

# CHAPTER 6

# POWER SUPPLY UNIT

This specially designed Power Supply Unit supplies dual voltages to the entire system, for working of its individual circuit blocks. It supplies +12 Volts for relay driving sections, and +5 Volts for rest of the circuit.

The power supply, unsung hero of every electronic circuit, plays very important role in smooth running of the connected circuit. The main object of this 'power supply' is, as the name itself implies, to deliver the required amount of stabilized and pure power to the circuit. Every typical power supply contains the following sections:

## 6.1 Step-down Transformer

The conventional supply, which is generally available to the user, is 230V AC. It is necessary to step down the mains supply to the desired level. This is achieved by using suitably rated step-down transformer. While designing the power supply, it is necessary to go for little higher rating transformer than the required one. The reason for this is, for proper working of the regulator IC (say KIA 7805) it needs at least 2.5V more than the expected output voltage

## 6.2 Rectifier stage

Then the step-downed Alternating Current is converted into Direct Current. This rectification is achieved by using passive components such as diodes. If the power supply is designed for low voltage/current drawing loads/circuits (say +5V), it is sufficient to employ full-wave rectifier with centre-tap transformer as a power source. While choosing the diodes the PIV rating is taken into consideration.

## 6.3 Filter stage

But this rectified output contains some percentage of superimposed a.c. ripples. So to filter these a.c. components filter stage is built around the rectifier stage. The cheap, reliable, simple and effective filtering for low current drawing loads (say upto 50 mA) is done by using shunt capacitors. This electrolytic capacitor has polarities.

## 6.4 Voltage Regulation

The filtered d.c. output is not stable. It varies in accordance with the fluctuations in mains supply or varying load current. This variation of load current is observed due to voltage drop in transformer windings, rectifier and filter circuit. These variations in d.c. output voltage may cause inaccurate or erratic operation or even malfunctioning of many electronic circuits. For example, the circuit boards which are implanted by CMOS or TTL ICs.

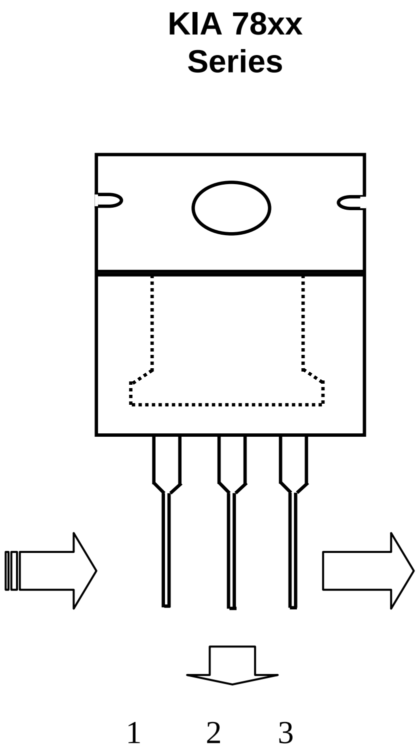



Fig: 6.1 Voltage Regulator

The stabilization of d.c. output is achieved by using the three terminal voltage regulator IC. This regulator IC comes in two flavors: 78xx for positive voltage output and 79xx for negative voltage output. For example 7805 gives +5V output and 7905 gives -5V stabilized output. These regulator ICs have in-built short-circuit protection and auto-thermal cutout provisions. If the load current is very high the IC needs ‘heat sink’ to dissipate the internally generated power.

