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ELECTRONICS PROJECTS VOL. 13

A Compilation of 105 tested Electronic Construction Projects and Circuit Ideas for Professionals and Enthusiasts

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Electronics Projects
Vol. 13

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FOR YOU

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ELECTRONICS PROJECTS VOL. 13

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FOREWORD

This volume of Electronics Projects is the thirteenth in the series published by EFY Enterprises Pvt Ltd. It is a compilation of 24 construction projects and 81 circuit ideas published in 'Electronics For You' magazine during 1992.

In keeping with the past trend, all modifications, corrections and additions sent by the readers and authors have been incorporated in the articles. Queries from readers along with the replies from authors/EFY have also been published towards the end of relevant articles. It is a sincere endeavour on our part to make each project as error-free and comprehensive as possible. However, EFY cannot resume any responsibility if readers are unable to make a circuit successfully, for whatever reason.

This collection of tested circuit ideas and construction projects in a handy volume, would provide all classes of electronics enthusiasts—be they students, teachers, hobbyists or professionals—with a valuable resource of electronic circuits, which can be fabricated using readily-available and reasonably-priced components. These circuits could either be used independently or in combination with other circuits, described in this and other volumes. We are confident that this volume, like its predecessors, will generate tremendous interest amongst the readers.

CONTENTS

Section A: Construction Projects

Section B: Circuit Ideas

Section A:
Construction Projects

Make Your Own Audio Cassette Copier

Ashok Kumar T.

Any audio electronics hobbyist will be interested in a quality cassette copier to enrich his music collection. Here is a quality recording circuitry which has been tested and used for over six months and found working efficiently.

The whole circuit is in fact an integration of some well-known circuits. A cassette copier has four main sections. First, a head preamplifier to pick-up the signals from the playback head and, second, a high frequency booster to boost the amplitude of high frequency signals during recording. The high frequency response is deliberately boosted in order to give a high signal-to-noise ratio on playback and to increase the clarity of the recorded signal. In this circuit this requirement can be met by keeping bass flat (no bass boosting; potentiometer at mid position '0') and increasing the high frequency by keeping the pot above '0', the mid position.

Listening to the depth of the tone of the playback signal and one's preference, the overall tone of the recording signal can also be controlled using active tone control circuit besides high frequency emphasis. One must note that a very good quality in recording can be achieved by proper setting of the tone control section.

The third section is a recording amplifier. The gain of the amplifier is around 85, which is more than sufficient. The gain is determined by the ratio (R7 + R9)/R9.

VR3 is a dual potentiometer which controls overall recording signal to be supplied to the recording amplifier in stereo applications. Using two separate potentiometers for VR4, individual channel signal strength can be controlled

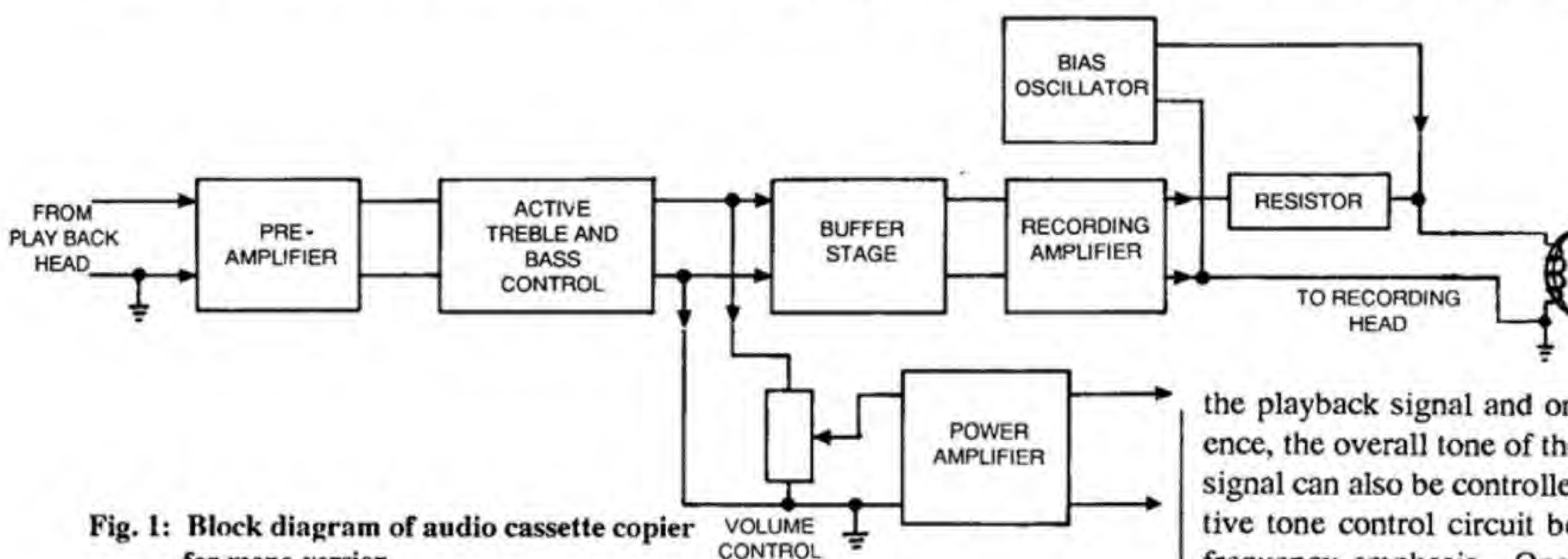


Fig. 1: Block diagram of audio cassette copier for mono version.

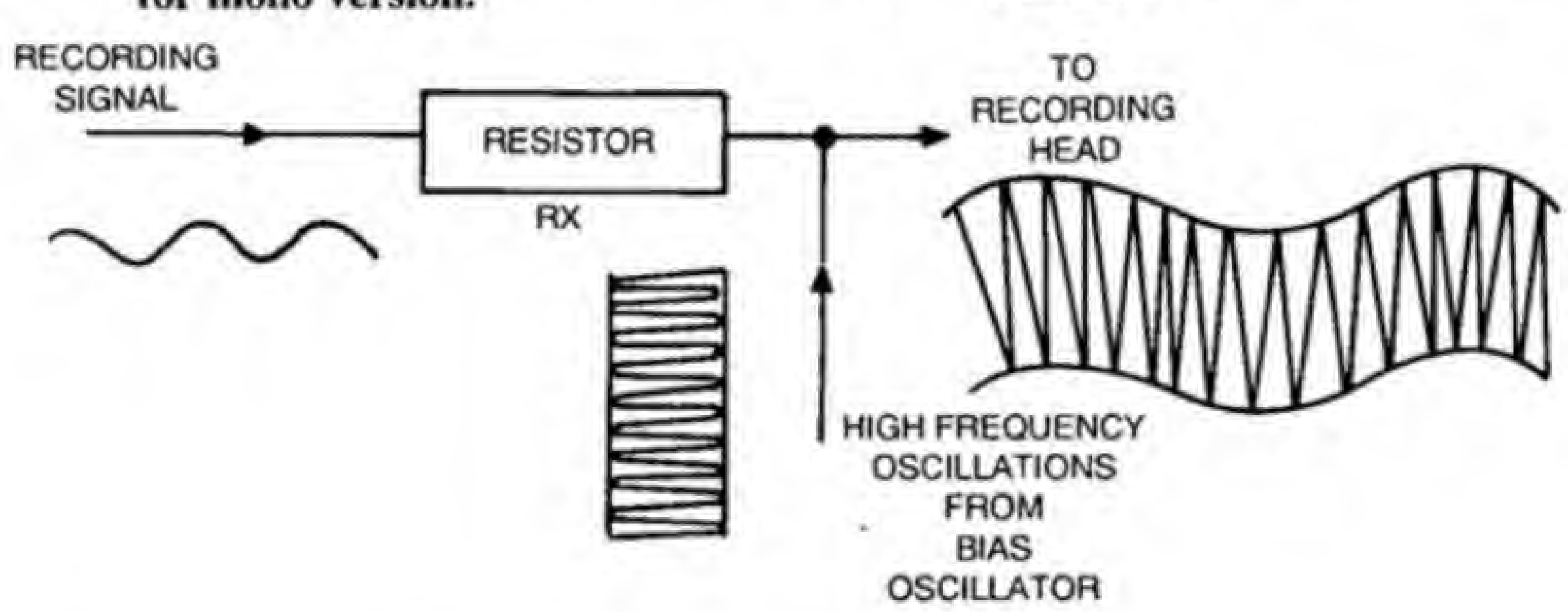


Fig. 2: Modulation of signal.

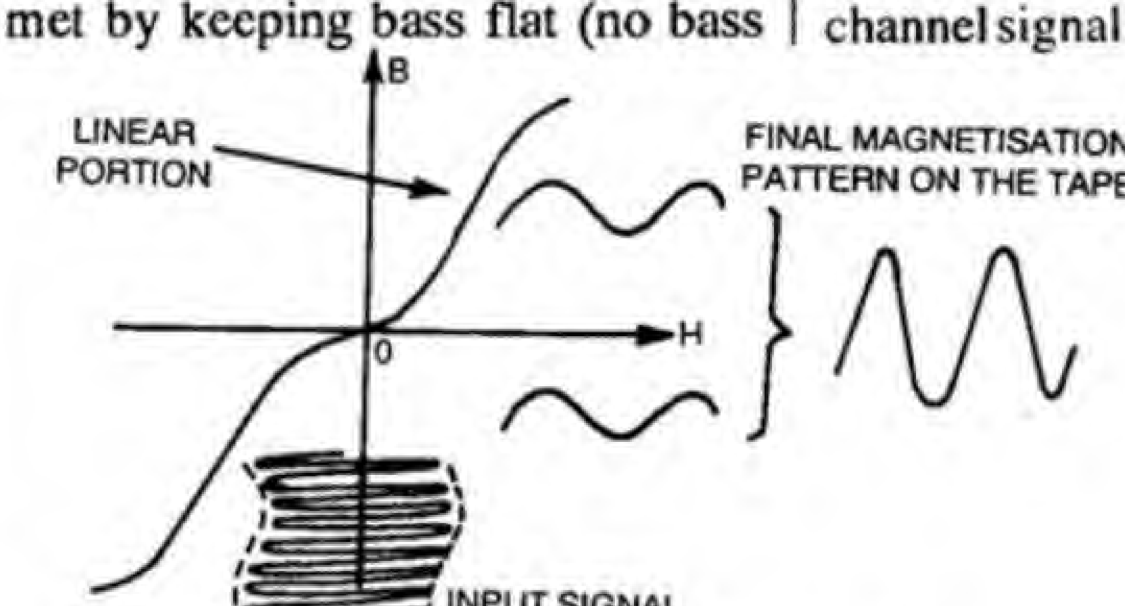


Fig. 3: B-H curve of the magnetic tape material.

The author is a lecturer in Department of Electronics, K.V.G. College of Engineering, P.O. Sullia (Karnataka).

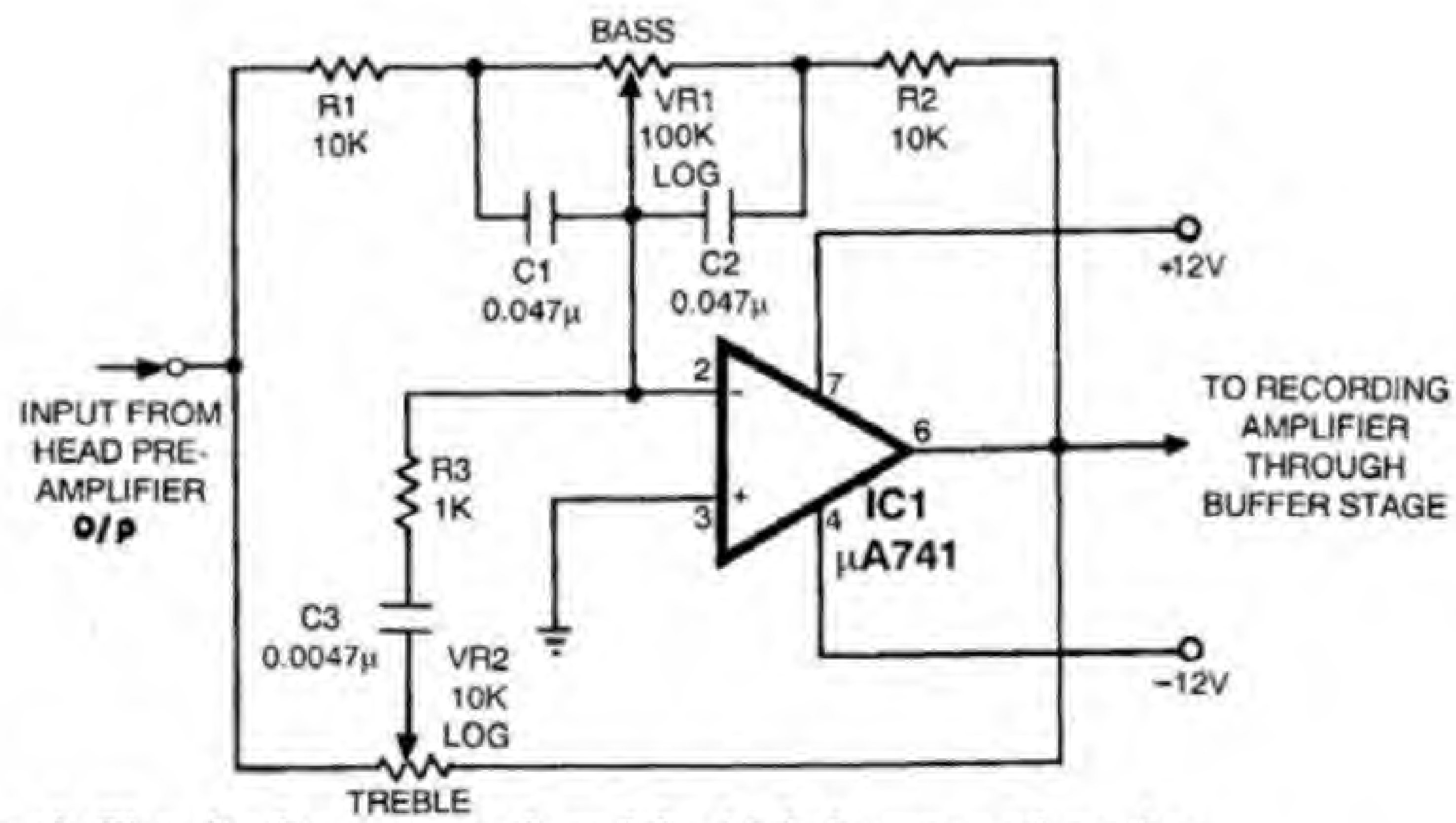


Fig. 4: Circuit of tone control used for high-frequency boosting.

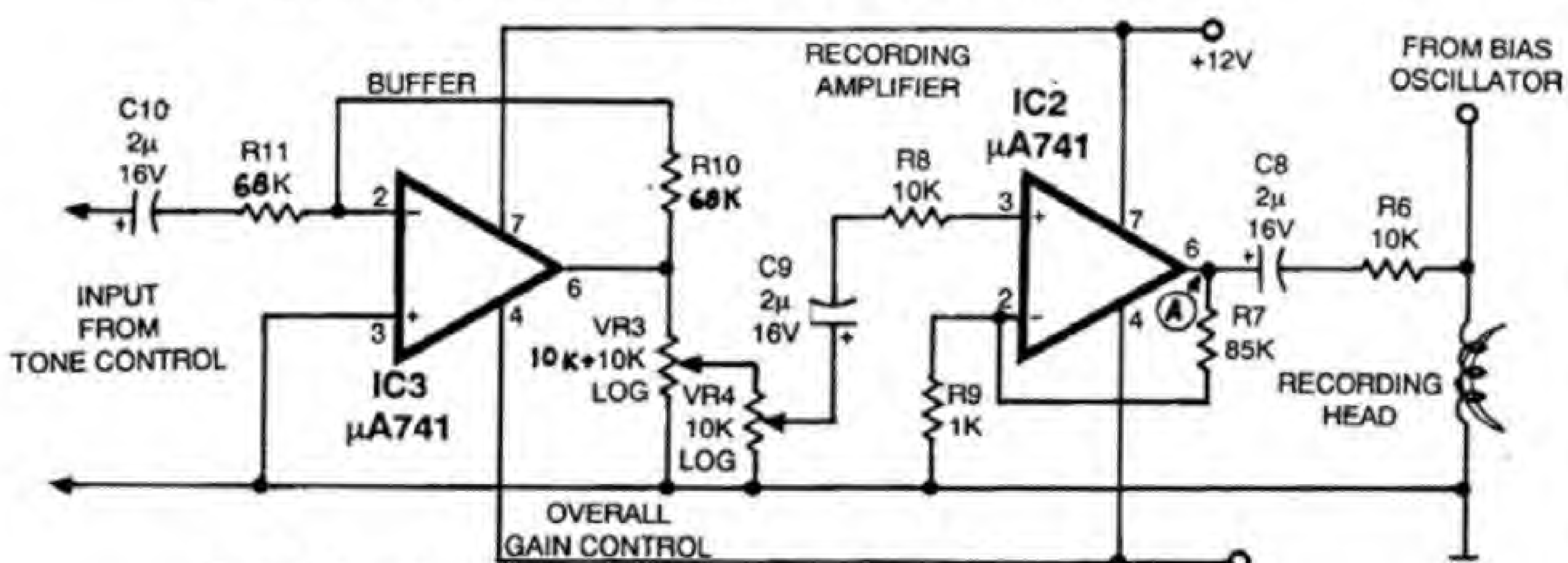


Fig. 5: Circuit of buffer and recording amplifier.

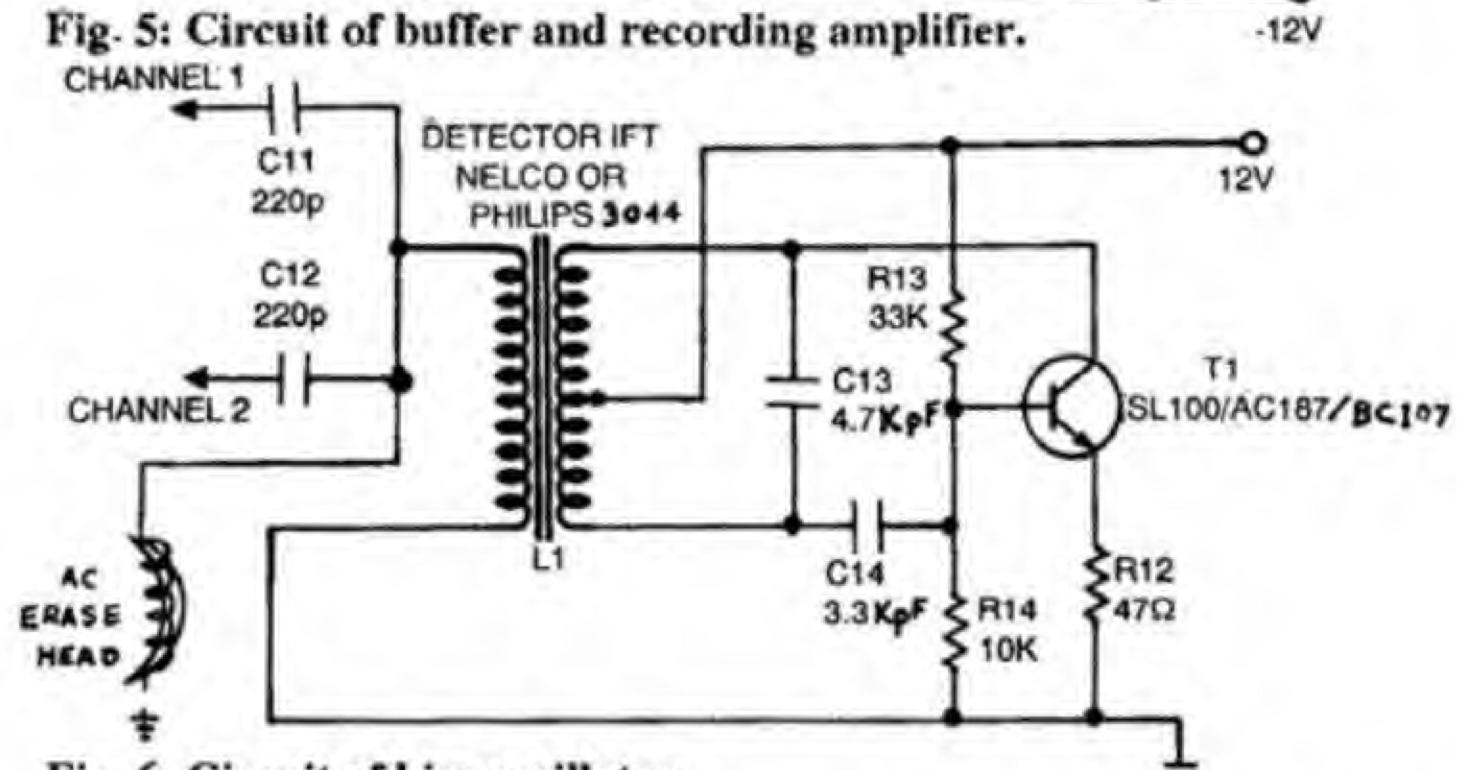


Fig. 6: Circuit of bias oscillator.

independently. The recording signal can also be tapped out from the volume control of the power amplifier section of any tape recorder set.

The final section is of a bias oscillator. Bias signal is applied to the recording head from a high frequency oscillator. The bias places the recording signal into the linear portion of the tape's magnetisation curve which brings about improved linearity, lowered distortion etc. An AC bias (sinusoidal) is preferred over a steady DC bias.

The frequency of the bias signal must be above audibility, i.e. in the range of 75 kHz to100 kHz. The bias frequency can be set by adjusting the core depth of the oscillator coil or IFT. A detector IFT with a capacitor can be used as an oscillator coil. The oscillations must be ensured and set properly using a CRO. It is highly impossible to record the signals without proper bias voltage. (Ref. Fig. 3.) The bias must be above 18 volts.

Finally, the tape recorder must have a provision for erasing previous recordings. Here also AC erasing is preferred over DC erasing. The output of a bias oscillator can be used to feed the erase head

Final recording quality, sharpness, channel separation etc depend upon one's skill in adjusting Master and Slave heads and amplitude of the recording signal. More and more signal amplitude leads to saturation of the magnetic particles on the tape which increases the distortion during playback. A head similar to the playback head does the function of recording in the recording set.

PARTS LIST

Semiconductors:		
IC1-IC3	—	μA741, operational amplifier
T1	—	SL100B/BC107 silicon transistor
D1,D2	—	1N4001 rectifier diode
Resistors (all ¼ ± 5% carbon, unless stated otherwise):		
R1, R2, R6 R8, R14, R15	—	10-kilohm
R3,R9	—	1-kilohm
R4,R5	—	220-ohm
R7	—	85-kilohm
R10,R11	—	68-kilohm
R12	—	47-ohm
R13	—	33-kilohm
VR1	—	100-kilohm log potentiometer
VR2,VR4	—	10 kilohm log potentiometer
VR3	—	Dual (10K+10K) log
Capacitors:		
C1, C2	—	0.047μF ceramic
C3,C13	—	0.0047μF ceramic
C4-C7	—	220μF, 16V electrolytic
C8-C10	—	2μF, 16 electrolytic
C11,C12	—	220pF styroflex
C14	—	313Kpf
Miscellaneous:		
S1	—	On/off switch
X1	—	230V AC primary to 12V-0-12V, 500mA secondary transformer
L1	—	Detector IFT (Nelco or Philips 3044)
	—	Recording head
	—	Erase head (AC type)
	—	Neon lamp
	—	Fuse, 500mA

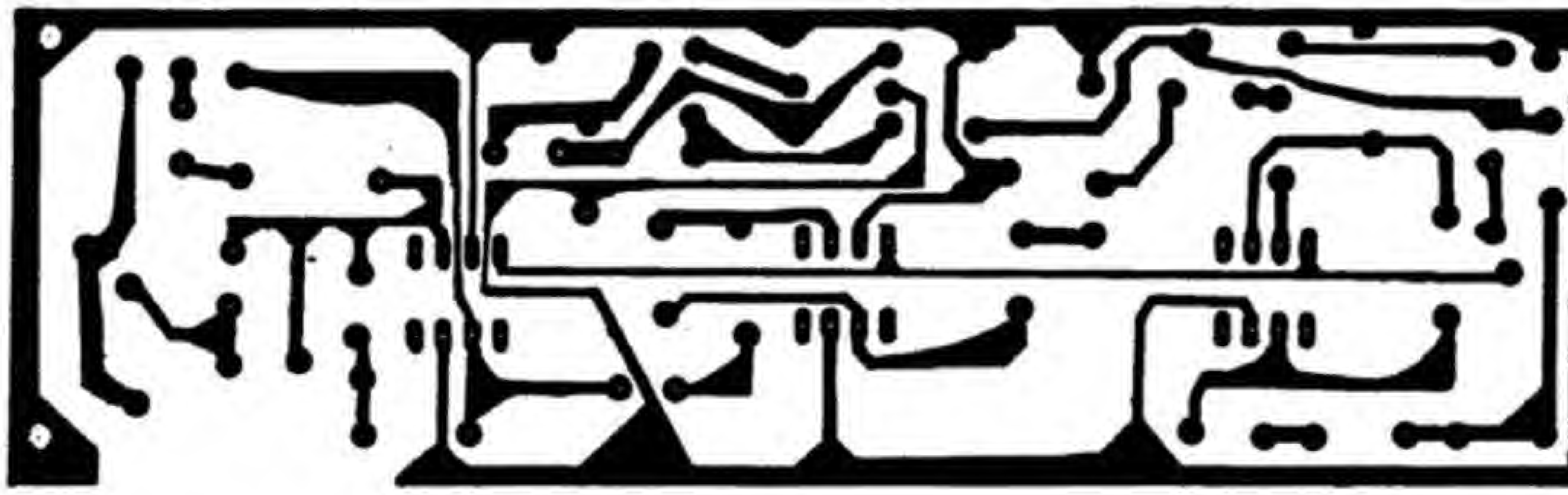


Fig.7 : Actual-size PCB layout of Figs 4, 5, 6.

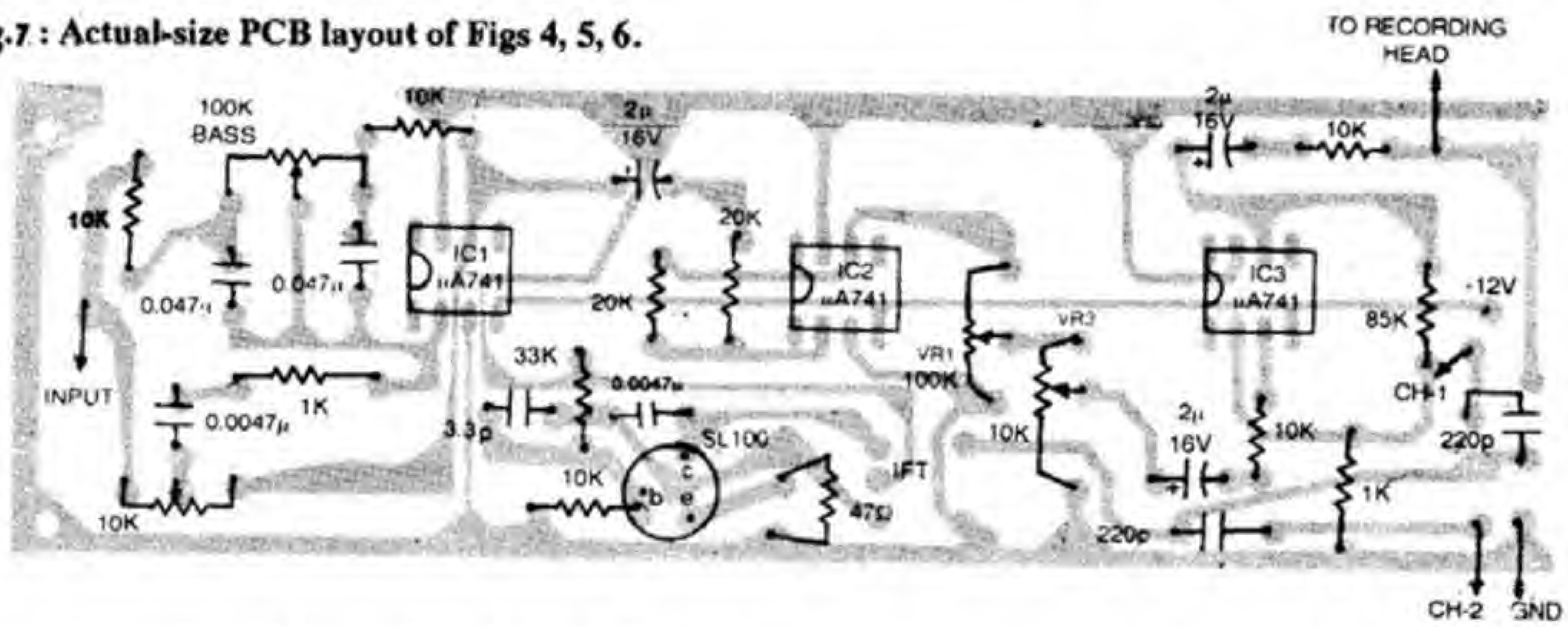


Fig.8 : Components layout for the PCB shown in Fig.7 .

