TALK FINE

Telephone Accessory Logical Kit For Industry's Noisy Environment

Project Report 1999 - 2000

Submitted By

M. K. Gopalakrishnan

P. Sadhasivam

J. Sathish

S. Vijaya Ramesh

Under the guidance of

Prof. Muthuraman Ramasamy M. E., M. I. E., C. ENGG(I)., M.IEE(USA).,(Ph.D).

in partal fulfilment of the requirement for the award of the Degree of

BACHELOR OF ENGINEERING IN

ELECTRONICS AND COMMUNICATION ENGINEERING

Of

Bharathiar University, CBE.

Department Of Electronics and Communication Engineering

KUMARAGURU COLLEGE OF TECHNOLOGY

Coimbatore – 641 006.

KUMARAGURU COLLEGE OF TECHNOLOGY

COIMBATORE-641006

Department of Electronics And Communication Engineering

Certificate

This is to Certify that this Project Entitled

TALKFINE

(Telephone Accessory Logical Kit For Industry's Noisy Environment)

Has been submitted by

Mr. M. K. Gopalakrishnan

Mr. P. Sadhasivam

Mr. J. Sathish

Mr. S. Vijaya Ramesh

in partial fulfilment of the requirements for the award of Degree of Bachelor of Engineering in the Electronics and Communication Engineering Branch of the Bharathiar University, Coimbatore –641046 during academic year 1999 – 2000

(GUIDE) (HEAD OF THE DEPARTMENT)

Certified that the Candidate was Examined by us in the Project Work.

Viva –voce Examination Held on 16.03.2000

University Register Number ....

(INTERNAL EXAMINER) (EXTERNAL EXAMINER)

A. P. M. Memorial Training Centre

(Sponsored by Narayani Charities)

Coimbatore,
06.03.2000.

The Head of the Department,
ECE Department,
Kumaraguru College of Technology,
Coimbatore.

Dear Sir,

This is to bring to your notice that the Project work titled " TALKFINE" done by the following 4 students,

Mr.M.K.GOPALAKRISHNAN
Mr.P.SADHASIVAN
Mr.J.SATHISH
Mr.S.VIJAYARAMESH

doing Final B.E (E.C.E) in your institution has been tested in our machine shop.

The instrument designed by them is in excellent working condition and it suited the noisy environment in the machine shop. We really appreciate their good work which would be very useful in our machine shop. So we have decided to sponsor for this project and get the module for ourselves.

Thanking you

Yours faithfully
for A.P.M.Memorial Training Centre,

M.Damodharan
Unit Incharge.

SF No. 822/823, Near SNGIT, Madukkarai, Coimbatore-641 105 — Phone : 822483

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ACKNOWLEDGEMENT

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We feel highly elated in manifesting our deep senses of thankfulness to our project guide **Prof.MUTHURAMAN RAMASAMY** ME., M.I.S.T.E., M.IEEE (USA)., C.ENGG (I)., (Ph.D)., The Head of the department. We can say with utmost confidence that he was the backbone of this project. We also thank **Prof.K.RAMPRAKASH** M.E., M.I.S.T.E., and **Prof.S.GOVINDARAJU** M.E., M.I.S.T.E., Assistant Professors of Electronics and Communication Engineering Department.

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We also thank our teaching and non-teaching staffs of Electronics department, Kumaraguru College of Technology. We also express our sincere gratitude to our parents without whose co-operation we wouldn't have completed this project. They provided us with the much needed inspiration and that helped us through the course of our project work.

Last but not the least we express our sincere gratitude to our classmates for all of them have been a source of encouragement, and have come out with useful ideas and suggestions about our project. We also thank other people who are not mentioned here for their bits and pieces of advice.

SYNOPSYS

Telephone Accessory Logical Kit For Industry's Noisy Environment

TALK FINE

This project "**TALK FINE**" provides an effective aid to enable easy communication through telephone in a noisy industrial environment. In the machine shop the noisy is so high that the ringing tone is inaudible, where the telephone accessory kit comes to the rescue. This project encompasses four modules which is briefed in the forthcoming paragraphs.

The first module gives a visual aid using a xenon lamp which is trigged at 4500V DC .The telephone ringing tone pulse is sensed and a xenon lamp flashes which can alert employees in and around 50 meters in the shop floor and this flash continues till the handset is lifted or till the ringing tone stops, whichever happens first. The second module gives an audio aid in the form of powerful siren after the fifth ring tone which will make someone lift the handset as the call happens to be an important one.

The third module provides an innovative caller line identification using a calculator, the main advantage of this circuit is its low cost. In the fourth Module a full fledged telephone amplifier is provided which needs no external supply. This enables the conversation to be heard clearly through an external speaker. Thus the Project gives a practically useful telephone accessory kit in a noisy environment at a very low cost.

This equipment has been tested in our laboratory and at A.P.M Training Centre (Unit of Universal Radiators Ltd.) and has proved to successful.

1.0 INTRODUCTION

In this project we have designed,devised and tested four full fledged modules for effective communication in the machine floor of an industry. In an industry the machine shop is the most noisy place. Whenever a person is being called through telephone the probability of hearing the ring tone is very less. In order to aid the person to attend the incoming call a xenon flash lamp is made to flash for every ring tone after sensing it through a special circuitry. This xenon lamp operators at 4500V DC for which a special trigger coil is used. This flash overcomes all the lighting in the machine shop and it can alert a person for about a radius of 50 meters and flash stops only when the handset is lifted or the ring tone stops, whichever happens first. This very high voltage circuitry is completely isolated from the Telephone line for safety purpose. This module in our project actually helps to communicate in a noisy environment. Often industrial people use intercom for frivolous queries to be asked . So after two or three rings if there is no one to disconnect the line on the other side if it is an important call, the caller waits for atleast four or five times to go.

In the machine floor if a person is called for these frivolous matters he gets irritated sometimes and the productivity may not go smoothly . There are also dangers of some injury to the person in the machine floor if he is disturbed again and again. So in order to alert the person for the important call this module of project gives a wave siren which enables him to lift the handset. This module needs a special circuitry for detecting upto 5 rings and alerting the person in machine floor by giving a reasonable sound to take the handset from the cradle for conversation.

The third module gives the provision for calling number identification through an innovative circuit which uses a calculator. The main advantage of this type of caller ID is its very low cost. This enables the person in the machine shop to decide whether the call is important or not This helps him to avoid unnecessary disturbances.

The last module enables the person in the noisy environment for effective conversation through the telephone. Often when a distant subscriber calls a person, his voice through the phone is very feeble. In order to enable the conversation to be heard clearly through an external speaker, this circuit is used.

The main feature of this circuit is that it doesn't need an external power supply as it draws power from the telephone line itself. A bright light will be thrown on all these modules of our project with effective terse illustrations in the forthcoming pages.

2.0 ABOUT TALK FINE

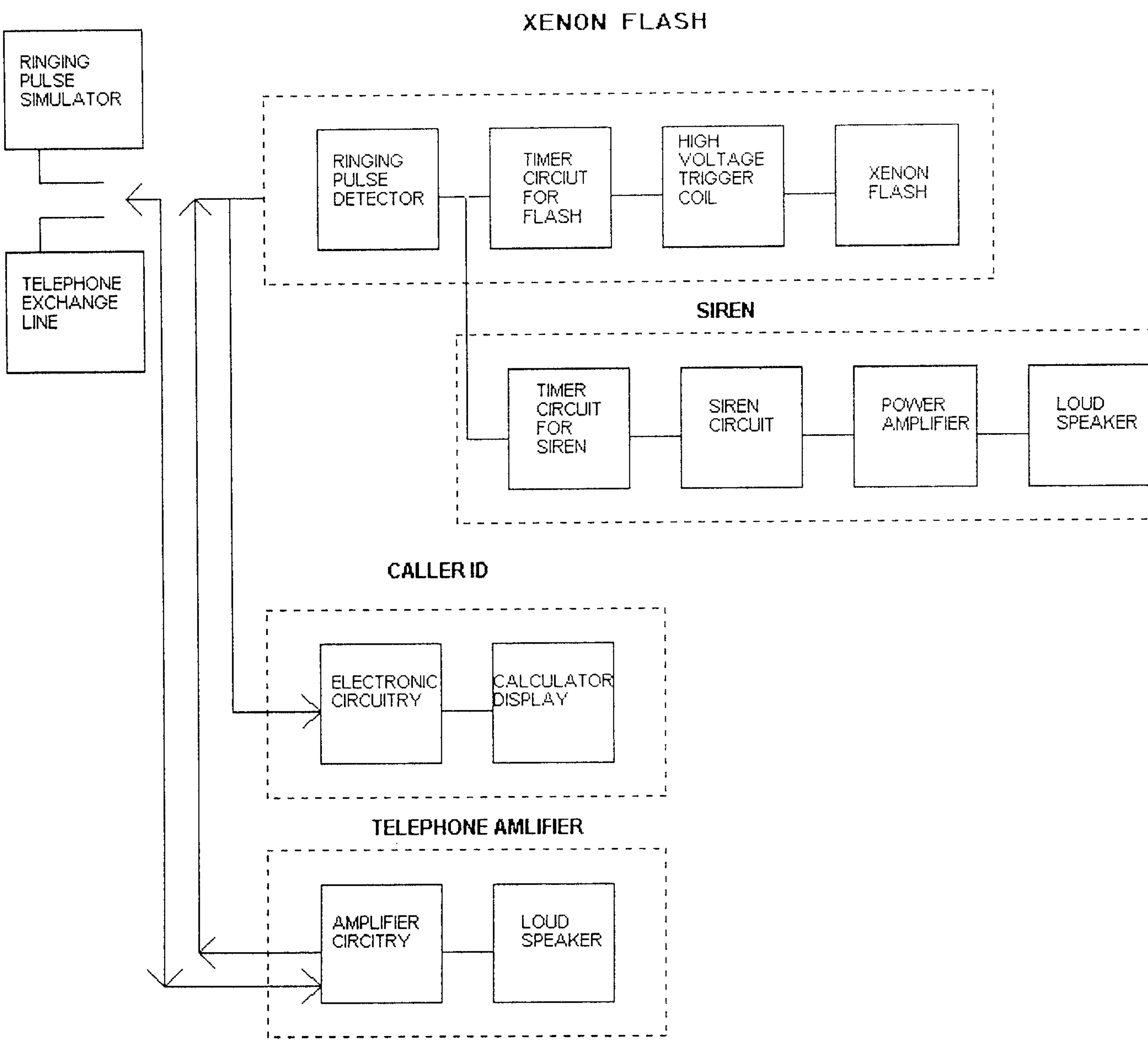
The telephone set is connected to either an exchange line or a telephone simulator. When the telephone rings the ringtone is sensed and this is used to trigger a high voltage coil and its output is used to flash a xenon lamp (about 4500v DC), Once the ringing starts the timer gets started. After the 5th ring the astable multivibrator circuit(timer) gives a high and this activates a siren. The siren as well as the flash stops only if the handset is lifted or if the caller stops the ringtone, whichever happens first. Calling number display module displays the caller's number. Here we use an innovative idea of display using a calculator. The last module is the telephone amplifier circuit connected in series with the telephone which enables conversation through the phone to be heard outside. The main advantages here is that it does not need an external power supply.

3.0 XENON FLASH MODULE :

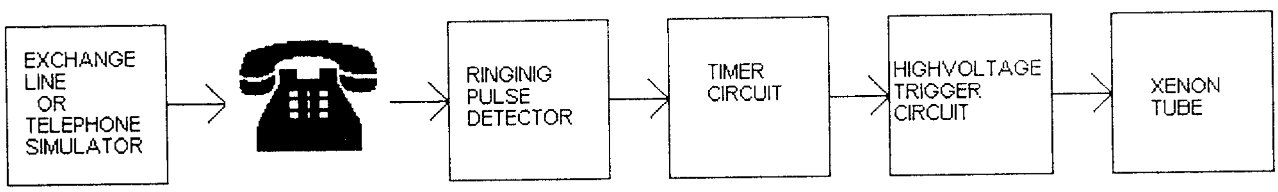
3.1 Block Diagram Explanation :

The Telephone goes to ringing mode when it gets appropriate pulses from the exchange line or the telephone simulator. The ringing pulse detector is connected in parallel to the telephone line which senses the ring tone. The timer circuit is in turn connected to high voltage trigger Circuit. This high voltage trigger circuit triggers the xenon lamp to flash at about 4500V DC . Thus when the telephone rings xenon lamp starts to flash.

BLOCK DIAGRAM



XENON FLASH MODULE

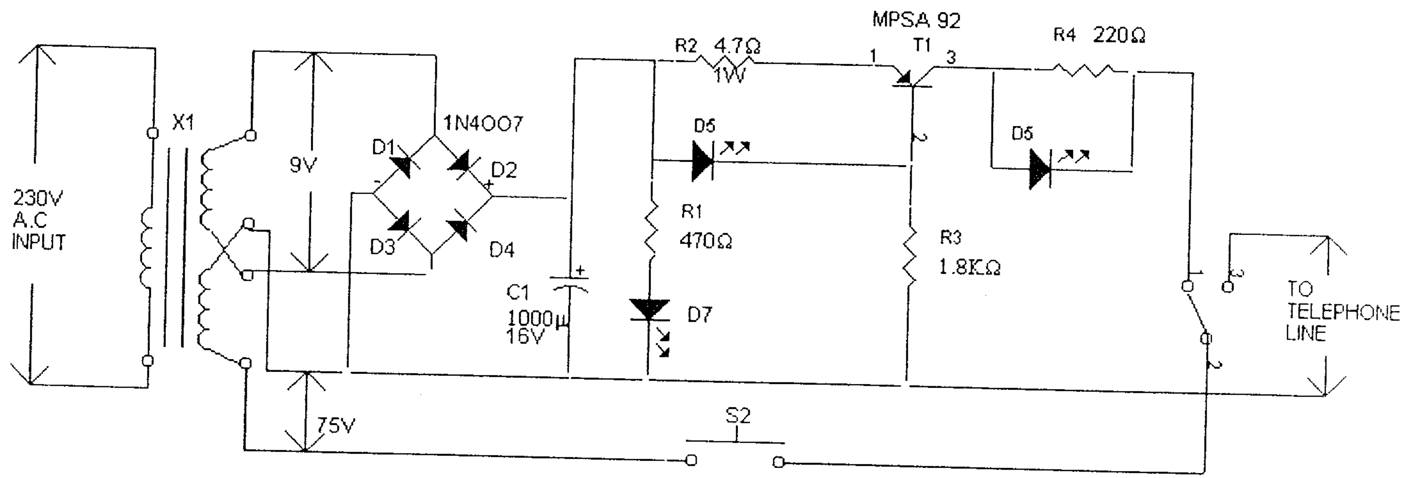


3.2 TELEPHONE SIMULATOR AND TESTER

The circuit described here is capable of testing almost all types of electronic telephone instruments. (The circuit consists of a mini power supply, providing 9V DC for normal testing and 75V AC for ring testing). The circuit is very useful for checking telephones, mainly during repairs and can simulate the ringing pulse. Here we provide this mainly for the demonstration of this project.

The heart of the circuit is transformer XI. Diodes DI-D4 form a bridge rectifier circuit. The circuit comprising resistors R2 and R3, and LED D5 provides 150 mA of constant current at 9 volts. LED D6 in conduction with resistor R4 functions as a response indicator which indicates whether a telephone under test is 'dead' or 'alive'. Switch S1 is used to select the testing mode (normal/ring). When switch S1 is in position 1 (normal mode), 9V supply is applied to the circuit. Switch S2 is connected in series with the 75V AC secondary winding of transformer X1,which functions as a ring generator.

TELEPHONE SIMULATOR AND TESTER



230 A.C Primary to
0-9V,500mA
0-75,150mA
Secondary
Transformer

3.2.1 Operation

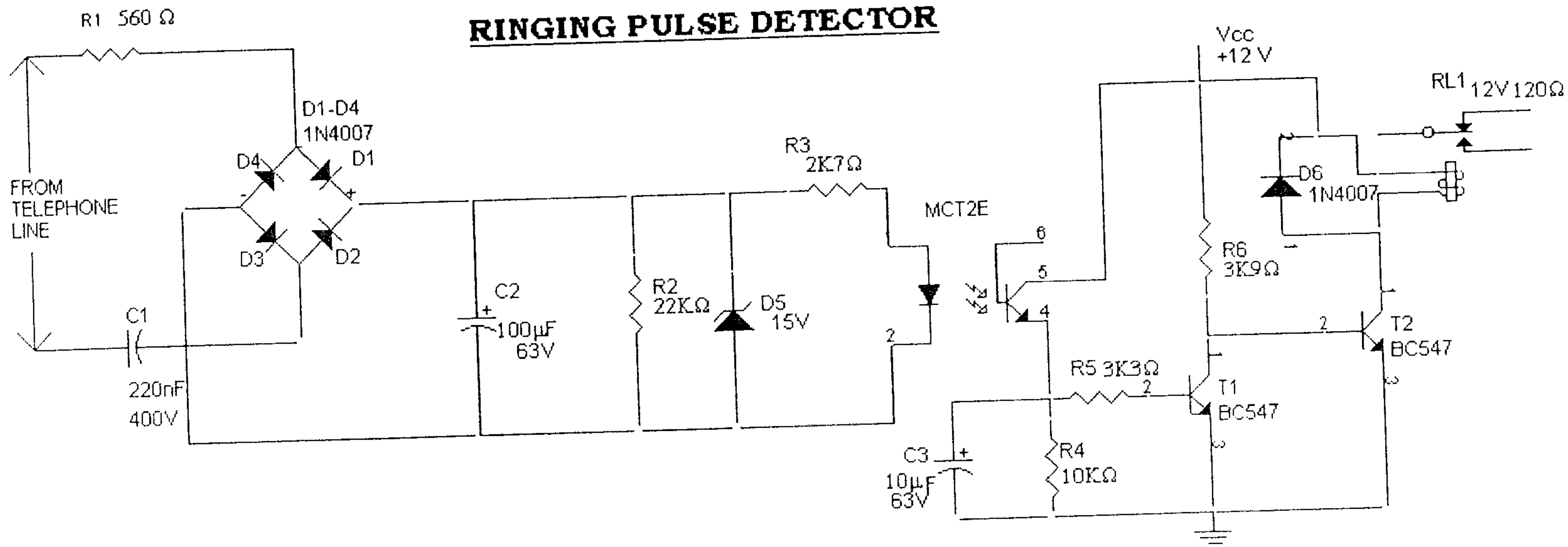
Operation of the circuit is quite simple. The telephone is connected to the test terminals with correct polarity and switch S1 is put to position 1. If Leeds D5 and D6 start glowing, it indicates that the telephone is having some sort of a short circuit. In case LEDs D5 and D6 do not glow, the handset is lifted. Now if LED D6 starts glowing, it indicates that the telephone circuit is alright. Any digit in the keypad is pressed and it is observed that LED D6 starts flickering, indicating that the dialling function is normal. When switch S1 is placed at position 2 and switch S2 is pressed, while keeping the handset on the cradle, a continuous bell will be heard if the ringer section is alright. Else, it is faulty.

3.3 RINGING PULSE DETECTOR

This circuit is used to make sure that ringing tone has been made by the activation of the optocoupler. Optocoupler is to isolate the telephone from the other circuits existing after it. When the phone rests on the cradle 48 volts DC reach the telephone. When someone rings ie., when a ring reaches the phone a 75 volts AC flows along 48 volts DC. To filter 48 volts DC we put a capacitor Cl(220nF,400V). This allows only75 volts AC to pass through it. This 75 volts AC is reduced a little before it is given to bridge rectifier circuit. This bridge rectifier circuit converts AC voltage to pulsating DC. This pulsating DC is converted to constant DC using a filter which is nothing but a capacitor (100 μF,25 V) Parallel with a 22 kΩ. resistor. This produces constant DC value.A zener diode(125V,500mV)is used to limit the voltage output and gives a constant 15V DC output. Optocoupler LED needs only 2 V to glow and so a 2.7 KΩ, resistor is used to reduce the voltage of 25V to a lower value. When this LED glows it activates the phototransistor.