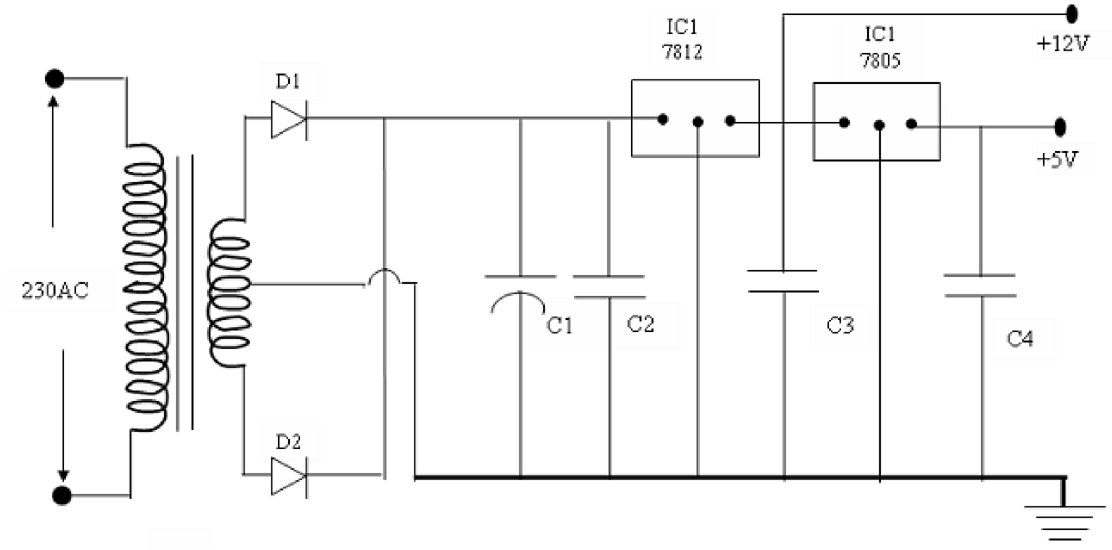



Fig: 6.2 Circuit Diagram of +5V & +12V Full Wave Regulated Power Supply

**Parts List:**

| | | |
|---|---|---|
| IC1 | 7812 Regulator IC | 1 |
| IC2 | 7805 Regulator IC | 1 |
| D1& D2 | 1N4007 Rectifier Diodes | 2 |
| C1 | 1000 µf/25V Electrolytic | 1 |
| C2 to C4 | 0.1µF Ceramic Disc type | 3 |
| X1 | 230V AC Pri,14-0-14 1Amp Sec Transformer | 1 |

## 6.5 Circuit Description

A d.c. power supply which maintains the output voltage constant irrespective of a.c. mains fluctuations or load variations is known as *regulated d.c. power supply.* It is also referred as full-wave regulated power supply as it uses four diodes in bridge fashion with the transformer. This laboratory power supply offers excellent line and load regulation and output voltages of +5V & +12 V at output currents up to one amp.

The transformer rating is 230V AC at Primary and 12-0-12V, 1Ampers across secondary winding. This transformer has a capability to deliver a current of 1Ampere, which is more than enough to drive any electronic circuit or varying load. The

12VAC appearing across the secondary is the RMS value of the waveform and the peak value would be 12 x 1.414 = 16.8 volts. This value limits our choice of rectifier diode as 1N4007, which is having PIV rating more than 16Volts.

In the Rectifier Stage, two diodes D1 & D2 are connected across the secondary winding of the transformer as a full-wave rectifier. During the positive half-cycle of secondary voltage, the end A of the secondary winding becomes positive and end B negative. This makes the diode D1 forward biased and diode D2 reverse biased. Therefore diode D1 conducts while diode D2 does not. During the negative half-cycle, end A of the secondary winding becomes negative and end B positive. Therefore diode D2 conducts while diode D1 does not. Note that current across the centre tap terminal is in the same direction for both half-cycles of input a.c. voltage. Therefore, pulsating d.c. is obtained at point ‘C’ with respect to Ground.

In the Filter Stage, Capacitor C1 is used for filtering purpose and connected across the rectifier output. It filters the a.c. components present in the rectified d.c. and gives steady d.c. voltage. As the rectifier voltage increases, it charges the capacitor and also supplies current to the load. When capacitor is charged to the peak value of the rectifier voltage, rectifier voltage starts to decrease. As the next voltage peak immediately recharges the capacitor, the discharge period is of very small duration. Due to this continuous charge-discharge-recharge cycle very little ripple is observed in the filtered output. Moreover, output voltage is higher as it remains substantially near the peak value of rectifier output voltage. This phenomenon is also explained in other form as: the shunt capacitor offers a low reactance path to the a.c. components of current and open circuit to d.c. component. During positive half cycle the capacitor stores energy in the form of electrostatic field. During negative half cycle, the filter capacitor releases stored energy to the load.

Across the point ‘D’ and Ground there is rectified and filtered d.c. In the present circuit KIA 7812 three terminal voltage regulator IC is used to get +12V and KIA 7805 voltage regulator IC is used to get +5V regulated d.c. output. In the three terminals, pin 1 is input i.e., rectified & filtered d.c. is connected to this pin. Pin 2 is common pin and is grounded. The pin 3 gives the stabilized d.c. output to the load. The circuit shows two more decoupling capacitors C2 & C3, which provides ground path to the high frequency noise signals. Across the point ‘E’ and ‘F’ with respect to ground +5V & +12V stabilized or regulated d.c. output is measured, which can be connected to the required circuit.