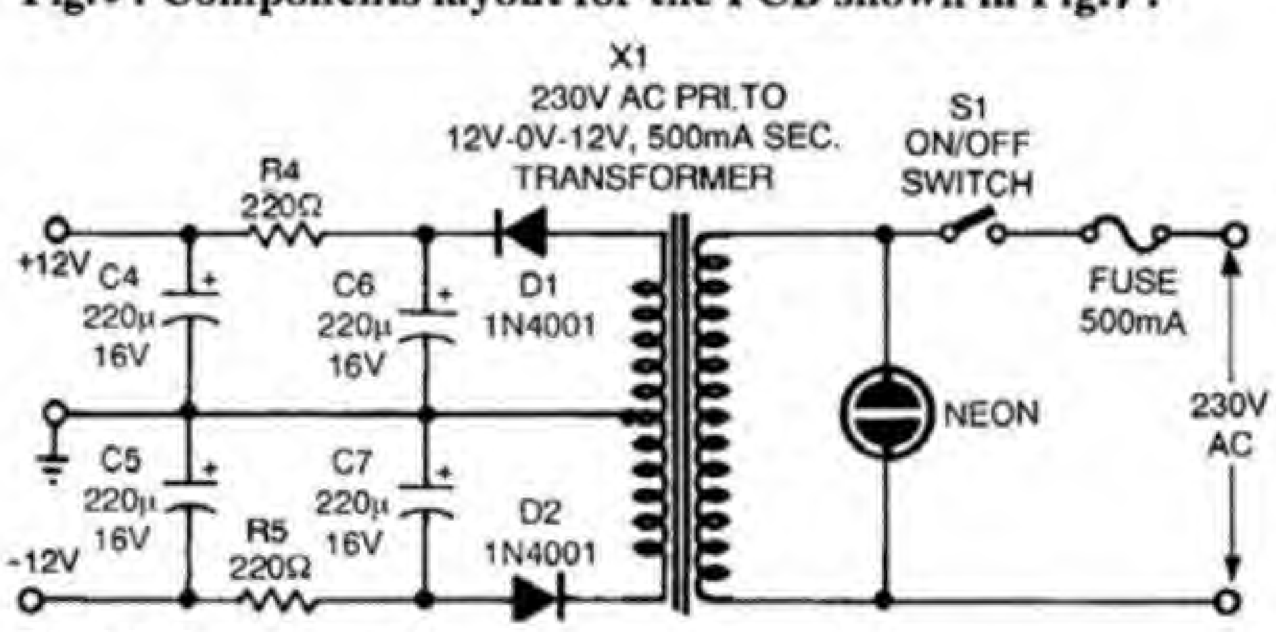


Fig.10: Power supply.

Some important tips

1. Good and smooth running mechanism solves most of the problems concerning the project. Mechanisms should be properly grounded.

2. Both mechanisms must be operated in play mode and the heads should be aligned properly for sharp pick-up using any standard pre-recorded cassette.

3. The bias oscillator works with detector IFT (Philips 30044, 30043 brown) or Nelco detector IFT (black) and delivers a peak-to-peak output voltage nearly twice the input.

4. All signal connections must be done with shielded wires.

5. Frequency booster and preamplifier circuits must be less noisy. Any tone control circuit built around transistor may also be used.

6. If the buffer stage is not used, the playback signal to the power amplifier will be reduced significantly.

Construct a provision such that the buffer stage gets connected to the preamplifier only when the record button is pressed.

For a stereo construction, the above PCB must again be duplicated except bias oscillator.

The bias oscillator can be checked as follows without a CRO. Connect the output of bias oscillator to an AC erase head and play a pre-recorded cassette in the recording deck.

The recording will be erased, only if the oscillator is giving the oscillations and working well.

Authors' comment:

In response to several letters received from EFY readers regarding my construction project published in Jan.'92 issue, I'm pleased to give below some clarifications:

1. The cassette copier is mean. to be a stereo copier, though only one channel was shown for simplicity. An identical channel has to be made for stereo.

The bias oscillator is however common to both the channels. This oscillator delivers a frequency of about 80 kHz when the IFT core is at the top position and about 65 kHz when the core is at the bottom. The oscillator output is directly fed to the recording head through the capacitor.

2. The value of C13 should have been 4.7 kpF and of C14 3.3 kpF. Transistors such as BC549C or BC149 can also be used in place of T1.

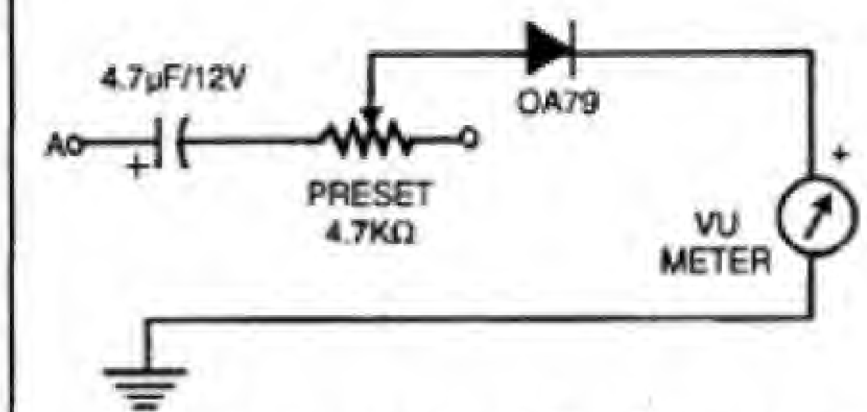
3. IC 741 is a bit noisy only if used to amplify low-level signals of less than 100 mV. Usually the output signal amplitude from a preamplifier is 350 mV to 600 mV. This recording circuit does not give any unwanted noise other than preamp noise. One can use low-noise operational amplifiers if necessary.

Please note, our intention is to have a recording circuit with independent controls for both the channels. Therefore an automatic controller has not been discussed.

Potentiometer VR3 is a dual control and common to both the amplifiers for simultaneous control on the balanced channel. Each channel can be balanced by using two individual potentiometers (VR4) for the two channels, if required. One can mark the 'normal' position of level controls by recording the signals from a standard pre-recorded cassette of a reputed make. Some trial and error may be required in doing so.

5. No special noise limiters are required. Hissing noise will increase if the 'treble' is boosted highly.

6. A level VU meter can be added to the output point A of the recording amplifier as follows.



7. The circuit should be kept away from the transformer. A separate transformer may be required for the motor supply. Try to isolate the power supplies of motor and recording circuits. Keep the circuits at least 3 cms above the cabinet's base. Ground the bodies of all the potentiometers.

To get better bass effect, connect a 1kpF or 4.7kpF capacitor in place of 220pF.

ASHOK KUMAR T.
Sullia

Make Yourself This Special Two-Way Intercom

Amrit Bir Tiwana

Intercom sets are immensely useful and almost indispensible at places where a communication link between two or more persons is required. The installation of most of the commercially available intercoms involves the cumbersome process of laying the signal transmission wires, which results in increased expenditure and frequent failures (due to snapping of wires etc).

This article describes functional and constructional details of a simple, fail-safe, mains operated, integrated two-way intercom set. The circuit, in addition to being extremely versatile and low in cost, possesses a number of desirable features like in-built calling facility, self-contained solidstate power supply, activation indicator, APO (auto-power off) etc. As the circuit uses no transformers, transistors etc, it is extremely compact.

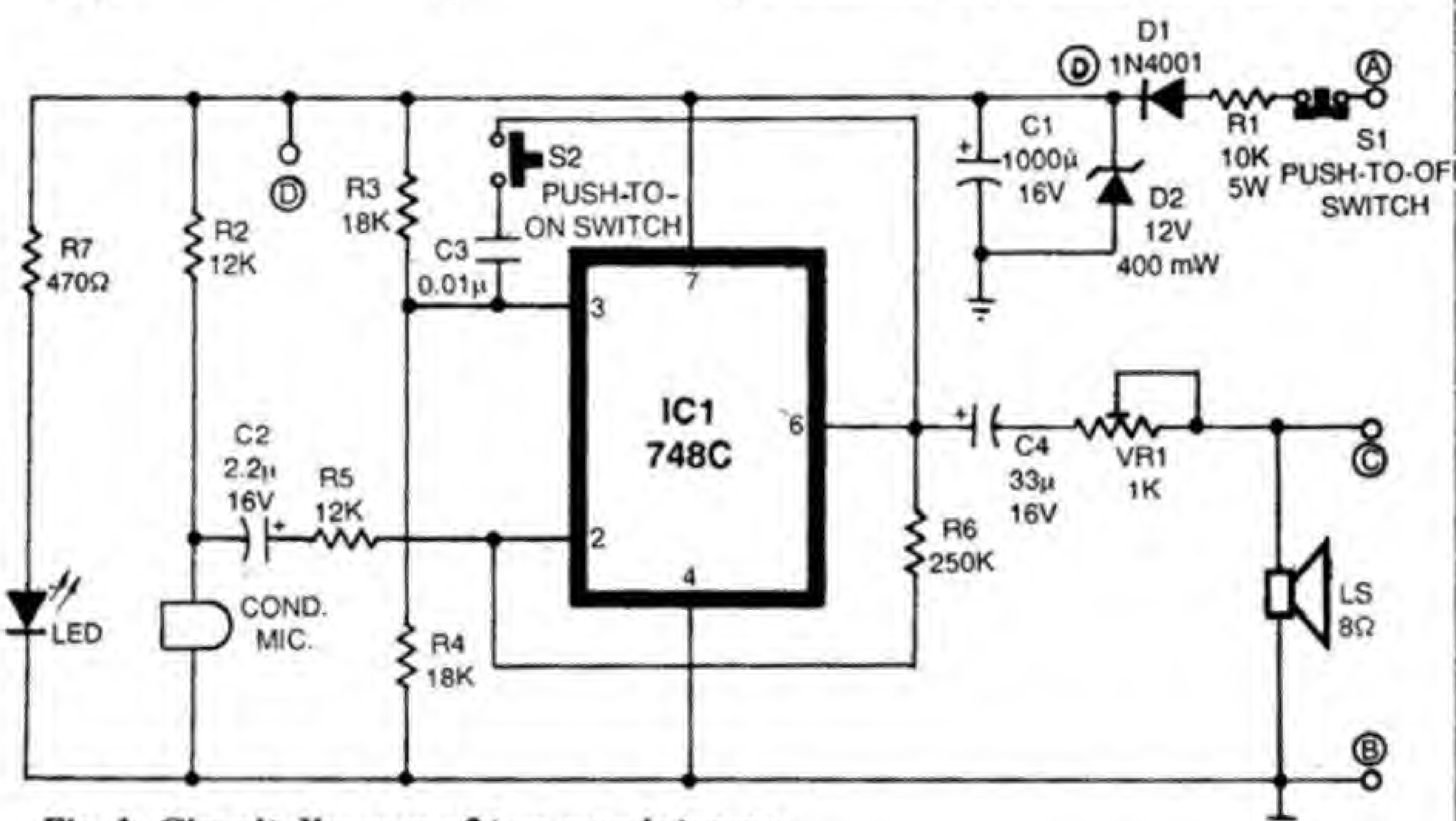


Fig. 1: Circuit diagram of two-way intercom.

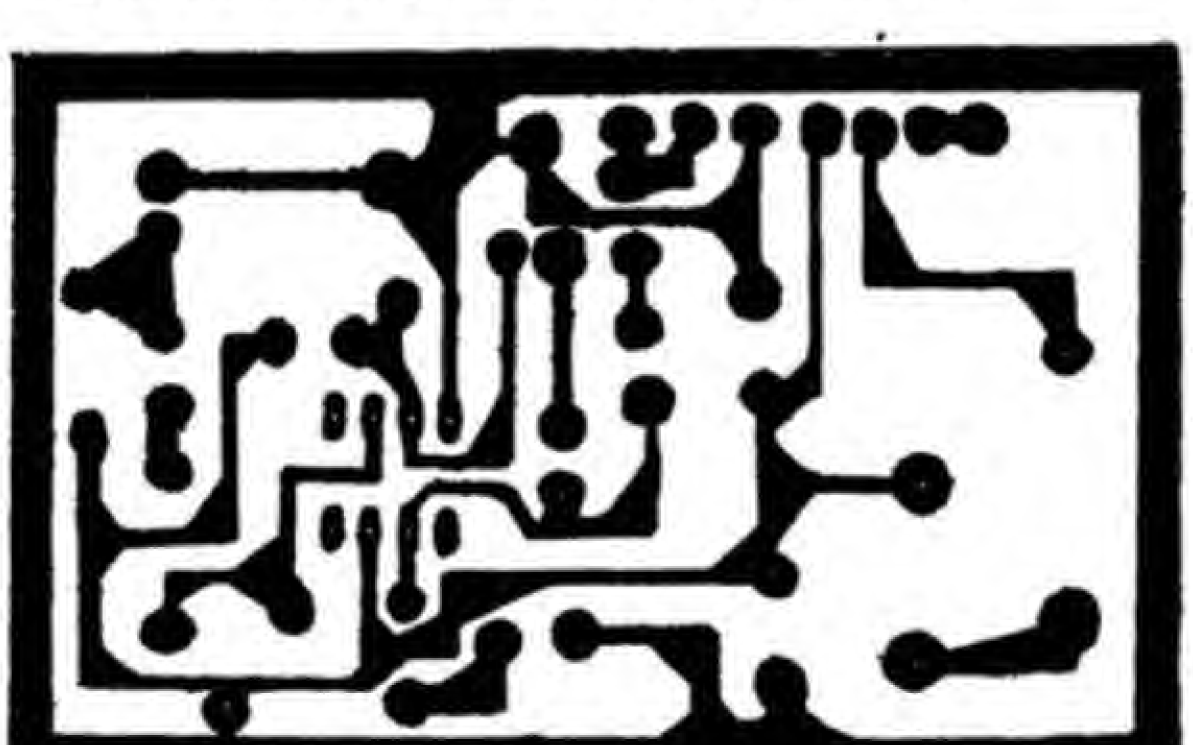


Fig.2: Actual-size PCB layout for two-way intercom.

The circuit eliminates the need for any extra connecting wires by utilising the AC mains wires. The circuit uses the live and neutral wires for powering itself, and the neutral and ground wires (the potential difference between which is almost zero) for sending and receiving signals.

Working

The circuit of the two-way intercom is shown in Fig 1. Low-cost op-amp IC 748 forms the heart of the circuit. Resistor R1 drops the mains voltage to a suitable level. This voltage is rectified, filtered and stabilised by D1, C1 and D2 respectively. The 12-volt regulated supply thus obtained drives the rest of the circuit. Resistors R3 and R4 tap this voltage which in turn biases the non-inverting input of IC1. Resistor R2 biases the condenser microphone. Capacitor C2 couples the same to the inverting input of IC1. Resistor R5 is used to attenuate this input signal. Resistor R6 determines the gain of IC1. Capacitor C4 is used to couple the output signal to the speaker and to the other set/sets, while VR1 is used to attenuate the output signal to a suitable level.

The calling function is obtained by pressing switch S2. When S2 is pressed, capacitor C3 is introduced as a feedback element between the output and non-inverting input of IC1. IC1 thus begins to oscillate and an audio tone is generated at the output. When switch S1 is pressed, the circuit gets deactivated and vice versa.

Construction

The PCB pattern of the circuit and the components placement on the PCB are shown in Figs 2 and 3. Soldering should be done using good quality sol-

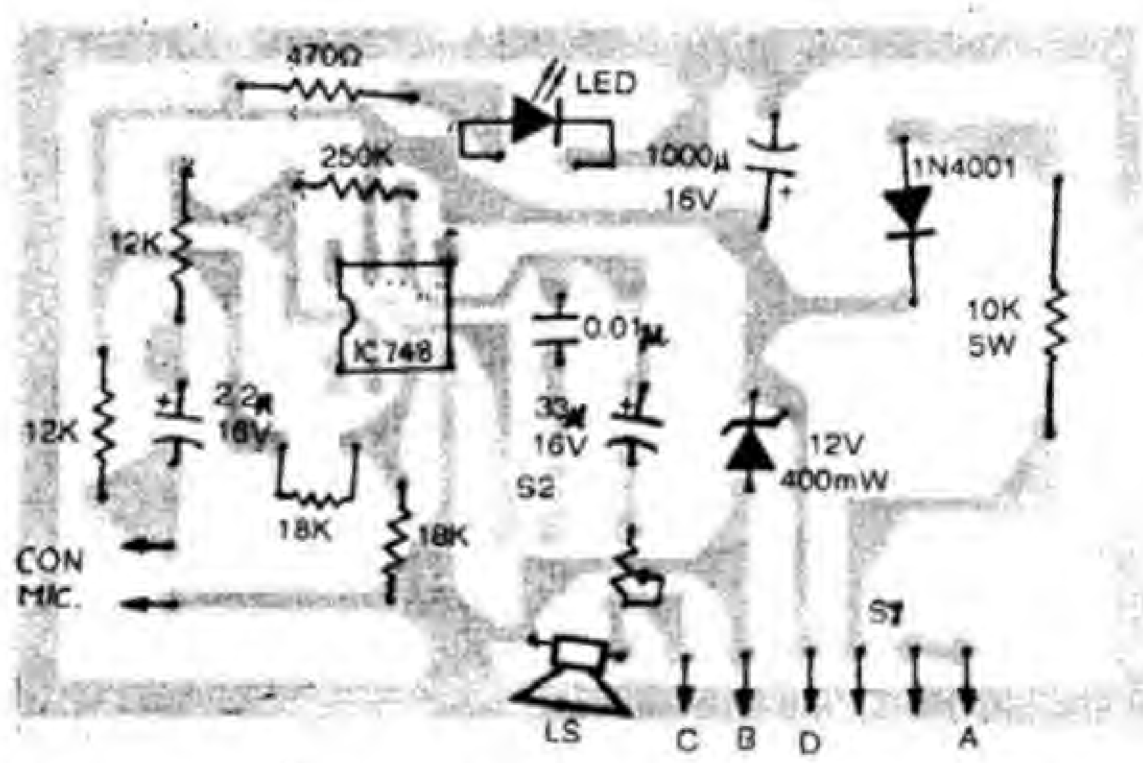


Fig. 3: Components layout for the PCB shown in Fig. 2.

dering core and flux. Extreme care should be taken in soldering the components, especially IC1. A socket is recommended for use with IC1. The pin configuration of the IC is shown in Fig.5.

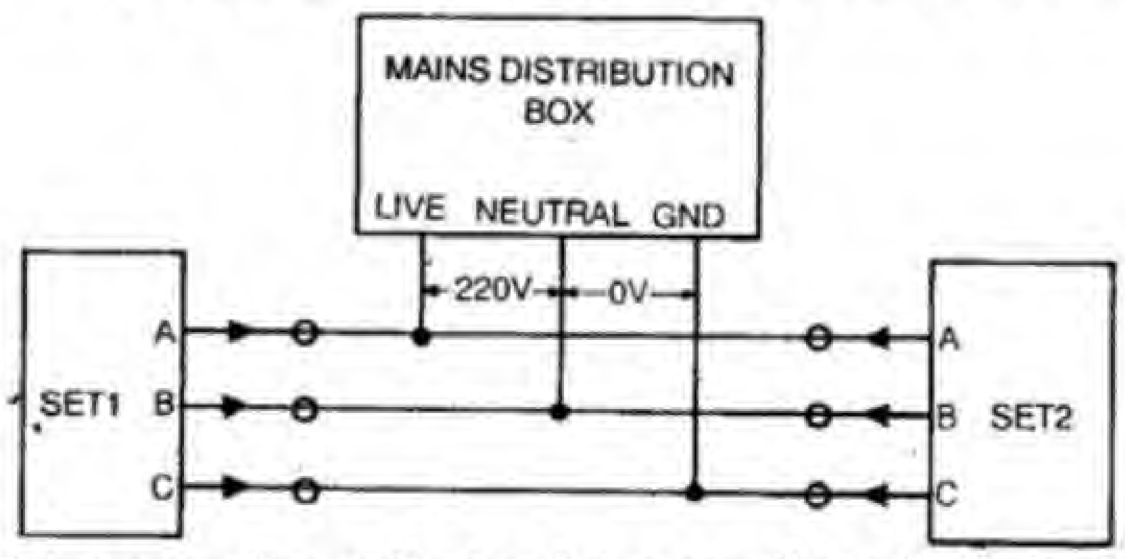


Fig. 4: Interconnection of the two intercoms through the mains.

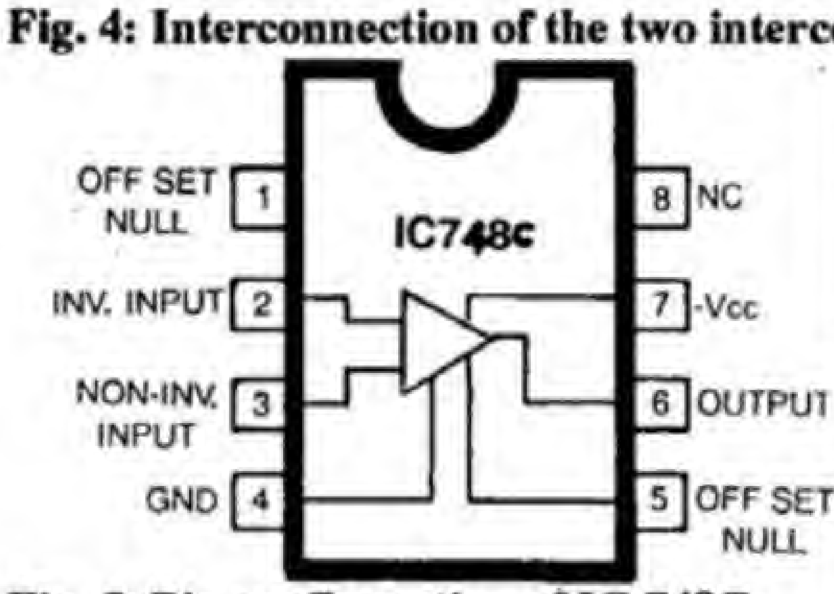


Fig. 5: Pin configuration of IC 748C.

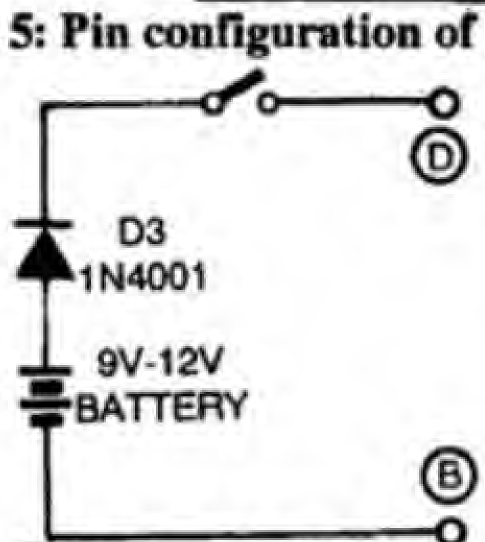


Fig. 6: Battery back-up circuit.

After the soldering on the PCB has been done, excessive flux should be removed with the help of petrol. All connections with the PCB should be made using flat ribbon cables. The circuit may be housed in a suitable plastic cabinet. The circuit, being quite compact, can be enclosed in the handset cabinet itself.

Switch S1 should be mounted on the cabinet in such a way that the circuit is switched on when the handset is lifted, and switched off when it is kept back in its original position. The speaker and mic. may be fixed inside the cabinet using a strong adhesive. The LED should be mounted on a LED holder. Finally, points A, B and C on the PCB should be connected to a 3-pin mains plug using a 3-core colour coded cable.

Adjustment and installation

The adjustment of the circuit is very simple. Only VR1 has to be adjusted for the optimum level of output. Keep VR1 in minimum resistance position which will produce a whistling sound from the speaker. Increase the in-circuit resistance of VR1 so that the whistling sound stops.

The circuit, if used between places having common live and netural mains wires, needs no extra connections except those with the mains lines. The connections between the two sets should be made as shown in Fig. 4. The completed intercom should always be kept facing downwards so that switch S1 remains pressed and the circuit remains deactivated.

Precautions

The circuit may be irrepairably damaged if any of the three mains wires (i.e. live, neutral or ground) are interchanged. It is advisable to colour code the 3-core input-output cable, using red for live, black for neutral and green for ground in all the sets.

No part of the circuit should be touched when the intercom is in use as it is directly connected to the mains.

Useful tips

1. The circuit may be used as a multichannel intercom by utilising digital or electromechanical switching techniques.

2. A battery back-up may be provided by connecting a 9/12-volt battery as shown in Fig. 6.

3. Use the smallest possible speaker for a compact assembly.

4. The circuit may be used as a door-answering system after increasing the value of R6 and replacing the small speaker with a larger one.

5. The call-tone frequency may be changed by changing C3.

The complete circuit (one side) would cost around Rs 30 only, excluding the cabinet.

❑

PARTS LIST

Semiconductors:

IC1	— 748C op-amplifier IC
D1	— 1N4001 diode
D2	— 12 volt, 400mW zener diode

Resistors (all 1/4W, ±5% carbon, unless stated otherwise):

R1	— 10-kilohm, 5W wirewound
R2, R5	— 12-kilohm
R3, R4	— 18-kilohm
R6	— 250-kilohm
R7	— 470-ohm
VR1	— 1-kilohm preset

Capacitors:

C1	— 1000µF, 16V electrolytic
C2	— 2.2µF, 16V electrolytic
C3	— 0.01µF ceramic
C4	— 33µF, 16V electrolytic

Miscellaneous:

S1	— Push-to-off switch
S2	— Push-to-on switch
LS	— 8-ohm, 0.5W speaker
	— Condenser microphone
	— IC socket
	— 9V battery
	— Ribbon cable
	— LED

Readers' Comments:

In 'Make Yourself This Special 2-way Intercom' project in Jan.'92 issue, since the output of one intercom is connected to the speaker of the same set, how can we expect the output to reach the other end?

And, instead of IC 748C, can we use general-purpose op-amp IC 741 or any other easily available IC?

J. RAVINDRA
Davangere

❑ In our house we are having common 'live' and neutral mains wires but we do not have any ground wire in our electricity board. So how do we use this circuit?

MAHAVIR D. CHHAJED
Pune

Please clarify:

1. Can I use IC 741 for IC1?

2. Can a protection circuit be used, in case mains wires get interchanged?

3. If I use the circuit for a door-answering system. Is one-side circuit enough or both sides would be required?

4. Can I use loudspeaker as a mic.?

A. NAGABABU
Rajahmundry

❑ The components layout shows it as a carbon mic. while the parts list indicates a condensor mic.! Which one is to be used?

If IC 748C is not available, can it be replaced by μA741?

The circuit as such seems excellent. This circuit was a much awaited one.

SUNISH ISSAC
Calicut

The author, Mr Amrit Bir Tiwana, replies:

Its quite heartening to see a bundle of letters from EFY readers for my intercom design. Some common queries are replied below:

The output will reach the other end since the two speakers are connected in parallel.

As for IC 748 used, on practical verification it was found that IC 741, specifically makes μA741 and LM741 in 8-pin DIPs, can be directly used instead. Results were not found to be as good with some other makes and with the TO-3 metal-can package and RAM741 and CA741.