The phototransistor's collector is connected to 12 V and the emitter through a 3.3 KΩ. It is connected to the base of BC 147 transistor T1,that activates the relay. Capacitor C3 is used to charge when the ring tone occurs. When T1 is on the relay is switched on. A reverse biased diode is kept parallel to the relay (12V,120Ω). This is to avoid "inductive kick" effect which spoils the induction coil of the relay.

RINGING PULSE DETECTOR

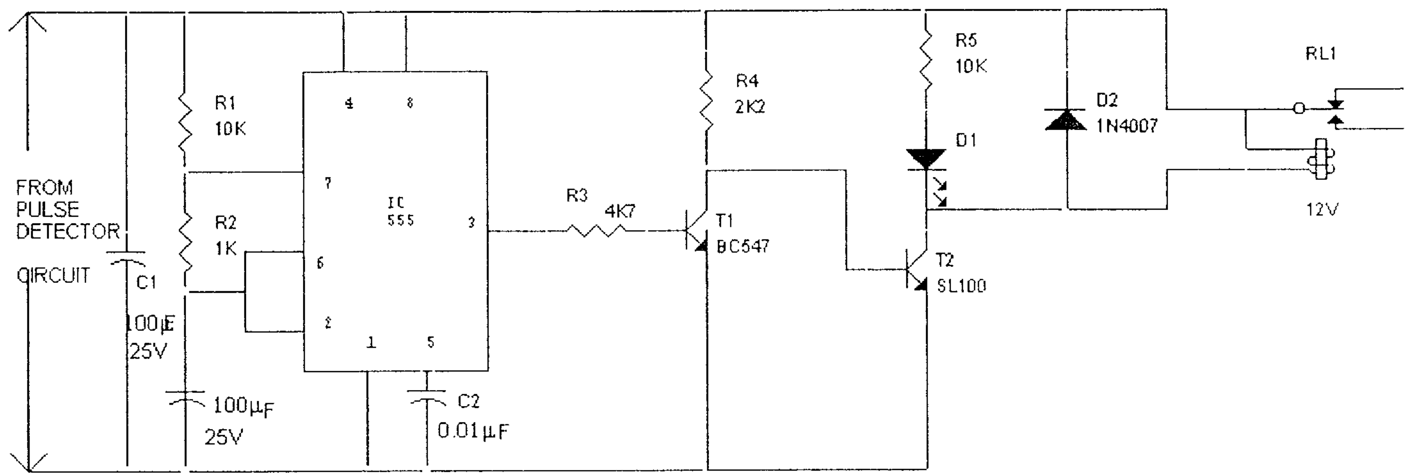


3.4 TIMER CIRCUIT –XENON FLASH MODULE

3.4.1 Astable operation

As the relay gives the supply to the astable multivibrator the capacitor charges through Ra & Rb, when the voltage of the capacitor is around 2/3 of the supply voltage,the voltage comparator in the IC555 sets a flip flop and this drives the output pin to a high state. After this time the capacitor starts discharging through R2 and as its voltage passes below 1/3 of supply voltage another comparator in the time IC chip resets the flip flop so that pin3(output) goes to a low state. The ON time & OFF time are decided by the resistor Ra, Rb and capacitor C.

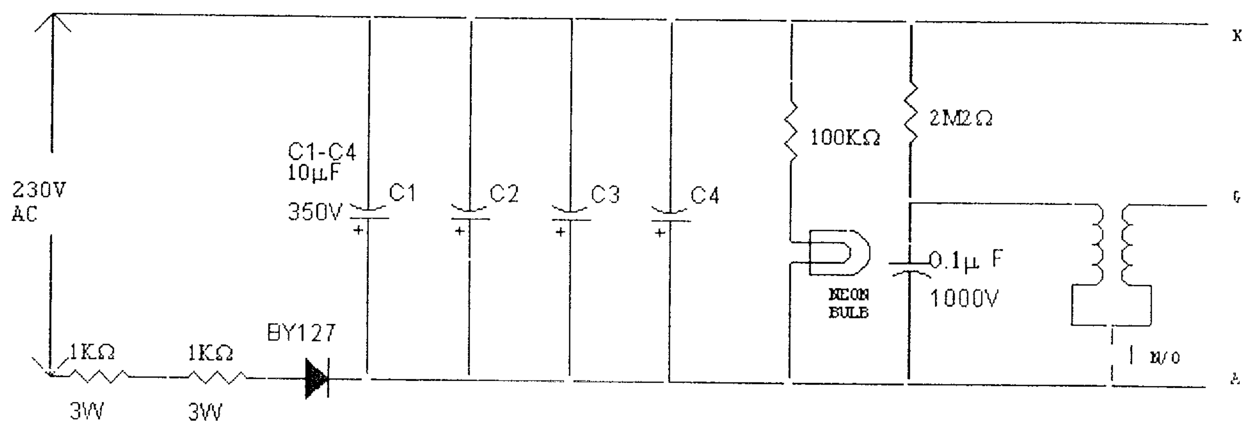
TIMER CIRCUIT



3.5 HIGH VOLTAGE TRIGGER CIRCUIT

In this circuit 230 V AC is converted to a very high DC voltage about 4500 volts DC which can flash a xenon lamp. 230 volts is set through two 3W 1K Ω resistors and a diode D1(BY 127) which is used to give a half wave rectified output which is sent across 47 μF, 350volts. Capacitor 47 μF, 350v could have been directly used but for practically feasibility and availability, we use 10 μF, 400V capacitors in parallel (C1,C2,C3,C4). These capacitors charge to a high voltage. Charging of the Capacitors is indicated by the glow a neon lamp which is kept across Capacitors C1,C2,C3,C4 and to limit current through the neon lamp, we use a 100 kilo Ω resistor R3 . This high voltage charges the capacitor C5 (0.1μF ,1000V) through a 2.2 M Ω resistor R4. Junction of C5 and R4 is connected to the primary of the trigger coil. One end of the secondary is connected to the grid. The unconnected ends of the primary and secondary coils are connected to the normally open coils of a relay on receiving the ring tone the normally open relay closes and the primary and the secondary are suddenly grounded and a very high voltage of about 4500V DC releases the grid meanwhile anode and cathode are maintained at a high potential voltage i.e. across A and K is approximately that across the capacitor. A flow of charges takes place from anode to cathode and this discharge appears as a flash in the tube.

HIGH VOLTAGE TRIGGER CIRCUIT

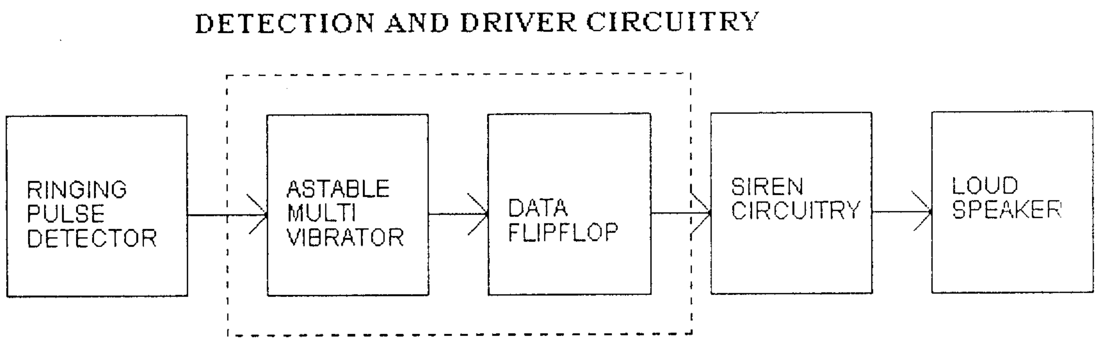


4.0 TALKFINE'S SIREN MODULE

4.1 Detection and driver circuitry

This circuit detects the ringing pulses and operates the siren at the 5^{th} pulse. If the handset has not been lifted or if the ring tone does not stop. If either of this happens the relay opens and cuts off the supply to the forthcoming circuits in the module .The relay of the first switches of an astable mulitvibarator. The astable mutivibrator circuit is constructed using timer IC. The ON time of this is 1 second. As the astable multivibrator starts with an ON time the output of it is given at NOT gate . The output of the NOT gate is fed to an AND gate. Now when the astable multivibrator is ON the NOT gate gives a low pulse of time period 13 seconds and high pulses for around 1 second. The design is made in purpose because the fifth ringing sounds exactly 12 seconds and 70 milliseconds after the start of first ringing tone. The NOT gate output is given to an AND(gate) whose another input comes from Q pin of D-Flip flop.

BLOCK DIAGRAM OF SIREN MODULE



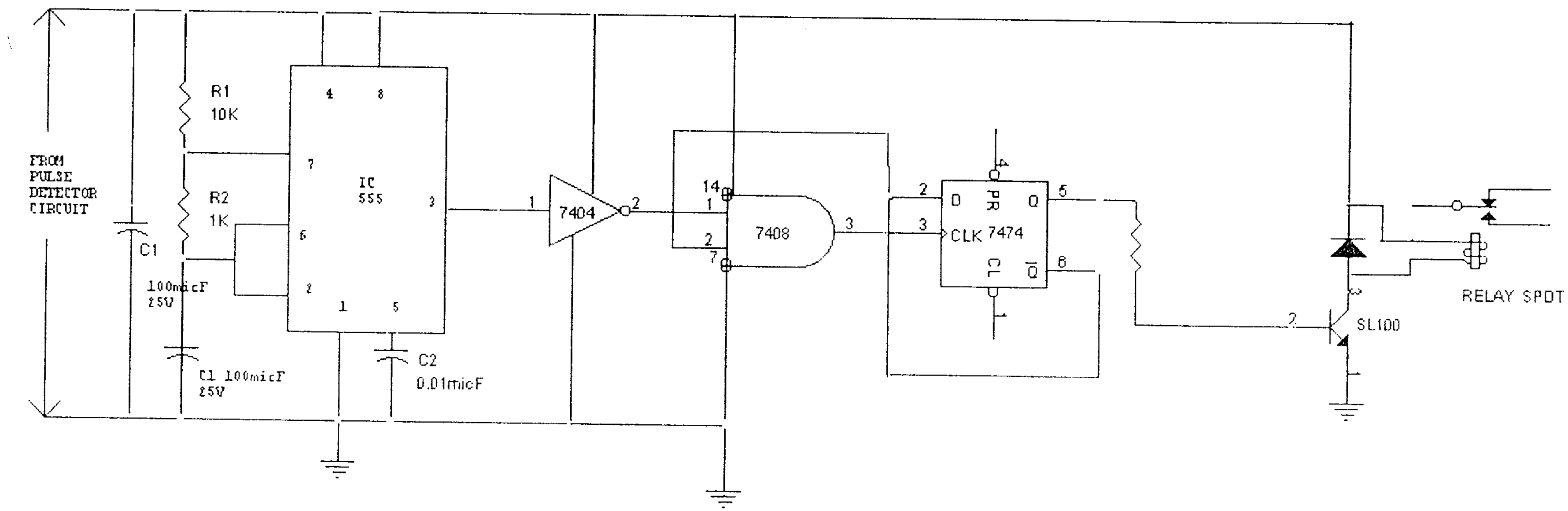
4.2 Control Circuitry

The $\overline{Q}$ pin is tied to the D input so that for a first clock the Q output goes high and remains high till it receives the second close pulses. It is also connected with a separate battery to avoid problems of presetting D flipflop.

The $\overline{Q}$ pin is connected to the AND gate which gives a high output since the initial stage of Q is high. After the NOT gate switches the D flipflop the output becomes low and this stops further interruption from the previous circuits. For driving the relay we use a NPN transistor SL100. Its base is connected to the Q output of the D flip flop. At the collector of SL100 we have a diode and a relay to switch ON the siren. The diode is connected in parallel to avoid the reverse current.

If the ring tone stops or if the called person lifts the handset from the cradle we have to stop the flash and the siren modules. Since they are connected to the same relay as and when either of the two things happen the relay opens and the supply to the entire circuit is cut off.

DETECTION AND DRIVER CIRCUITRY



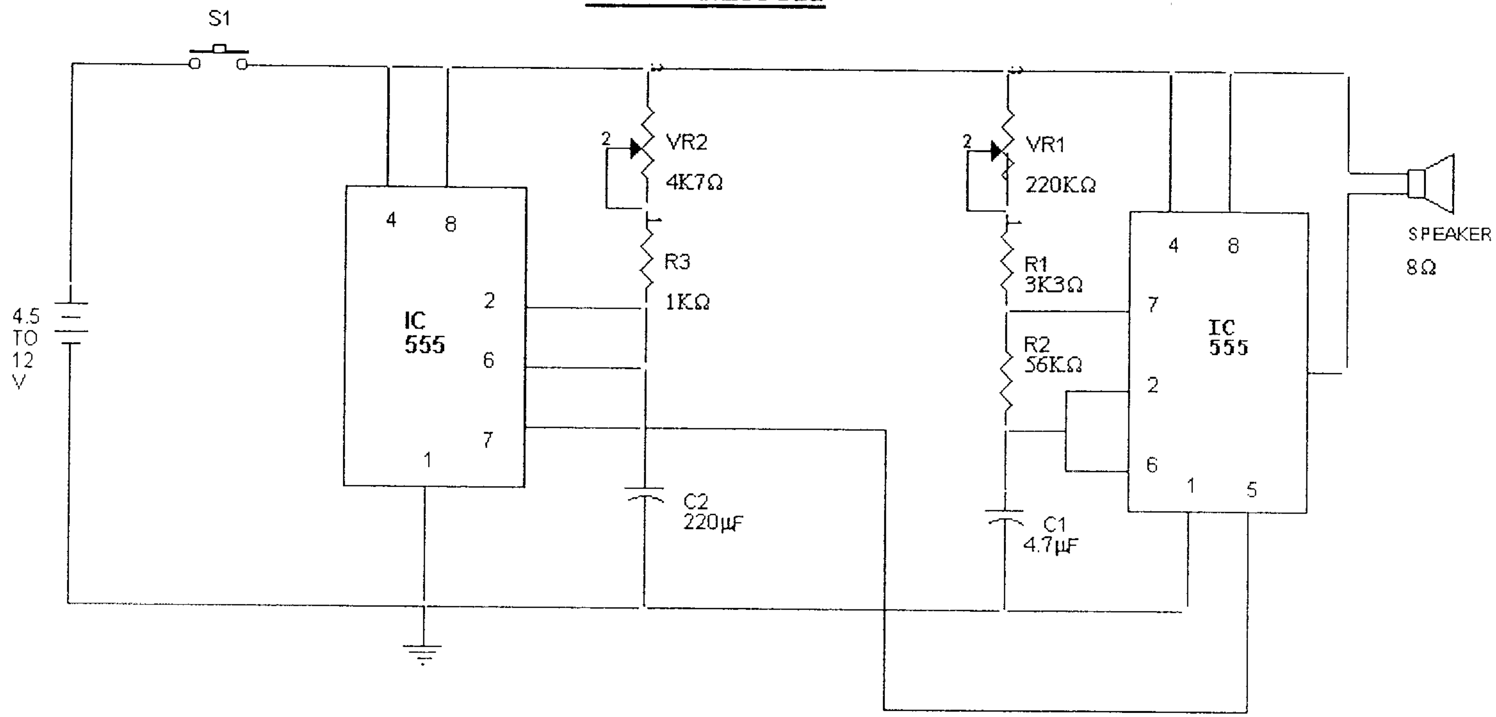
4.3 SIREN CIRCUIT

This circuit uses two timers. IC1 functions as a normal astable multivibrator. Therefore the output of this IC are rectangular waves. If IC2 were not there this output will drive the loud speaker, producing a tone whose frequency can be adjusted by varying VR1. However the presence of IC2 and the manner in which it is connected to IC1 produces a totally different effect.

IC2 is wired to generate a saw-tooth output. This output is available at pin6 of IC2 and is applied to pin5 of IC1. Now pin5 of the timer is connected to the inverting terminal of the thereshold comparator inside the timer. The terminal has 2/3 Vcc and is therefore available at pin 5 also.

By applying saw tooth voltage out put of IC2 of pin5 of IC1 the output of IC1 is frequency modulated with sawtooth voltage. The frequency of the sawtooth can be varied by means of VR2 the frequency modulated signal then activates the load speaker which emits sound like that of a siren. The pitch of the sound can be adjusted by means of VR1 and the modulation rate by means of VR2.

SIREN CIRCUIT



5.0 CALLING NUMBER IDENTIFICATION SYSTEM

Here is a simple and inexpensive circuit to identify the calling number of the telephone system. Recently the telecommunication department has introduced the facility of calling number identification system for cities like Mumbai and NewDelhi. Many companies have already advertised their products which can display. The calling number with added features like storage of the previous calling numbers and desired number blanking etc.., But these units are quite expensive. The circuit of calling number identification system presented here will cost less than Rs:450 including the cost of a calculator which has been used in the project for displaying the calling number.

The dedicated CM DTMF TO BCD converter IC KT3170 or 8870 forms the heart of the circuit. The IC converts the incoming DTMF signals sent by the MTNL in between the ringing signals into corresponding BCD codes. IC KT3170 or its equivalent CM 8870 is low power CMOS IC having the following features,

1. Detects all 16 standards DTMF tones
2. Typical power consumption is 15 mw
3. Single 5 V power supply operation.

4. Three state outputs for interfacing to microprocessors

5. Uses commonly available 3.579545 MHz crystal

6. Valid input signal range range is as low as –29 dbm

7. Can be used in single ended or differential input signal configuration.

Pin description of KT3170/CM8870 IC is given in the box above. The BCD coded outputs from decoder IC5 are converted into decimal signals by IC4 which is BCD to decimal decoder. The output pins of IC will be high corresponding to the BCD given at the input of IC4. The BCD output from IC5 is coupled to IC4 via four AND gates.