# CHAPTER 7

# SUMMARY

In this project we have developed a circuit**,** that control's the devices connected to telephone lines using cell phones or any other phone. The system is connected to the telephone line in parallel to the user's telephone set. Whenever a call comes it detects it and starts counting the number of pulses. After a predefined number of rings it automatically lifts the cradle switch which means that the call has gone through. Now depending on the key pressed by the caller, the respective load goes on and off.

Key features:

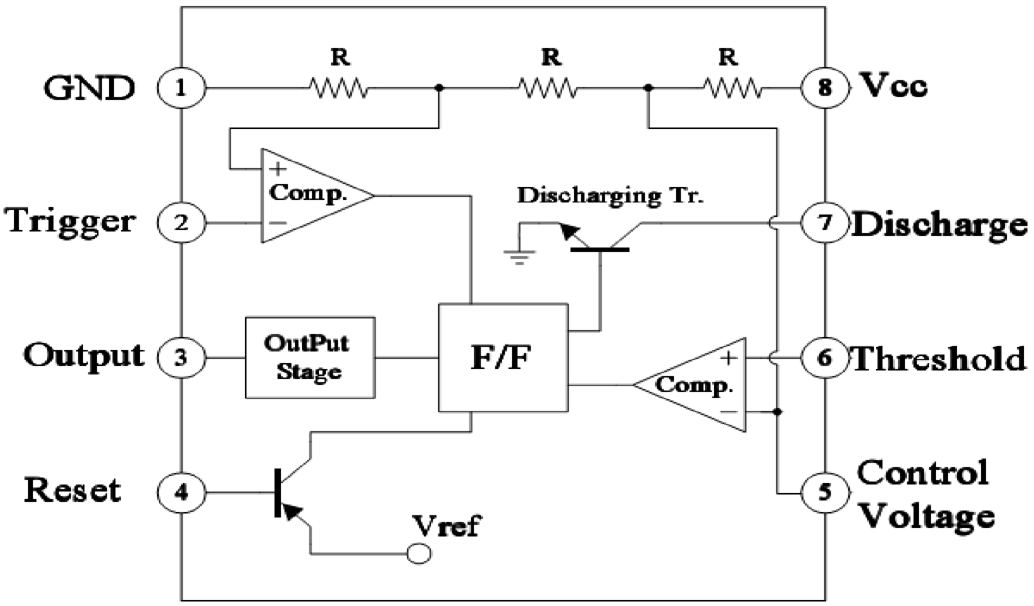
1. From anywhere around the world, devices can be controlled.
2. Effective in implementation.
3. High reliability, due to the usage of semiconductor devices.
4. Easy to use.

# CHAPTER 8

# DATASHEETS

## 8.1 IC 555

### 8.1.1 Internal Block Diagram




### 8.1.2 Description

The LM555/NE555/SA555 is a highly stable controller capable of producing accurate timing pulses. With a monostable operation, the time delay is controlled by one external resistor and one capacitor. With an astable operation, the frequency and duty cycle are accurately controlled by two external resistors and one capacitor.

### 8.1.3 Features

8 – DIP

1. High Current Drive Capability (200mA) stable controller
2. Adjustable Duty Cycle capable of producing accurate timing pulses.
3. Temperature Stability of 0.005%/°C
4. Timing From µSec to Hours external resistor and one capacitor.
5. Turn off Time Less Than 2µSec