Although this design will work best without additional wires, in absence of ground wiring one may run an extra wire, or run the circuit on batteries (9 to 12V) like a normal intercom.

No protection circuit may be feasible at a reasonable cost and is not needed—provided you take care in wiring and use a plastic enclosure for housing the intercom.

The terms condenser mic. and carbon mic. are invariably interchangeable. It is the button-sized component used in cassette recorders. The idea of using a speaker is not feasible. In any case, it would be costlier than using a Rs 7 mic.!

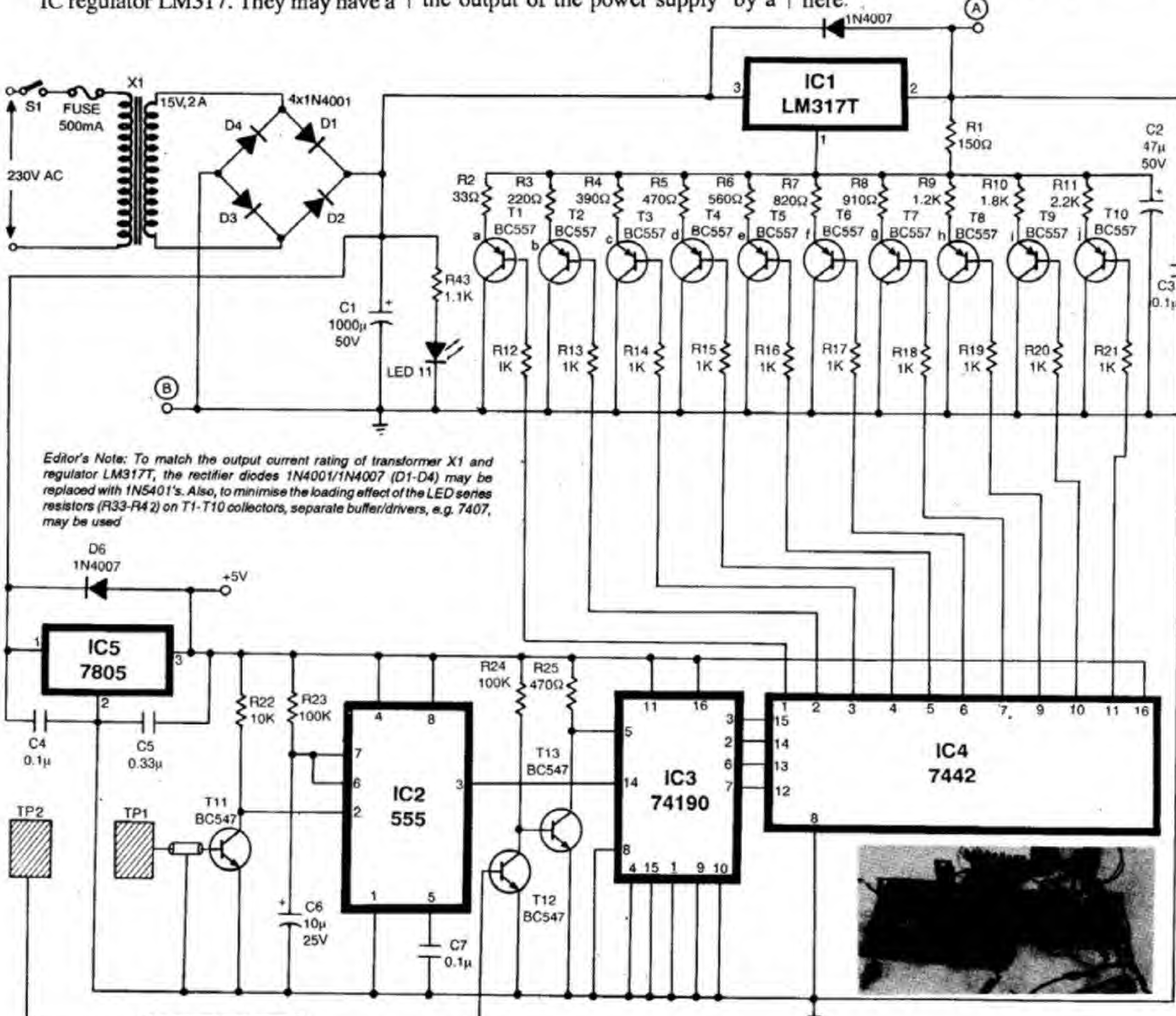
For using as a doorphone, you may use one side only if you wish to talk 'one-way'. Otherwise, both sides are needed.

Full Featured Touch Control
Programmable Power Supply

Kalpesh Dalwadi

Touch control of electronic gadgets is no longer a dream. Almost all electronic hobbyists have their own power supply using the most common IC regulator LM317. They may have a selectable rotary switch to select a particular output or a potentiometer to vary the output smoothly.

Here is a circuit which will change the output of the power supply by a slight touch of the finger! Those who have a power supply can just add this feature while those who do not have one may construct it fully as presented here.



Editor's Note: To match the output current rating of transformer X1 and regulator LM317T, the rectifier diodes 1N4001/1N4007 (D1-D4) may be replaced with 1N5401's. Also, to minimise the loading effect of the LED series resistors (R33-R42) on T1-T10 collectors, separate buffer/drivers, e.g. 7407, may be used

Fig.1: Circuit for programmable power supply.

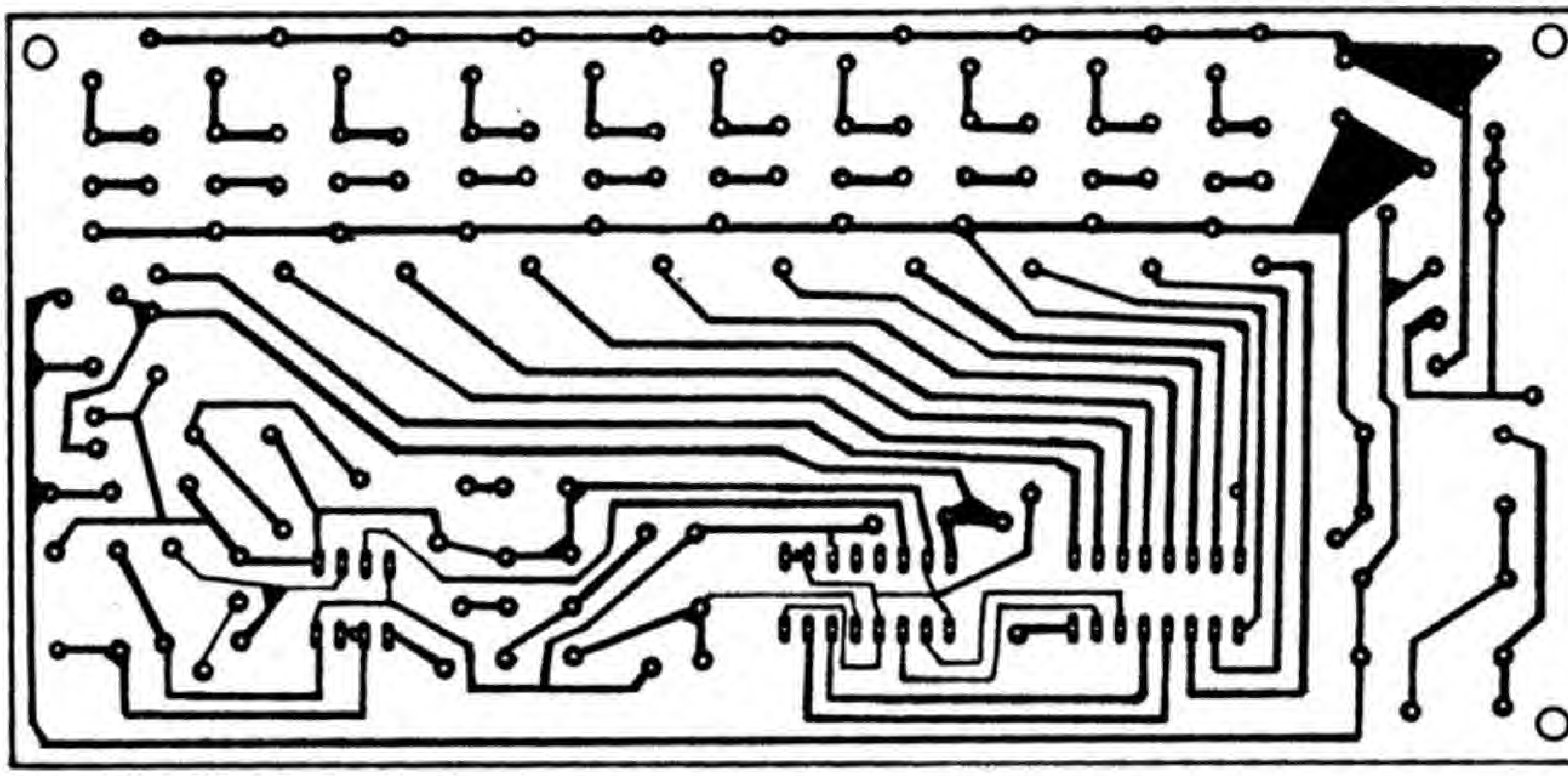


Fig.2: Actual-size PCB layout for programmable power supply.

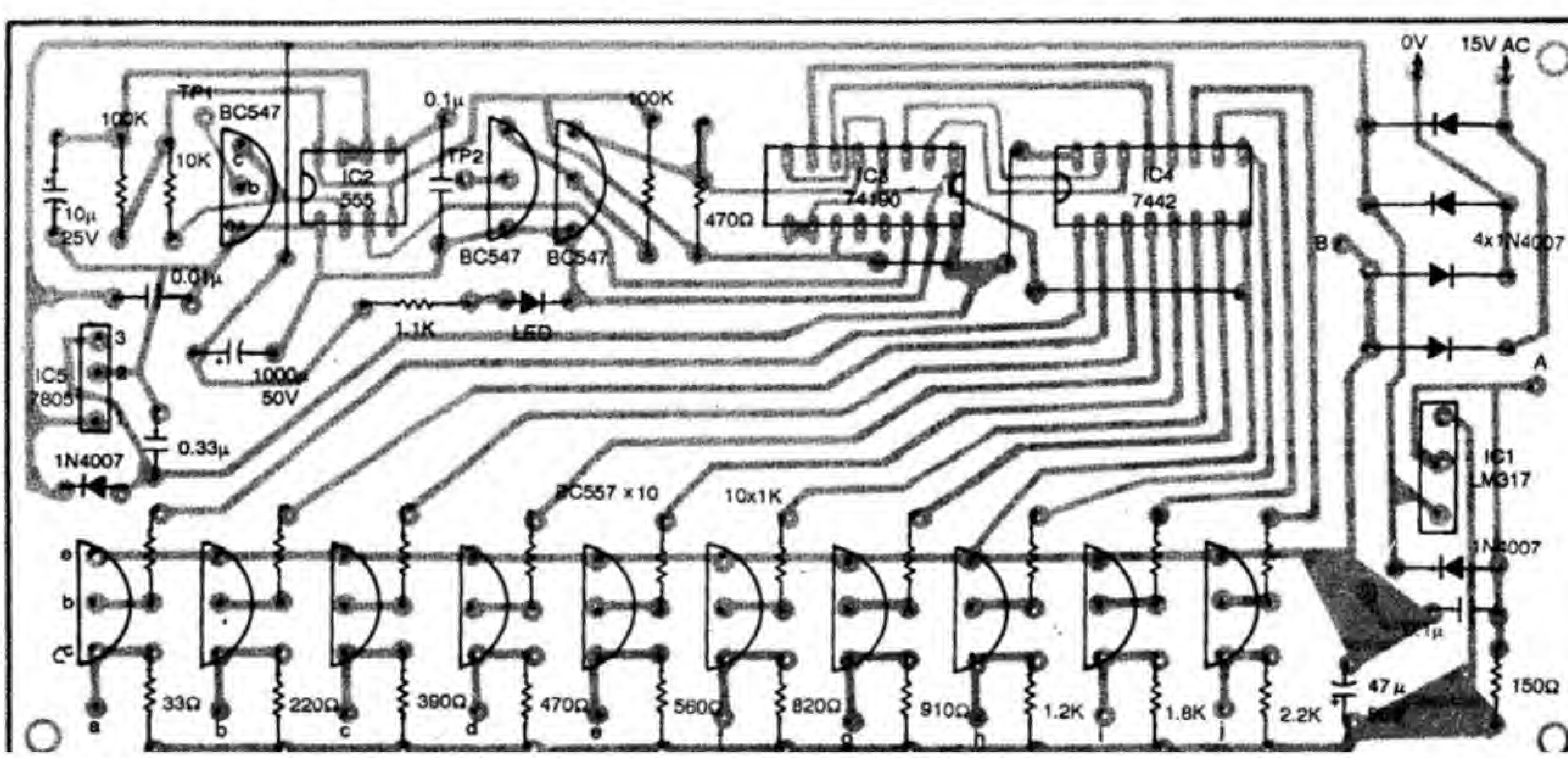
The circuit

The logic of the circuit is very simple and even a common hobbyist can easily understand it. Moreover, it uses easily available components which are also very cheap, thus suiting a common man's wallet.

Here diodes D1 through D4 act as a rectifier bridge while capacitor C1 is used for smoothing. Finally, IC1 regulates the output voltage which is selected by transistors T1 through T10. These transistors are made to switch on and off turn by turn, thus selecting resistors R2 through R11 one by one. Thus, instead of a single-pole 10-way rotary switch, we are using transistors to select a particular output voltage at a time. Capacitor C2 is used to improve the transient response of the power supply, while C3 is used to filter the 50Hz hum.

Touch control

The touch control is achieved by a very simple principle. IC2 is used in mono-shot mode with output pulse width of slightly more than a second. Touch plate TP1 is connected at base of T11. The 50Hz hum of our body is coupled through this touch plate to the base of T11 and switches the circuit 'on', thus grounding pin 2 of IC2. This low-going pulse applied at pin 2 triggers IC2. The output pulse at pin 3 of IC2 is in turn given to pin 14 (clock) of IC3 which is a 4-bit decade up/down counter. At the positive transition of each clock pulse at pin 14, the counter advances in



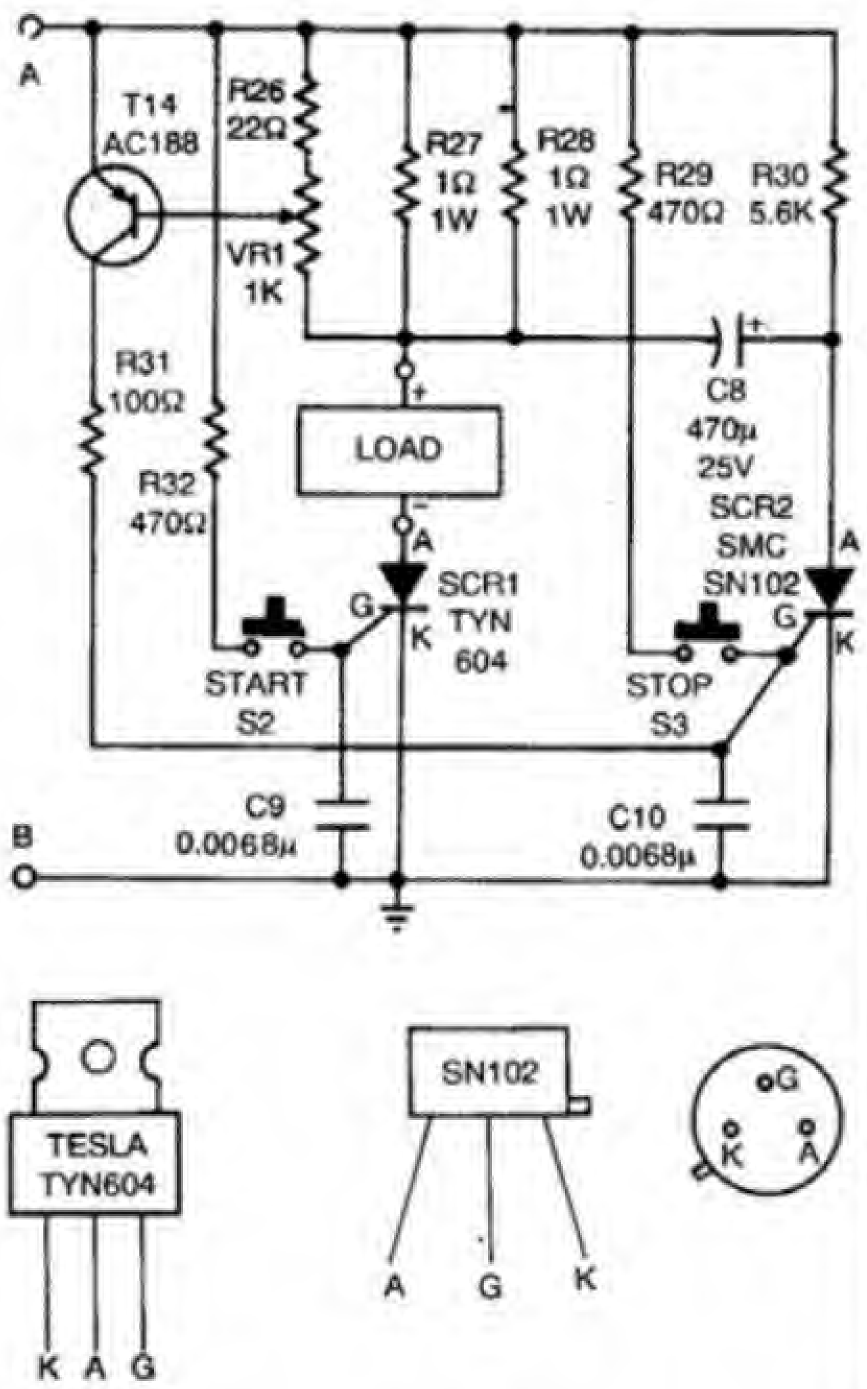


Fig.4: Circuit for short circuit protection.

forward (up mode) direction when pin 5 is kept low through T13. Thus, in this condition touching TP1 each time will change the output such that it goes on increasing. Touching TP2 makes pin 5 of IC3 switch to logic 1. Now for each clock at pin 14, the counter advances in reverse down mode direction.

In this condition, touching TP1 each time will change the output across A-B such that it goes on decreasing. IC4 is a BCD-to-decimal decoder with active low output. The output pins 1 through 11 go 'low' according to the BCD input at pins 12 through pin 15 of IC4. Thus, the outputs of IC4 are used to switch the particular transistor 'on', changing the voltage across A-B.

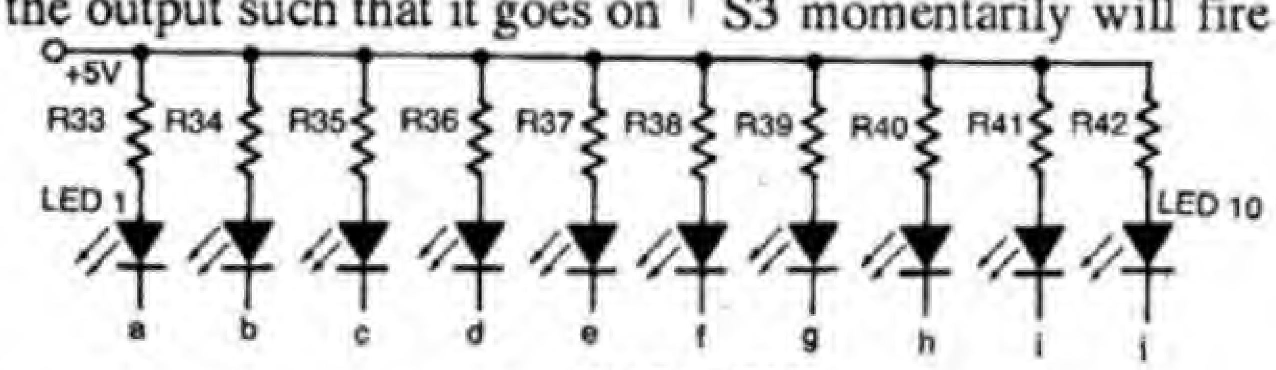


Fig.5: Circuit for indication of output voltages.

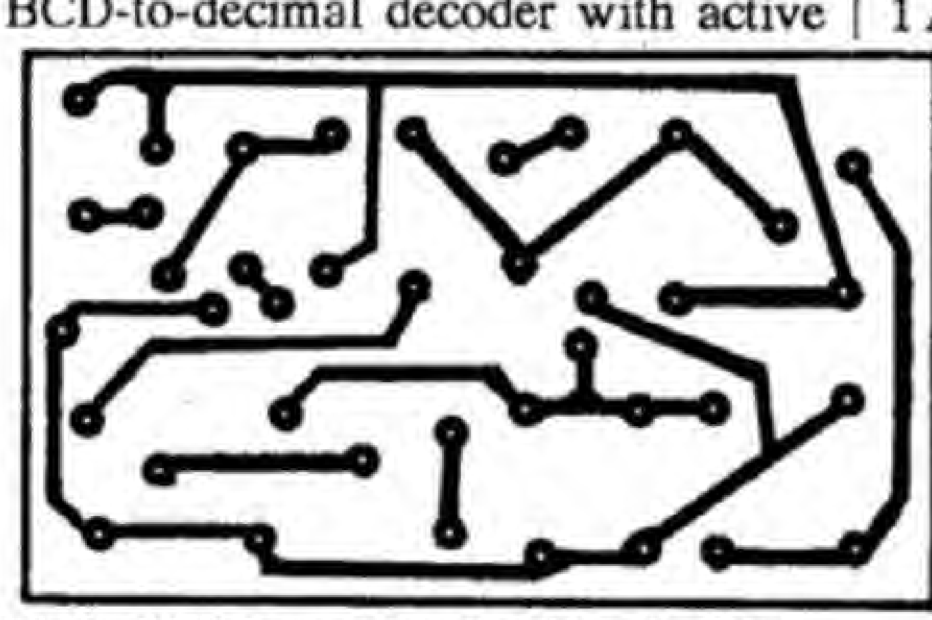


Fig.6: PCB layout for the Figs 4 and 5.

Short circuit protection

Fig. 4 shows a fully solidstate short circuit protection for the given power supply. The current value over which short circuit protection is to be achieved can be set by VR1.

The circuit is a simple capacitor-commutated SCR flip-flop. On connecting the load as shown in Fig. 4 and pressing S2 momentarily latches SCR1, and the load gets the supply. Parallel combination of R27 and R28 senses the load current while R26 along with VR1 varies the base bias of transistor T14.

When load is operated, capacitor C8 charges through R30. When short circuit is detected, which depends on VR1 settings, T14 conducts and fires SCR2. This discharges C8 through SCR2 and SCR1 commutates, thus tripping the load. If we wish to stop the load from conducting in-between, pressing S3 momentarily will fire SCR2, thus disconnecting the load.

The only disadvantage using this short circuit protection is that minimum of 4.5V is required across A-B terminals. For the value shown in Fig. 4, VR1 can be calibrated to achieve short circuit protection from 30 mA to 1 A. Also, the load must consume more than the holding current of SCR1, which in this case is 15 mA.

Indicating output voltage

The indication of output voltage can be done using a voltmeter across A-B terminals or an analogue-to-digital converter which in turn drives the 7-segment display.

PARTS LIST

Semiconductors:	
IC1	— LM317T voltage regulator
IC2	— NE555 timer
IC3	— 74190 up/down decade counter
IC4	— 7442 BCD-to-decimal decoder
IC5	— 7805, +5V regulator
D1-D6	— 1N4007 silicon diode
T1-T10	— BC557 pnp transistor
T11-T13	— BC547 npn transistor
T14	— AC188 pnp transistor
SCR1	— TYN 604
SCR2	— SMC SN102
Resistors: (all 1/4W, ±5% carbon unless stated otherwise)	
R1	— 150-ohm
R2	— 33-ohm
R3	— 220-ohm
R4	— 390-ohm
R5,R25,R29, R32	— 470-ohm
R6	— 560-ohm
R7	— 820-ohm
R8	— 910-ohm
R9	— 1.2-kilohm
R10	— 1.8-kilohm
R11	— 2.2-kilohm
R12-R21	— 1-kilohm
R22	— 10-kilohm
R23,R24	— 100-kilohm
R26	— 22-ohm
R27,R28	— 1-ohm, 1W
R30	— 5.6-kilohm
R31	— 100-ohm
R33-R42	— 120-ohm
R43	— 1.1kilohm
VR1	— 1-kilohm potentiometer
Capacitors:	
C1	— 1000µF, 50V electrolytic
C2	— 47µF, 50V eletrolytic
C3,C4,C7	— 0.1µF ceramic
C5	— 0.33µF ceramic
C6	— 10µF, 25V electrolytic
C8	— 470µF, 25V electrolytic
C9,C10	— 0.0068µF ceramic
Miscellaneous:	
X1	— 230V AC primary to 0-15V AC, 2amp secondary transformer
S1	— On/off switch
S2,S3	— Push-to-on switch
	— 100mA fuse
	— LEDs

Both the above methods are expensive and bulky too. Here we are using simple indication using LEDs. Depending upon the output voltages, which in this case are in standard steps of 1.5V,

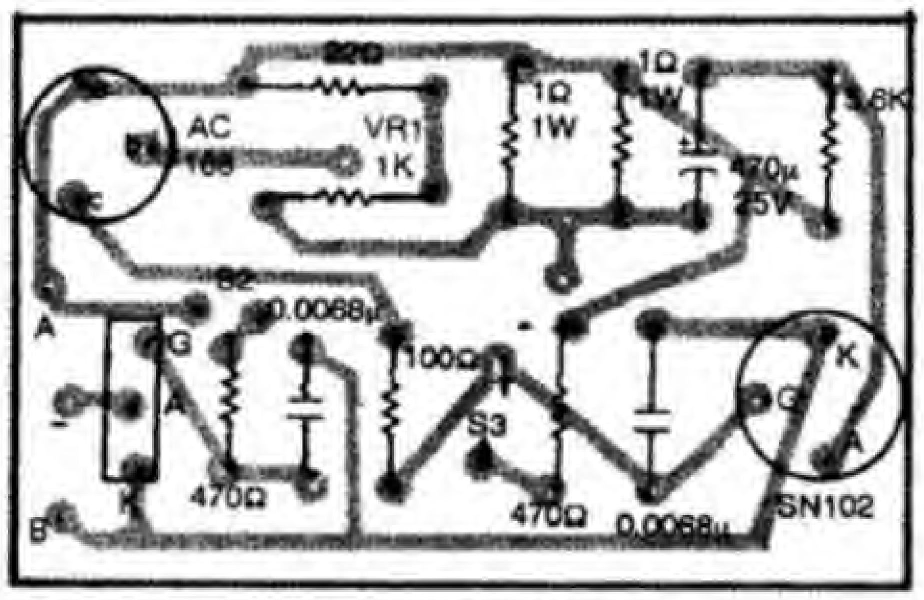


Fig.7: Components layout for PCB shown in Fig.6.

3V, 4.5V, 5V, 6V, 7.5V, 9V, 12V, 15V and 18V, a particular LED will glow giving a simple but still reliable indication of output voltage (Fig. 5).

Construction

IC1 is to be mounted on a relatively large heatsink because it will dissipate a maximum of 18W on full-load current of 1-amp. IC5 is to be mounted on a small heatsink as very little heating is expected. IC2, IC3 and IC4 must be mounted on sockets for convenience. Touch plates can be constructed using aluminium foils. Each should measure 1cm x 1cm. Copper plates can also be used. If aluminium foils are used, the surface has to be roughened up using a file, otherwise the solder will not adhere. Use shielded wire to connect the bases of transistors T11 and T12 with the touch plates. Wire lengths must be kept as small as possible.

Fault finding and testing the circuit

After assembling the circuit on a PCB and switching the power supply on, carry the following tests:

(1) Check the voltage across capacitor C1. It must be between +18 and +21V. If a good quality transformer is used, it will be +21V approximately.

(2) Check the output of 7805 (IC5) which must be +5 volts.

(3) Measure the collector current drawn by IC2, IC3 and IC4. It should be 30 to 40 mA. If it is more, there may be some wrong connection which should be detected.