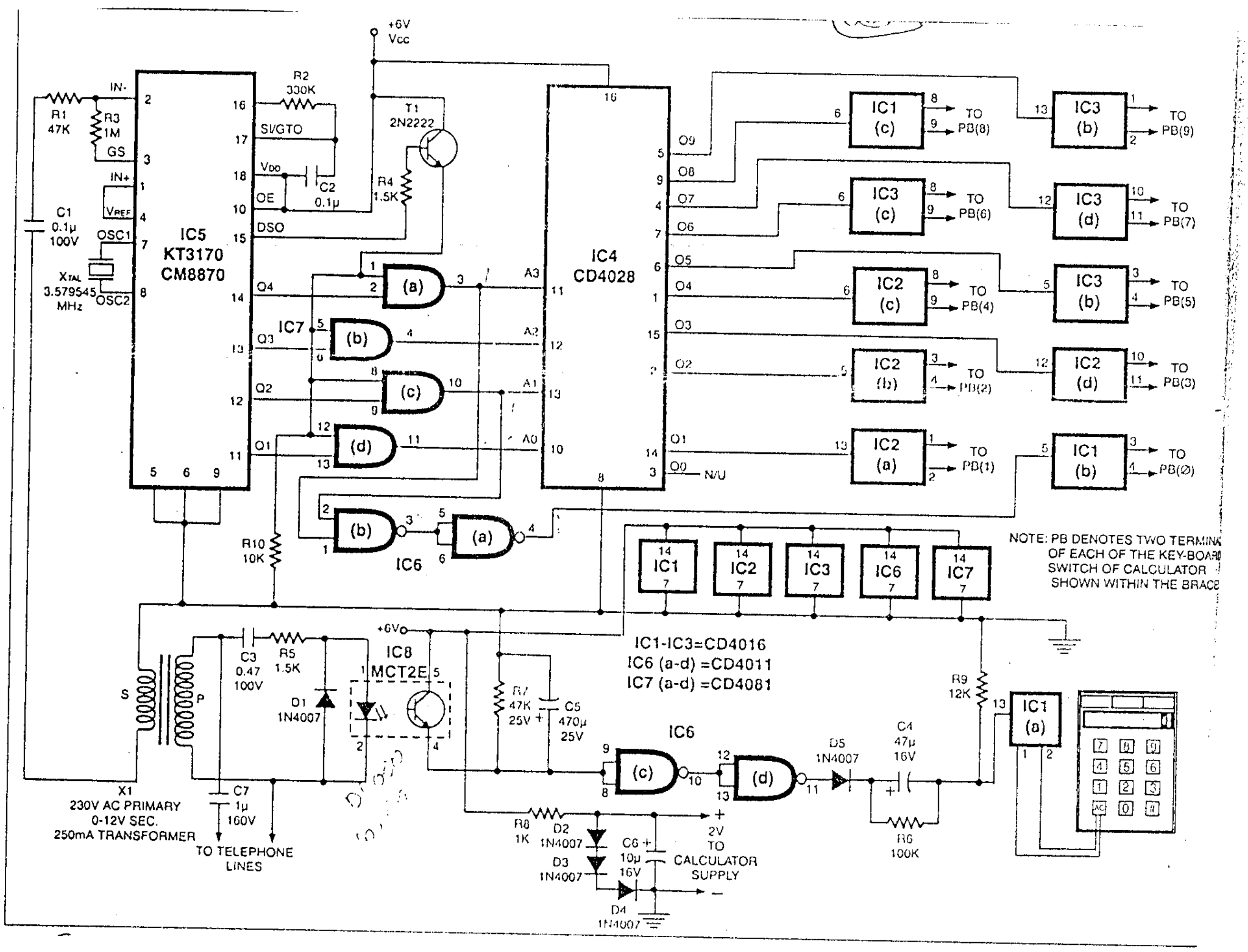
The gates are enabled by the delayed steering output (DOS), a pulsed digital signal available at pin 15 of IC5 which will be high only when the DTMF tone is detected by the IC. ICI through IC3 are all quad analog switches controlled by the decimal outputs from IC4. The analog switches are controlled by the decimal outputs from IC4. The analog switch triggers from the corresponding decimal number in the calculator which is used as a display in the circuit. IC4 responds to all the BCD codes except the zero decimal because the output of IC5 for zero will be 1010 which will not activate IC4. NAND gate is used to sense the zero code. Active low input of gates IC6(A) is to trigger the "0"display in the calculator.

IC9 is an optocoupler. It is wired to sense the ringing signals . When the first ring comes the output of IC6 goes high because the transistor inside the optocoupler conducts. Capacitor C5 holds the input high for few seconds the output of IC6 also goes high simultaneously and it causes a pulse to pass through capacitor C4 which closes the analog switch and the calculator is switched on. Any common type of calculator can be used for this application. However one should ensure that the calculator has 10 or more digits so that the calling number along with area code etc could be accommodated for interfacing the calculator with this circuit.

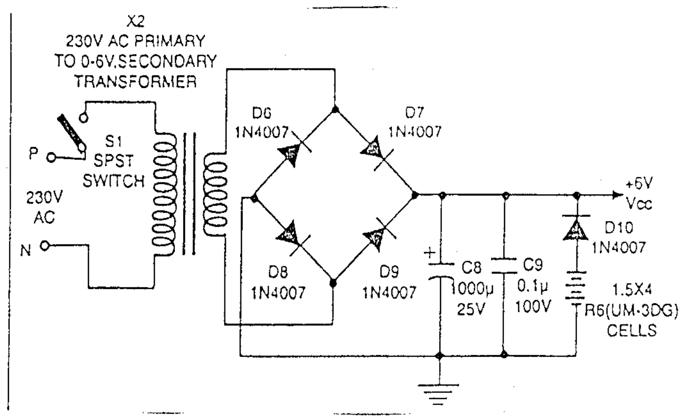
The cabinet of the calculator is removed. It is seen that the tracks under the pushbutton side are etched in such a way that when a pushbutton is pressed the corresponding two tracks under the pushbutton gets shorted. A pair of leads is taken from the corresponding two tracks by scratching the green mask and soldering the wires carefully.

A proper actual size single sided PCB for the circuits is shown and its components layout is shown. After assembling the unit can be fixed into a small plastic enclosure which should have a cutout for the display.

The power supply for the calculator can be taken from the circuit itself. If the calculator requires 3V for operation, the diode D2 through the D4 is replaced with a 3.3V, 250 mW zener. The given power supply circuit having a battery back up is suggested for proper operation. Not only calling numbers but even the called numbers are displayed on calculator display. Apparently lifting of the handset from cradle, which causes sudden change of voltage from 48v to about 12 volts, sends a pulse to switch ON the calculator to display the dialed numbers. Capacitor C7 is added in the original circuit to obviate loading of the telephone line to avoid its behaving as busy while the handset is still on the cradle.



+6V Vcc
R1 47K
R3 1M
C1 0.1µ 100V
IC5 KT3170 CM8870
R2 330K
C2 0.1µ
T1 2N2222
R4 1.5K
IC4 CD4028
IC7
IC6
R10 10K
XTAL 3.579545 MHz
X1
230V AC PRIMARY
0-12V SEC.
250mA TRANSFORMER
C3 0.47 100V
R5 1.5K
D1 1N4007
IC8 MCT2E
C7 1µ 160V
TO TELEPHONE LINES
R7 47K 25V
C5 470µ 25V
R8 1K
D2 1N4007
D3 1N4007
D4 1N4007
C6 10µ 16V
2V TO CALCULATOR SUPPLY
D5 1N4007
C4 47µ 16V
R6 100K
R9 12K
IC1-IC3=CD4016
IC6 (a-d) =CD4011
IC7 (a-d) =CD4081
NOTE: PB DENOTES TWO TERMINALS OF EACH OF THE KEY-BOARD SWITCH OF CALCULATOR SHOWN WITHIN THE BRACE

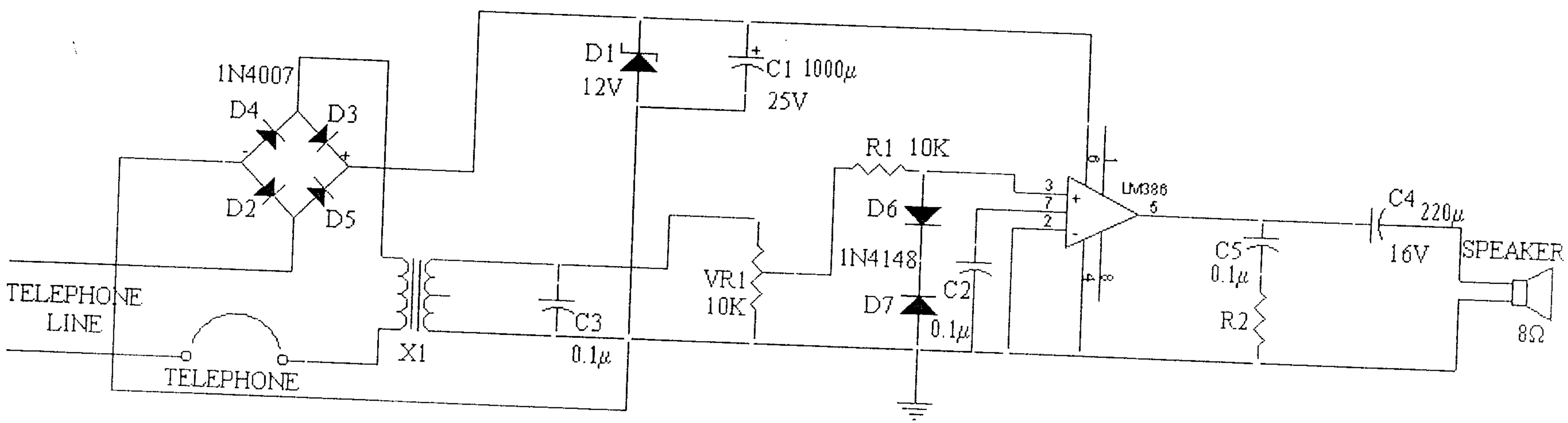

X2
230V AC PRIMARY
TO 0-6V SECONDARY
TRANSFORMER
P
S1
SPST
SWITCH
230V
AC
N
D6
1N4007
D7
1N4007
D8
1N4007
D9
1N4007
+6V
Vcc
D10
1N4007
C8
1000μ
25V
C9
0.1μ
100V
1.5X4
R6(UM-3DG)
CELLS

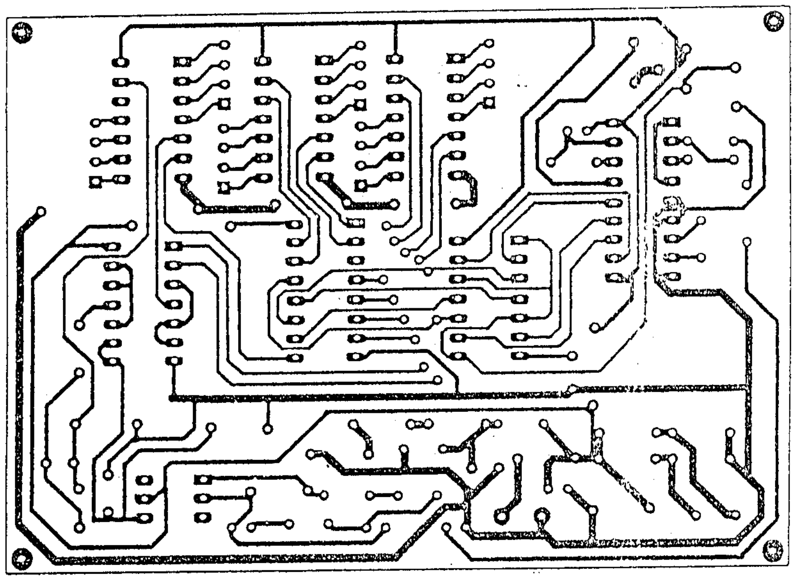
6.0 TELEPHONE AMPLIFIER

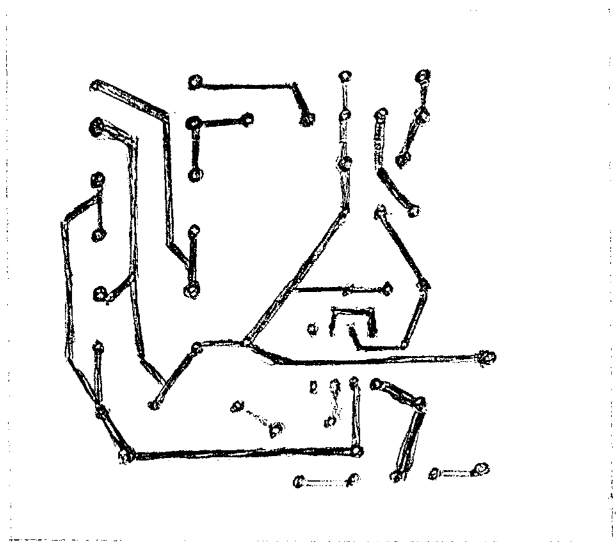
While talking to a distant subscriber and in the noisy environment on telephone, quite often we feel frustrated when the voice of the subscriber is so faint that is barely intelligible. To overcome the problem, a circuit of an inexpensive amplifier is presented here. It can be assembled and tested easily. There is no extra power source needed to power up the circuit, as it draws power from the telephone line itself.[7] The amplifier will provide fairly good volume for the telephone conversation to be properly heard in a living room. A volume control is included to adjust the volume as desired.

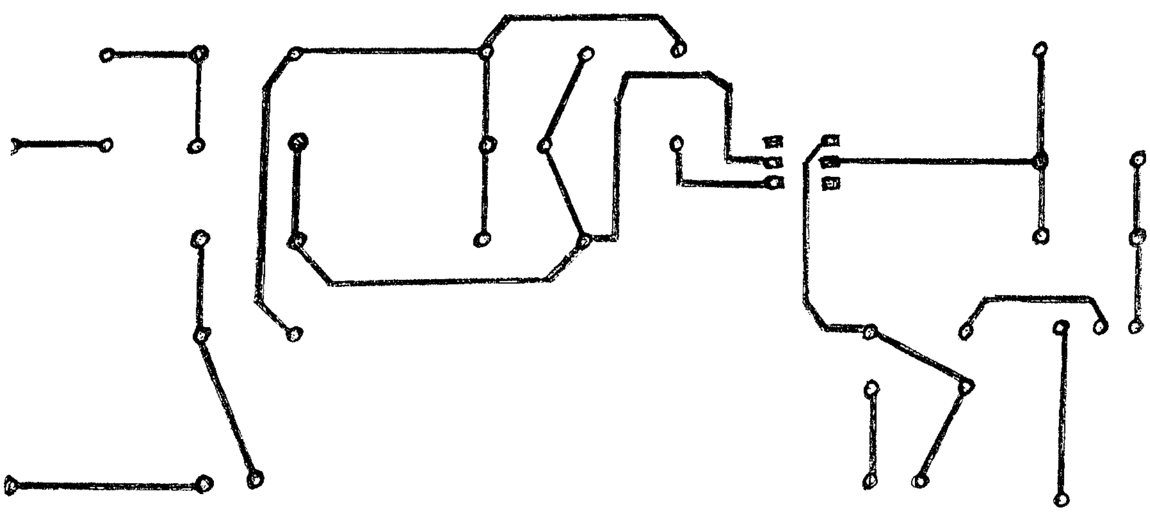
The circuit is built around IC LM 386. Diodes D6 and D7 are used to limit the input signal strength. Transformer X1 is a transistor radio's output transformer used in reverse. As original secondary (output) winding is connected in series with the telephone lines, the speech signal passing through the lines cause change in the magnetic flux in the core of transformer and thereby induce signal voltage across the primary winding. The audio signal is used as input for IC LM386. Diode D2 through D5 connected in bridge configuration constitute a polarity guard so that the amplifier is powered with correct polarity, irrespective of the polarity. Zener diode D1 may have any breakdown voltage between 6 and 12 volts range.

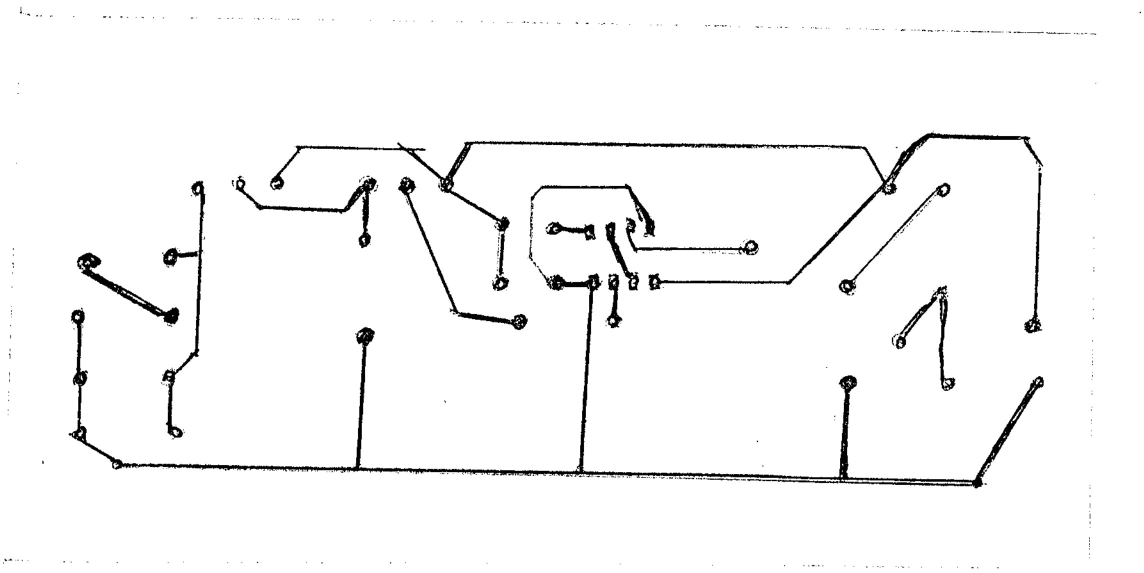
TELEPHONE AMPLIFIER

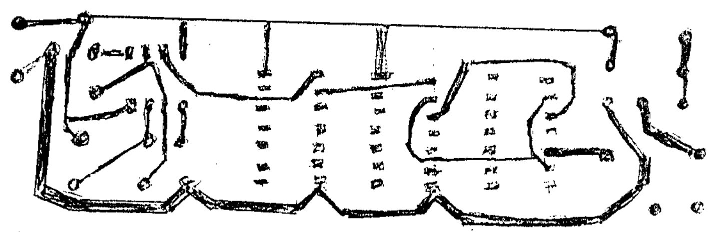


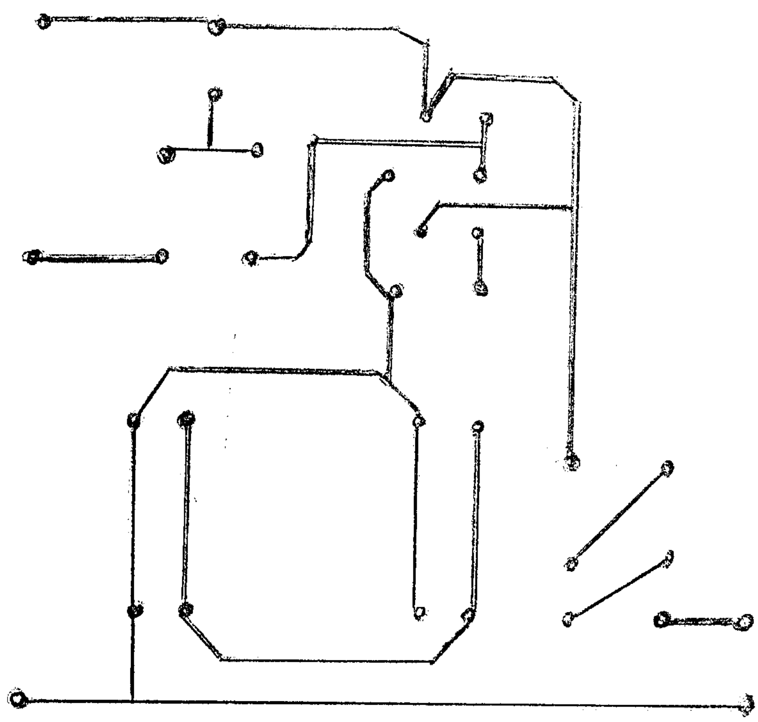


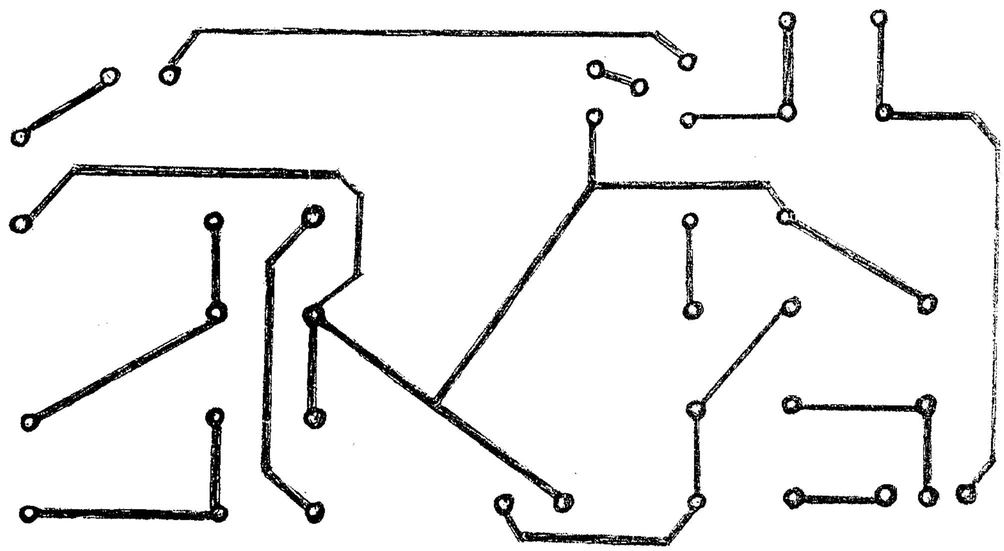












8.0 ADVANTAGES AND LIMITATIONS OF TALKFINE:

8.1 ADVANTAGES:

- Cost of the kit is very reasonable.
- Components used are all available easily.
- It suits noisy environment very well and test results proved to be excellent.
- Easily mountable on a small board.
- They are less prone to atmospheric and physical damages.