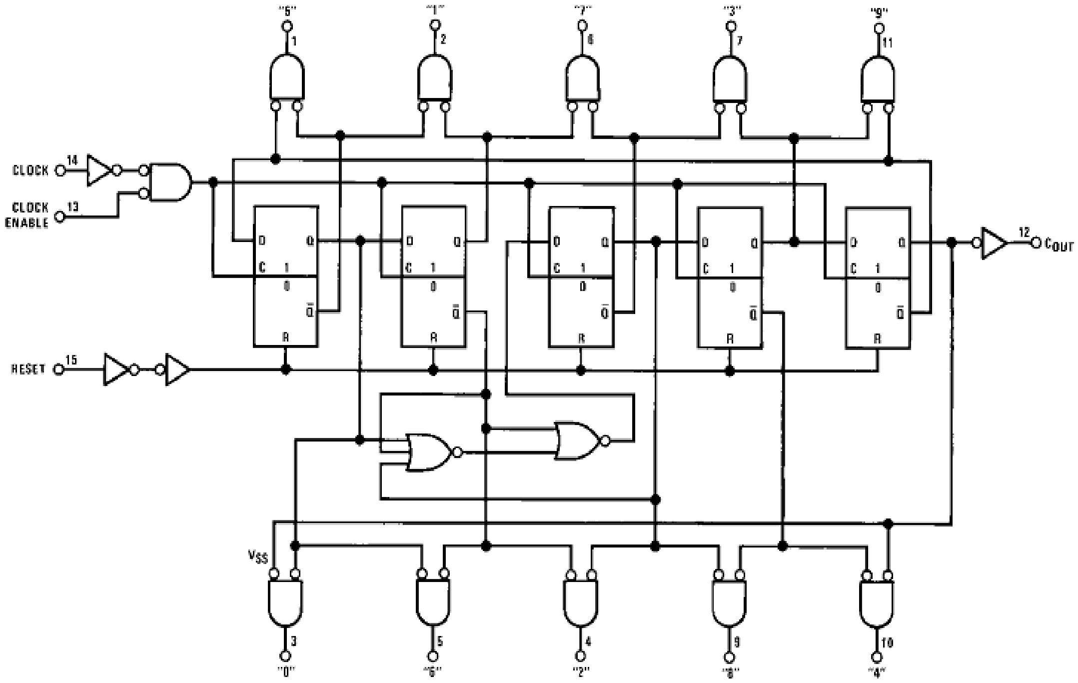
### 8.1.4 Applications

1. Precision Timing
2. Pulse Generation
3. Time Delay Generation
4. Sequential Timing

# 8.2 IC CD4017

## 8.2.1 Internal Block Diagram

CD4017B




## 8.2.2 Description

The CD4017BC is a 5-stage divide-by-10 Johnson counter with 10 decoded outputs and a carry out bit. The CD4022BC is a 4-stage divide-by-8 Johnson counter with 8 decoded outputs and a carry-out bit. These counters are cleared to their zero count by a logical “1” on their reset line. These counters are advanced on the positive edge of the clock signal when the clock enable signal is in the logical “0” state.

The configuration of the CD4017BC permits medium speed operation and assures a hazard free counting sequence. The 10/8 decoded outputs are normally in the logical “0” state and go to the logical “1” state only at their respective time slot. Each decoded output remains high for 1 full clock cycle. The carry-out signal completes a full cycle for every 10/8 clock input cycles and is used as a ripple carry signal to any succeeding stages.

### 8.2.3 Features

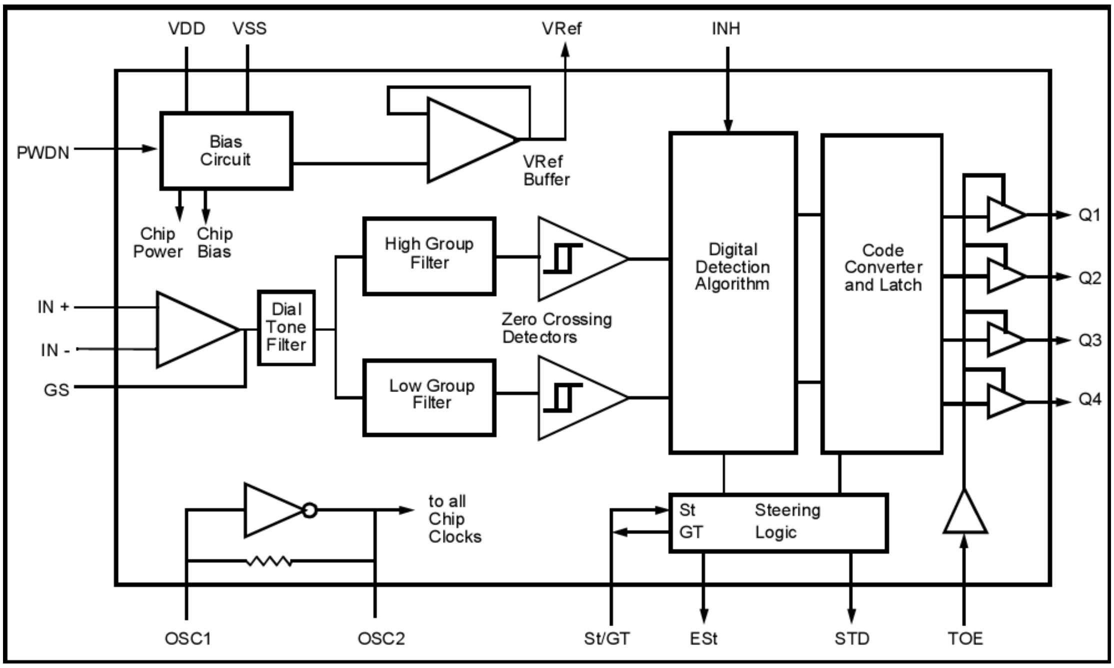
1. Wide supply voltage range: 3.0V to 15V
2. High noise immunity: 0.45 Vdd
3. Low power Fan out of 2 driving 74L TTL compatibility: or 1 driving 74LS
4. Medium speed operation:5.0 MHz with 10Vdd
5. Low power: 10 µW
6. Fully static operation