(4) Touch TP1 with your fingertip and see the response with a multimeter across pin 3 and ground of IC2. It should give a pulse of approximately 1 second.

(5) Check the outputs of IC3 in response to each touch on TP1. This must increment the counter upwards. Now touch TP2 and then touch TP1. This must decrement the outputs of IC3 (in BCD fashion).

(6) Finally, check the output across A-B terminals repeating the procedure in steps 4 and 5.

(7) To calibrate the current limit in case of short protection, connect a wirewound potentiometer across the load terminals. Now vary the potentiometer and for each setting measure the current drawn. Keeping multimeter across the pot, vary VR1 until the load trips.

If all the tests are satisfactory the power supply is ready for operation. The circuit costs around Rs 250. ❑

Hit The Target
An Electronic Game

Sakthidharan K.A.

Video games are very popular in urban area, even though video game equipment are very exclusive and expensive. The constructional details of an electronic shooting game are described here. It employs a minimum number of low-cost and easily available components, and has all the actual functions of electronic games. In place of video screen, this project uses an LED display.

Theme of the game

Shooting down a fast moving object in the sky is not easy. Here a number of military aeroplanes appear at different positions for very short durations. All the aircraft are green except one which is red. This one is considered to be the enemy's bomber. The player has to immobilise this particular plane with the help of a pushbutton switch, which is supposed to be the trigger of a gun. If the aim and timing is accurate, the red plane remains on the screen while other planes fade away. The player thus wins the game.

How to play

First switch on the gadget. Set the chance indicator to zero by pressing reset switch S1. Then press START switch S3. The LEDs (planes) start blinking, emulating the zigzag move-

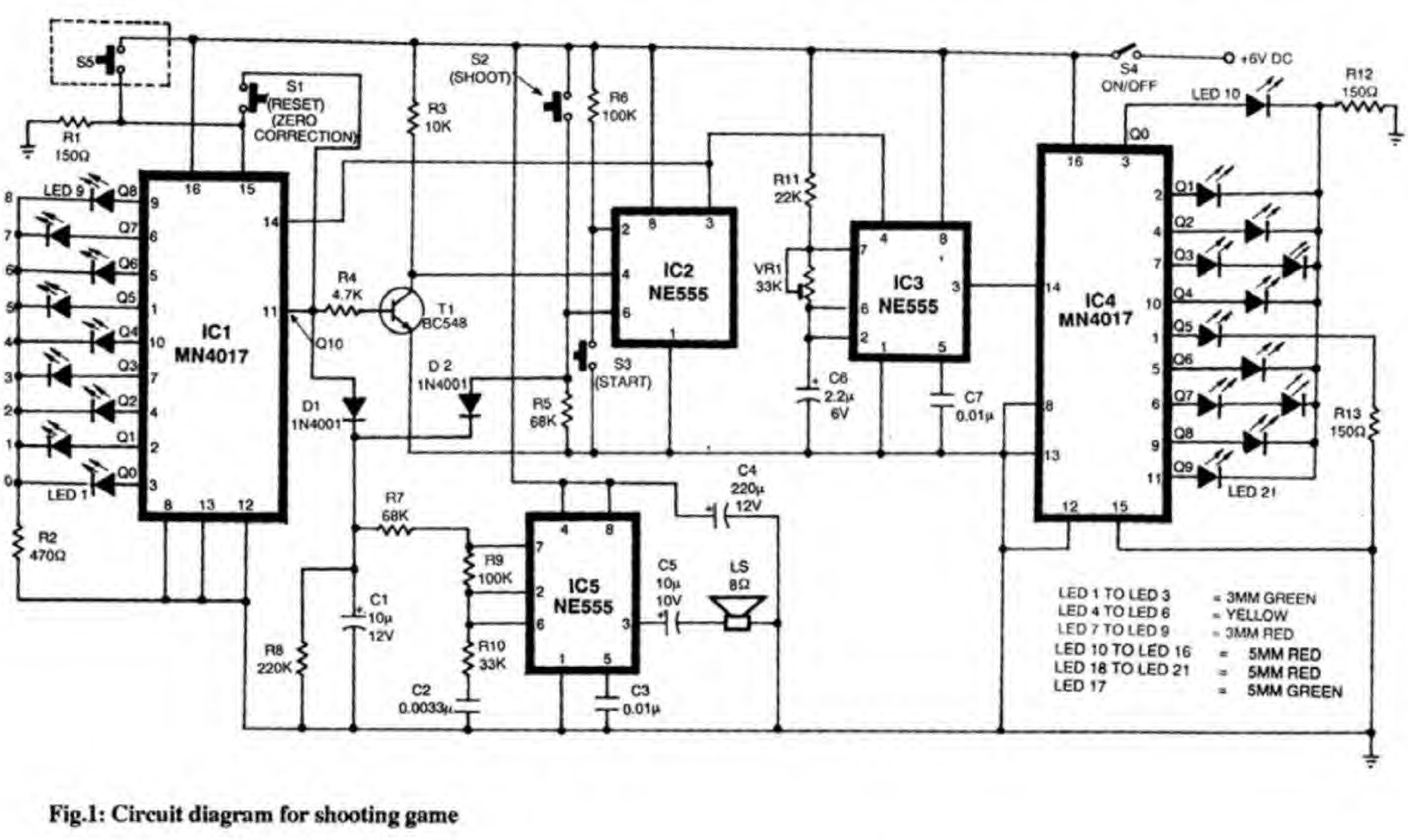


Fig.1: Circuit diagram for shooting game

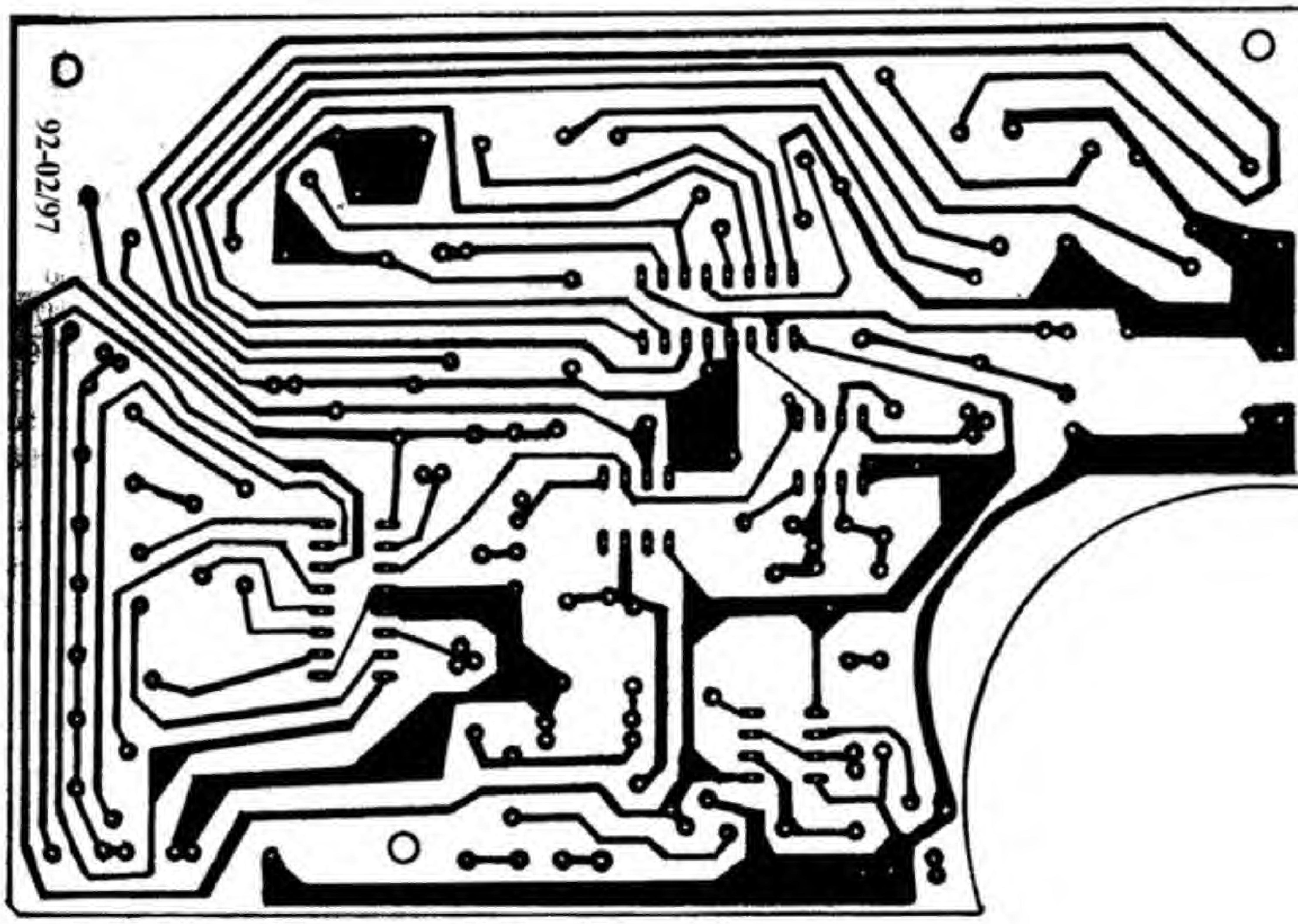


Fig. 2: Actual-size PCB layout for the circuit shown in Fig. 1.

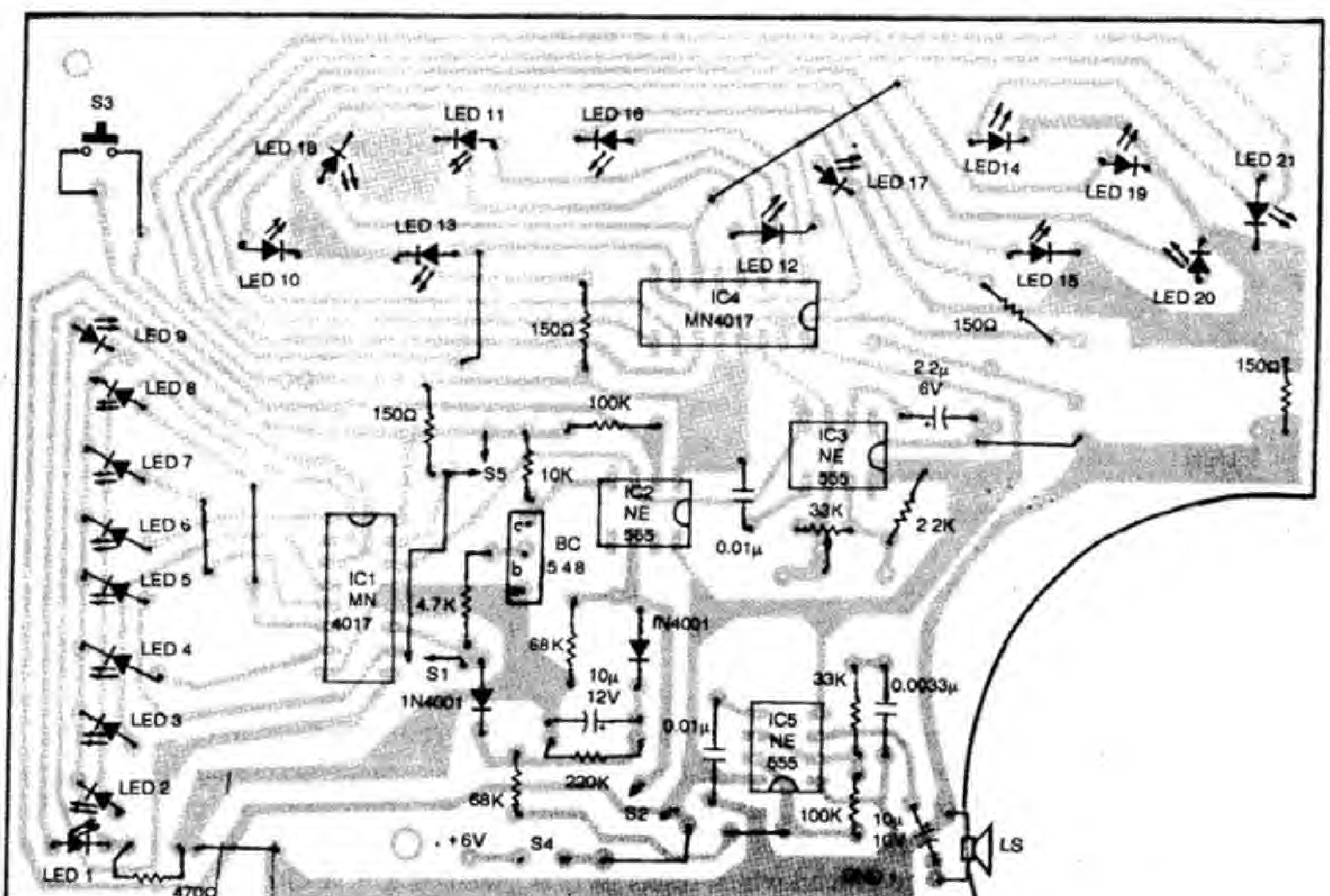


Fig.3: Components layout for PCB shown in Fig.2

ment of planes. Press SHOOT switch S2 to hit the target. Each shot is accompanied by an actual gun sound and one of the LEDs (planes) stays on the screen indicating that it has been shot. Press the START switch to animate the dis-

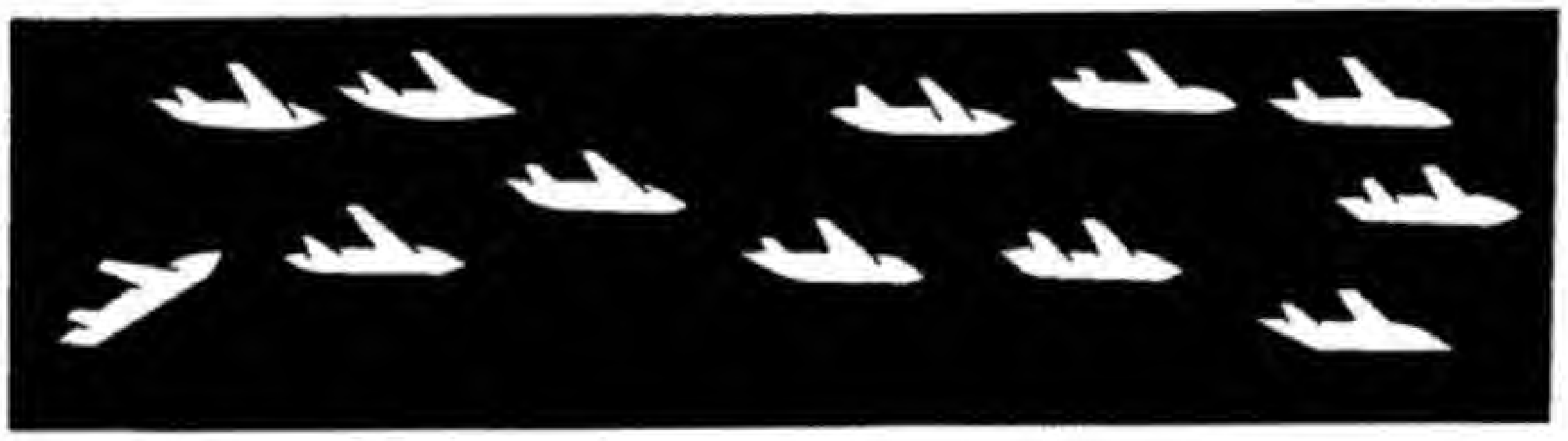


Fig.4: Display panel.

play again.

The player gets eight chances for shooting. The number of chances availed is indicated by LEDs. On ninth attempt the whole circuit becomes invalid and a long tone is sounded to indicate that the game is over and it is time for cease fire.

The circuit

IC4 (MN4017) along with the LEDs connected to its outputs functions as a sequential running light. IC3 is wired as a clock pulse generator. The input pin 14 of IC4 is connected to the output of IC3. IC MN4017 counts the clock pulses and drives the LEDs.

The reset pin 4 of IC3 is connected to the output of IC2 timer, which is wired as a bistable latch. By pressing S3, the voltage at trigger pin of IC2 is brought below 2/3 Vcc. As a result, the output goes high and remains in that stage until the voltage at threshold pin 6 of IC2 goes above 2/3 Vcc by pressing S2 (SHOOT). This brings the output of IC2 to low level and sets the functions of IC3 as well as IC4.

The audio oscillator wired around IC5 produces the gun sound effect. The positive voltage obtained through S2 is fed to the timing capacitor C2 through D2, R7, R9 and R10. The charging and discharging of capacitor C1 produces a decay effect to emulate the actual gun sound. D2 checks the charge of C1 affecting threshold pin 6 of IC2.

IC1 MN4017 is also a decade counter. Its input pin 14 is connected to the output of IC2. Each time the output of IC2 goes high, IC1 counts one and the corresponding LED glows. When power is applied to the circuit through S4, the Q0 output of IC1 goes high to indicate chance number zero. If it is not so, it may be brought to zero by pressing reset switch (S5/S1). Each time the start switch is pressed, the chance counter LEDs advance one step.

The Q10 output (pin 11) of IC1 is connected to the base of transistor T1 through resistor R4. On the ninth attempt of shooting, pin 11 goes high and the saturated transistor connects pin 4 of IC2 to ground which resets its output. The positive voltage present at pin 11 of IC1 is applied to the frequency-determining RC network of IC5 to produce a continuous tone instead of a gun sound.

PARTS LIST

Semiconductors:	
IC1, IC4	— MN4017 decade counter
IC2, IC3, IC5	— NE555 timer
D1-D2	— 1N4001 silicon diode
Resistors (all 1/4W, ±5% carbon unless stated otherwise)	
R1,R12,R13	— 150-ohm
R2	— 470-ohm
R3	— 10-kilohm
R4	— 4.7-kilohm
R5,R7	— 68-kilohm
R6,R9	— 100-kilohm
R8	— 220-kilohm
R10	— 33-kilohm
R11	— 22-kilohm
VR1	— 33-kilohm preset
Capacitors	
C1	— 10µF, 12V electrolytic
C2	— 0.0033µF ceramic
C3, C7	— 0.01µF ceramic
C4	— 220µF, 12V electrolytic
C5	— 10µF, 10V electrolytic
C6	— 2.2µF, 6V electrolytic
Miscellaneous	
S1-S3,S5	— Push-to-on switch
S4	— On/off switch
LS	— 8-ohm speaker
	LEDs

The zigzag idea

As a common practice, the LEDs on the output pins of IC4 (MN4017) are expected to glow in a sequential order. But in this project they are positioned haphazardly to confuse the player. This is achieved by the following techniques.

1. The positions of LEDs on the display board are not kept in sequential order.

2. Some LEDs are connected in series to the same output so that the simultaneous illumination of two LEDs at different points confuses the player further.

Adjust preset VR1 to get a fast LED drive so that the player is not able to win the game easily. However, it seems that the effective resistance of VR1 should be below 22-kilohm. Fig. 1 gives details of the circuit.

Construction

The actual- size PCB pattern is given in Fig. 2.All the three NE555 timer ICs can be soldered directly on the PCB. Use sockets for CMOS ICs.

Plastic or laminated sheet may be used for the panel. To make the gadget more attractive, the display panel should be covered with glass or transparent plastic sheet, as seen in calculators. The rear of this glass should be painted dark to make it opaque, leaving aeroplane-shaped spaces as shown in Fig. 4. The LEDs should be correctly positioned just below these spaces. The switches should be placed at most convenient positions. Switch S5 is mainly intended for commercial use of the project. It should not be under the control of player.

The miniature form of the electronic game described here can be modified to a commercial one by replacing the LEDs with AC mains lamps and SCR/triac circuits for a larger display. This modified model may be used for gambling in exhibitions and fairs. ❑

Stereo Spectrograph

Dinesh Kumar Raheja and J. Ramamurthy

Most stereo systems have some kind of music level indicator. The indicator may be as simple as a set of LEDs, ordinary low-voltage lamps or V-U (volume-unit) meters. These were later replaced by bar-graph type LED indicators. Though attractive, they provide only one-dimensional 'movement' of LEDs with the music. Now this system has also become very common.

Presented here is a spectacular system to replace the outdated music level indicators. This system is capable of providing a smart, two-dimensional 'dancing' effect on a square matrix of 100 LEDs.

In this system, out of 100 LEDs arranged in a square matrix, only one LED glows at a time and it keeps dancing within the so-formed LED array along with the music being played on the stereo system. The movement or dancing of the LED depends basically on the 'stereo' effect of the music. Hence, the system may be called a stereo spectrograph.

Working

This system's working depends not only on the type of music being played but also on the 'stereo' effects of the music. Greater the stereo effect, better the movement of the dancing LED. As you know, a stereo signal is recorded or played on two independent channels which are purposely isolated from each other. Therefore, at every instance the signal strengths of the right and left channels are different from each other. As shown in the schematic block diagram (Fig.1),

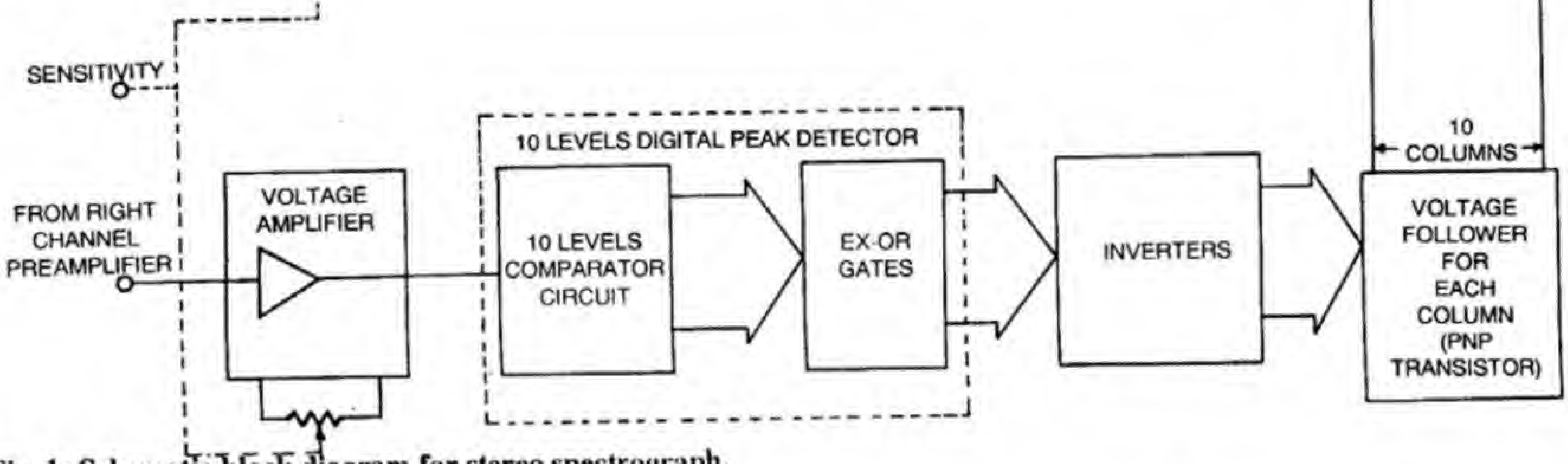
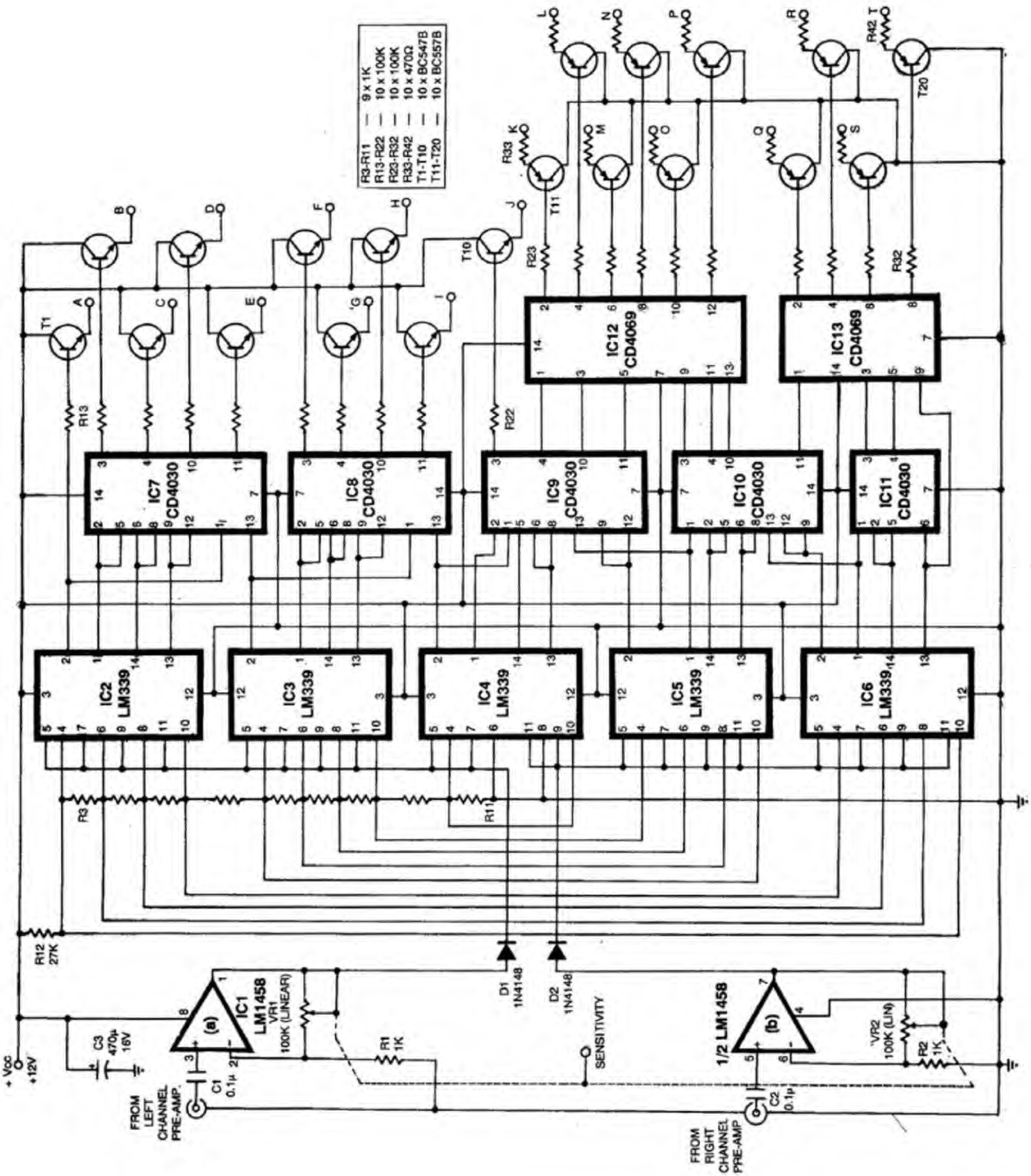


Fig. 1: Schematic block diagram for stereo spectrograph.