8.2 LIMITATIONS:

- The instrument should have been little more compact.
- Siren happens to be irritating at some instances.

9.0 FUTURE EXPANSIONS

We have following proposed plants to extend out project

- ☞ To include memory to called ID device so that it can store about 100 Telephone numbers. Further the instrument should have provision to store 10 different messages which can be altered at will. The information to be conveyed is to be stored in the memory along with the destination phone number.Every time a person calls us the Caller ID checks the number displayed and the 10 destination phone numbers stored. Suppose the number matches and also the called end person is absent the instrument transmits the information recorded by called end person to the caller. This would be very helpful if the person having this kit needs to send some information to the caller even in his absence.

- ☞ To implement a call diverter circuit which will divert the phone calls for this phone to some other phone where the person is at present available. This is very useful for administrative people as they are on the move. The phone should be made to have a facility of recording a phone number to which a call can be diverted.

10.0 SOME CONCULDING THOUGHTS:

Thus this project encompasses 4 full fledged modules, making "**TALK FINE**" an efficient instrument in the industry. Test results at our laboratory and **"APM TRAINING CENTRE"** has been successful and has been appreciated. The extension of our project as we have mentioned earlier in the previous chapter, would be done with the financial support of **"APM TRAINING CENTRE"**. Some of the drawbacks encountered in the present set up would be rectified and this instrument would grow out to be a very useful kit in the noisy industrial environment.

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National Semiconductor

LM386 Low Voltage Audio Power Amplifier

General Description

The LM386 is a power amplifier designed for use in low voltage consumer applications. The gain is internally set to 20 to keep external part count low, but the addition of an external resistor and capacitor between pins 1 and 8 will increase the gain to any value up to 200.

The inputs are ground referenced while the output is automatically biased to one half the supply voltage. The quiescent power drain is only 24 milliwatts when operating from a 6 volt supply, making the LM386 ideal for battery operation.

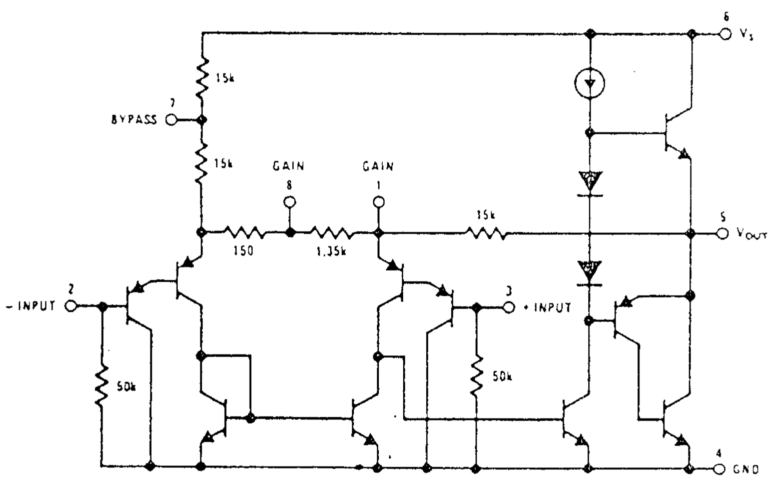
Features

- Battery operation
- Minimum external parts
- Wide supply voltage range 4V–12V or 5V–18V
- Low quiescent current drain 4 mA
- Voltage gains from 20 to 200
- Ground referenced input
- Self-centering output quiescent voltage
- Low distortion
- Eight pin dual-in-line package

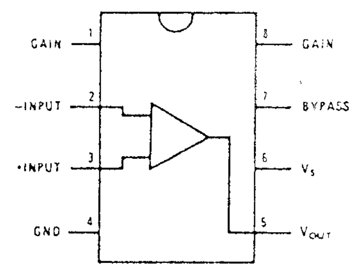
Applications

- AM-FM radio amplifiers
- Portable tape player amplifiers
- Intercoms
- TV sound systems
- Line drivers
- Ultrasonic drivers
- Small servo drivers
- Power converters

Equivalent Schematic and Connection Diagrams



Dual-In-Line Package

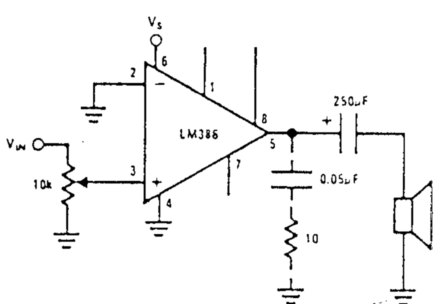


TOP VIEW

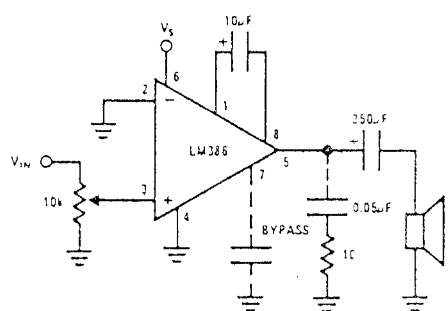
Order Number LM386N-1, LM386N-3 or LM386N-4
See NS Package N08B

Typical Applications

Amplifier with Gain = 20
Minimum Parts



Amplifier with Gain = 200



Absolute Maximum Ratings

Supply Voltage (LM386N)	15V
Supply Voltage (LM386N-4)	22V
Package Dissipation (Note 1) (LM386N-4)	1.25W
Package Dissipation (Note 2) (LM386)	660 mW
Input Voltage	±0.4V
Storage Temperature	−65°C to +150°C
Operating Temperature	0°C to +70°C
Junction Temperature	+150°C
Lead Temperature (Soldering, 10 seconds)	+300°C

Electrical Characteristics $T_A = 25°C$

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Operating Supply Voltage (V_S)					
LM386		4		12	V
LM386N-4		5		18	V
Quiescent Current (I_Q)	V_S = 6V, V_{IN} = 0		4	8	mA
Output Power (P_{OUT})					
LM386N-1	V_S = 6V, R_L = 8Ω, THD = 10%	250	325		mW
LM386N-3	V_S = 9V, R_L = 8Ω, THD = 10%	500	700		mW
LM386N-4	V_S = 16V, R_L = 32Ω, THD = 10%	700	1000		mW
Voltage Gain (A_V)	V_S = 6V, f = 1 kHz		26		dB
	10μF from Pin 1 to 8		46		dB
Bandwidth (BW)	V_S = 6V, Pins 1 and 8 Open		300		kHz
Total Harmonic Distortion (THD)	V_S = 6V, R_L = 8Ω, P_{OUT} = 125 mW f = 1 kHz, Pins 1 and 8 Open		0.2		%
Power Supply Rejection Ratio (PSRR)	V_S = 6V, f = 1 kHz, C_{BYPASS} = 10μF Pins 1 and 8 Open, Referred to Output		50		dB
Input Resistance (R_{IN})			50		kΩ
Input Bias Current (I_{BIAS})	V_S = 6V, Pins 2 and 3 Open		250		nA

Note 1: For operation in ambient temperatures above 25°C, the device must be derated based on a 150°C maximum junction temperature and a thermal resistance of 100°C/W junction to ambient.

Note 2: For operation in ambient temperatures above 25°C, the device must be derated based on a 150°C maximum junction temperature and a thermal resistance of 187°C junction to ambient.

Application Hints

GAIN CONTROL

To make the LM386 a more versatile amplifier, two pins (1 and 8) are provided for gain control. With pins 1 and 8 open the 1.35 kΩ resistor sets the gain at 20 (26 dB). If a capacitor is put from pin 1 to 8, bypassing the 1.35 kΩ resistor, the gain will go up to 200 (46 dB). If a resistor is placed in series with the capacitor, the gain can be set to any value from 20 to 200. Gain control can also be done by capacitively coupling a resistor (or FET) from pin 1 to ground.

Additional external components can be placed in parallel with the internal feedback resistors to tailor the gain and frequency response for individual applications. For example, we can compensate poor speaker bass response by frequency shaping the feedback path. This is done with a series RC from pin 1 to 5 (paralleling the internal 15kΩ resistor). For 6 dB effective bass boost: R ≅ 15 kΩ, the lowest value for good stable operation is R = 10 kΩ if pin 8 is open. If pins 1 and 8 are bypassed then R as low as 2 kΩ can be used. This restriction is because the amplifier is only compensated for closed-loop gains greater than 9.

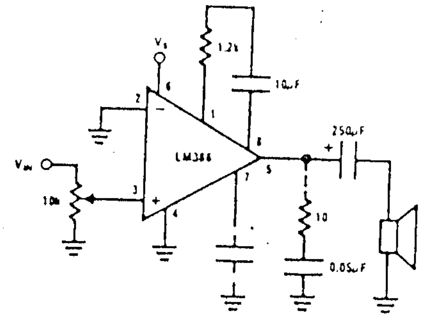
INPUT BIASING

The schematic shows that both inputs are biased to ground with a 50 kΩ resistor. The base current of the input transistors is about 250 nA, so the inputs are at about 12.5 mV when left open. If the dc source resistance driving the LM386 is higher than 250 kΩ it will contribute very little additional offset (about 2.5 mV at the input, 50 mV at the output). If the dc source resistance is less than 10 kΩ, then shorting the unused input to ground will keep the offset low (about 2.5 mV at the input, 50 mV at the output). For dc source resistances between these values we can eliminate excess offset by putting a resistor from the unused input to ground, equal in value to the dc source resistance. Of course all offset problems are eliminated if the input is capacitively coupled.

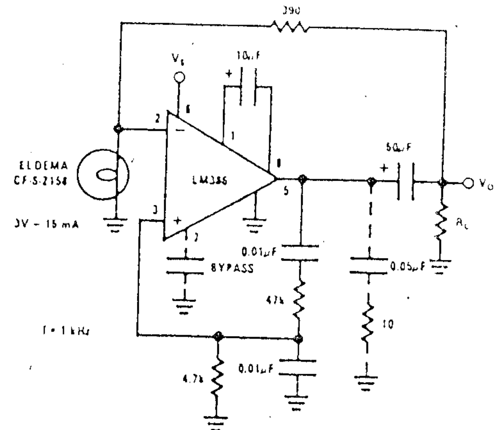
When using the LM386 with higher gains (bypassing the 1.35 kΩ resistor between pins 1 and 8) it is necessary to bypass the unused input, preventing degradation of gain and possible instabilities. This is done with a 0.1μF capacitor or a short to ground depending on the dc source resistance on the driven input.

Typical Applications (Continued)

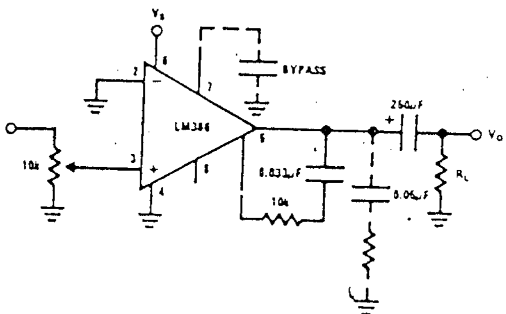
Amplifier with Gain = 50



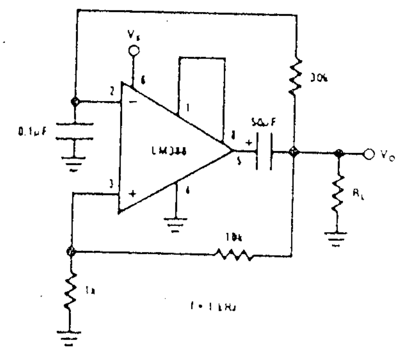
Low Distortion Power Wienbridge Oscillator



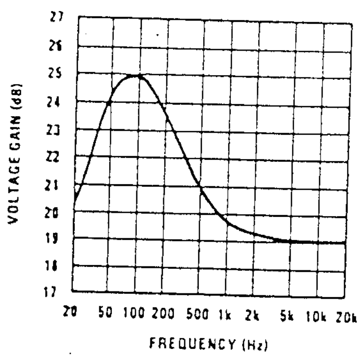
Amplifier with Bass Boost



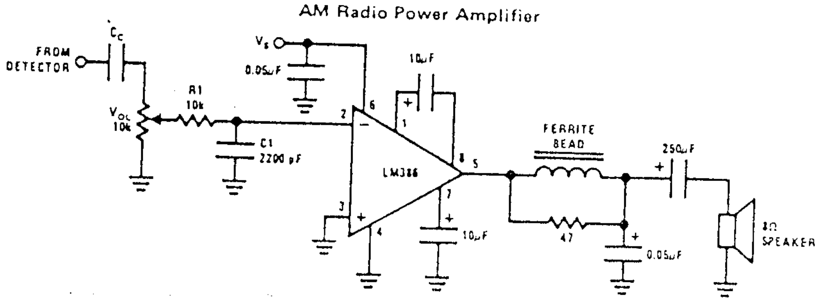
Square Wave Oscillator



Frequency Response with Bass Boost



AM Radio Power Amplifier



Note 1: Twist supply lead and supply ground very tightly.

Note 2: Twist speaker lead and ground very tightly.

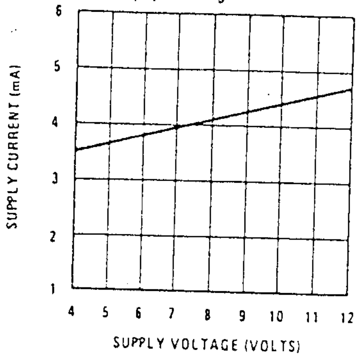
Note 3: Ferrite bead is Ferroxcube K5-001-001/38 with 3 turns of wire.

Note 4: R1C1 band limits input signals.

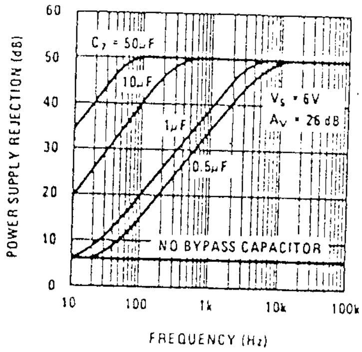
Note 5: All components must be spaced very close to IC.

Typical Performance Characteristics

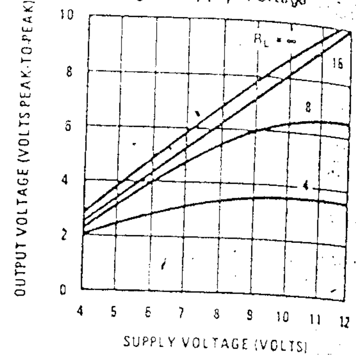
Quiescent Supply Current vs Supply Voltage



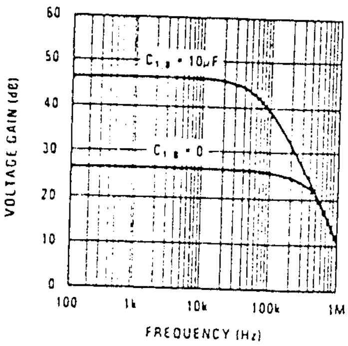
Power Supply Rejection Ratio (Referred to the Output) vs Frequency



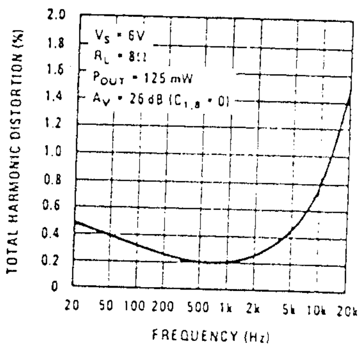
Peak-to-Peak Output Voltage Swing vs Supply Voltage



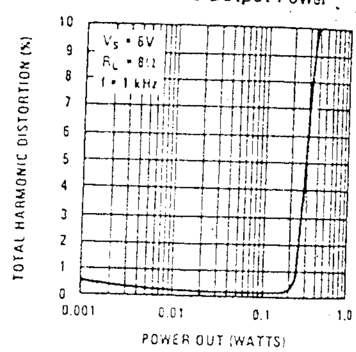
Voltage Gain vs Frequency



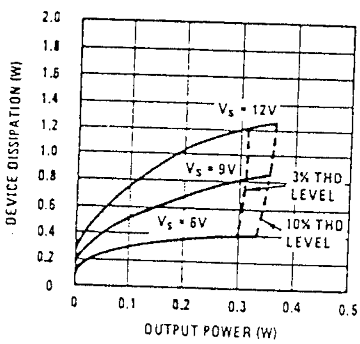
Distortion vs Frequency



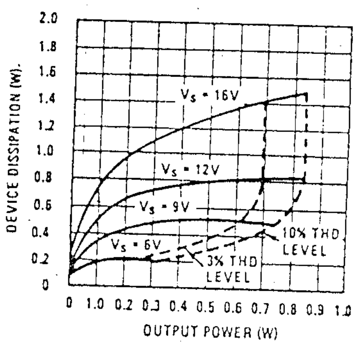
Distortion vs Output Power



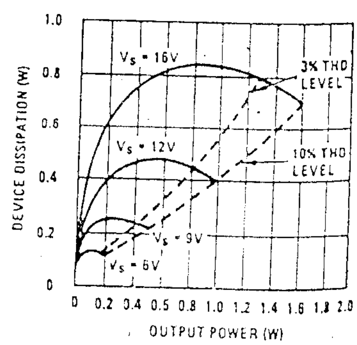
Device Dissipation vs Output Power—4Ω Load



Device Dissipation vs Output Power—8Ω Load



Device Dissipation vs Output Power—16Ω Load



National Semiconductor

LM555/LM555C Timer

General Description

The LM555 is a highly stable device for generating accurate time delays or oscillation. Additional terminals are provided for triggering or resetting if desired. In the time delay mode of operation, the time is precisely controlled by one external resistor and capacitor. For astable operation as an oscillator, the free running frequency and duty cycle are accurately controlled with two external resistors and one capacitor. The circuit may be triggered and reset on falling waveforms, and the output circuit can source or sink up to 200 mA or drive TTL circuits.