### 8.2.4 Applications

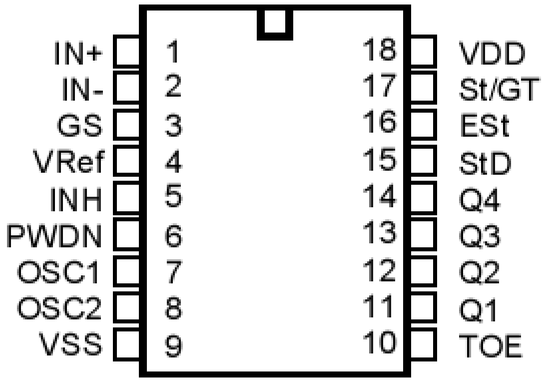
1. Automotive
2. Instrumentation
3. Medical electronic
4. Alarm systems
5. Industrial electronics
6. Remote metering

# 8.3 DTMF Decoder IC MT8870

## 8.3.1 Internal Block Diagram




## 8.3.2 Description




The MT8870D/MT8870D-1 is a complete DTMF receiver integrating both the band split filter and digital decoder functions. The filter section uses switched capacitor techniques for high and low group filters; the decoder uses digital counting techniques to detect and decode all 16 DTMF tone pairs into a 4-bit code. External component count is minimized by on chip provision of a differential input amplifier, clock oscillator and latched three-state bus interface.

### 8.3.3 Features

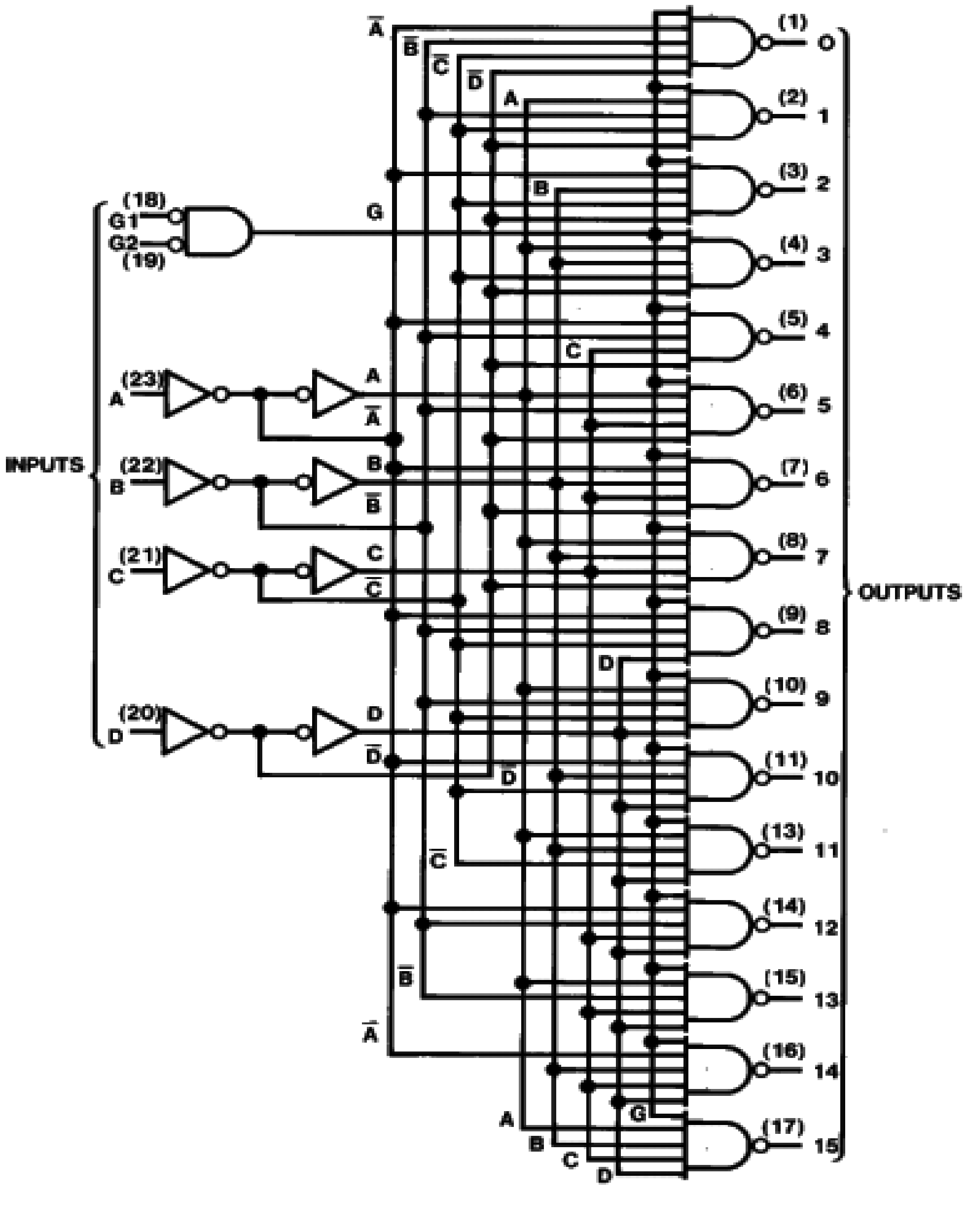
1. Complete DTMF Receiver
2. Low power consumption
3. Internal gain setting amplif
4. Adjustable guard time
5. Central office quality
6. Power-down mode
7. Inhibit mode