R3-R11 — 9 x 1K
R13-R22 — 10 x 100K
R23-R32 — 10 x 100K
R33-R42 — 10 x 470Ω
T1-T10 — 10 x BC547B
T11-T20 — 10 x BC557B
IC1 LM1458
1/2 LM1458
IC2 LM339
IC3 LM339
IC4 LM339
IC5 LM339
IC6 LM339
IC7 CD4030
IC8 CD4030
IC9 CD4030
IC10 CD4030
IC11 CD4030
IC12 CD4069
IC13 CD4069
FROM LEFT CHANNEL PRE-AMP.
FROM RIGHT CHANNEL PRE-AMP
SENSITIVITY
+Vcc +12V
C3 470μ 16V
C1 0.1μ
C2 0.1μ
VR1 100K (LINEAR)
VR2 100K (LIN)
R1 1K
R2 1K
R12 27K
D1 1N4148
D2 1N4148

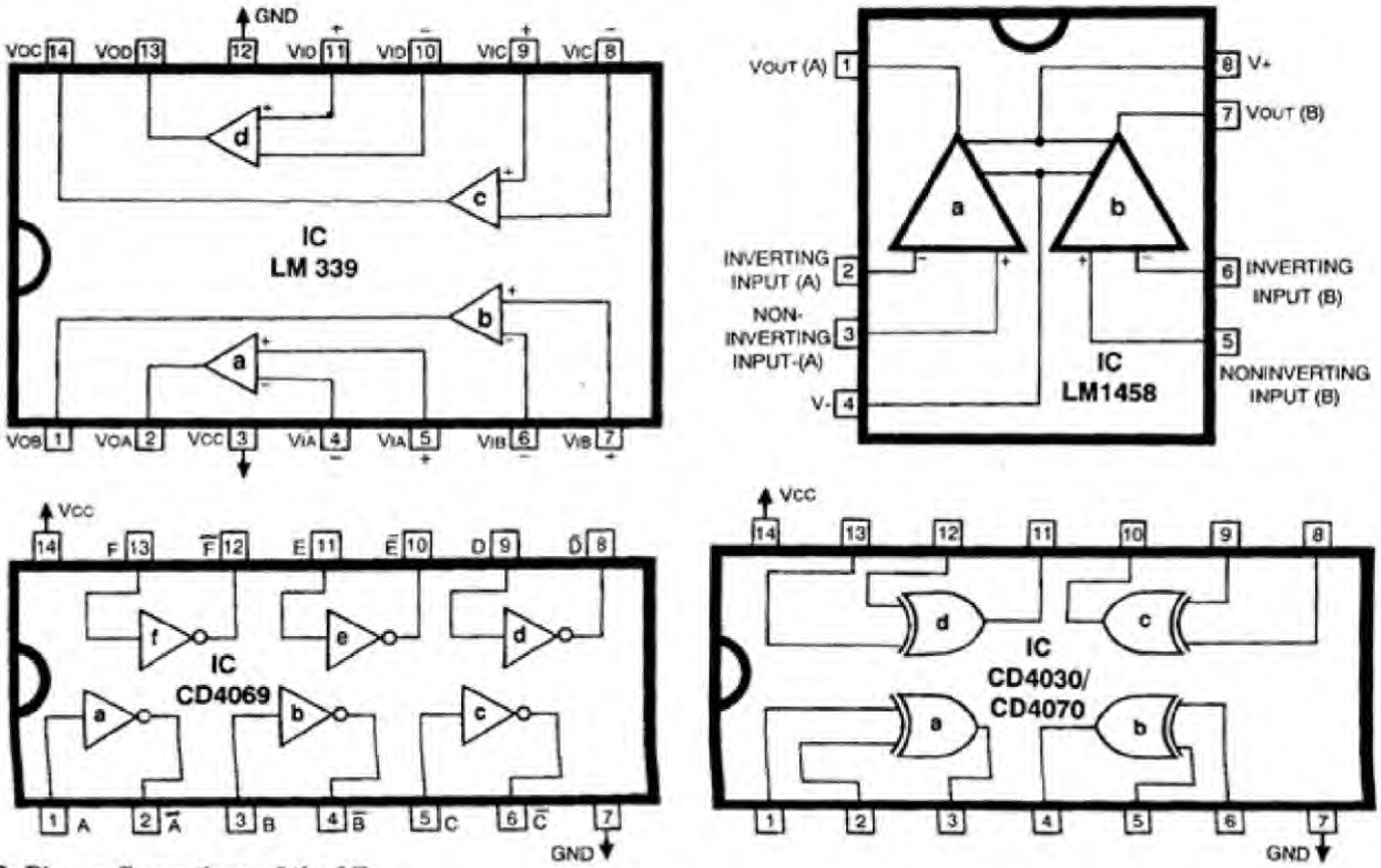


Fig. 3: Pin configurations of the ICs.

the audio signals from the left channel are made to force the glowing LED to move along the vertical columns and the signals from the right channel provide the movement of the LED along the horizontal rows. Hence, we see

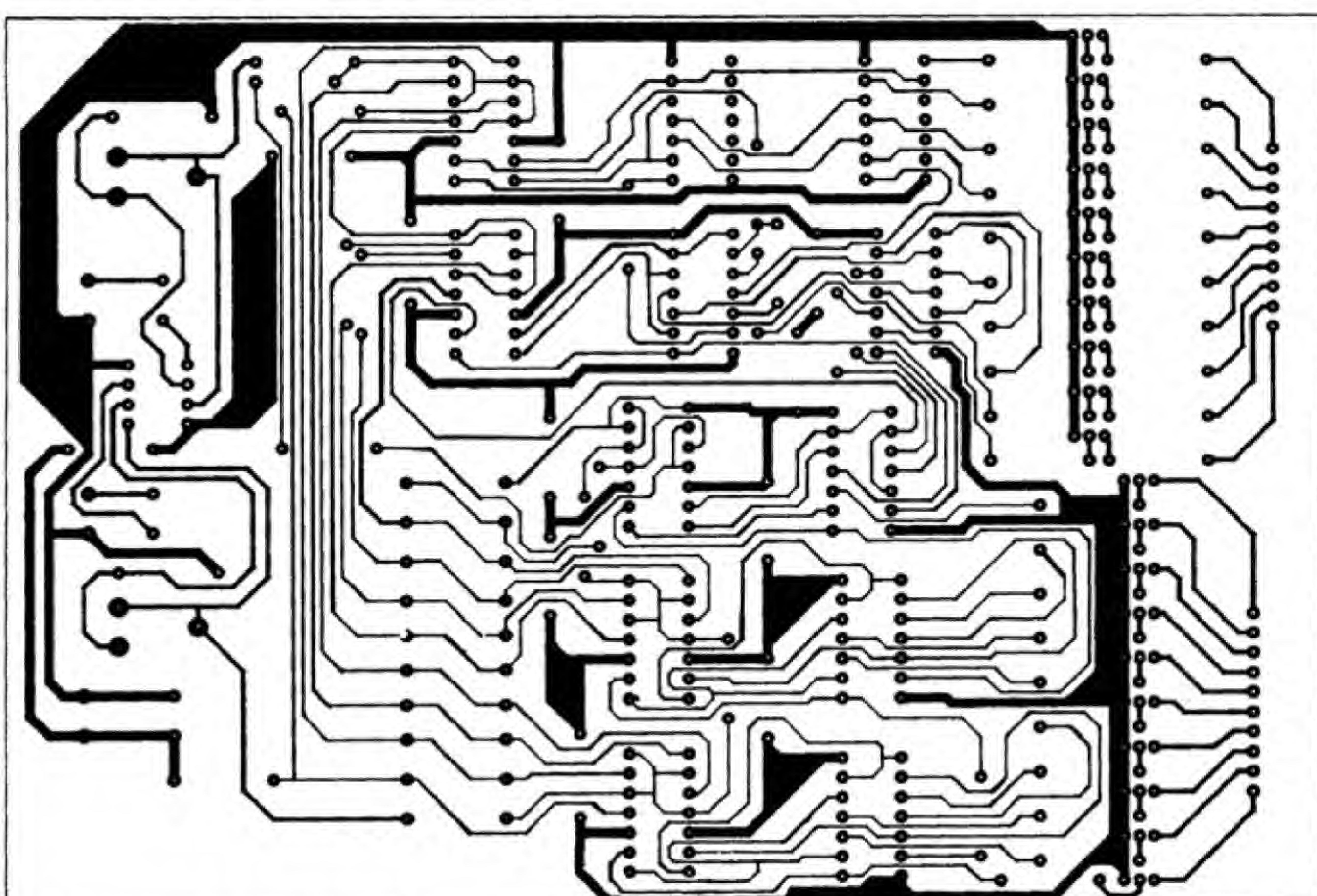


Fig.4: PCB layout for the circuit shown in Fig.2.

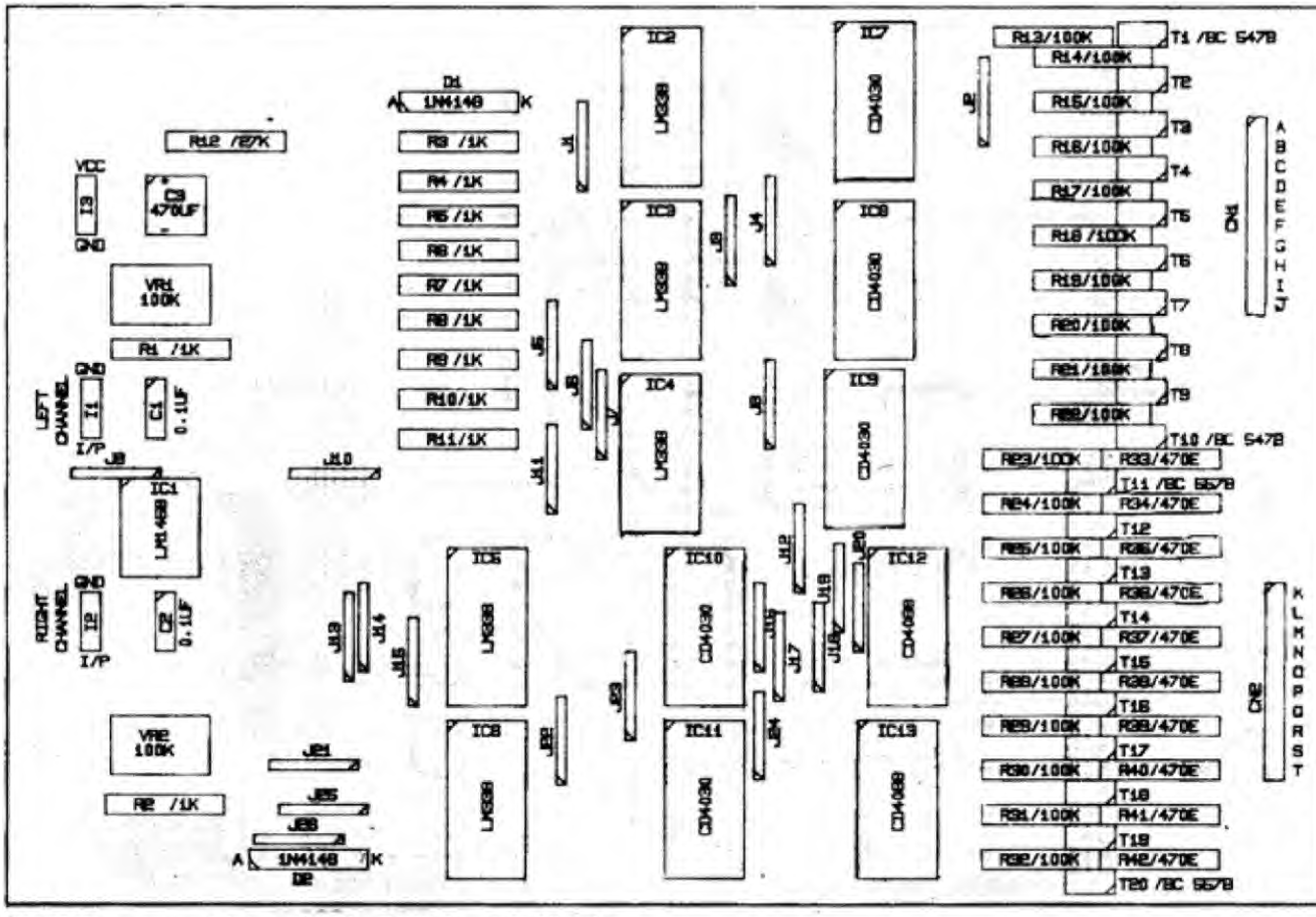


Fig. 5: Components layout for the PCB shown in Fig. 4.

'movement' of the glowing LED in a two-dimensional square area where the vertical and horizontal movements are isolated from each other, just like audio signals in both the channels.

The audio signals from the left channel are first amplified by a high-gain voltage amplifier that is built around an op-amp. The gain of this amplifier can be controlled by controlling the negative feedback. Thereafter the amplified signal is rectified using diodes. Then it is fed to a 10-level comparator circuit using LM339. The output of these are XORed (using CD4030/4070). So it works like a digital peak-detector for 10 levels.

The output of an XOR gate is high only if one input is high and the other is low. The output is low only if both the inputs are either high or low. Hence, we get high voltage at only one row that corresponds to the peak level of the audio signal in the left channel. An emitter-follower using npn transistor (BC547B) is connected to each row. This is required only to boost up sufficient current required for an LED. If these transistors are not used then the XOR gates will get damaged due to excessive current taken by an LED as compared to the source current capability of the XOR gates. In a similar fashion, the signal is amplified, compared and XORed from the right channel. Then using invertor logic, one column is made low and all others are kept high. Again we use voltage follower (pnp transistors) to drive the columns of the LED matrix.

Hence, only one row will have high voltage and only one column will have low voltage at a time. Therefore, only one LED that is connected between these rows and columns will glow. And it will keep on dancing with the stereo effects of the music being played.

If you play a mono record or cassette then the movement of the dancing LED will be equal in both the horizontal and vertical directions or the movement will be inclined at 45° typically.

PARTS LIST

Semiconductors:

IC1	—	LM1458/LF353 dual op-amp or LF442/LF412
IC2-IC6	—	LM339 quad comparators
IC7-IC11	—	CD4030/CD4070 quad exclusive OR gates (CMOS)
IC12, IC13	—	CD4069 hex inverters (CMOS)
T1-T10	—	BC547B npn silicon transistors
T11-T20	—	BC557B pnp silicon transistors
D1, D2	—	1N4148, silicon diodes

Resistors (all 1/4W, ±5% carbon, unless stated otherwise):

R1-R11	—	1-kilohm
R12	—	27-kilohm
R13-R32	—	100-kilohm
R33-R42	—	470-ohm
VR1	—	100-kilohm linear (dual pot)

Capacitors:

C1, C2	—	0.1μF/12V ceramic disc
C3	—	470μF/16V electrolytic

Miscellaneous:

LED3-LED102	—	(5mm-round) red LED

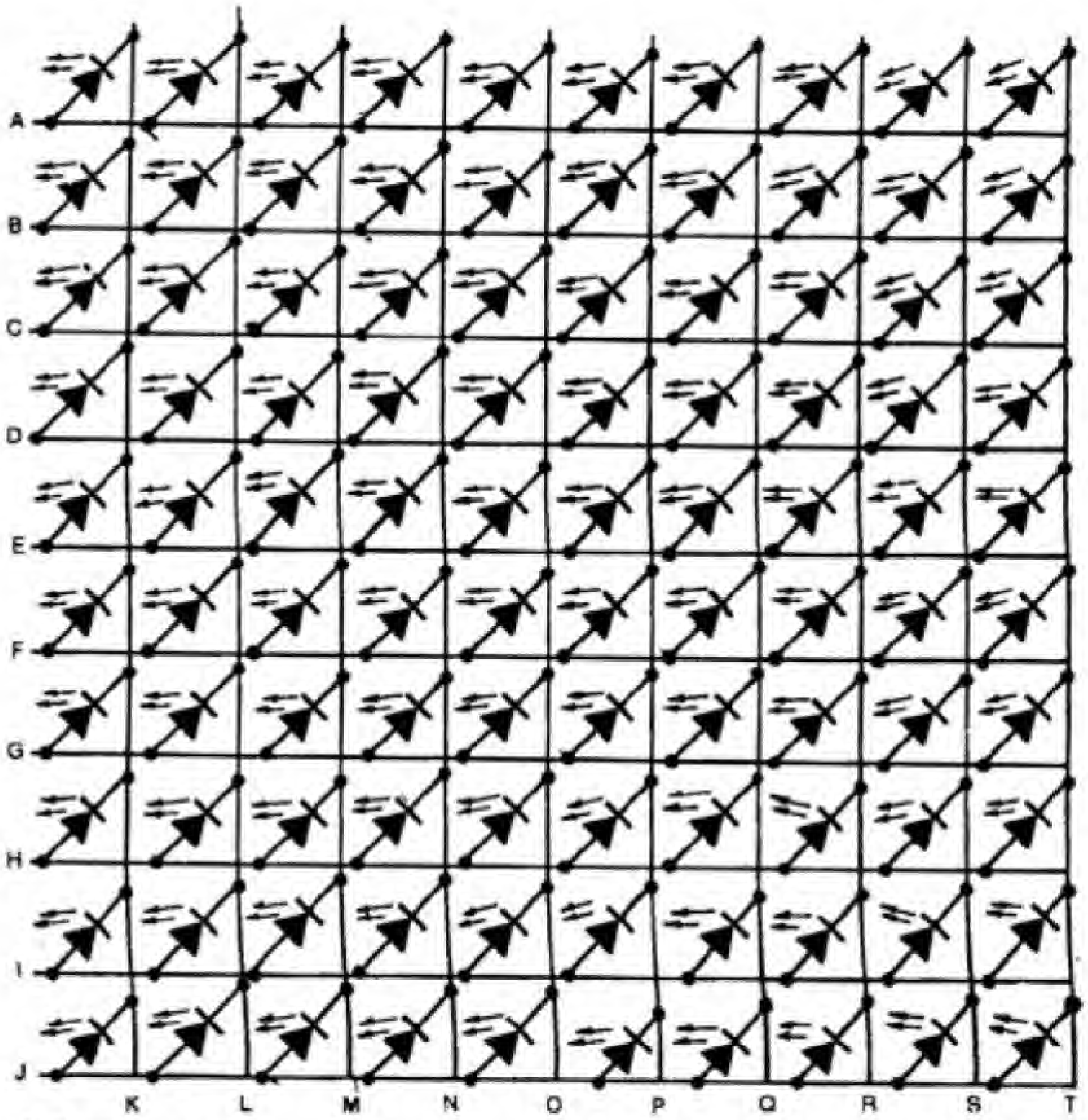


Fig. 6: Display panel.

The dual potentiometer, which is used in the feedback path of the op-amps, acts as a sensitivity control potentiometer for the system. You should adjust it properly to get a full wide area movement of the LED.

As shown in the circuit diagram (Fig.2), the system is driven by the preamplifier of the stereo system. Therefore, the visual effects must be made independent of the volume level of the power amplifiers used in your stereo systems. As this circuit requires a number of chips, the pin diagrams of the used chips are shown in Fig.3 (a, b, c and d).

You can construct this spectograph as per your convenience. The number of LEDs can be reduced or increased as required, but it must form a square array. As it requires very less power, you can directly take the supply lines (12V) from your stereo system. This stereo spectograph will surely add a new dimension to the visual effects of your stereo system. ❑

Readers' Comments:

Stereo Spectrograph project published in EFY March'92 issue is good. Please convey my thanks to the author for this very innovative idea.

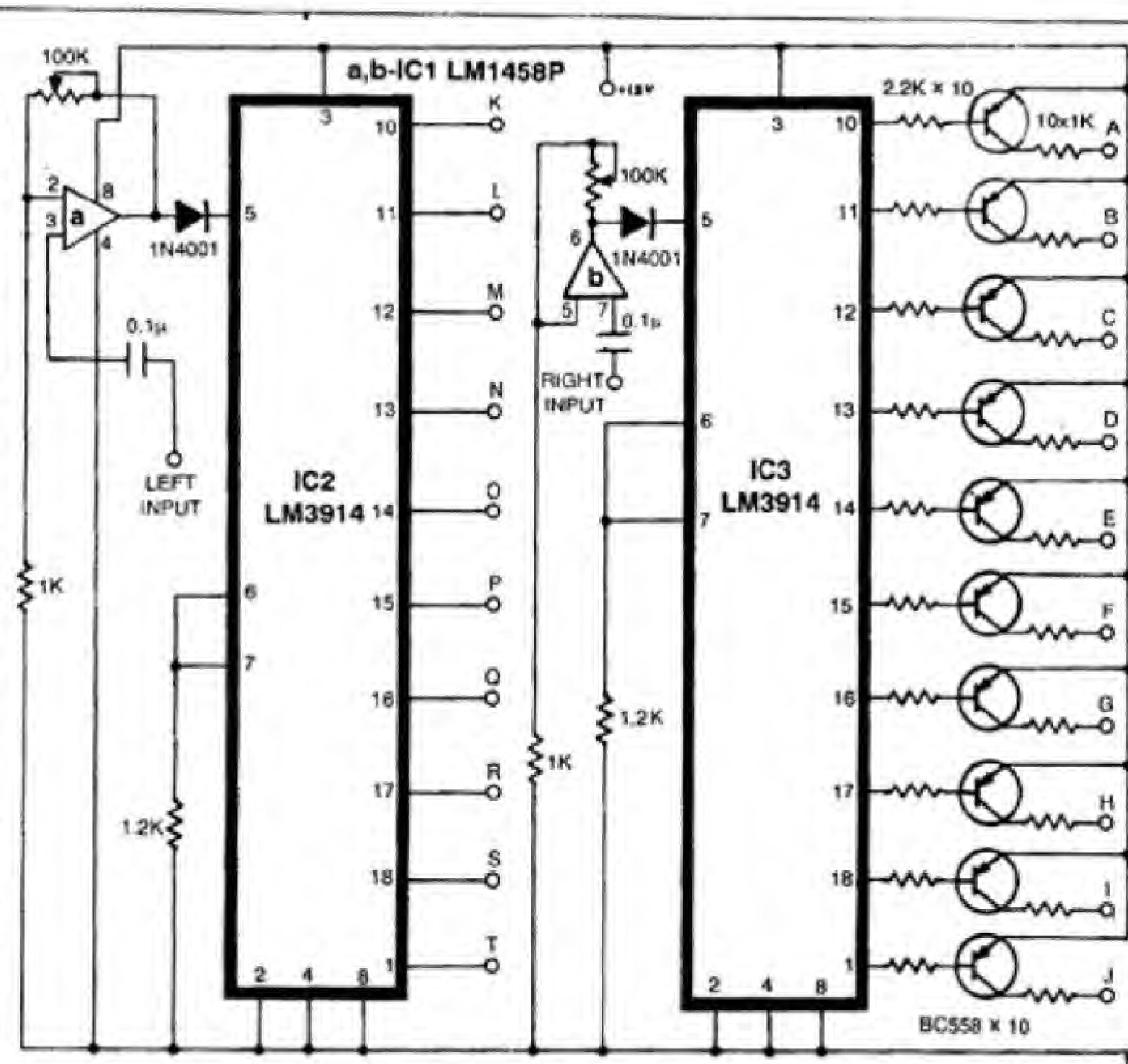
The circuit uses too many ICs, transistors and resistors, however. The entire idea could have been realised by using three ICs (one LM1458 and two LM3914), 10 transistors and 20 resistors, besides a few other components.

The new circuit can be constructed even on a general-purpose PCB and consumes very little power.

T.S.SHANKAR
Hyderabad

The author, Mr Dinesh Kumar Raheja, replies:

I'm thankful to Mr Shankar for his suggestion. His approach is very nice. His circuit can be further improved by connecting all the ten outputs of IC3 to +Vcc (12V) through pull-up resistors of 10K (1/4 W) each. This is required as the outputs of LM3914/3915 are 'current-regulated open collectors'. However, IC2 does not require these pull-up resistors because the 'open collectors' of IC2 are connected through LED matrix and transistors network.



Compact stereo spectrograph circuit.

Digital Time Switch

S. Batra

You might have noticed the street lights suddenly switching on in the evening and switching off early in the morning. Such operations for a complete row of lights are achieved automatically with the help of a 'time switch' which is usually mounted on an electric pole. It is generally an analogue type of 'time switch'. Digital time switches are not yet commonly available in our country.

Principle

Using the principle of 'Master Slave Clock' (published in EFY Nov.'91), I have developed a digital time switch. The block schematic diagram of the same is given in Fig.1. Basically, there are two independent clocks running synchronously. The 'on' clock gives a criterion for switching on the device. The desired on time can be adjusted up to the last minute. Similarly, the 'off' clock gives a criterion for switching off the device. The desired off time can also be adjusted (up to the last minute) for any time up to 24 hours. The 'on clock' criterion operates the relay and the 'off clock' criterion releases the relay through a relay control circuit. This way, any device can be controlled for a desired duration.

Circuit description

The complete circuit diagram of the project is shown in Fig.2. IC1 uses 5369 as a master oscillator/divider and supplies 60Hz drive at pin 1. IC2 and IC3 use 8361, a 40-pin clock chip. The 60Hz input at pin 35 receives the drive through 100-kilohm resistors R26 and R27 respectively. To economise the design, a common display is used for both the identical clocks. Segment outputs of IC2 and IC3 are paralleled through diodes D1-D24 and D25-D48. Common points are connected to limiting resistors R1-R24, which are connected to common-cathode display chips FND500 or their equivalent. The display will normally show the real clock time.

Set switches

S, F and R are the slow set, fast set and reset controls respectively. Applying $V_{CC(B)}$ at pins 32, 33 and 34 simultaneously, reset the clock to 0000 hour (as the clocks are operating in 24-hour mode). As it is desired to run both the clocks synchronously, reset operation is made common through diodes D49-D54.

To set 'on time' bring switch S1 towards 'on CTL'. Pressing the switch D will display the on time for the device. By keeping D pressed, set the desired time by operating respective switches S and F.

Similarly, by throwing the switch S1 towards 'off CTL', off time of the time switch can be set to desired time.

Relay control

In fact, the adjustment of 'on time/off time' is nothing but setting of two alarms for two synchronous clocks. When the alarm of 'on clock' is active, pin 25 of IC2 will be high and hence SR latch will set. Please note that four gates of IC 4011 have been used as SR flip-flop. The output 'Y' will be high. Hence, saturating transistor T1 activates relay RL1 to operate the device under control. Indication LED2 will light whenever the relay is operated.

Whenever the alarm of 'off clock' is active, SR latch will reset and the output Y will become 0. This in turn will release the relay RL1. LED2 will be no more lit.

Please note that the 'device under control' will be controlled by the time switch only when the auto/manual switch S7 is kept in 'Auto'. Whenever the time switch circuit poses problems or the device has to be operated in addition to the automatic set time, the device can be controlled manually by operating switch S7 to 'Manual' mode.

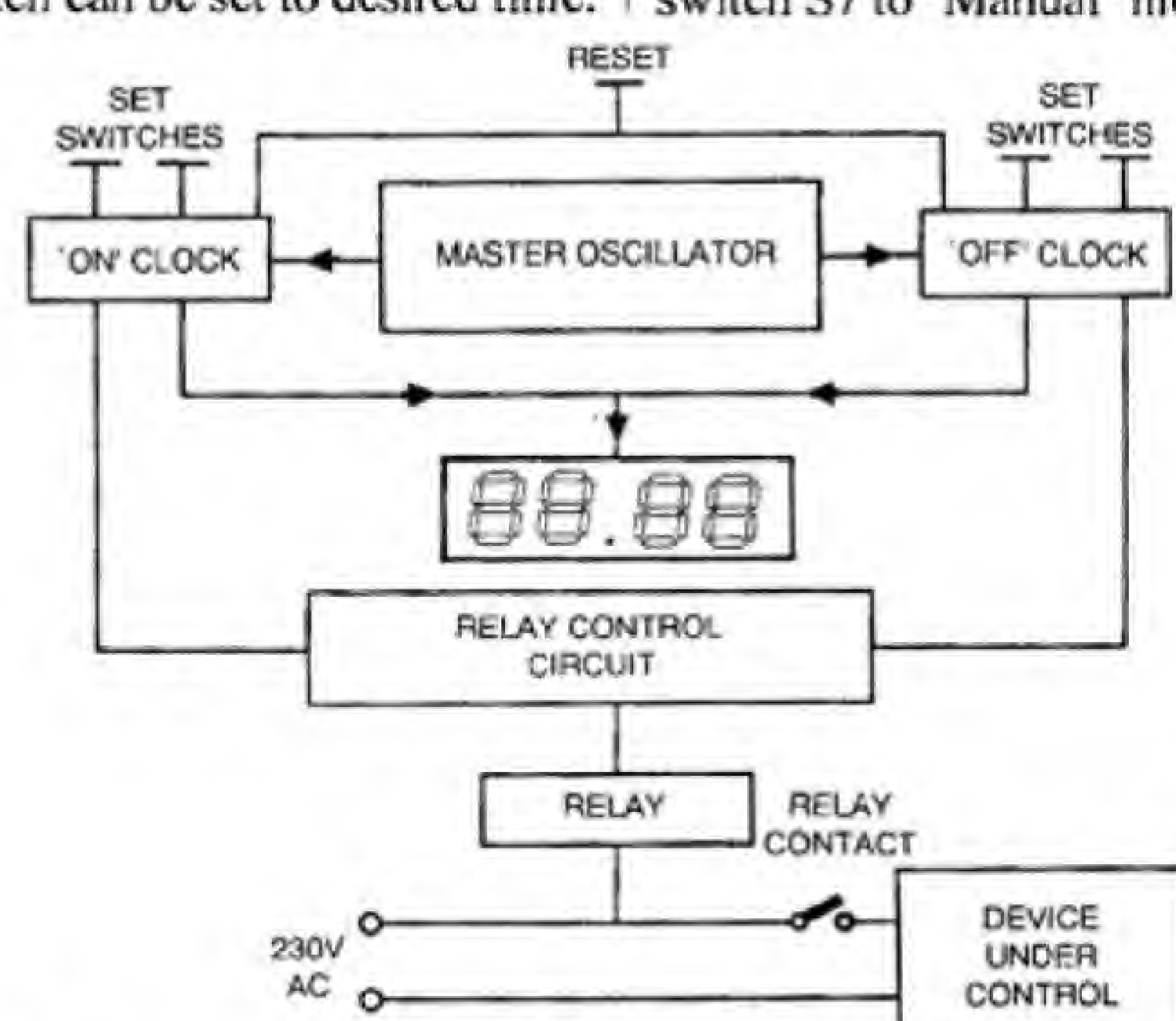


Fig. 1: Block diagram for digital time switch.