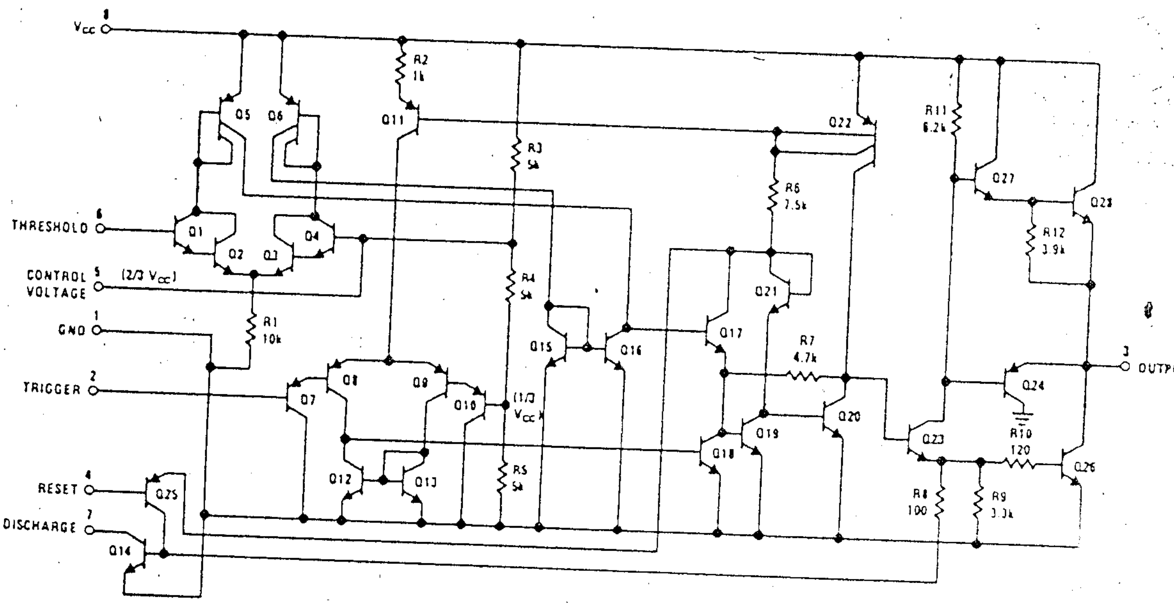
Features

- Direct replacement for SE555/NE555
- Timing from microseconds through hours
- Operates in both astable and monostable modes
- Adjustable duty cycle
- Output can source or sink 200 mA
- Output and supply TTL compatible
- Temperature stability better than 0.005% per °C
- Normally on and normally off output

Applications

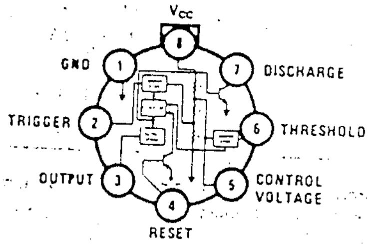
- Precision timing
- Pulse generation
- Sequential timing
- Time delay generation
- Pulse width modulation
- Pulse position modulation
- Linear ramp generator

Schematic Diagram



Connection Diagrams

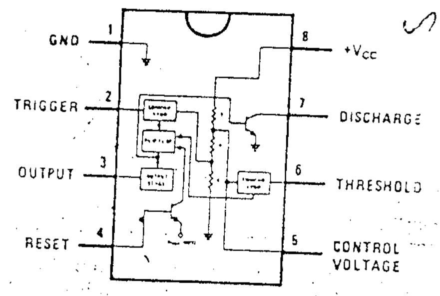
Metal Can Package



TOP VIEW

Order Number LM555H, LM555CH
See NS Package H08C

Dual-In-Line Package



TOP VIEW

Order Number LM555CN
See NS Package N08B
Order Number LM555J or LM555CJ
See NS Package J08A

Absolute Maximum Ratings

Supply Voltage	+18V
Power Dissipation (Note 1)	600 mW
Operating Temperature Ranges	
LM555C	0°C to +70°C
LM555	−55°C to +125°C
Storage Temperature Range	−65°C to +150°C
Lead Temperature (Soldering, 10 seconds)	300°C

Electrical Characteristics (T_A = 25°C, V_{CC} = +5V to +15V, unless otherwise specified)

PARAMETER	CONDITIONS	LIMITS LM555 MIN	LM555 TYP	LM555 MAX	LM555C MIN	LM555C TYP	LM555C MAX	UNITS
Supply Voltage		4.5		18	4.5		16	V
Supply Current	V_{CC} = 5V, R_L = ∞		3	5		3	6	mA
	V_{CC} = 15V, R_L = ∞ (Low State) (Note 2)		10	12		10	15	mA
Timing Error, Monostable								
Initial Accuracy	R_A, R_B = 1k to 100 k, C = 0.1µF, (Note 3)		0.5			1		%
Drift with Temperature			30			50		ppm/°C
Accuracy over Temperature			1.5			1.5		%
Drift with Supply			0.05			0.1		%/V
Timing Error, Astable								
Initial Accuracy			1.5			2.25		%
Drift with Temperature			90			150		ppm/°C
Accuracy over Temperature			2.5			3.0		%
Drift with Supply			0.15			0.30		%/V
Threshold Voltage			0.667			0.667		x V_{CC}
Trigger Voltage	V_{CC} = 15V	4.8	5	5.2		5		V
	V_{CC} = 5V	1.45	1.67	1.9		1.67		V
Trigger Current			0.01	0.5		0.5	0.9	µA
Reset Voltage		0.4	0.5	1	0.4	0.5	1	V
Reset Current			0.1	0.4		0.1	0.4	mA
Threshold Current	(Note 4)		0.1	0.25		0.1	0.25	µA
Control Voltage Level	V_{CC} = 15V	9.6	10	10.4	9	10	11	V
	V_{CC} = 5V	2.9	3.33	3.8	2.6	3.33	4	V
Pin 7 Leakage Output High			1	100		1	100	nA
Pin 7 Sat (Note 5)								
Output Low	V_{CC} = 15V, I_7 = 15 mA		150			180		mV
Output Low	V_{CC} = 4.5V, I_7 = 4.5 mA		70	100		80	200	mV
Output Voltage Drop (Low)	V_{CC} = 15V							
	I_{SINK} = 10 mA		0.1	0.15		0.1	0.25	V
	I_{SINK} = 50 mA		0.4	0.5		0.4	0.75	V
	I_{SINK} = 100 mA		2	2.2		2	2.5	V
	I_{SINK} = 200 mA		2.5			2.5		V
	V_{CC} = 5V							
	I_{SINK} = 8 mA		0.1	0.25				V
	I_{SINK} = 5 mA					0.25	0.35	V
Output Voltage Drop (High)	I_{SOURCE} = 200 mA, V_{CC} = 15V		12.5			12.5		V
	I_{SOURCE} = 100 mA, V_{CC} = 15V	13	13.3		12.75	13.3		V
	V_{CC} = 5V	3	3.3		2.75	3.3		V
Rise Time of Output			100			100		ns
Fall Time of Output			100			100		ns

Note 1: For operating at elevated temperatures the device must be derated based on a +150°C maximum junction temperature and a thermal resistance of +45°C/W junction to case for TO-5 and +150°C/W junction to ambient for both packages.

Note 2: Supply current when output high typically 1 mA less at V_{CC} = 5V.

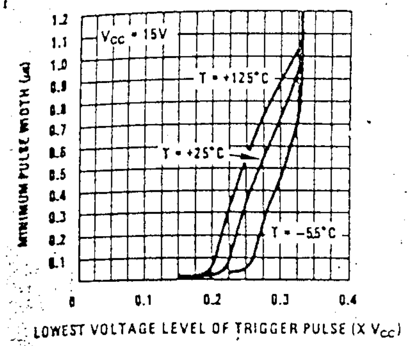
Note 3: Tested at V_{CC} = 5V and V_{CC} = 15V.

Note 4: This will determine the maximum value of $R_A + R_B$ for 15V operation. The maximum total ($R_A + R_B$) is 20 MΩ.

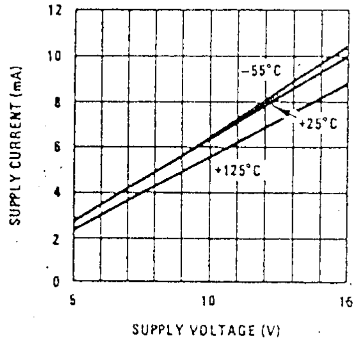
Note 5: No protection against excessive pin 7 current is necessary providing the package dissipation rating will not be exceeded.

Typical Performance Characteristics

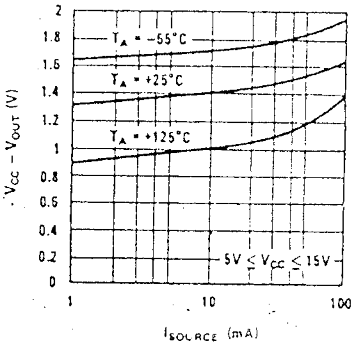
Minimum Pulse Width Required for Triggering



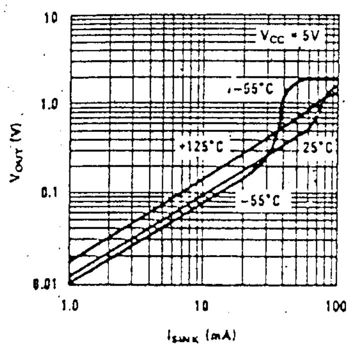
Supply Current vs Supply Voltage



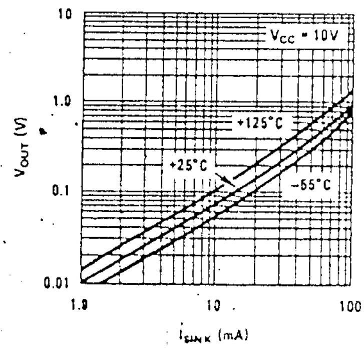
High Output Voltage vs Output Source Current



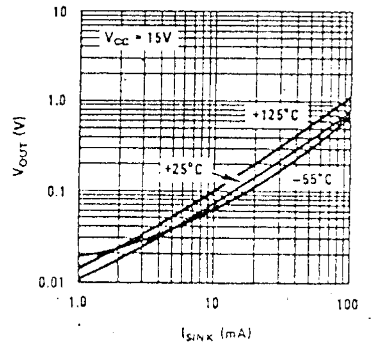
Low Output Voltage vs Output Sink Current



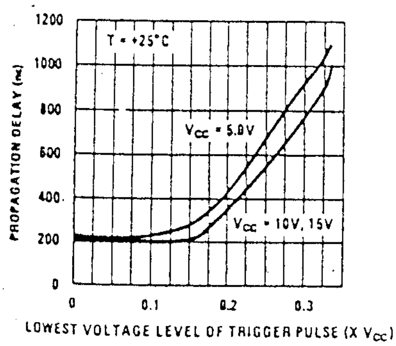
Low Output Voltage vs Output Sink Current



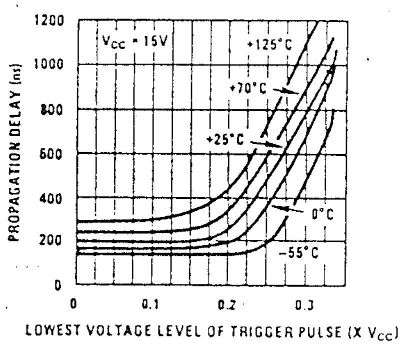
Low Output Voltage vs Output Sink Current



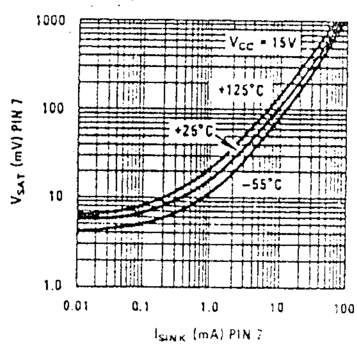
Output Propagation Delay vs Voltage Level of Trigger Pulse



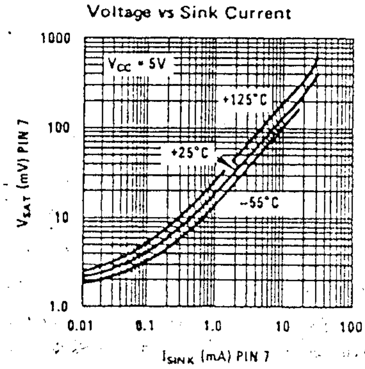
Output Propagation Delay vs Voltage Level of Trigger Pulse



Discharge Transistor (Pin 7) Voltage vs Sink Current



Discharge Transistor (Pin 7) Voltage vs Sink Current



Applications Information

MONOSTABLE OPERATION

In this mode of operation, the timer functions as a one-shot (*Figure 1*). The external capacitor is initially held discharged by a transistor inside the timer. Upon application of a negative trigger pulse of less than 1/3 V_{CC} to pin 2, the flip-flop is set which both releases the short circuit across the capacitor and drives the output high.

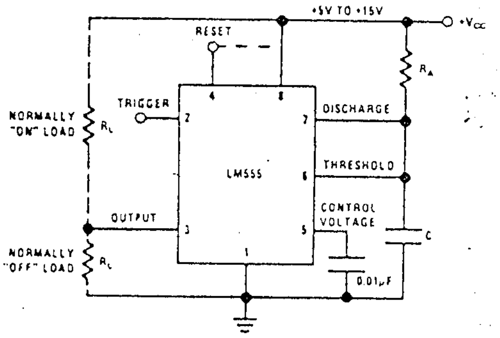


FIGURE 1. Monostable

The voltage across the capacitor then increases exponentially for a period of $t = 1.1\ R_AC$, at the end of which time the voltage equals 2/3 V_{CC}. The comparator then resets the flip-flop which in turn discharges the capacitor and drives the output to its low state. *Figure 2* shows the waveforms generated in this mode of operation. Since the charge and the threshold level of the comparator are both directly proportional to supply voltage, the timing internal is independent of supply.

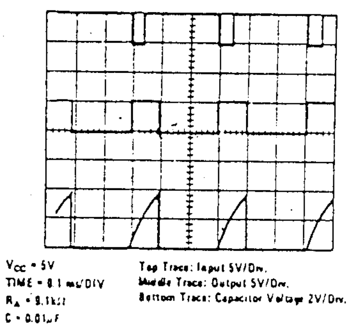


FIGURE 2. Monostable Waveforms

During the timing cycle when the output is high, the further application of a trigger pulse will not effect the circuit. However the circuit can be reset during this time by the application of a negative pulse to the reset terminal (pin 4). The output will then remain in the low state until a trigger pulse is again applied.

When the reset function is not in use, it is recommended that it be connected to V_{CC} to avoid any possibility of false triggering.

Figure 3 is a nomograph for easy determination of R, C values for various time delays.

NOTE: or operating ble operation, the trigger should be driver ce of +45°C/W junction f timing cycle.

2: Supply current when output t

Note 3: Tested at V_{CC} = 5V and V_{CC}

Note 4: This will determine the maximum in *Figure 4* (pins 2

Note 5: No protection against excessive self and free run as a

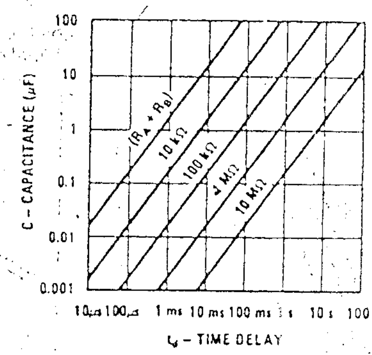


FIGURE 3. Time Delay

multivibrator. The external capacitor charges through $R_A + R_B$ and discharges through R_B. Thus the duty cycle may be precisely set by the ratio of these two resistors.

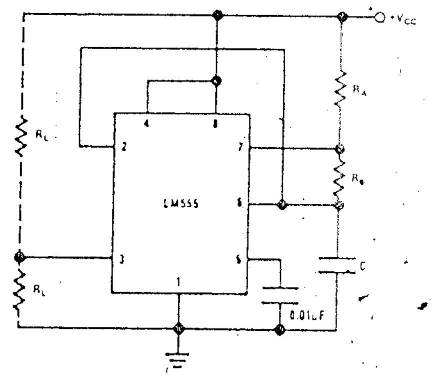


FIGURE 4. Astable

In this mode of operation, the capacitor charges and discharges between 1/3 V_{CC} and 2/3 V_{CC}. As in the triggered mode, the charge and discharge times, and therefore the frequency are independent of the supply voltage.

Figure 5 shows the waveforms generated in this mode of operation.

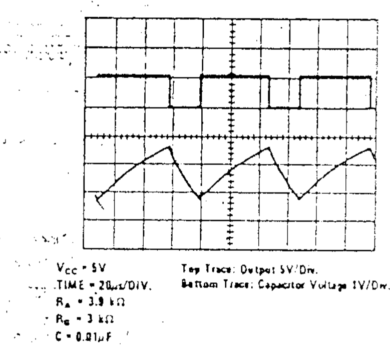


FIGURE 5. Astable Waveforms

The charge time (output high) is given by:

$$t_1 = 0.693\ (R_A + R_B)\ C$$

And the discharge time (output low) by:

$$t_2 = 0.693\ (R_B)\ C$$

Thus the total period is:

$$T = t_1 + t_2 = 0.693\ (R_A + 2R_B)\ C$$

Applications Information (Continued)

The frequency of oscillation is:

$$f = \frac{1}{T} = \frac{1.44}{(R_A + 2R_B)\,C}$$

Figure 6 may be used for quick determination of these RC values.

The duty cycle is:

$$D = \frac{R_B}{R_A + 2R_B}$$

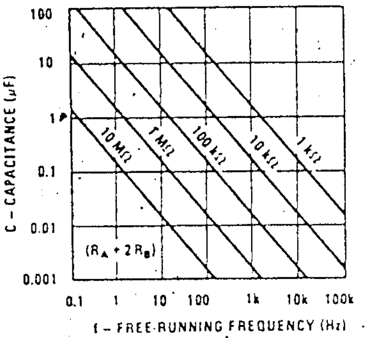


FIGURE 6. Free Running Frequency

FREQUENCY DIVIDER

The monostable circuit of *Figure 1* can be used as a frequency divider by adjusting the length of the timing cycle. *Figure 7* shows the waveforms generated in a divide by three circuit.

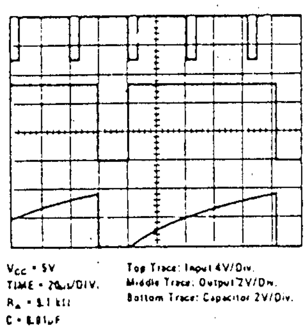


FIGURE 7. Frequency Divider

PULSE WIDTH MODULATOR

When the timer is connected in the monostable mode and triggered with a continuous pulse train, the output pulse width can be modulated by a signal applied to pin 5. *Figure 8* shows the circuit, and in *Figure 9* are some waveform examples.

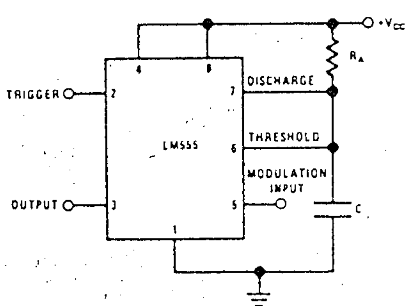


FIGURE 8. Pulse Width Modulator

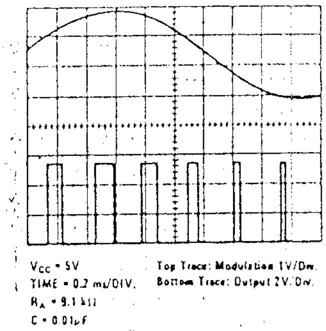


FIGURE 9. Pulse Width Modulator

PULSE POSITION MODULATOR

This application uses the timer connected for astable operation, as in *Figure 10*, with a modulating signal again applied to the control voltage terminal. The pulse position varies with the modulating signal, since the threshold voltage and hence the time delay is varied. *Figure 11* shows the waveforms generated for a triangle wave modulation signal.