### 8.3.4 Applications

1. Receiver system for British Telecom (BT)
2. Paging systems
3. Repeater systems/mobile radio
4. Credit card systems
5. Remote control
6. Personal computers
7. Telephone answering machine

## 8.4 4 to 16 Decoder IC 74154

### 8.4.1 Internal Block Diagram




### 8.4.2 Description

Each of these4-line-to-16-linedecoder utilizes TTL circuitry to decode four binary-coded inputs into one of sixteen mutually exclusive outputs when both the strobe inputs G1 and G2 are low .The demultiplexing function is performed by using the 4 input lines to address the output line, passing data from one of the strobe inputs with the other strobe input low .When either strobe input is high all outputs are high These demultiplexers are ideally suited for implementing high performance memory decoders .All inputs are buffered and input clamping diodes are provided to minimize transmission-line effects and thereby simplify system design.

## 8.4.3 Features

1. Decodes 4binary-coded inputs into one of 16 mutually exclusive outputs
2. Performs the demultiplexing function by distributing data from one input line to any one of 16 outputs
3. Input clamping diodes simplify system design
4. High fan-out low-impedance totem-pole outputs
5. Typical propagation delay

    3 levels of logic 19 ns

    Strobe18ns

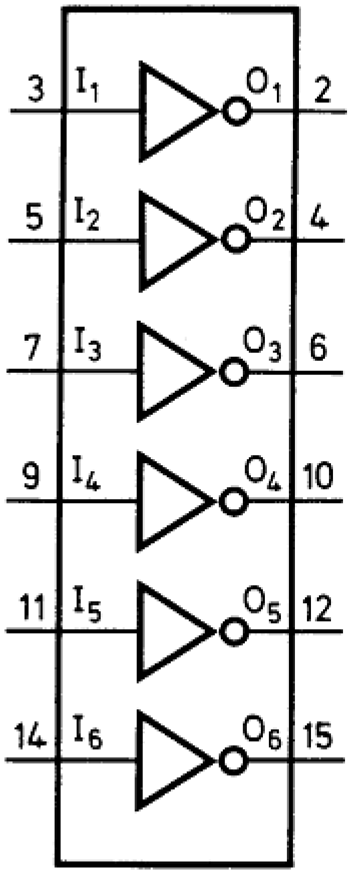
6. Typical power dissipation 170mW

## 8.4.4 Function Table

| Inputs | | | | | | Outputs | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| G1 | G2 | D | C | B | A | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| L | L | L | L | L | L | L | H | H | H | H | H | H | H | H | H | H | H | H | H | H | H |
| L | L | L | L | L | H | H | L | H | H | H | H | H | H | H | H | H | H | H | H | H | H |
| L | L | L | L | H | L | H | H | L | H | H | H | H | H | H | H | H | H | H | H | H | H |
| L | L | L | L | H | H | H | H | H | L | H | H | H | H | H | H | H | H | H | H | H | H |
| L | L | L | H | L | L | H | H | H | H | L | H | H | H | H | H | H | H | H | H | H | H |
| L | L | L | H | L | H | H | H | H | H | H | L | H | H | H | H | H | H | H | H | H | H |
| L | L | L | H | H | L | H | H | H | H | H | H | L | H | H | H | H | H | H | H | H | H |
| L | L | L | H | H | H | H | H | H | H | H | H | H | L | H | H | H | H | H | H | H | H |
| L | L | H | L | L | L | H | H | H | H | H | H | H | H | L | H | H | H | H | H | H | H |
| L | L | H | L | L | H | H | H | H | H | H | H | H | H | H | L | H | H | H | H | H | H |