Power supply

The power supply is a conventional one. Diodes D55 and D56 are used as full-wave rectifier with transformer X1. Vcc(A) is the supply with battery back-up whereas Vcc(B) is without back-up. Two Ni-Cd batteries of 3.6V each can be used. 'Varta' make Ni-Cd rechargeable batteries are now easily available in the market. However, A 9V ordinary battery can also be used.

Vcc(B) is supplied through S1 to pins 23 of IC2 and IC3 whereas Vcc(A) is extended to pins 28 of IC2 and IC3 as well as pin 8 of IC1 and pin 14 of IC4. This arrangement will keep the oscillator IC1, memory of clocks and SR flip-flop energised even during power interruptions or failures. Only the display will be inactive during power failures. Under no-load conditions, more than 12V appearing on Vcc(A) bus may cease oscillation of IC1. Introduction of LED3 and D60-D62 keep Vcc(A)/Vcc(B) within 12V and result in better stability.

Assembly

The project can be simplified if the components are arranged as per two recommended PCBs. A motherboard (155mm x 135mm) will house all the components except the transformer and the relay whereas a display board (75mm x 35mm) will accommodate only four display chips. Both the PCBs are interconnected through 26 flexible wires. The completed time switch can be given the shape of a wall-hanging and kept near the device to be controlled.

Before starting the assembly check all resistors, capacitors, transformers, transistors etc with the help of a multimeter or otherwise. First, assemble display PCB and check all the segments of all the four display chips by extending test bench supply to +12V or 9V battery to anodes of every LED seg-

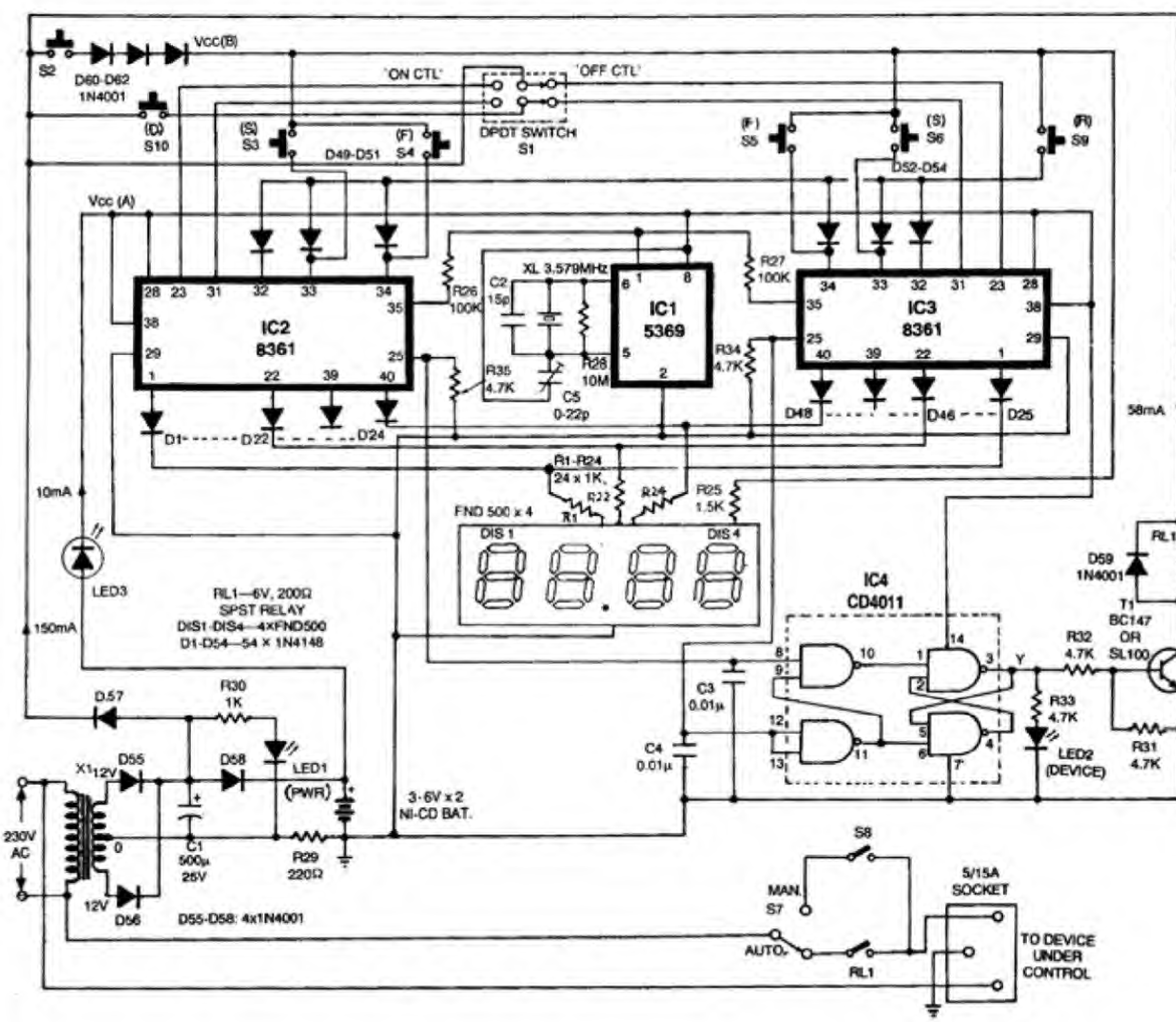


Fig. 2: Circuit diagram for digital time switch.

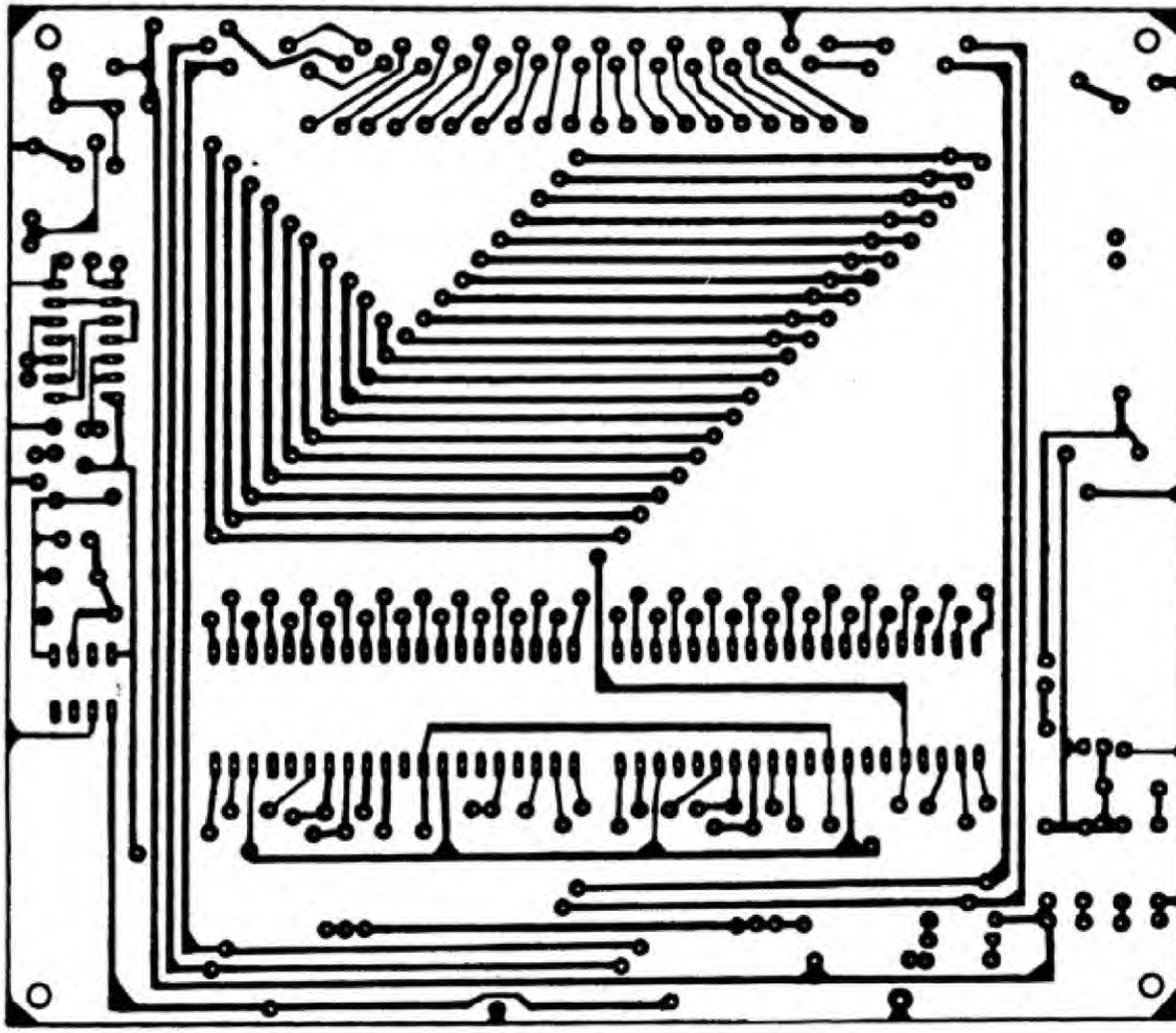


Fig. 3: Actual-size PCB layout for the circuit.

ment, one by one, in series with a 1k resistor. After the display PCB is tested, start assembling the motherboard. Mount all the diodes and resistors and solder them.

After soldering check all the diodes/resistors on the PCB with the help of a multimeter once again.

Complete the assembly of master oscillator IC1, quartz crystal and associated resistors and capacitors. Extend 9V or 12V through test bench power supply and test the functioning of the master oscillator. If oscillating, 60Hz output should be available at pin 1 of IC1. This can be easily seen through a DMM (digital multimeter) having provision for frequency measurements.

Now complete the soldering job of both the clock chips. Interconnect both the PCBs through 26 flexible leads of approximately 150mm length. Connect the various leads on the motherboard which go to various switches. Through these leads test the functioning of both the clock chips.

Now fit rest of the components, e.g. IC4, X1, switches, power supply circuit and two Ni-Cd batteries. These batteries will automatically get charged and supply back-up current during power interruptions. Mount the motherboard on the back cover of the box and mount display PCB, switches and indicators on the front panel.

Testing

After the assembly job is over, test the project as follows, keeping switch S2 in 'on' position:

(a) When the time switch is switched on, the display may be blinking. If so, note the position of S1 and with the help of respective S or F switches make the display steady.

(b) By pressing R reset both the clocks.

(c) By keeping S1 in 'off CTL' position adjust the real clock time. Similarly, in 'on CTL' position adjust the real clock time.

(d) Keep S1 in 'on CTL' position, and by keeping D pressed, adjust on time with the help of respective S and F switches.

(e) Keep S1 in 'off CTL' position and similarly set off time.

Now the time switch is ready for use. Extend the power socket to device under control through auto/manual switches S7 and S8. Switch S2 is an optional switch, which when operated to disable position will prevent clock

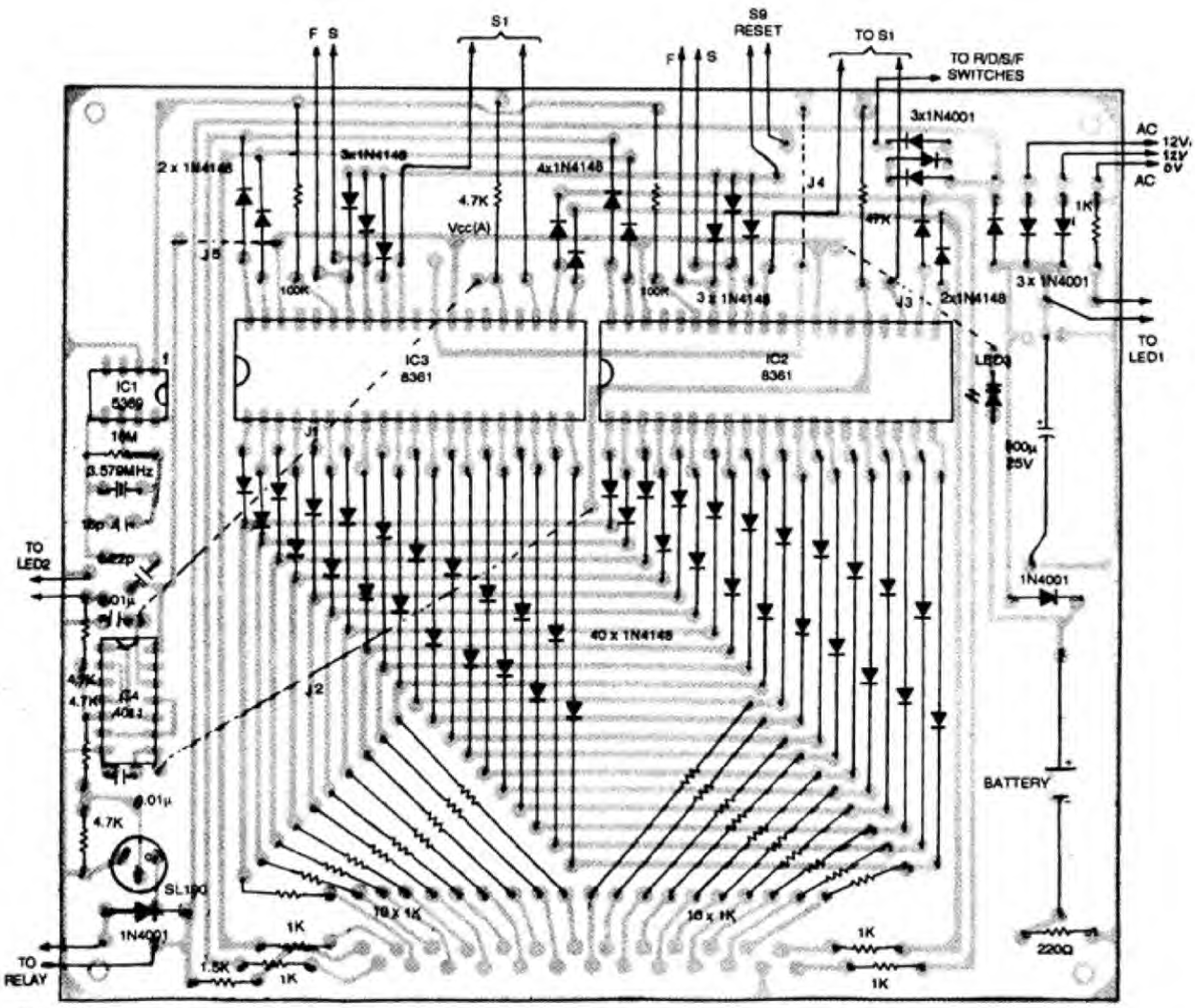


Fig. 4: Components layout for the PCB.

time from getting disturbed by accidental pressing of S or F switches. Keep switch S2 in enable position while setting the time etc.

Sometimes it may happen that, depending upon the setting of SR latch, the device may remain switched off when it should be on, and vice-versa. Under these conditions, keep the switch S1 to 'on CTL' or 'off CTL' position and make the real clock time ahead by 24 hours with the respective F and S switches. It may set to correct position after one or

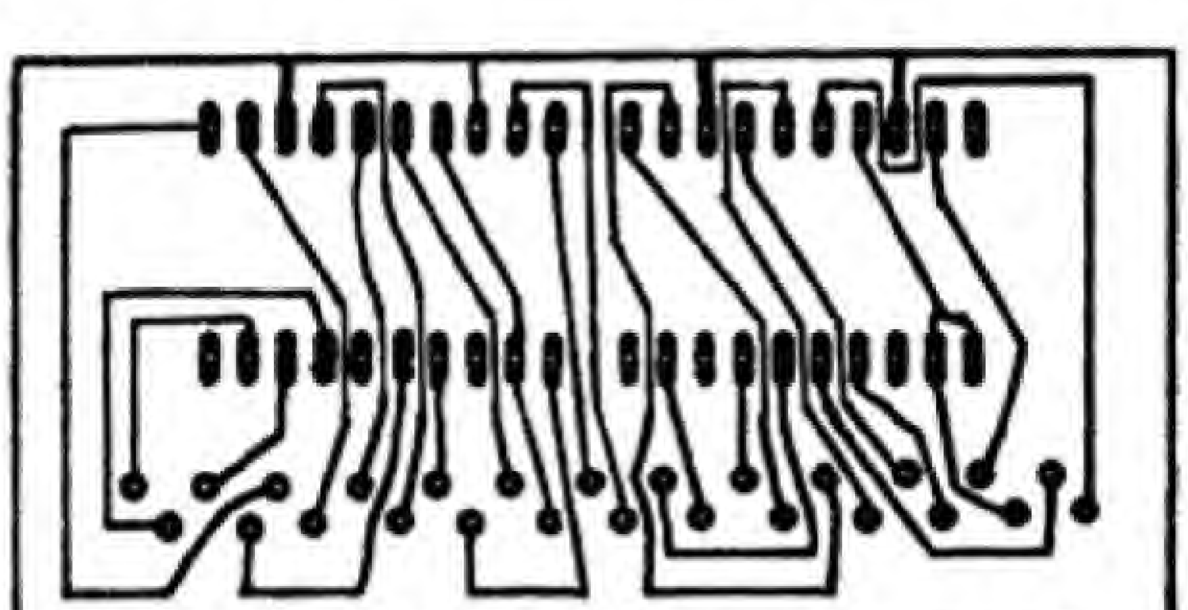


Fig. 5: PCB layout for display panel.

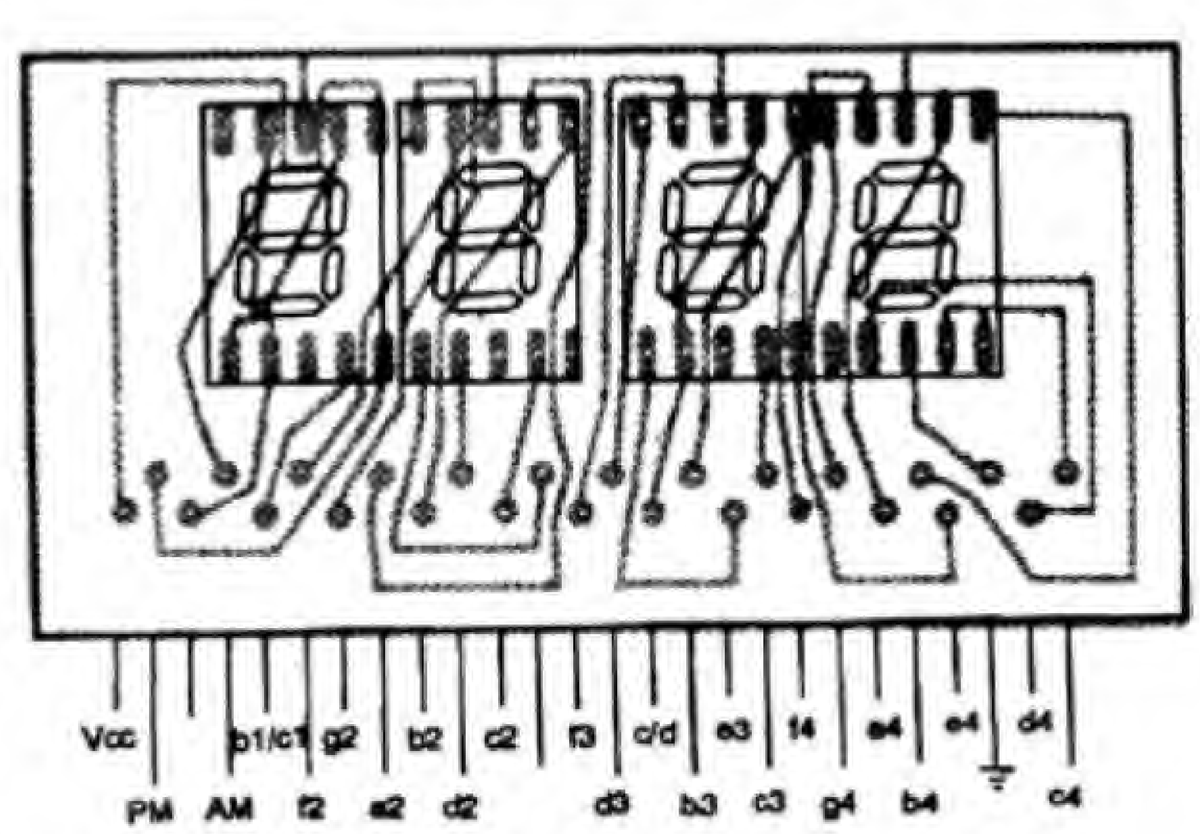


Fig. 6: Components layout for the display panel PCB.

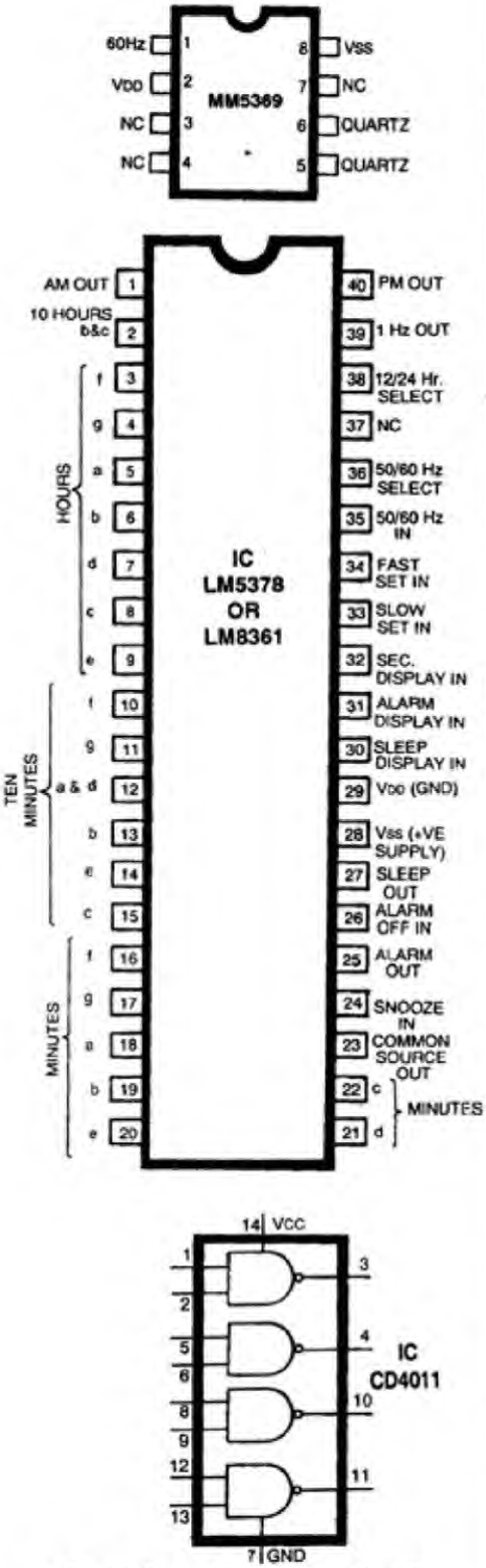


Fig. 7: Pin configuration of the ICs.

two trials.

The digital time switch will be more useful when the device has to be controlled precisely up to the last minute. The analogue time switch has a least count of about 15 minutes.

PARTS LIST

Semiconductors:

IC1	— 5369 quartz controlled oscillator
IC2, IC3	— 8361
IC4	— CD4011 quad two input NAND gate
D1-D54	— 1N4149 silicon diode
D55-D62	— 1N4001 silicon diode
T1	— BC147/SL100 npn transistor

Resistors (all 1/4W, ±5% carbon unless stated otherwise)

R1-R24, R30	— 1-kilohm
R25	— 1.5-kilohm
R26, R27	— 100-kilohm
R28	— 10-megohm
R29	— 220-ohm
R31-R35	— 4.7-kilohm

Capacitors:

C1	— 500µF, 25V electrolytic
C2	— 15pF ceramic
C3, C4	— 0.01µF ceramic
C5	— 0.22pF trimmer

Miscellaneous:

X1	— 220V AC primary to 12V-0-12V AC, 300mA secondary transformer
XL	— 3.579MHz crystal
S1	— DPDT switch
S7	— 1-pole, 2-way switch
S2-S6, S9, S10	— Push-to-on switch
S8	— On/off switch
RL1	— 6V, 200-ohm SPST relay
DIS1-DIS4	— FND500
	— Battery 3.6V
	— PCBs
	— LEDs
	— 5 amp two pin socket

The most popular application of this time switch can be in controlling the daily pump-motor operation, the duration of which is normally fixed, depending upon the water consumption. This time switch can be designed for 5A or 15A of the load current. The relay contacts will have to be of the appropriate rating, the complete design remaining the same.

It has typical industrial applications such as controlling street lights, compound lights and in oil heating installations, water processing plants, electric heaters etc. In general, it can be used to control any electrical device or appliance.

❑

Readers' Comments:

I could not make the Digital Time Switch project published in EFY March'92 issue because of certain discrepancies in figures.

Capacitor C2 and crystal XL are shown connected between pins 5 and 6 in Fig. 2 but they are shown between pins 5 and 8 in the PCB pattern! Please clarify and give some more information about pins 24, 26, 27 etc of IC 8361.

SAYED JAFAR NAQVI
Aligarh

I am thankful to the author for his superb Digital Time Switch project published in EFY Mar.'92 issue. As IC LM8361 is not available in the market can I use IC LM8362 instead?

SANJAY SARAWAGI
Vapi

The author, Mr S.Batra, replies:
Capacitor C2 and crystal XL are shown correctly in Fig. 2 whereas they have been shown wrongly connected in the PCB layout. Inconvenience caused is regretted.

IC8361's pin 24 is used when alarm facility of the clock is in use. When the alarm rings, but you want to sleep some more (snooze), a high potential (snooze input) is extended to this pin through a pushbutton. This enables snooze and the alarm rings automatically after nine minutes. One can have this facility for an hour. Pin 26 is used to stop the alarm. When the alarm is ringing, if the high potential is extended to pin 26 (alarm off input), the alarm stops and rings the next day at the same time.

Pin 30 comes into action when IC 8361 is used for a clock-cum-radio. This pin for 'sleep display' feature enables one to listen to a radio up to 59 minutes. It is found useful if you wish the radio to switch off automatically after a desired period when you are going to bed. With the pushbutton pressed, if the desired time is set through the slow set switch, a maximum 59-minute down counter is activated and the radio is switched on.

Pin 27 is a 'sleep out' point which is used to activate the radio while using the sleep down counter.

I have gone through the technical data of both the ICs and have found them pin-to-pin compatible to MM5397 except for a minor difference which is not relevant to this project. Therefore, 8362 may be used in place of the 8361 without any hesitation.

Digital Frequency Counter

Sanjay Goel

A digital frequency counter (DFC) is used for building, testing and designing analogue and digital circuits. It can also be used for measuring the frequency of any periodic waveform.

The fundamental operation is shown in the block diagram in Fig. 1.

The cost of a DFC is largely governed by the number of digits in its display and the maximum input frequency it can handle. An inexpensive instrument would typically offer a 4-digit display. This frequency counter, incorporating all the features, is comparatively cheaper.