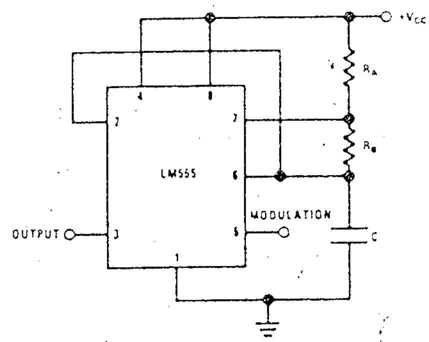


FIGURE 10. Pulse Position Modulator

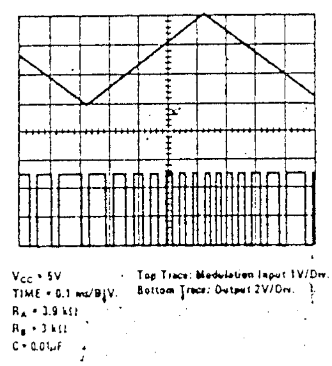


FIGURE 11. Pulse Position Modulator

LINEAR RAMP

When the pullup resistor, R_A, in the monostable circuit is replaced by a constant current source, a linear ramp is

Applications Information (Continued)

generated. *Figure 12* shows a circuit configuration that will perform this function.

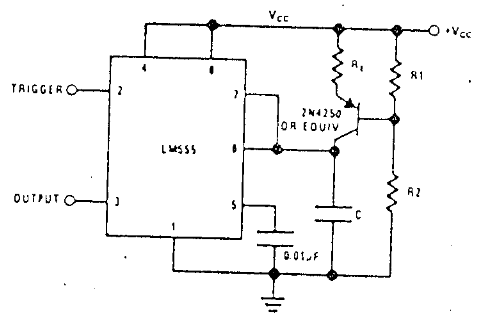


FIGURE 12.

Figure 13 shows waveforms generated by the linear ramp.

The time interval is given by:

$$T = \frac{2/3\ V_{CC}\ R_E\ (R_1 + R_2)\ C}{R_1\ V_{CC} - V_{BE}\ (R_1 + R_2)}$$

$V_{BE} \simeq 0.6V$

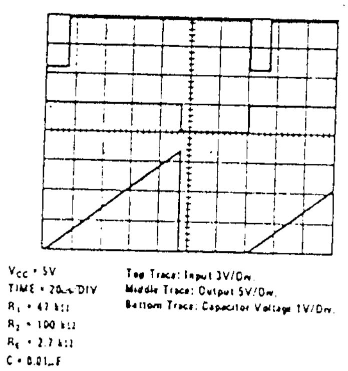


FIGURE 13. Linear Ramp

50% DUTY CYCLE OSCILLATOR

For a 50% duty cycle, the resistors R_A and R_B may be connected as in *Figure 14*. The time period for the output high is the same as previous, $t_1 = 0.693\ R_A\ C$. For the output low it is $t_2 =$

$$[(R_A\ R_B)/(R_A + R_B)]\ C\ln \left[\frac{R_B - 2R_A}{2R_B - R_A}\right]$$

Thus the frequency of oscillation is $f = \frac{1}{t_1 + t_2}$

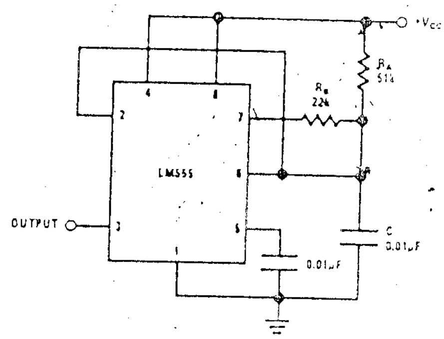


FIGURE 14. 50% Duty Cycle Oscillator

Note that this circuit will not oscillate if R_B is greater than 1/2 R_A because the junction of R_A and R_B cannot bring pin 2 down to 1/3 V_{CC} and trigger the lower comparator.

ADDITIONAL INFORMATION

Adequate power supply bypassing is necessary to protect associated circuitry. Minimum recommended is 0.1μF in parallel with 1μF electrolytic.

Lower comparator storage time can be as long as 10μs when pin 2 is driven fully to ground for triggering. This limits the monostable pulse width to 10μs minimum.

Delay time reset to output is 0.47μs typical. Minimum reset pulse width must be 0.3μs, typical.

Pin 7 current switches within 30 ns of the output (pin 3) voltage.

TYPES SN5474, SN54H74, SN54L74, SN54LS74A, SN54S74, SN7474, SN74H74, SN74LS74A, SN74S74
DUAL D-TYPE POSITIVE-EDGE-TRIGGERED FLIP-FLOPS WITH PRESET AND CLEAR

REVISED DECEMBER 1983

- Package Options Include Both Plastic and Ceramic Chip Carriers in Addition to Plastic and Ceramic DIPs
- Dependable Texas Instruments Quality and Reliability

description

These devices contain two independent D-type positive-edge-triggered flip-flops. A low level at the preset or clear inputs sets or resets the outputs regardless of the levels of the other inputs. When preset and clear are inactive (high), data at the D input meeting the setup time requirements are transferred to the outputs on the positive-going edge of the clock pulse. Clock triggering occurs at a voltage level and is not directly related to the rise time of the clock pulse. Following the hold time interval, data at the D input may be changed without affecting the levels at the outputs.

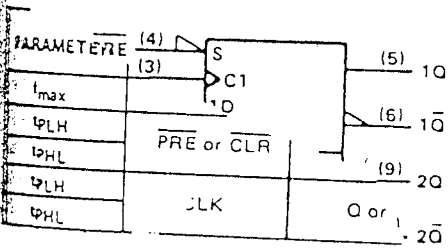
The SN54' family is characterized for operation over the full military temperature range of −55 °C to 125 °C. The SN74' family is characterized for operation from 0 °C to 70 °C.

FUNCTION TABLE

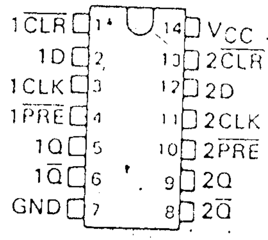
INPUTS				OUTPUTS	
$\overline{PRE}$	$\overline{CLR}$	CLK	D	Q	$\overline{Q}$
L	H	X	X	H	L
H	L	X	X	L	H
L	L	X	X	H†	H†
H	H	↑	H	H	L
H	H	↑	L	L	H
H	H	L	X	Q_0	$\overline{Q}_0$

† The output levels in this configuration are not guaranteed to meet the minimum levels in V_{OH} if the lows at preset and clear are near V_{IL} maximum. Furthermore, this configuration is nonstable; that is, it will not persist when either preset or clear returns to its inactive (high) level.

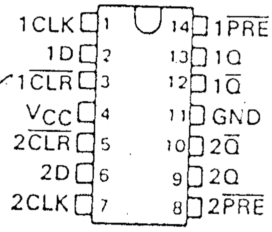
logic symbol



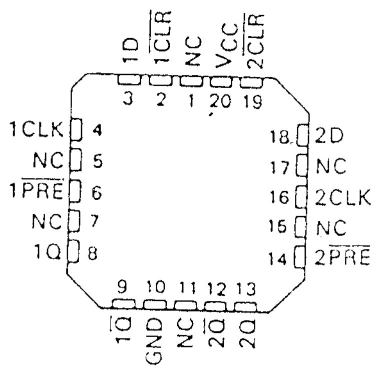
SN5474, SN54H74, SN54L74 . . . J PACKAGE
SN54LS74A, SN54S74 . . . J OR W PACKAGE
SN7474, SN74H74 . . . J OR N PACKAGE
SN74LS74A, SN74S74 . . . D, J OR N PACKAGE
(TOP VIEW)



SN5474, SN54H74 . . . W PACKAGE
(TOP VIEW)

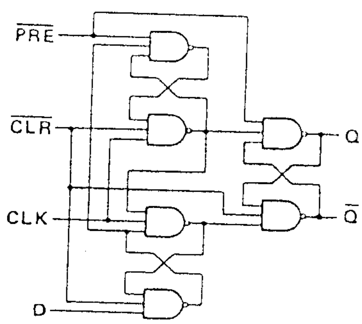


SN54LS74A, SN54S74 . . . FK PACKAGE
SN74LS74A, SN74S74 . . . FN PACKAGE
(TOP VIEW)



NC - No internal connection

logic diagram



recommended operating conditions

		SN5474 MIN	SN5474 NOM	SN5474 MAX	SN7474 MIN	SN7474 NOM	SN7474 MAX	UNIT
V_{CC} Supply voltage		4.5	5	5.5	4.75	5	5.25	V
V_{IH} High-level input voltage		2			2			V
V_{IL} Low-level input voltage				0.8			0.8	V
I_{OH} High-level output current				− 0.4			− 0.4	mA
I_{OL} Low-level output current				16			16	mA
t_w Pulse duration	CLK high	30			30			ns
	CLK low	37			37			
	$\overline{PRE}$ or $\overline{CLR}$ low	30			30			
t_{su} Input setup time before CLK↑		20			20			ns
t_h Input hold time-data after CLK↑		5			5			ns
T_A Operating free-air temperature		− 55		125	0		70	°C

ectrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER		TEST CONDITIONS†			SN5474 MIN	SN5474 TYP‡	SN5474 MAX	SN7474 MIN	SN7474 TYP‡	SN7474 MAX	UNIT
V_{IK}		V_{CC} = MIN,	I_I = − 12 mA				− 1.5			− 1.5	V
V_{OH}		V_{CC} = MIN, I_{OH} = − 0.4 mA	V_{IH} = 2 V,	V_{IL} = 0.8 V,	2.4	3.4		2.4	3.4		V
V_{OL}		V_{CC} = MIN, I_{OL} = 16 mA	V_{IH} = 2 V,	V_{IL} = 0.8 V,		0.2	0.4		0.2	0.4	V
I_I		V_{CC} = MAX,	V_I = 5.5 V				1			1	mA
I_{IH}	D	V_{CC} = MAX,	V_I = 2.4 V				40			40	mA
	$\overline{CLR}$						120			120	
	All Other						80			80	
I_{IL}	D	V_{CC} = MAX,	V_I = 0.4 V				− 1.6			− 1.6	mA
	$\overline{PRE}$★						− 1.6			− 1.6	
	$\overline{CLR}$★						− 3.2			− 3.2	
	CLK						− 3.2			− 3.2	
I_{OS}§		V_{CC} = MAX			− 20		− 57	− 18		− 57	mA
I_{CC}		V_{CC} = MAX,	See Note 2			8.5	15		8.5	15	mA

† For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.
‡ All typical values are at V_{CC} = 5 V, T_A = 25°C.
★ Clear is tested with preset high and preset is tested with clear high.
§ Not more than one output should be shorted at a time.
NOTE 2: With all outputs open, I_{CC} is measured with the Q and $\overline{Q}$ outputs high in turn. At the time of measurement, the clock input is grounded.

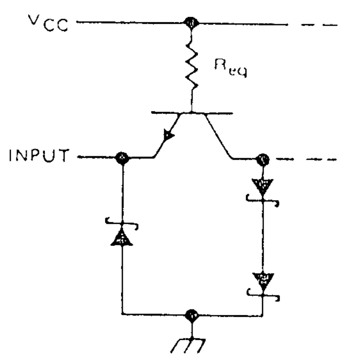
ching charateristics, V_{CC} = 5 V, T_A = 25°C (see note 3)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	MIN	TYP	MAX	UNIT
f_{max}			R_L = 400 Ω, C_L = 15 pF	15	25		MHz
t_{PLH}	$\overline{PRE}$ or $\overline{CLR}$	Q or $\overline{Q}$				25	ns
t_{PHL}						40	ns
t_{PLH}	CLK	Q or $\overline{Q}$			14	25	ns
t_{PHL}					20	40	ns

schematics of inputs and outputs

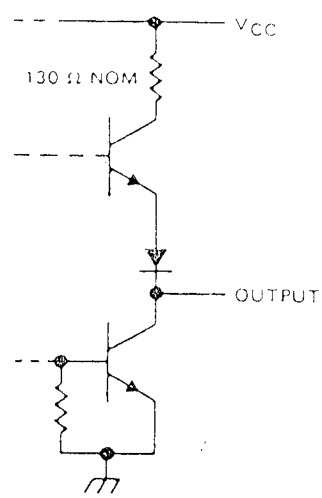
'74

EQUIVALENT OF EACH INPUT



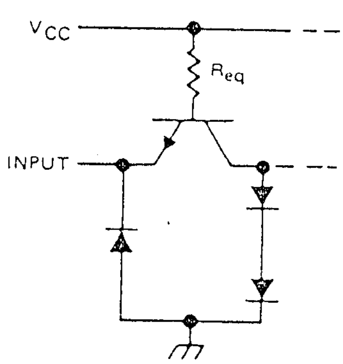
I_{IL} MAX	R_{eq} NOM
−1.6 mA	4 kΩ
−3.2 mA	2 kΩ

TYPICAL OF ALL OUTPUTS



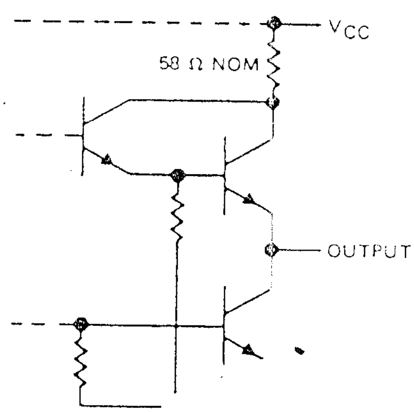
'H74

EQUIVALENT OF EACH INPUT



I_{IL} MAX	R_{eq} NOM
−2 mA	2.8 kΩ
−4 mA	1.4 kΩ

TYPICAL OF ALL OUTPUTS



recommended operating conditions

			MIN	NOM	MAX	UNIT
V_{CC}	Supply voltage		4.5	5	5.5	V
V_{IH}	High-level input voltage		2			V
V_{IL}	Low-level input voltage				0.7	V
I_{OH}	High-level output current				− 0.1	mA
I_{OL}	Low-level output current				2	mA
t_w	Pulse duration	CLK high or low	200			ns
		$\overline{CLR}$ or $\overline{PRE}$ low	100			ns
t_{su}	Setup time before CLK↑		50			ns
t_h	Hold time data after CLK↑		15			ns
T_A	Operating free-air temperature		− 55		125	°C

electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER		TEST CONDITIONS†	MIN	TYP‡	MAX	UNIT
V_{OH}		V_{CC} = MIN, V_{IH} = 2 V, V_{IL} = 0.7 V, I_{OH} = − 0.1 mA	2.4	3.3		V
V_{OL}		V_{CC} = MIN, V_{IH} = 2 V, V_{IL} = 0.7 V, I_{OL} = 2 mA		0.15	0.3	V
I_I	D	V_{CC} = MAX, V_I = 5.5 V			0.1	mA
	$\overline{CLR}$				0.3	mA
	$\overline{PRE}$ or CLK				0.2	mA
I_{IH}	D	V_{CC} = MAX, V_I = 2.4 V			10	µA
	$\overline{CLR}$				30	µA
	$\overline{PRE}$ or CLK				20	µA
I_{IL}	D or $\overline{PRE}$	V_{CC} = MAX, V_I = 0.3 V			− 0.18	µA
	$\overline{CLR}$ or CLK				− 0.36	µA
I_{OS}		V_{CC} = MAX	− 3		− 15	mA
I_{CC}		V_{CC} = MAX, See Note 2		0.8	1.5	mA

† For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.

‡ All typical values are at V_{CC} = 5 V, T_A = 25°C.

NOTE 2: With all outputs open, I_{CC} is measured with the Q and $\overline{Q}$ outputs high in turn. At the time of measurement, the clock input is grounded.

switching characteristics, V_{CC} = 5 V, T_A = 25°C (see note 3)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	MIN	TYP	MAX	UNIT
f_{max}			R_L = 4 kΩ, C_L = 50 pF	2.5	3		MHz
t_{PLH}	$\overline{PRE}$ or $\overline{CLR}$	Q or $\overline{Q}$			50	75	ns
t_{PHL}	$\overline{PRE}$ or $\overline{CLR}$ (CLK high)	$\overline{Q}$ or Q			80	150	ns
	$\overline{PRE}$ or $\overline{CLR}$ (CLK low)				80	150	ns
t_{PLH}	Clock	Q or $\overline{Q}$		15	65	100	ns
t_{PHL}				15	65	150	ns

recommended operating conditions

			SN54H74			SN74H74			UNIT
			MIN	NOM	MAX	MIN	NOM	MAX	
V_{CC}	Supply voltage		4.5	5	5.5	4.75	5	5.25	V
V_{IH}	High-level input voltage		2			2			V
V_{IL}	Low-level input voltage				0.8			0.8	V
I_{OH}	High-level output current				−1			−1	mA
I_{OL}	Low-level output current				20			20	mA
t_w	Pulse duration	CLK high	15			15			ns
		CLK low	13.5			13.5			
		$\overline{CLR}$ or $\overline{PRE}$ low	25			25			
t_{su}	Setup time before CLK↑	High-level data	10			10			ns
		Low-level data	15			15			
t_h	Hold time · data after CLK↑		5			5			ns
T_A	Operating free-air temperature		−55		125	0		70	°C

electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

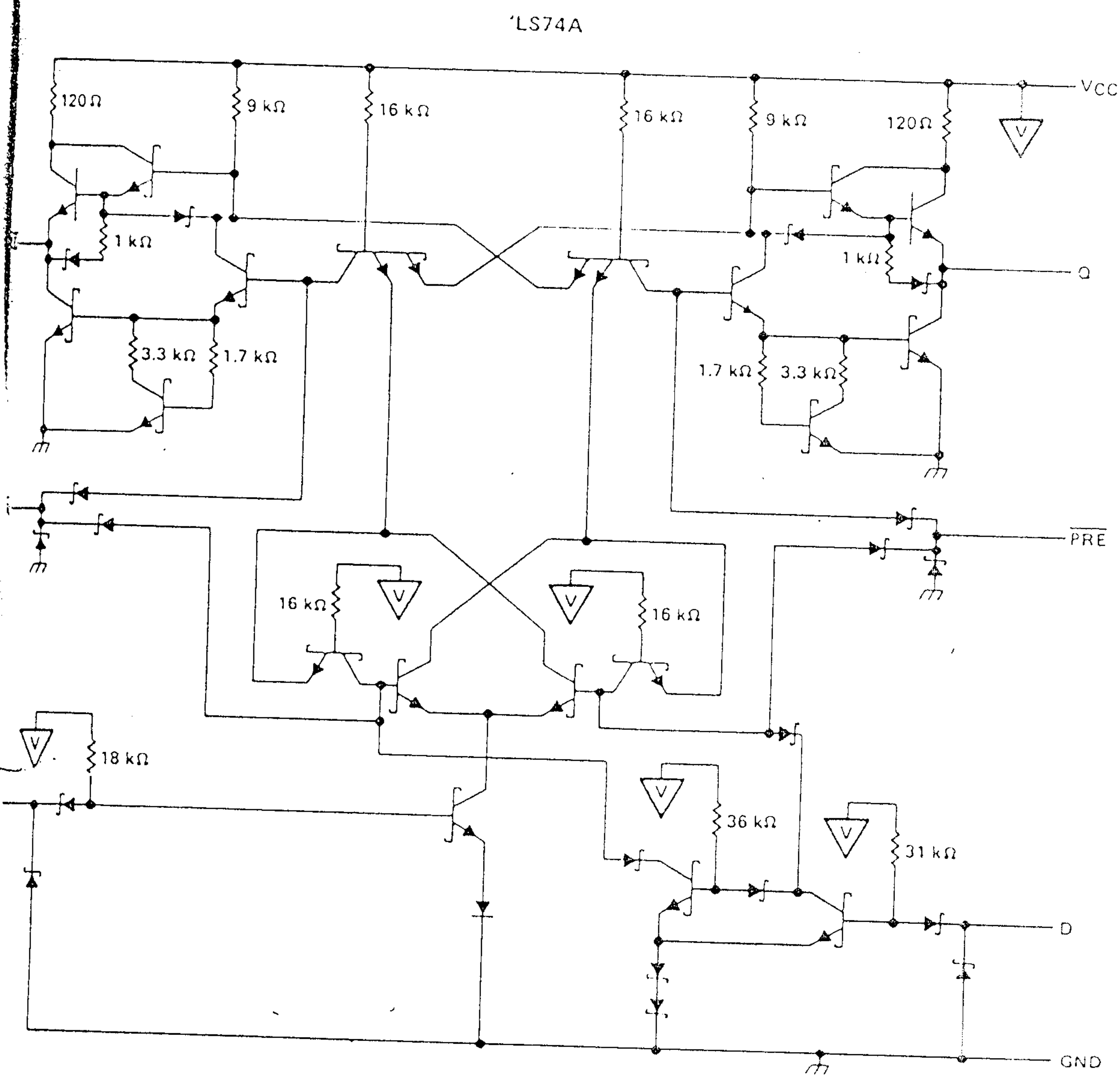
PARAMETER		TEST CONDITIONS†	SN54H74			SN74H74			UNIT
			MIN	TYP‡	MAX	MIN	TYP‡	MAX	
V_{IK}		V_{CC} = MIN, I_I = −8 mA			−1.5			−1.5	V
V_{OH}		V_{CC} = MIN, V_{IH} = 2 V, V_{IL} = 0.8 V, I_{OH} = −1 mA	2.4	3.4		2.4	3.4		V
V_{OL}		V_{CC} = MIN, V_{IH} = 2 V, V_{IL} = 0.8 V, I_{OL} = 20 mA		0.2	0.4		0.2	0.4	V
I_I		V_{CC} = MAX, V_I = 5.5 V			1			1	mA
I_{IH}	D	V_{CC} = MAX, V_I = 2.4 V			50			50	µA
	$\overline{CLR}$				150			150	
	$\overline{PRE}$ or CLK				100			100	
I_{IL}	D	V_{CC} = MAX, V_I = 0.4 V			−2			−2	mA
	$\overline{CLR}$*				−4			−4	
	$\overline{PRE}$*				−2			−2	
	CLK				−4			−4	
I_{OS}§		V_{CC} = MAX	−40		−100	−40		−100	mA
I_{CC}		V_{CC} = MAX, See Note 2		15	21		15	25	mA