| L | L | H | L | H | L | H | H | H | H | H | H | H | H | H | H | L | H | H | H | H | H |
| L | L | H | L | H | H | H | H | H | H | H | H | H | H | H | H | H | L | H | H | H | H |
| L | L | H | H | L | L | H | H | H | H | H | H | H | H | H | H | H | H | L | H | H | H |
| L | L | H | H | L | H | H | H | H | H | H | H | H | H | H | H | H | H | H | L | H | H |
| L | L | H | H | H | L | H | H | H | H | H | H | H | H | H | H | H | H | H | H | L | H |
| L | L | H | H | H | H | H | H | H | H | H | H | H | H | H | H | H | H | H | H | H | L |
| L | H | X | X | X | X | H | H | H | H | H | H | H | H | H | H | H | H | H | H | H | H |
| H | L | X | X | X | X | H | H | H | H | H | H | H | H | H | H | H | H | H | H | H | H |
| H | H | X | X | X | X | H | H | H | H | H | H | H | H | H | H | H | H | H | H | H | H |

## 8.5 Hex Inverting Buffer 4049

### 8.5.1 Internal Block Diagram




### 8.5.2 Description

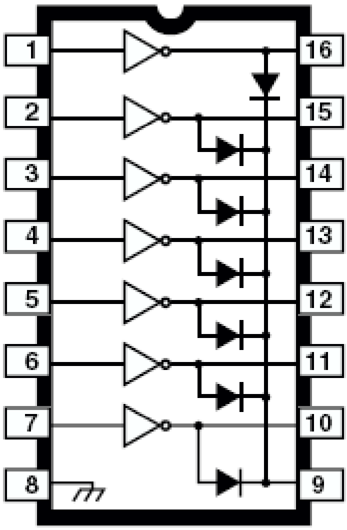
The HEF4049B provides six inverting buffers with high current output capability suitable for driving TTL or high capacitive loads. Since input voltages in excess of the buffers’ supply voltage are permitted, the buffers may also be used to convert logic levels of up to 15 V to standard TTL levels. Their guaranteed fan-out into common bipolar logic elements.

### 8.5.3 Applications

1. LOCMOS to DTL/TTL converter
2. HIGH sink current for driving 2 TTL loads
3. HIGH-to-LOW level logic conversion

# 8.6 IC 2003

## 8.6.1 Internal Block Diagram




## 8.6.1 Description

Ideally suited for interfacing between low-level logic circuitry and multiple peripheral power loads, the Series ULN20xxA/L high-voltage, high-current Darlington arrays feature continuous load current ratings to 500 mA for each of the seven drivers. At an appropriate duty cycle depending on ambient temperature and number of drivers turned ON simultaneously, typical power loads totaling over 230 W (350 mA x 7,95 V) can be controlled. Typical loads include relays, solenoids, stepping motors, magnetic print hammers, multiplexed LED and incandescent displays, and heaters. All devices feature open-collector outputs with integral clamp diodes.

## 8.6.2 Features

1. TTL, DTL, PMOS, or CMOS-Compatible Inputs
2. Output Current to 500 mA
3. Output Voltage to 95 V
4. Transient-Protected Outputs
5. Dual In-Line Plastic Package or Small-Outline IC Package

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