A DFC normally has several measuring ranges. It is possible to add a few digits to the display by a method known as 'over ranging'.

Block diagram

A clock oscillator circuit generates approximately 100Hz signal whose frequency is divided by the divider network. At the output of the divider 1Hz signal is obtained. This frequency has 1-sec. time period. The 1-sec. pulse is applied to the AND gate. Therefore, the unknown signal is passed through the AND gate for 1 sec. and the waveform frequency or the number of pulses per second are counted by the counter. The frequency is displayed on the 7-segment LEDs with the help of a digital panel meter.

The unknown input frequency should be a perfect square wave. For this, we use the schmitt trigger which converts any waveform into a square wave. This unknown input signal must not be greater than 4V. If the input signal is very low (millivolts) it should be amplified with the help of an amplifier before being fed to the schmitt trigger circuit.

The circuit

IC 555 is used to generate the clock frequency and the output frequency at pin 3 is given to pin 1 of 7490, i.e. IC2.

IC2, IC3 and IC4 use decade counters. The frequency at pin 12 of IC2 is

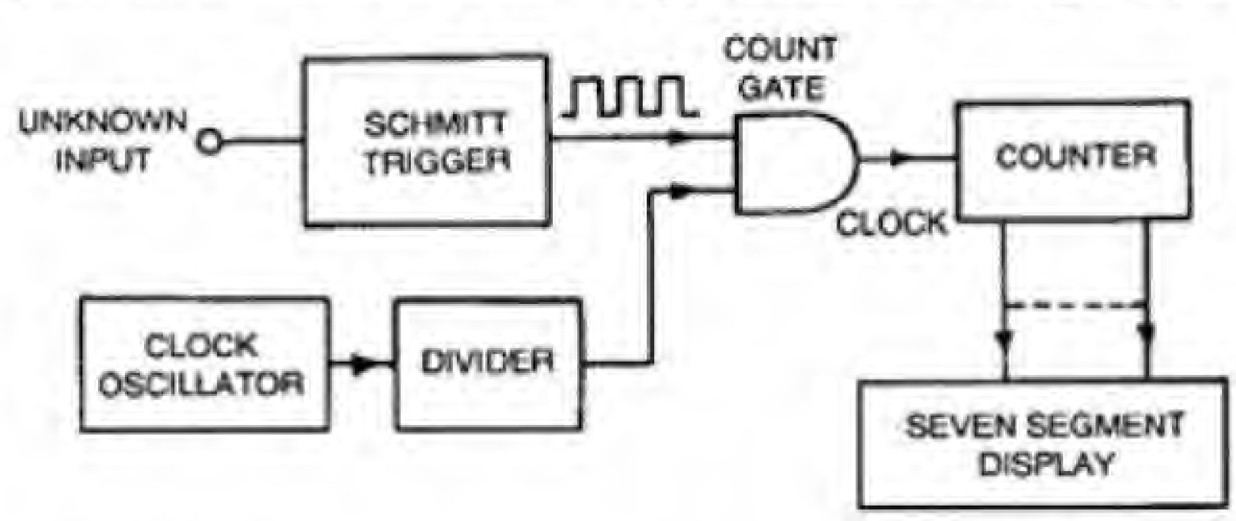
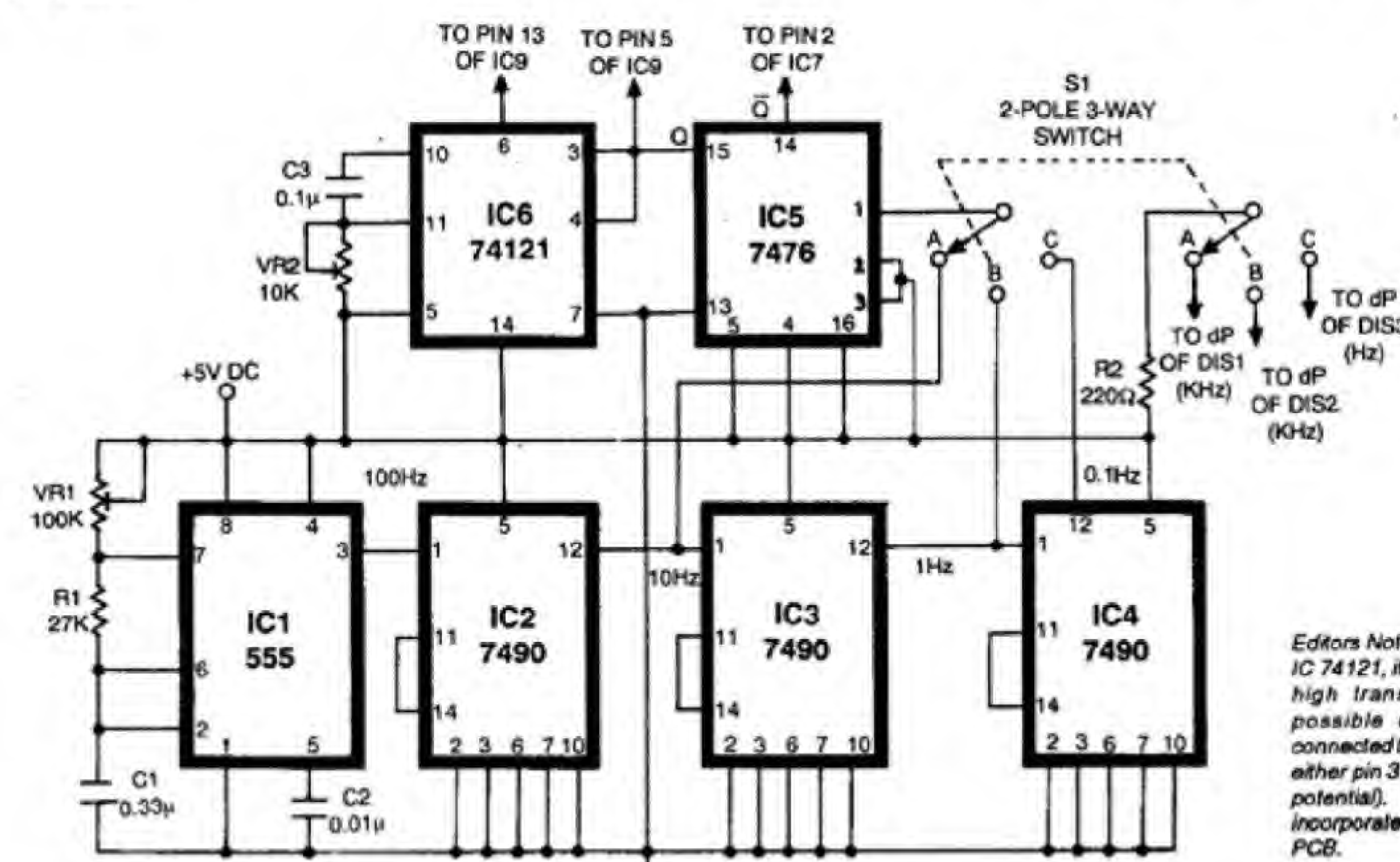


Fig. 1: Block diagram.



Editors Note: As per truth table of IC 74121, its triggering by a low to high transition wave-form is possible only if the input is connected to its pin 5 while keeping either pin 3 or pin 4 low (at ground potential). This change may be incorporated in figure 2 and its PCB.

Fig. 2: Circuit diagram of digital frequency counter.

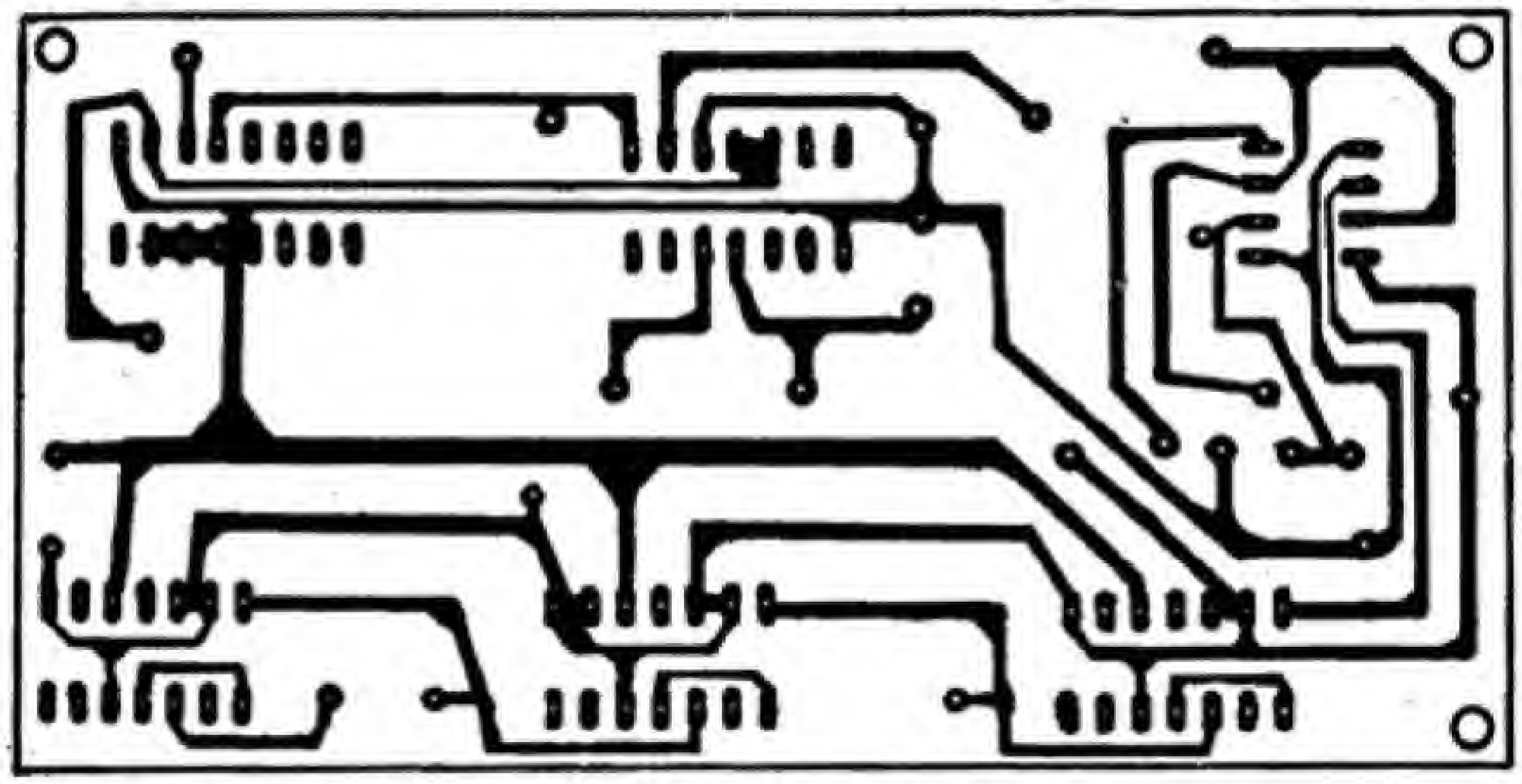


Fig. 3: Actual-size PCB layout for frequency counter.

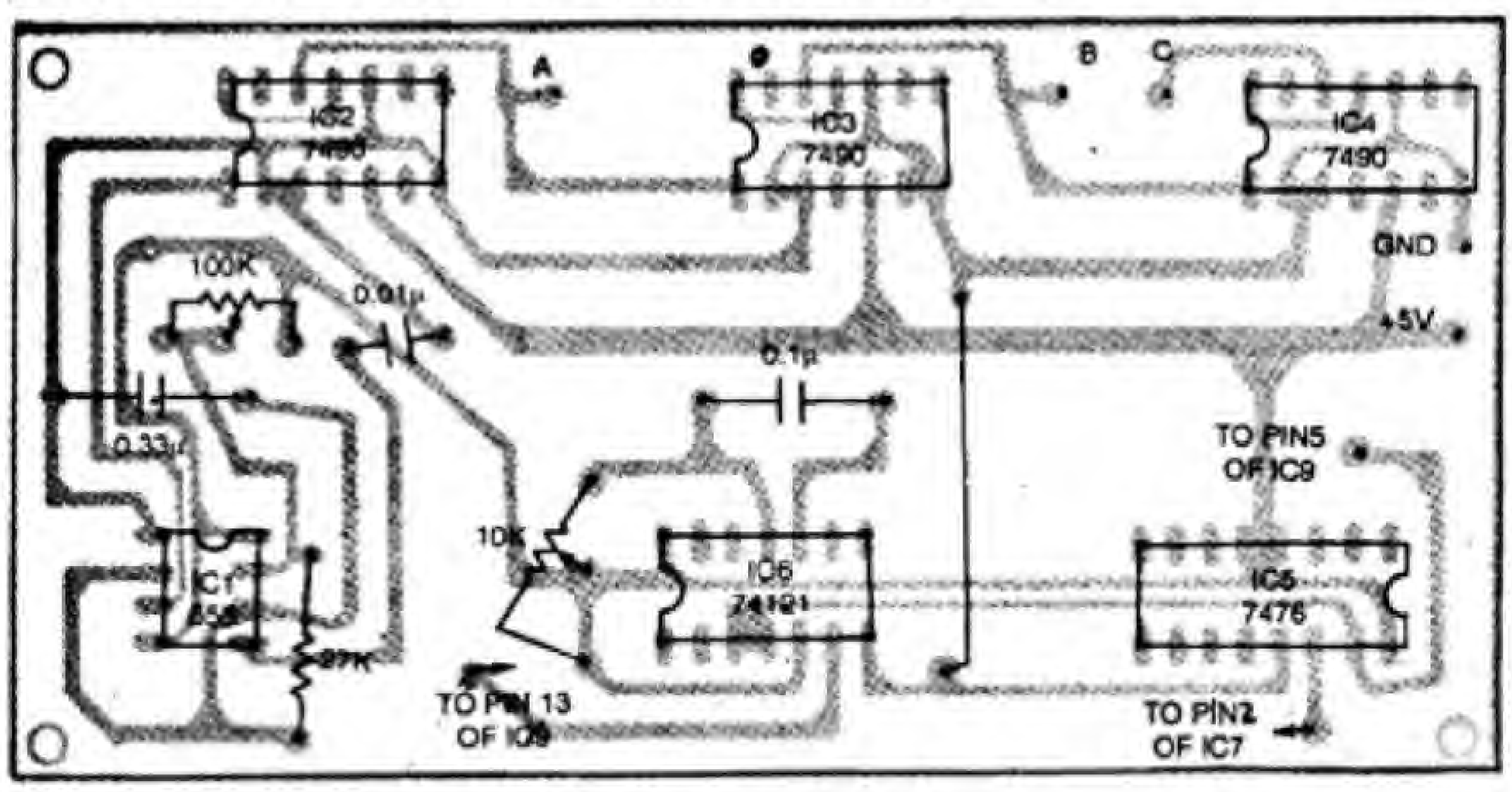


Fig. 4: Components layout for the PCB shown in Fig. 3.

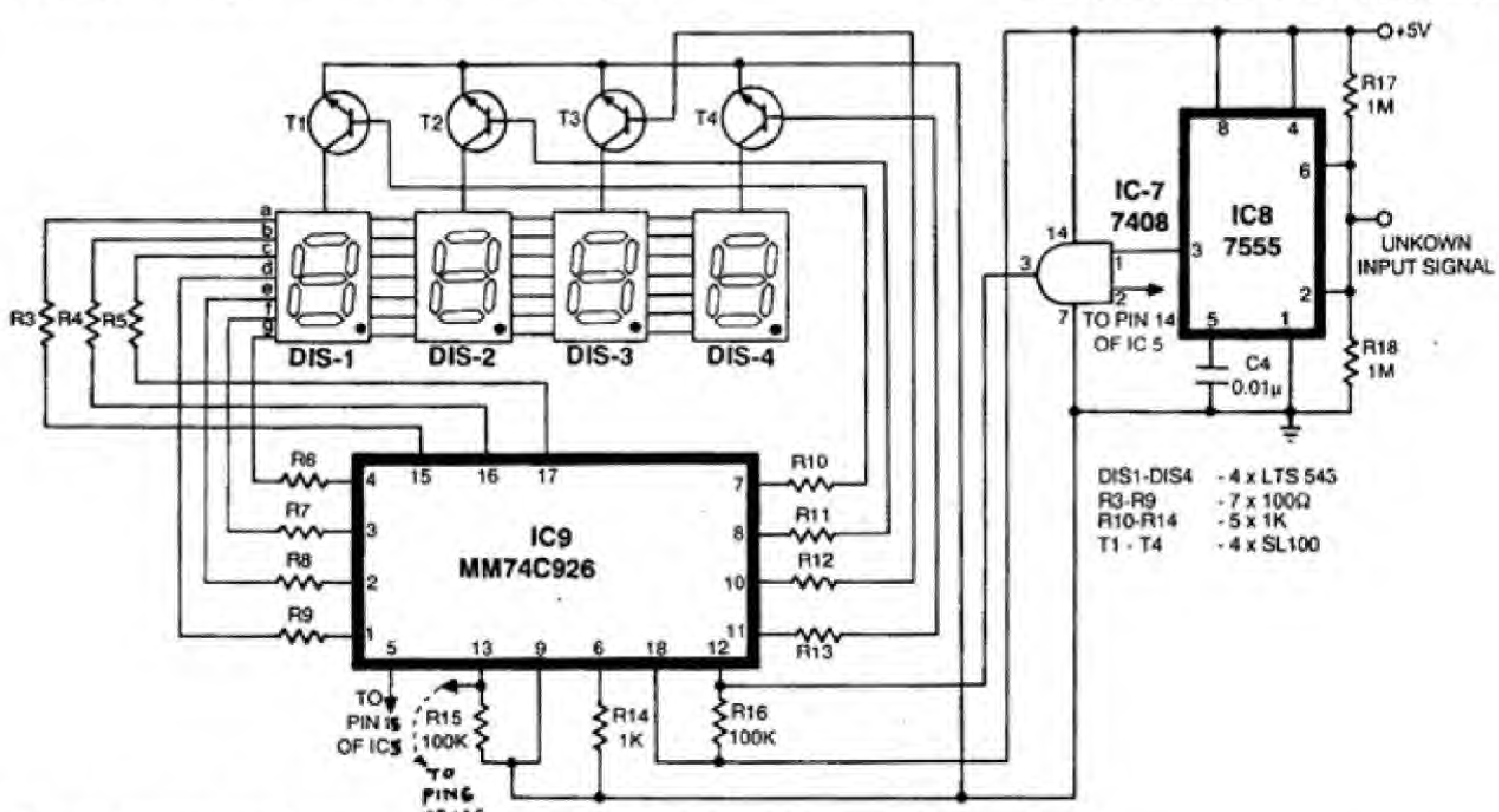


Fig. 5: 4-digit counter and display circuit.

exactly 10 Hz. At pin 12 of IC3 and IC4 the frequency is 1 Hz and 0.1 Hz respectively. Hence, the time period of generating pulse at pin 12 of IC2, IC3 and IC4 is 0.1 sec., 1 sec. and 10 sec. respectively. These pulses are used for the ENABLE gate signals. This time period is used for measuring the frequency of input signals.

The output at pin 12 of IC2 is connected to pin 1 of IC5 by the DPDT switch S1. The IC5 is a dual J-K flip-flop with separate sets, clears and clocks. If 1Hz square wave is used to drive the J-K flip-flop, its output Q will be 0.5 Hz square wave.

The output Q will be high for exactly 1 sec. and low for 1 sec., and it will thus be used for the ENABLE gate signal. Note that 10Hz square wave will generate a 0.1-sec. gate and the 0.1Hz square wave will generate a 10-sec. gate enable time.

When the J-K flip-flop is toggled high, measurement period starts. Now the unknown input signal passes through the COUNT gate IC7 (7408) and advances the counter. Assume that the counter is at 0000. At the end of the gate time, say 1 sec., the counter reading is the final frequency. Positive transition of Q of IC5 triggers the monostable multivibrator IC6 (74121) one-shot. Therefore, at pin 6 of IC6, a positive RESET pulse appears. This pulse is used to reset the counters. Now to latch the contents of counter, a negative pulse is required. Hence, the output Q of IC5 is used for this purpose. The input signal

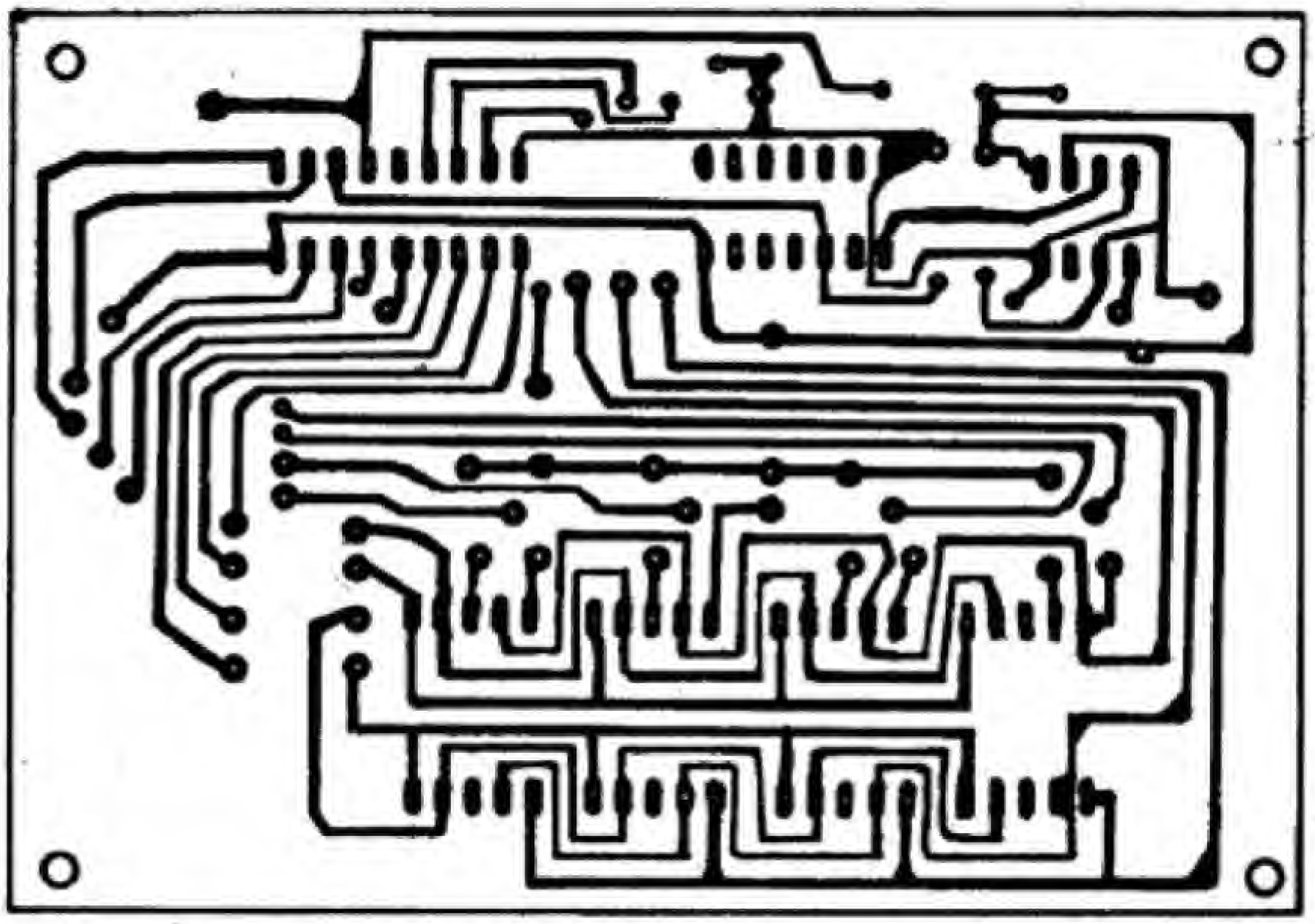


Fig. 6: Actual-size PCB layout for Fig. 5.

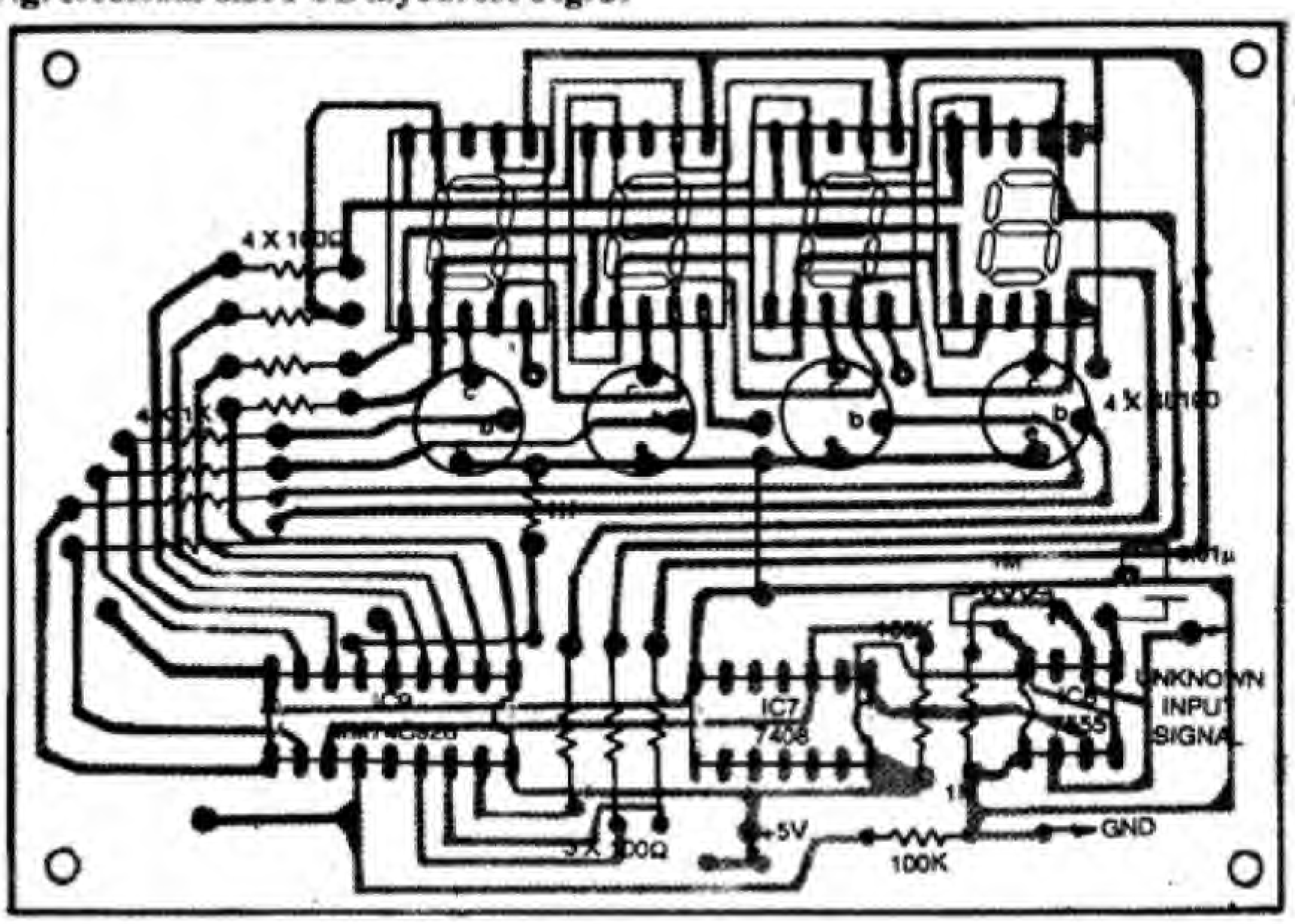


Fig. 7: Components layout for the PCB shown in Fig. 6.