† For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.
‡ All typical values are at V_{CC} = 5 V, T_A = 25°C.
§ Not more than one output should be shorted at a time, and the duration of the short circuit should not exceed one second.
* Clear is tested with preset high and preset is tested with clear high.
NOTE 2: With all outputs open, I_{CC} is measured with the Q and $\overline{Q}$ outputs high in turn. At the time of measurement, the clock input is grounded.

switching characteristics, V_{CC} = 5 V, T_A = 25°C (see note 3)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	MIN	TYP	MAX	UNIT
f_{max}			R_L = 280 Ω, C_L = 25 pF	35	43		MHz
t_{PLH}	$\overline{PRE}$ or $\overline{CLR}$	Q or $\overline{Q}$				20	ns
t_{PHL}						30	ns
t_{PLH}	CLK	Q or $\overline{Q}$			8.5	15	ns
t_{PHL}					13	20	ns

...atic



...te maximum ratings over operating free-air temperature range (unless otherwise noted)

Supply voltage, V_{CC} (see Note 1)		7 V
Input voltage:	'74, 'H74, 'L74, 'S74	5.5 V
	'LS74A	7 V
Operating free-air temperature range:	SN54'	− 55°C to 125°C
	SN74'	0°C to 70°C
Storage temperature range		− 65°C to 150°C

...E 1: Voltage values are with respect to network ground terminal.

recommended operating conditions

			SN54LS74A MIN	SN54LS74A NOM	SN54LS74A MAX	SN74LS74A MIN	SN74LS74A NOM	SN74LS74A MAX	UNIT
V_{CC}	Supply voltage		4.5	5	5.5	4.75	5	5.25	V
V_{IH}	High-level input voltage		2			2			V
V_{IL}	Low-level input voltage				0.7			0.8	V
I_{OH}	High-level output current				−0.4			−0.4	mA
I_{OL}	Low-level output current				4			8	mA
f_{clock}	Clock frequency		0		25	0		25	MHz
t_w	Pulse duration	CLK high	25			25			ns
		$\overline{PRE}$ or $\overline{CLR}$ low	25			25			
t_{su}	Setup time-before CLK↑	High-level data	20			20			ns
		Low-level data	20			20			
t_h	Hold time-data after CLK↑		5			5			ns
T_A	Operating free-air temperature		−55		125	0		70	°C

electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER		TEST CONDITIONS†	SN54LS74A MIN	SN54LS74A TYP‡	SN54LS74A MAX	SN74LS74A MIN	SN74LS74A TYP‡	SN74LS74A MAX	UNIT
V_{IK}		V_{CC} = MIN, I_I = −18 mA			−1.5			−1.5	V
V_{OH}		V_{CC} = MIN, V_{IH} = 2 V, V_{IL} = MAX, I_{OH} = −0.4 mA	2.5	3.4		2.7	3.4		V
V_{OL}		V_{CC} = MIN, V_{IL} = MAX, V_{IH} = 2 V, I_{OL} = 4 mA		0.25	0.4		0.25	0.4	V
		V_{CC} = MIN, V_{IL} = MAX, V_{IH} = 2 V, I_{OL} = 8 mA					0.35	0.5	
I_I	D or CLK	V_{CC} = MAX, V_I = 7 V			0.1			0.1	mA
	$\overline{CLR}$ or $\overline{PRE}$				0.2			0.2	
I_{IH}	D or CLK	V_{CC} = MAX, V_I = 2.7 V			20			20	μA
	$\overline{CLR}$ or $\overline{PRE}$				40			40	
I_{IL}	D or CLK	V_{CC} = MAX, V_I = 0.4 V			−0.4			−0.4	mA
	$\overline{CLR}$ or $\overline{PRE}$				−0.8			−0.8	
I_{OS}§		V_{CC} = MAX, See Note 4	−20		−100	−20		−100	mA
I_{CC}		V_{CC} = MAX, See Note 2		4	8		4	8	mA

† For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.

‡ All typical values are at V_{CC} = 5 V, T_A = 25°C.

§ Not more than one output should be shorted at a time, and the duration of the short circuit should not exceed one second.

NOTE 2: With all outputs open, I_{CC} is measured with the Q and $\overline{Q}$ outputs high in turn. At the time of measurement, the clock input is grounded.

NOTE 4: For certain devices where state commutation can be caused by shorting an output to ground, an equivalent test may be performed with V_O = 2.25 V and 2.125 V for the 54 family and the 74 family, respectively, with the minimum and maximum limits reduced to one half of their stated values.

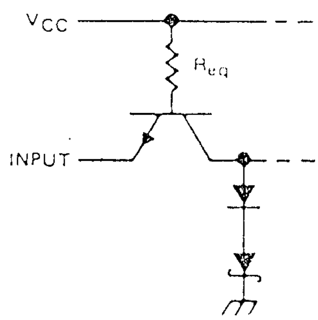
switching characteristics, V_{CC} = 5 V, T_A = 25°C (see note 3)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	MIN	TYP	MAX	UNIT
f_{max}			R_L = 2 kΩ, C_L = 15 pF	25	33		MHz
t_{PLH}	$\overline{CLR}$, $\overline{PRE}$ or CLK	Q or $\overline{Q}$			13	25	ns
t_{PHL}					25	40	ns

schematics of inputs and outputs (continued)

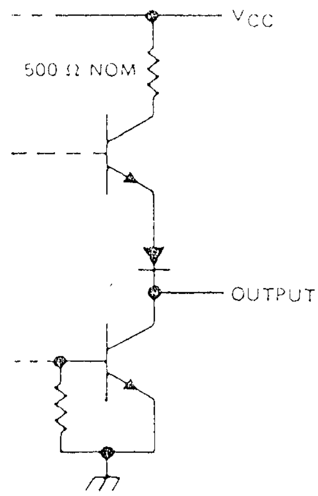
'L74

EQUIVALENT OF EACH INPUT



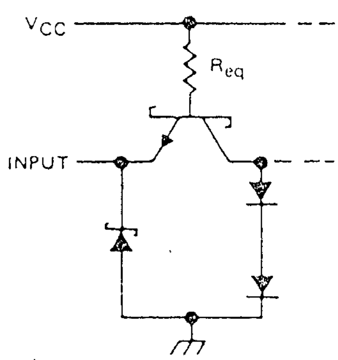
I_{IL} MAX	R_{eq} NOM
−0.18 mA	40 kΩ
−0.36 mA	20 kΩ

TYPICAL OF ALL OUTPUTS



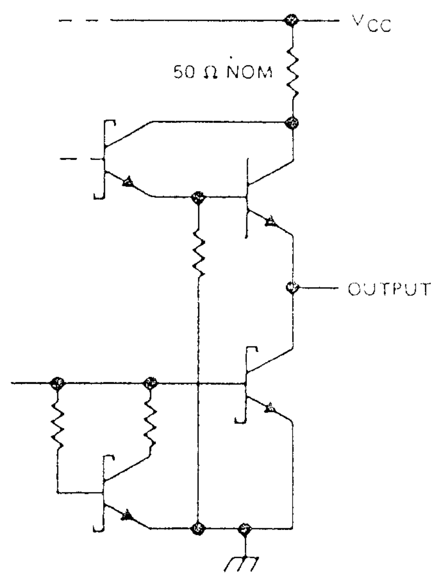
'S74

EQUIVALENT OF EACH INPUT



I_{IL} MAX	R_{eq} NOM
−2 mA	2.8 kΩ
−4 mA	1.4 kΩ
−6 mA	940 Ω

TYPICAL OF ALL OUTPUTS



...commended operating conditions

			SN54S74			SN74S74			UNIT
			MIN	NOM	MAX	MIN	NOM	MAX	
V_{CC}	Supply voltage		4.5	5	5.5	4.75	5	5.25	V
V_{IH}	High-level input voltage		2			2			V
V_{IL}	Low-level input voltage				0.8			0.8	V
I_{OH}	High-level output current				– 1			– 1	mA
I_{OL}	Low-level output current				20			20	mA
t_w	Pulse duration	CLK high	6			6			ns
		CLK low	7.3			7.3			ns
		$\overline{CLR}$ or $\overline{PRE}$ low	7			7			ns
t_{su}	Setup time, before CLK ↑	High-level data	3			3			ns
		Low-level data	3			3			ns
t_h	Input hold time - data after CLK ↑		2			2			ns
T_A	Operating free-air temperature		– 55		125	0		70	°C

...ectrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER		TEST CONDITIONS†	SN54S74			SN74S74			UNIT
			MIN	TYP‡	MAX	MIN	TYP‡	MAX	
V_{IK}		V_{CC} = MIN, I_I = – 18 mA,			– 1.2			– 1.2	V
V_{OH}		V_{CC} = MIN, V_{IH} = 2 V, V_{IL} = 0.8 V, I_{OH} = – 1 mA	2.5	3.4		2.7	3.4		V
V_{OL}		V_{CC} = MIN, V_{IH} = 2 V, V_{IL} = 0.8 V, I_{OL} = 20 mA			0.5			0.5	V
I_I		V_{CC} = MAX, V_I = 5.5 V			1			1	mA
I_{IH}	D	V_{CC} = MAX, V_I = 2.7 V			50			50	mA
	$\overline{CLR}$				150			150	
	$\overline{PRE}$ or CLK				100			100	
I_{IL}	D	V_{CC} = MAX, V_I = 0.5 V			– 2			– 2	mA
	$\overline{CLR}$★				– 6			– 6	
	$\overline{PRE}$★				– 4			– 4	
	CLK				– 4			– 4	
I_{OS}§		V_{CC} = MAX	– 40		– 100	– 40		– 100	mA
I_{CC}		V_{CC} = MAX, See Note 2		15	25		15	25	mA

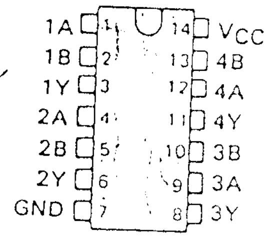
†For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.
‡All typical values are at V_{CC} = 5 V, T_A = 25°C.
§Not more than one output should be shorted at a time, and the duration of the short circuit should not exceed one second.
★Clear is tested with preset high and preset is tested with clear high.
NOTE 2: All outputs open, I_{CC} is measured with the Q and $\overline{Q}$ outputs high in turn. At the time of measurement, the clock input is grounded.

...itching characteristics, V_{CC} = 5 V, T_A = 25°C (see note 3)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	MIN	TYP	MAX	UNIT
f_{max}			R_L = 280 Ω, C_L = 15 pF	75	110		MHz
t_{PLH}	$\overline{PRE}$ or $\overline{CLR}$	Q or $\overline{Q}$			4	6	ns
t_{PHL}	$\overline{PRE}$ or $\overline{CLR}$ (CLK high)	$\overline{Q}$ or Q			9	13.5	ns
	$\overline{PRE}$ or $\overline{CLR}$ (CLK low)				5	8	ns
t_{PLH}	CLK	Q or $\overline{Q}$			6	9	ns
t_{PHL}					6	9	ns

- Package Options Include Both Plastic and Ceramic Chip Carriers in Addition to Plastic and Ceramic DIPs
- Dependable Texas Instruments Quality and Reliability

SN5408, SN54LS08, SN54S08 . . . J OR W PACKAGE
SN7408 . . . J OR N PACKAGE
SN74LS08, SN74S08 . . . D, J OR N PACKAGE
(TOP VIEW)

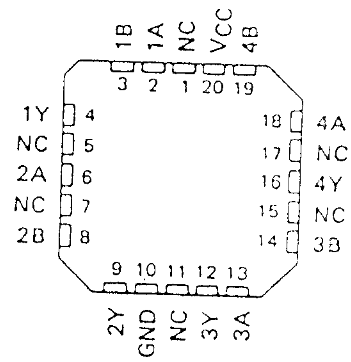


description

These devices contain four independent 2-input AND gates.

The SN5408, SN54LS08, and SN54S08 are characterized for operation over the full military temperature range of −55°C to 125°C. The SN7408, SN74LS08 and SN74S08 are characterized for operation from 0°C to 70°C.

SN54LS08, SN54S08 . . . FK PACKAGE
SN74LS08, SN74S08 . . . FN PACKAGE
(TOP VIEW)

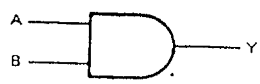


NC - No internal connection

FUNCTION TABLE (each gate)

INPUTS		OUTPUT
A	B	Y
H	H	H
L	X	L
X	L	L

ogic diagram (each gate)



positive logic

$$Y = A \cdot B \text{ or } Y = \overline{\overline{A} + \overline{B}}$$

t_{PLH}
t_{PHL}

NOTE 2:

recommended operating conditions

		SN5408			SN7408			UNIT
		MIN	NOM	MAX	MIN	NOM	MAX	
V_{CC}	Supply voltage	4.5	5	5.5	4.75	5	5.25	V
V_{IH}	High-level input voltage	2			2			V
V_{IL}	Low-level input voltage			0.8			0.8	V
I_{OH}	High-level output current			−0.8			−0.8	mA
I_{OL}	Low-level output current			16			16	mA
T_A	Operating free-air temperature	−55		125	0		70	°C

electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER	TEST CONDITIONS †	SN5408			SN7408			UNIT
		MIN	TYP‡	MAX	MIN	TYP‡	MAX	
V_{IK}	V_{CC} = MIN, I_I = −12 mA			−1.5			−1.5	V
V_{OH}	V_{CC} = MIN, V_{IH} = 2 V, I_{OH} = −0.8 mA	2.4	3.4		2.4	3.4		V
V_{OL}	V_{CC} = MIN, V_{IL} = 0.8 V, I_{OL} = 16 mA		0.2	0.4		0.2	0.4	V
I_I	V_{CC} = MAX, V_I = 5.5 V			1			1	mA
I_{IH}	V_{CC} = MAX, V_I = 2.4 V			40			40	μA
I_{IL}	V_{CC} = MAX, V_I = 0.4 V			−1.6			−1.6	mA
I_{OS}§	V_{CC} = MAX	−20		−55	−18		−55	mA
I_{CCH}	V_{CC} = MAX, V_I = 4.5 V		11	21		11	21	mA
I_{CCL}	V_{CC} = MAX, V_I = 0 V		20	33		20	33	mA

† For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.
‡ All typical values are at V_{CC} = 5 V, T_A = 25°C.
§ Not more than one output should be shorted at a time.

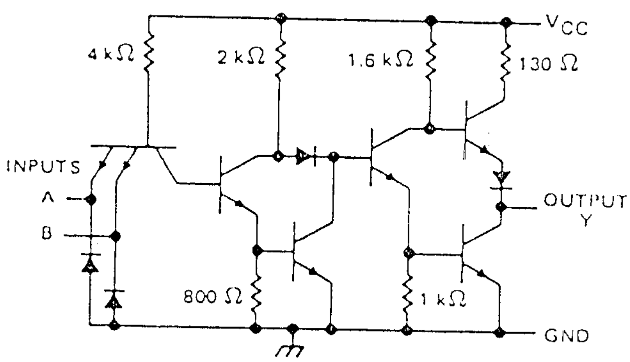
switching characteristics, V_{CC} = 5 V, T_A = 25°C (see note 2)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_{PLH}	A or B	Y	R_L = 400 Ω, C_L = 15 pF		17.5	27	ns
t_{PHL}					12	19	ns

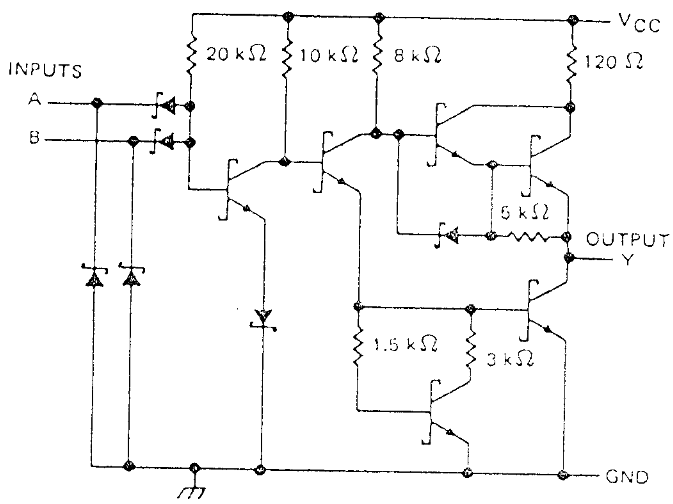
NOTE 2: See General Information Section for load circuits and voltage waveforms.

schematics (each gate)

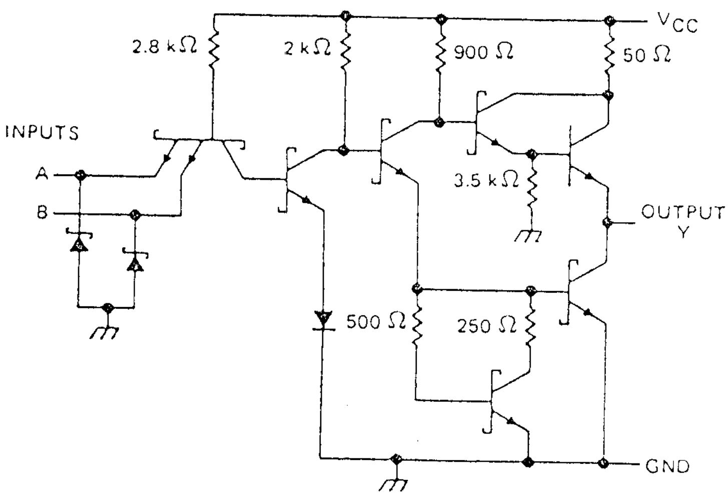
'08



'LS08



'S08



Resistor values are nominal.

absolute maximum ratings over operating free-air temperature range (unless otherwise noted)

Supply voltage, V_{CC} (see Note 1)	
Input voltage: '08, 'S08	5.5
'LS08	7 V
Operating free-air temperature range: SN54'	−55°C to 125°C
SN74'	0°C to 70°C
Storage temperature range	−65°C to 150°C

NOTE 1: Voltage values are with respect to network ground terminal.

recommended operating conditions

		SN54S08			SN74S08			UNIT
		MIN	NOM	MAX	MIN	NOM	MAX	
V_{CC}	Supply voltage	4.5	5	5.5	4.75	5	5.25	V
V_{IH}	High-level input voltage	2			2			V
V_{IL}	Low-level input voltage			0.8			0.8	V
I_{OH}	High-level output current			−1			−1	mA
I_{OL}	Low-level output current			20			20	mA
T_A	Operating free-air temperature	−55		125	0		70	°C

electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER	TEST CONDITIONS †	SN54S08			SN74S08			UNIT
		MIN	TYP‡	MAX	MIN	TYP‡	MAX	
V_{IK}	V_{CC} = MIN, I_I = −18 mA			−1.2			−1.2	V
V_{OH}	V_{CC} = MIN, V_{IH} = 2 V, I_{OH} = −1 mA	2.5	3.4		2.7	3.4		V
V_{OL}	V_{CC} = MIN, V_{IL} = 0.8 V I_{OL} = 20 mA			0.5			0.5	V
I_I	V_{CC} = MAX, V_I = 5.5 V			1			1	mA
I_{IH}	V_{CC} = MAX, V_I = 2.7 V			50			50	μA
I_{IL}	V_{CC} = MAX, V_I = 0.5 V			−2			−2	mA
I_{OS}§	V_{CC} = MAX	−40		−100	−40		−100	mA
I_{CCH}	V_{CC} = MAX, V_I = 4.5 V		18	32		18	32	mA
I_{CCL}	V_{CC} = MAX, V_I = 0 V		32	57		32	57	mA

† For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.
‡ All typical values are at V_{CC} = 5 V, T_A = 25°C.
§ Not more than one output should be shorted at a time, and the duration of the short-circuit should not exceed one second.

switching characteristics, V_{CC} = 5 V, T_A = 25°C (see note 2)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_{PLH}	A or B	Y	R_L = 280 Ω, C_L = 15 pF		4.5	7	ns
t_{PHL}					5	7.5	ns
t_{PLH}			R_L = 280 Ω, C_L = 50 pF		6		ns
t_{PHL}					7.5		ns

NOTE 2: See General Information Section for load circuits and voltage waveforms.

QUADRUPLE 2-INPUT POSITIVE-AND GATES

recommended operating conditions

		SN54LS08			SN74LS08			UNIT
		MIN	NOM	MAX	MIN	NOM	MAX	
V_{CC}	Supply voltage	4.5	5	5.5	4.75	5	5.25	V
V_{IH}	High-level input voltage	2			2			V
V_{IL}	Low-level input voltage			0.7			0.8	V
I_{OH}	High-level output current			– 0.4			0.4	mA
I_{OL}	Low-level output current			4			8	mA
T_A	Operating free-air temperature	– 55		125	0		70	°C

electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER	TEST CONDITIONS †	SN54LS08			SN74LS08			UNIT
		MIN	TYP‡	MAX	MIN	TYP‡	MAX	
V_{IK}	V_{CC} = MIN, I_I = – 18 mA			– 1.5			– 1.5	V
V_{OH}	V_{CC} = MIN, V_{IH} = 2 V, I_{OH} = – 0.4 mA	2.5	3.4		2.7	3.4		V
V_{OL}	V_{CC} = MIN, V_{IL} = MAX, I_{OL} = 4 mA		0.25	0.4		0.25	0.4	V
	V_{CC} = MIN, V_{IL} = MAX, I_{OL} = 8 mA					0.35	0.5	
I_I	V_{CC} = MAX, V_I = 7 V			0.1			0.1	mA
I_{IH}	V_{CC} = MAX, V_I = 2.7 V			20			20	μA
I_{IL}	V_{CC} = MAX, V_I = 0.4 V			– 0.4			– 0.4	mA
I_{OS}§	V_{CC} = MAX	– 20		– 100	– 20		– 100	mA
I_{CCH}	V_{CC} = MAX, V_I = 4.5 V		2.4	4.8		2.4	4.8	mA
I_{CCL}	V_{CC} = MAX, V_I = 0 V		4.4	8.8		4.4	8.8	mA

† For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.
‡ All typical values are at V_{CC} = 5 V, T_A = 25°C
§ Not more than one output should be shorted at a time, and the duration of the short-circuit should not exceed one second.

switching characteristics, V_{CC} = 5 V, T_A = 25°C (see note 2)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_{PLH}	A or B	Y	R_L = 2 kΩ, C_L = 15 pF		8	15	ns
t_{PHL}					10	20	ns

SN54H04, SN54L04, SN54LS04, SN54S04, SN7404, SN74H04, SN74LS04, SN74S04 HEX INVERTERS

REVISED DECEMBER 198[illegible]

- **Package Options Include Both Plastic and Ceramic Chip Carriers in Addition to Plastic and Ceramic DIPs**
- **Dependable Texas Instruments Quality and Reliability**

description

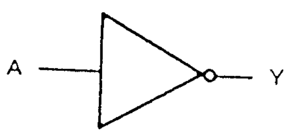
These devices contain six independent inverters.

The SN5404, SN54H04, SN54L04, SN54LS04 and SN54S04 are characterized for operation over the full military temperature range of −55°C to 125°C. The SN7404, SN74H04, SN74LS04 and SN74S04 are characterized for operation from 0°C to 70°C.

FUNCTION TABLE (each inverter)

INPUTS A	OUTPUT Y
H	L
L	H

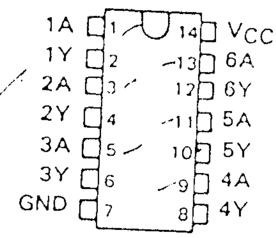
logic diagram (each inverter)



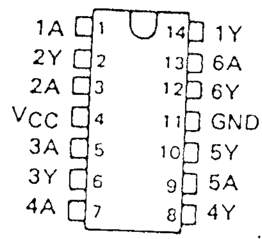
positive logic

$$Y = \overline{A}$$

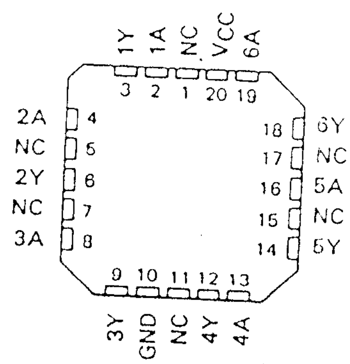
SN5404, SN54H04, SN54L04 . . . J PACKAGE
SN54LS04, SN54S04 . . . J OR W PACKAGE
SN7404, SN74H04 . . . J OR N PACKAGE
SN74LS04, SN74S04 . . . D, J OR N PACKAGE
(TOP VIEW)



SN5404, SN54H04 . . . W PACKAGE
(TOP VIEW)



SN54LS04, SN54S04 . . . FK PACKAGE
SN74LS04, SN74S04 . . . FN PACKAGE
(TOP VIEW)



NC – No internal connection

recommended operating conditions

		SN54S03			SN74S03			UNIT
		MIN	NOM	MAX	MIN	NOM	MAX	
V_{CC}	Supply voltage	4.5	5	5.5	4.75	5	5.25	V
V_{IH}	High-level input voltage	2			2			V
V_{IL}	Low-level input voltage			0.8			0.8	V
V_{OH}	High-level output voltage			5.5			5.5	V
I_{OL}	Low-level output current			20			20	mA
T_A	Operating free-air temperature	−55		125	0		70	°C

electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER	TEST CONDITIONS†			MIN	TYP‡	MAX	UNIT
V_{IK}	V_{CC} = MIN,	$I_I = -18$ mA				−1.2	V
I_{OH}	V_{CC} = MIN,	V_{IL} = 0.8 V,	V_{OH} = 5.5 V			0.25	mA
V_{OL}	V_{CC} = MIN,	V_{IH} = 2 V,	I_{OL} = 20 mA			0.5	V
I_I	V_{CC} = MAX,	V_I = 5.5 V				1	mA
I_{IH}	V_{CC} = MAX,	V_I = 2.7 V				50	µA
I_{IL}	V_{CC} = MAX,	V_I = 0.5 V				−2	mA
I_{CCH}	V_{CC} = MAX,	V_I = 0 V			6	13.2	mA
I_{CCL}	V_{CC} = MAX,	V_I = 4.5 V			20	36	mA

† For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.
‡ All typical values are at V_{CC} = 5 V, T_A = 25°C.

switching characteristics, V_{CC} = 5 V, T_A = 25°C (see note 2)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS		MIN	TYP	MAX	UNIT
t_{PLH}	A or B	Y	R_L = 280 Ω,	C_L = 15 pF	2	5	7.5	ns
t_{PHL}					2	4.5	7	ns
t_{PLH}			R_L = 280 Ω,	C_L = 50 pF		7.5		ns
t_{PHL}						7		ns

NOTE 2: See General Information Section for load circuits and voltage waveforms.

recommended operating conditions

		SN5404			SN7404			UNIT
		MIN	NOM	MAX	MIN	NOM	MAX	
V_{CC}	Supply voltage	4.5	5	5.5	4.75	5	5.25	V
V_{IH}	High-level input voltage	2			2			V
V_{IL}	Low-level input voltage			0.8			0.8	V
I_{OH}	High-level output current			– 0.4			– 0.4	mA
I_{OL}	Low-level output current			16			16	mA
T_A	Operating free-air temperature	– 55		125	0		70	°C

electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER	TEST CONDITIONS†	SN5404			SN7404			UNIT
		MIN	TYP‡	MAX	MIN	TYP‡	MAX	
V_{IK}	V_{CC} = MIN, I_I = – 12 mA			– 1.5			– 1.5	V
V_{OH}	V_{CC} = MIN, V_{IL} = 0.8 V, I_{OH} = – 0.4 mA	2.4	3.4		2.4	3.4		V
V_{OL}	V_{CC} = MIN, V_{IH} = 2 V, I_{OL} = 16 mA		0.2	0.4		0.2	0.4	V
I_I	V_{CC} = MAX, V_I = 5.5 V			1			1	mA
I_{IH}	V_{CC} = MAX, V_I = 2.4 V			40			40	μA
I_{IL}	V_{CC} = MAX, V_I = 0.4 V			– 1.6			– 1.6	mA
I_{OS}§	V_{CC} = MAX	– 20		– 55	– 18		– 55	mA
I_{CCH}	V_{CC} = MAX, V_I = 0 V		6	12		6	12	mA
I_{CCL}	V_{CC} = MAX, V_I = 4.5 V		18	33		18	33	mA

† For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.
‡ All typical values are at V_{CC} = 5 V, T_A = 25°C.
§ Not more than one output should be shorted at a time.

switching characteristics, V_{CC} = 5 V, T_A = 25°C (see note 2)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_{PLH}	A	Y	R_L = 400 Ω, C_L = 15 pF		12	22	ns
t_{PHL}					8	15	ns

NOTE 2: See General Information Section for load circuits and voltage waveforms.

recommended operating conditions

		SN5404			SN7404			UNIT
		MIN	NOM	MAX	MIN	NOM	MAX	
V_{CC}	Supply voltage	4.5	5	5.5	4.75	5	5.25	V
V_{IH}	High-level input voltage	2			2			V
V_{IL}	Low-level input voltage			0.8			0.8	V
I_{OH}	High-level output current			−0.4			−0.4	mA
I_{OL}	Low-level output current			16			16	mA
T_A	Operating free-air temperature	−55		125	0		70	°C

electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER	TEST CONDITIONS†	SN5404			SN7404			UNIT
		MIN	TYP‡	MAX	MIN	TYP‡	MAX	
V_{IK}	V_{CC} = MIN, I_I = −12 mA			−1.5			−1.5	V
V_{OH}	V_{CC} = MIN, V_{IL} = 0.8 V, I_{OH} = −0.4 mA	2.4	3.4		2.4	3.4		V
V_{OL}	V_{CC} = MIN, V_{IH} = 2 V, I_{OL} = 16 mA		0.2	0.4		0.2	0.4	V
I_I	V_{CC} = MAX, V_I = 5.5 V			1			1	mA
I_{IH}	V_{CC} = MAX, V_I = 2.4 V			40			40	μA
I_{IL}	V_{CC} = MAX, V_I = 0.4 V			−1.6			−1.6	mA
I_{OS} §	V_{CC} = MAX	−20		−55	−18		−55	mA
I_{CCH}	V_{CC} = MAX, V_I = 0 V		6	12		6	12	mA
I_{CCL}	V_{CC} = MAX, V_I = 4.5 V		18	33		18	33	mA

† For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.
‡ All typical values are at V_{CC} = 5 V, T_A = 25°C.
§ Not more than one output should be shorted at a time.

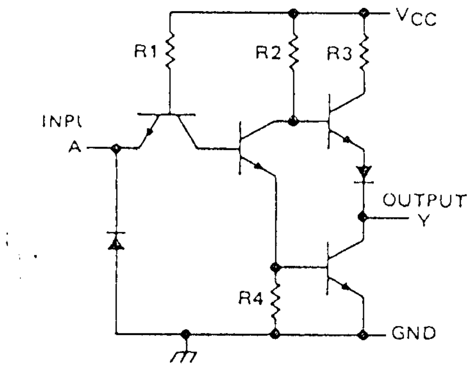
switching characteristics, V_{CC} = 5 V, T_A = 25°C (see note 2)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_{PLH}	A	Y	R_L = 400 Ω, C_L = 15 pF		12	22	ns
t_{PHL}					8	15	ns

NOTE 2: See General Information Section for load circuits and voltage waveforms.

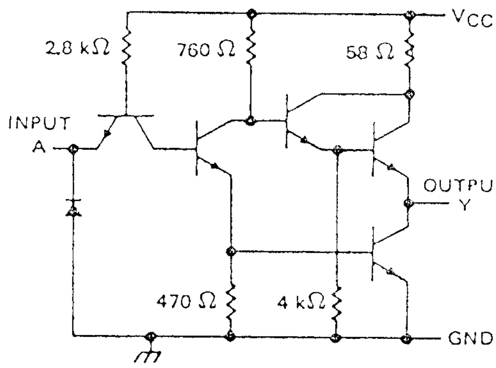
schematics (each gate)

'04,'L04

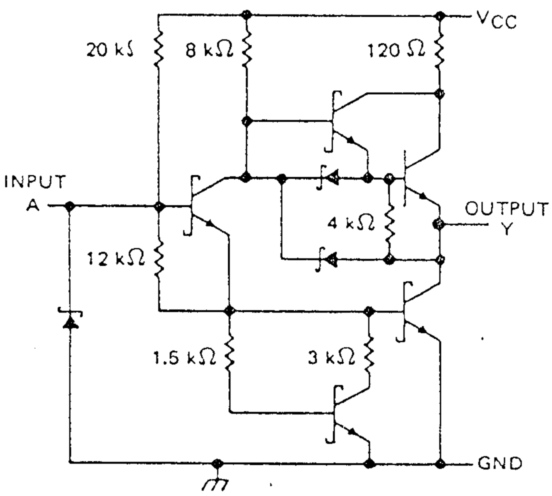


CIRCUIT	R1	R2	R3	R4
'04	4 kΩ	1.6 kΩ	130 Ω	1 kΩ
'L04	40 kΩ	20 kΩ	500 Ω	12 kΩ

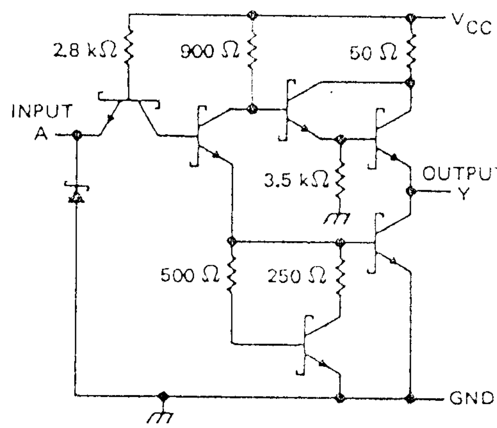
'H04



'LS04



'S04



Resistor values shown are nominal.

absolute maximum ratings over operating free-air temperature range (unless otherwise noted)

Supply voltage, V_{CC} (see Note 1): '04, 'H04, 'LS04, 'S04 . . . . 7 V
'L04 . . . . 8 V
Input voltage: '04, 'H04, 'L04, 'S04 . . . . 5.5 V
'LS04 . . . . 7 V
Operating free-air temperature range: SN54' . . . . −55°C to 125°C
SN74' . . . . 0°C to 70°C
Storage temperature range . . . . −65°C to 150°C

NOTE 1: Voltage values are with respect to network ground terminal.

recommended operating conditions

		SN54H04			SN74H04			UNIT
		MIN	NOM	MAX	MIN	NOM	MAX	
V_{CC}	Supply voltage	4.5	5	5.5	4.75	5	5.25	V
V_{IH}	High-level input voltage	2			2			V
V_{IL}	Low-level input voltage			0.8			0.8	V
I_{OH}	High-level output current			−0.5			−0.5	mA
I_{OL}	Low-level output current			20			20	mA
T_A	Operating free-air temperature	−55		125	0		70	°C

electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER	TEST CONDITIONS†			MIN	TYP‡	MAX	UNIT
V_{IK}	V_{CC} = MIN,	$I_I = -8$ mA				−1.5	V
V_{OH}	V_{CC} = MIN,	V_{IL} = 0.8 V,	$I_{OH} = -0.5$ mA	2.4	3.5		V
V_{OL}	V_{CC} = MIN,	V_{IH} = 2 V,	I_{OL} = 20 mA		0.2	0.4	V
I_I	V_{CC} = MAX,	V_I = 5.5 V				1	mA
I_{IH}	V_{CC} = MAX,	V_I = 2.4 V				50	μA
I_{IL}	V_{CC} = MAX,	V_I = 0.4 V				−2	mA
I_{OS}§	V_{CC} = MAX			−40		−100	mA
I_{CCH}	V_{CC} = MAX,	V_I = 0 V			16	26	mA
I_{CCL}	V_{CC} = MAX,	V_I = 4.5 V			40	58	mA

† For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.
‡ All typical values are at V_{CC} = 5 V, T_A = 25°C.
§ Not more than one output should be shorted at a time, and the duration of the short-circuit should not exceed one second.

switching characteristics, V_{CC} = 5 V, T_A = 25°C (see note 2)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_{PLH}	A	Y	R_L = 280 Ω, C_L = 25 pF		6	10	ns
t_{PHL}					6.5	10	ns

NOTE 2: See General Information Section for load circuits and voltage waveforms.