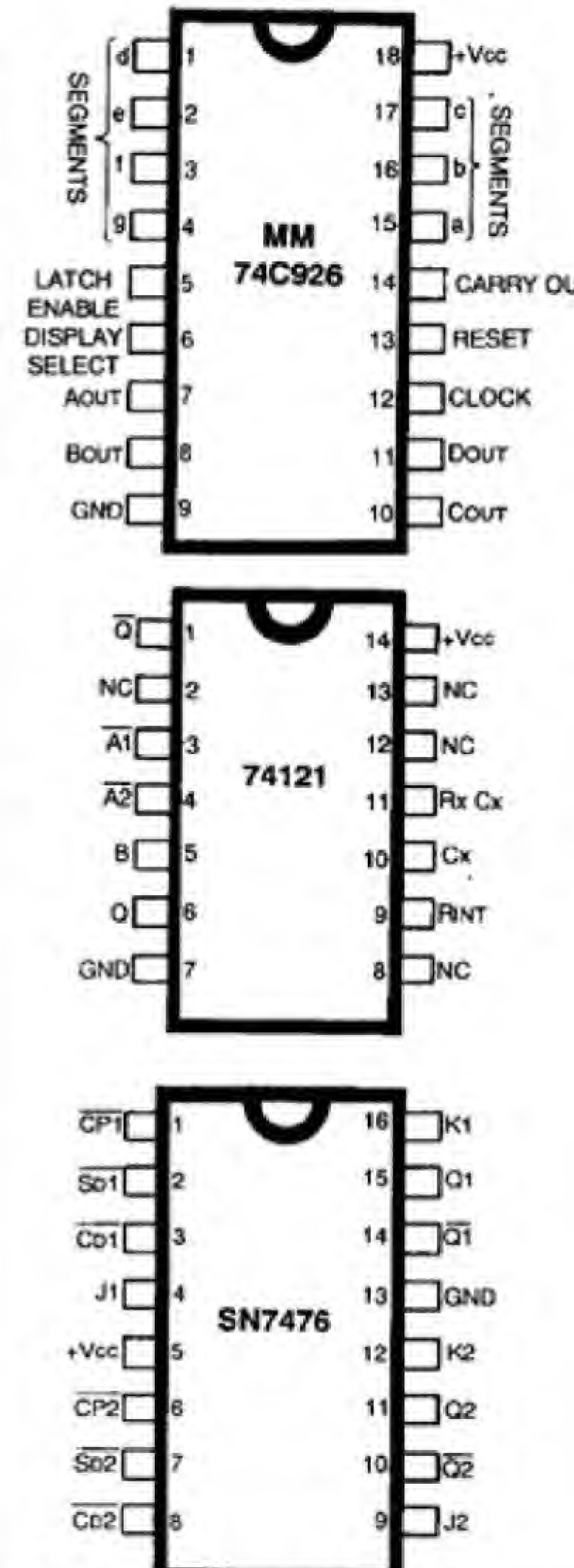


Fig. 8: Pin configurations of ICs.

can be of any form. To convert these signals into square wave, schmitt trigger is used. The schmitt trigger is built around timer 7555. A square wave of equivalent frequency of input signal is received at pin 3 of IC8 and is fed into AND gate. To count the frequency, AND gate is used as count gate which passes the frequency for the selected gate time. The gate time is selected by switch S1.

The display circuit is built around the National Semiconductor IC 74C926. It has a 4-digit counter with multiplexed 7-segment output drivers, internal output latch and a source driver for the display.

The CMOS IC is an 18-pin, dual-in-line package. It has four decade counters, latches and reset input. It consists of an enternal multiplexing circuitry with four multiplexed outputs. This multiplexed circuit has its own free-running oscillator.

A carry out pin, i.e. pin 14, is also available for cascading the counter. Hence we can also increase the range of this frequency counter. With the help of this pin, we can increase the number of digits from four to eight. The internal counter of the IC advances on each negative edge of the clock pulse, which is received at pin 12 by IC7. A high signal on DISPLAY SELECT, i.e. pin 6, through 1-kilohm resistor selects the number in the counter to be displayed. Low signal on latch enable input latches the count at the output. The display used for this chip is 7-segment common-cathode type. IC 74C926's range of supply is +3V to +6V with high noise immunity (noise swings 1V).

The signal generated by IC6 is fed to the reset terminal of 74926 IC. This reset pulse has an arbitrary width of 1µs, set by capacitor C3 and preset VR1 timing components. The end of the reset pulse is the end of one measurement period.

If we select one second gate time, at that instant the decimal point will be at

PARTS LIST

IC1	— 555 timer
IC2-IC4	— 7490, decade counters
IC5	— 7476 dual JK flip-flop
IC6	— 74121, monostable multivibrator
IC7	— 7408 quad 2-input NAND gate
IC8	— 7555 CMOS timer
IC9	— MM74C926, 4-digit counter
T1-T4	— SL100 npn transistor

Resistors (all 1/4W, ±5% carbon, unless stated otherwise):

R1	— 27-kilohm
R2	— 220-ohm
R3-R9	— 100-ohm
R10-R14	— 1-kilohm
R15, R16	— 100-kilohm
R17, R18	— 1-megohm
VR1	— 100-kilohm preset
VR2	— 10-kilohm preset

Capacitors:

C1	— 0.33µF ceramic
C2, C4	— 0.01µF ceramic
C3	— 0.1µF ceramic

Miscellaneous

DIS1-DIS4	— LTS 543S
S1	— 2-pole 3-way switch

the right of the third digit (DIS1) and the counter will be capable of counting up to 9999 Hz full scale. With the help of this counter we can measure up to 10 kHz by selecting different gate timings, and the accuracy is compatible with that of the counter.

You can set the reset pulse by a suitable combination of capacitor C3 and preset VR2, as shown in Fig.2.

Assembly, testing and calibration

This project is easy to assemble on a general-purpose or the suggested PCB. All the ICs should be mounted on IC sockets and soldered carefully. All components should be checked before assembly. After completing the assembly, the power supply should be checked. It should not be greater than 5 volts regulated. Also check whether IC 555 is generating clock pulses or not. The output at the counters should also be examined.

For calibration of the circuit give known input frequency at the input terminal and set it at display with the help of presets VR1 and VR2. When it displays the input frequency correctly, the calibration is complete. Now the frequency counter is ready for measuring any unknown frequency of an input signal. All the above circuits, including the display, may be enclosed in a metal cabinet. For better results, the cabinet should be shorted to ground.

Conclusion

A DFC is not difficult to use, but you need to be careful about the choice of the test-point when testing LC oscillator, especially the high frequency types. In general, it is best to choose a low impedance part of the circuit and, as far as possible, avoid taking the signal directly.

Remember there will be a certain amount of capacitance in the test leads, and the DFC itself will have a small amount of input capacitance. This can significantly reduce the operating frequency of the circuit and, in an extreme case, damp the oscillator to the point where it will cease to function. ❑

Fire Sensing System

Kalpesh Dalwadi

Fire is one of the most hazardous natural forces. Sensing fire and fighting it in the early stages can prevent losses to a great extent. Sensing fire electronically has become one of the most reliable fire-fighting techniques today.

Sensing fire needs reliable smoke/fire sensors. Thermistors can sense fire depending on temperature increase principle. We can also use opto devices to sense smoke. One of the projects published in EFY Vol.6 used Japanese Figaro TGS gas sensors. Such sensors are expensive and are not easily available.

The system presented here uses the most common yet very reliable bimetallic strip of a tubelight starter as a heat sensor. The system, besides giving an alarm, also visually indicates the exact position where the fire has taken place. This system becomes very necessary in large multistoreyed buildings, hotels, offices etc.

It is very flexible and can take inputs from any number of sensors. It is very simple to construct and is quite

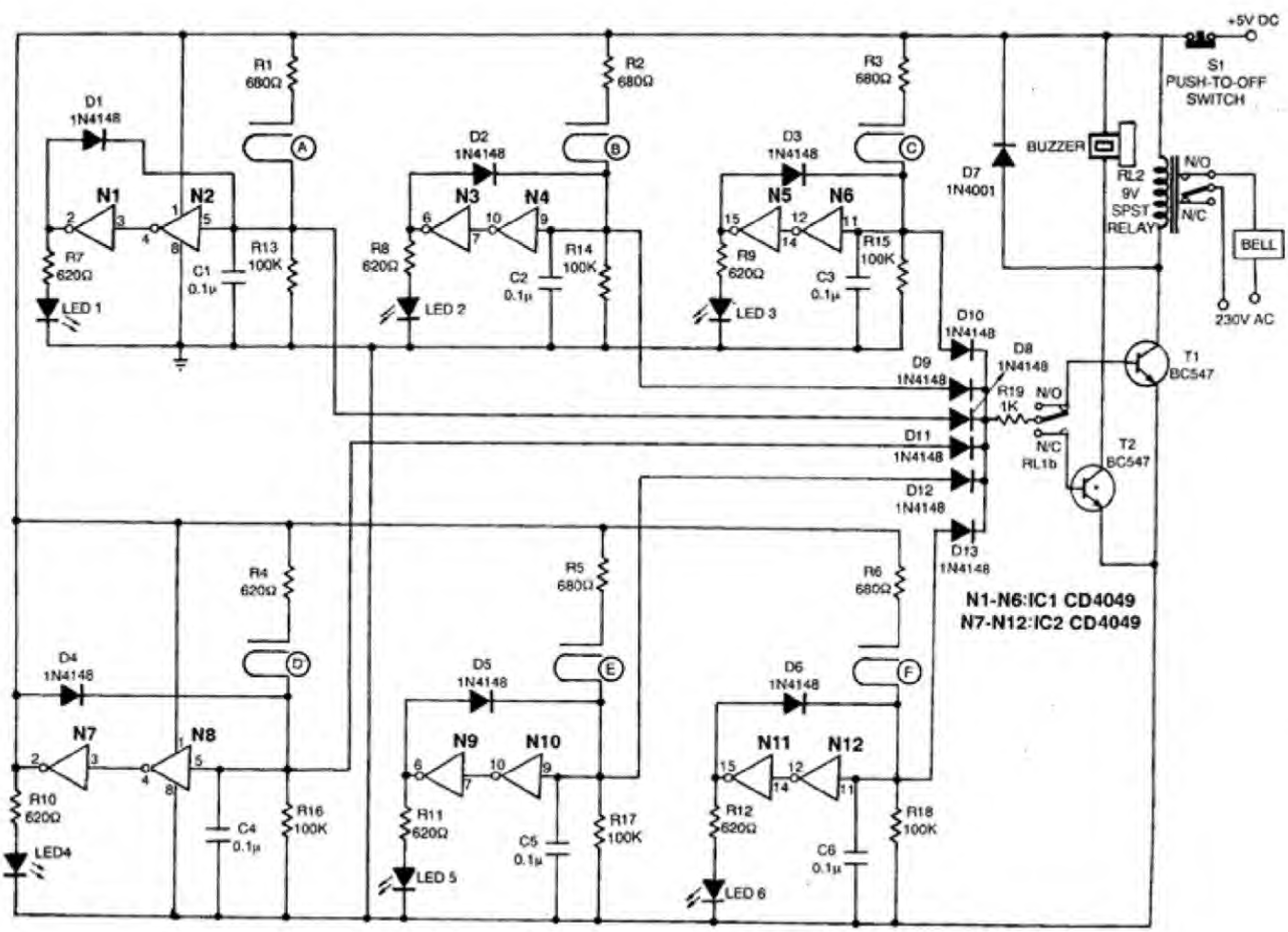


Fig.1: Circuit diagram of fire sensing system.

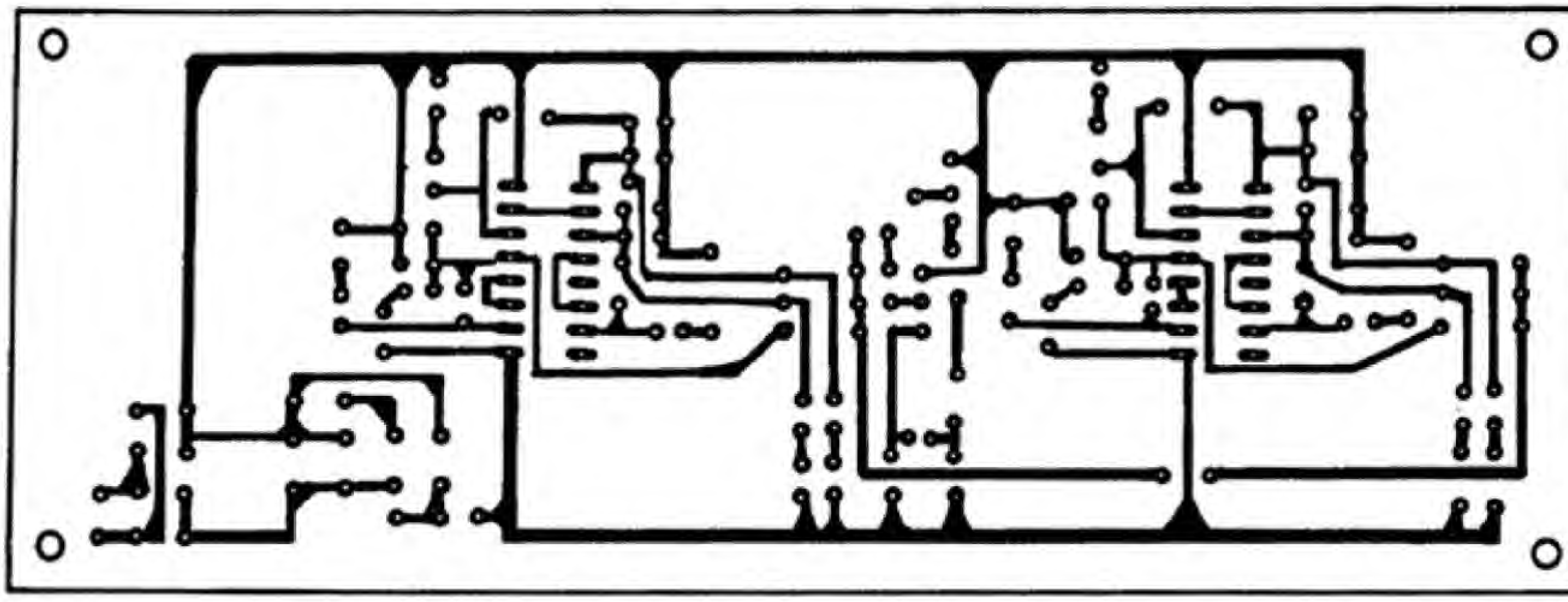


Fig.2: Actual-size PCB layout for fire sensing system.

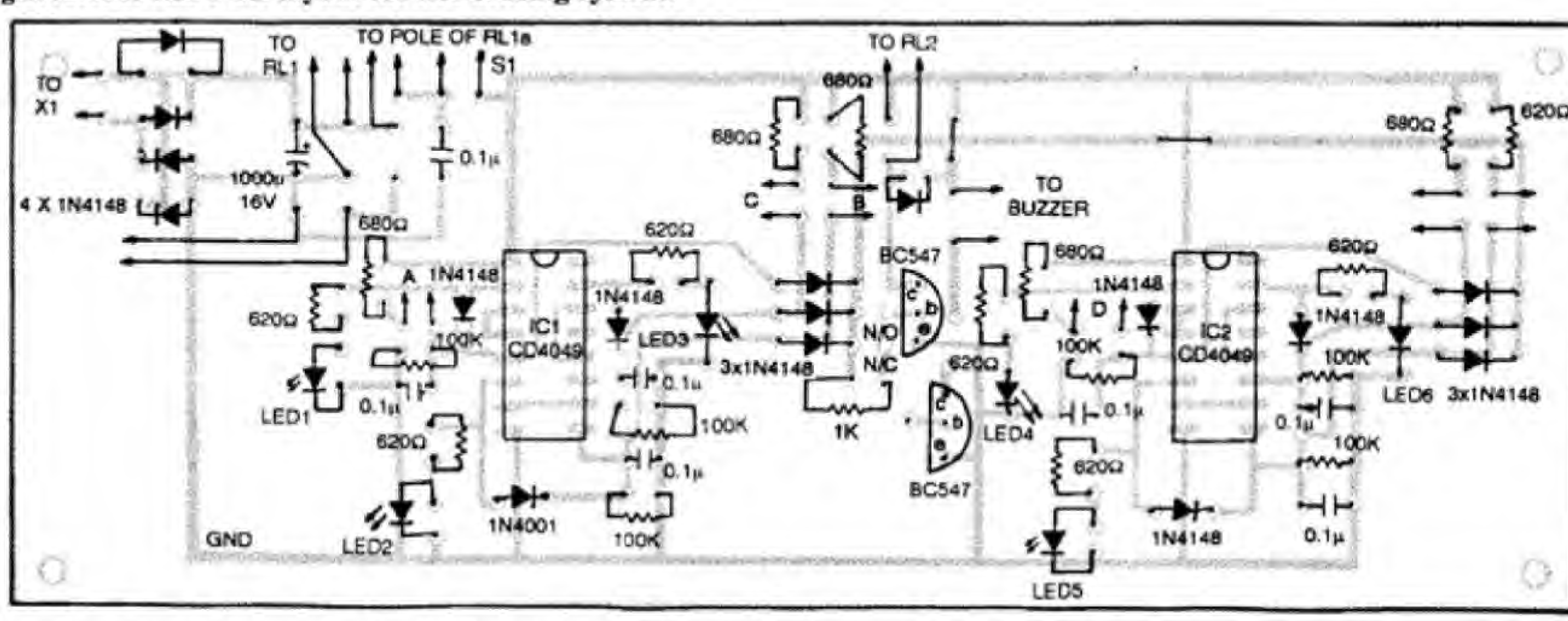


Fig.3: Components layout for the PCB shown in Fig. 2.

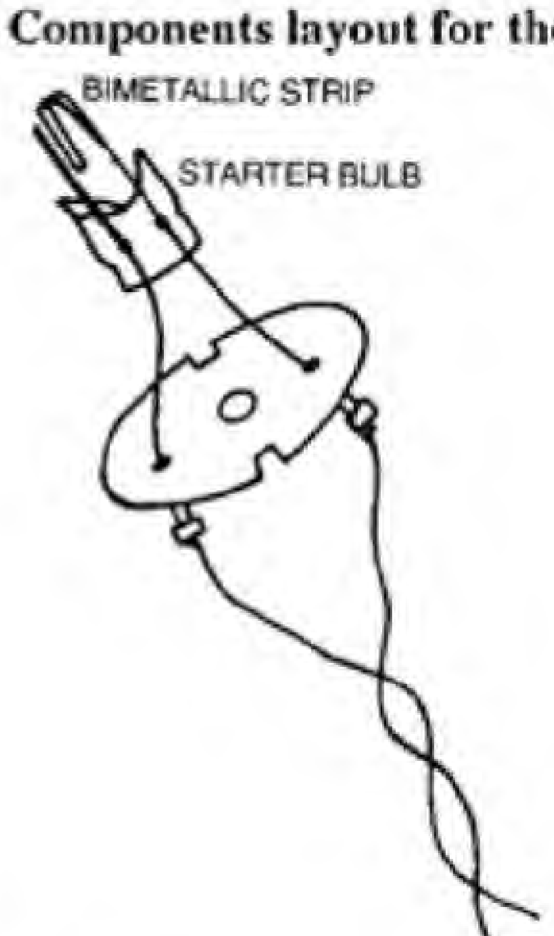


Fig.4: Sensor.

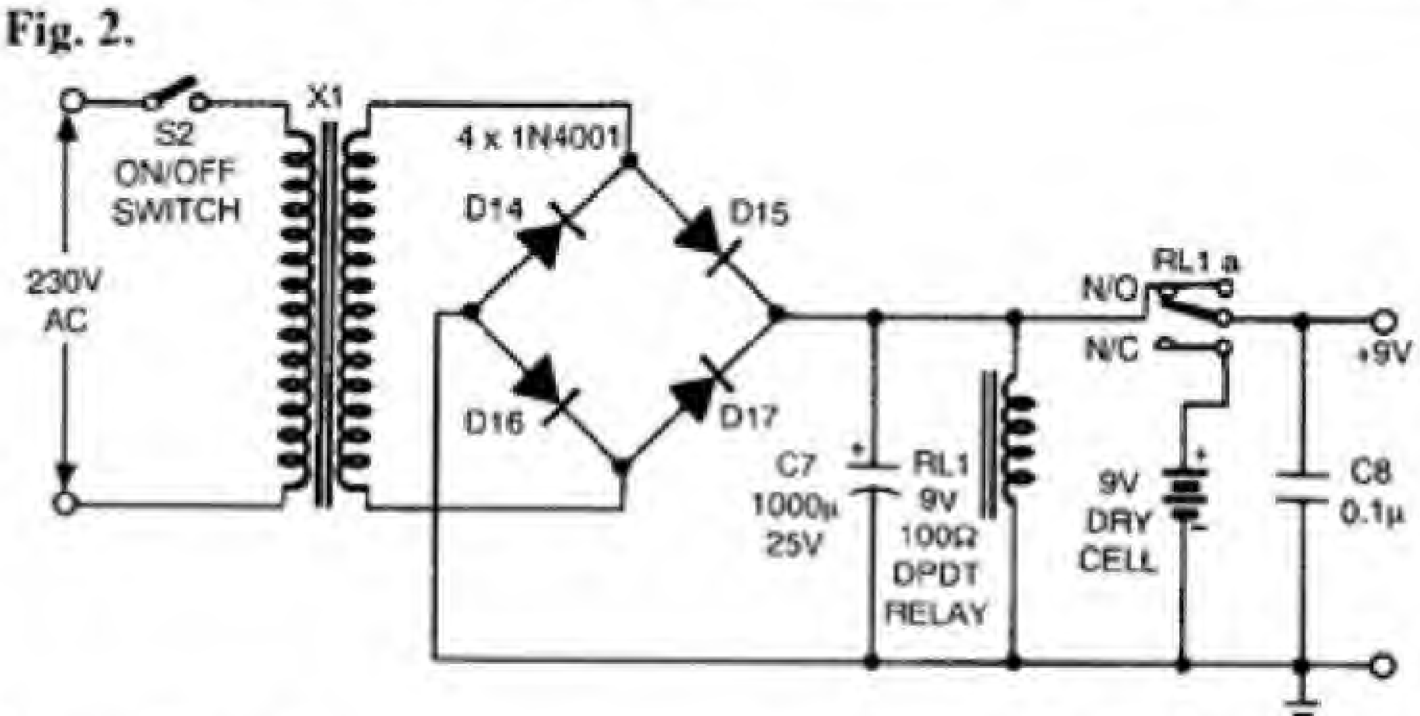


Fig. 5: Power supply.

economical too.

The circuit

The entire system works on a very simple principle. The bimetallic strip acts as a switch to switch on the corresponding latch circuit. Here latching property is needed so that once the fire is sensed the alarm remains 'on' until adequate precautions are taken.

When the bimetallic strip gets heated due to the fire flame, it connects the positive supply line to the input of digital latch circuit, thus latching the latch. The digital latch circuit is built around easily available CMOS inverter CD4049 ICs.

When sensor A is operated, the input of gate N2 (pin 5) is at logic 1 through the 680-ohm limiting resistor. After two inversions, output of N1 (pin 2) is at logic 1 which is fed back through switching diode 1N4148 to the input of N2, thus latching the circuit. LED2 connected across the output of N1 and ground indicates the particular position

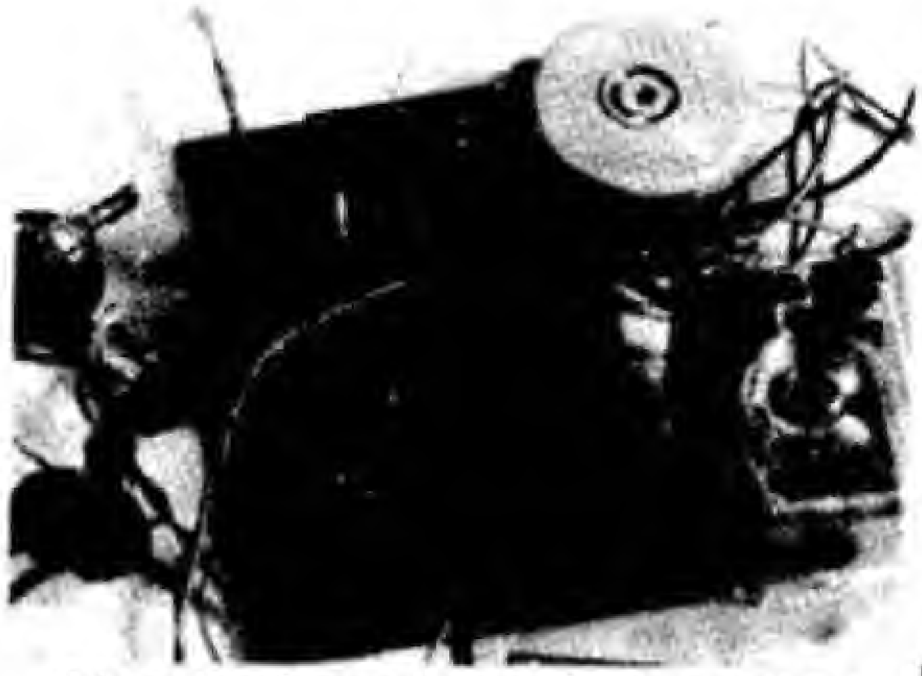


Fig.6: Photograph of author's prototype.

where sensor A is installed, indirectly indicating the place where the fire has occurred. At the same time, diode D8 conducts and provides base bias to transistor T1 and the relay operates the hooter or an electric bell.

The 0.1µF capacitor at input of latch circuit filters the noise pick-up by long wires leading to sensors, thus preventing any false triggering of the alarm.

Switch S1 acts as a master reset switch. OR logic is implemented at the base of transistor T1 to sense signal from each sensor. In this circuit only six sensors are shown but they can be increased without changing the main circuit.

PARTS LIST

Semiconductors:

IC1, IC2	— CD4049 Hex inverter
D1-D6, D8-D13	— 1N414 silicon diode
D7, D14-D17	— 1N4001 silicon diode
T1, T2	— BC547 npn transistor

Resistors (all 1/4W, ±5% carbon, unless stated otherwise):

R1-R6	— 680-ohm
R7-R12	— 620-ohm
R13-R18	— 100-kilohm
R19	— 1-kilohm

Capacitors:

C1-C6, C8	— 0.1µF ceramic disc
C7	— 1000µF, 16V electrolytic

Miscellaneous:

X1	— 230V AC primary to 0-6V AC, 500mA secondary transformer
RL1	— 9V, 100-ohm DPDT relay
RL2	— 9V, 100-ohm SPST relay
S2	— On/off switch
S1	— Push-to-off switch
Buzzer	— ICPB27 (Canon make) or PEC27IH (PEC make)
	— 9V dry battery
	— LEDs

Power supply

The power supply for the system is very straightforward and simple. No regulator is required as the CMOS IC needs no regulation.

Full-wave bridge and smoothing capacitor form the main components of the power supply. A 9V dry cell is used as battery back-up in case of mains failure. In this case, instead of an electric bell a buzzer operates. RL1 is a DPDT (double-pole, double-throw) relay which connects the 9V battery in the circuit and the buzzer driving transistor. Battery back-up does not affect the remaining operations of the system except the sound of the alarm.

Construction

The complete circuit can be constructed on a general-purpose PCB even though the suggested PCB layout is provided for readers' convenience.

A tubelight starter element is taken out of its aluminium/plastic covering and is used as a sensor. With great care the glass bulb covering of the bimetallic strip is to be broken. Only the upper half of the bulb is to be broken so that the bimetallic strip is exposed.

Now the sensor is ready for use. It is to be installed at the nearest point possible where fire may occur so that maximum sensitivity is achieved. The bimetallic strip is basically a fast acting sensor which gets connected within 4 to 5 seconds when in direct contact with a fire flame.

Testing the circuit

After completing the fabrication, light up a candle. Switching on the power supply, bring the candle near the bimetallic strip. Within 3 to 4 seconds the strip gets connected and the particular LED lights up and simultaneously the relay operates. If the circuit operates in the given sequence, the system is ready for installation and use.

The complete system with the power supply and a good metallic cabinet would cost around Rs 150 which is quite reasonable as compared to such systems available in the market. ❑

Readers' Comments:

While thanking the author for this wonderful project, I request him to inform me:

1. Can I use a failed starter as a fire sensor?

2. How to use a thermistor as a fire sensor?

3. How to use a loudspeaker instead of buzzer?

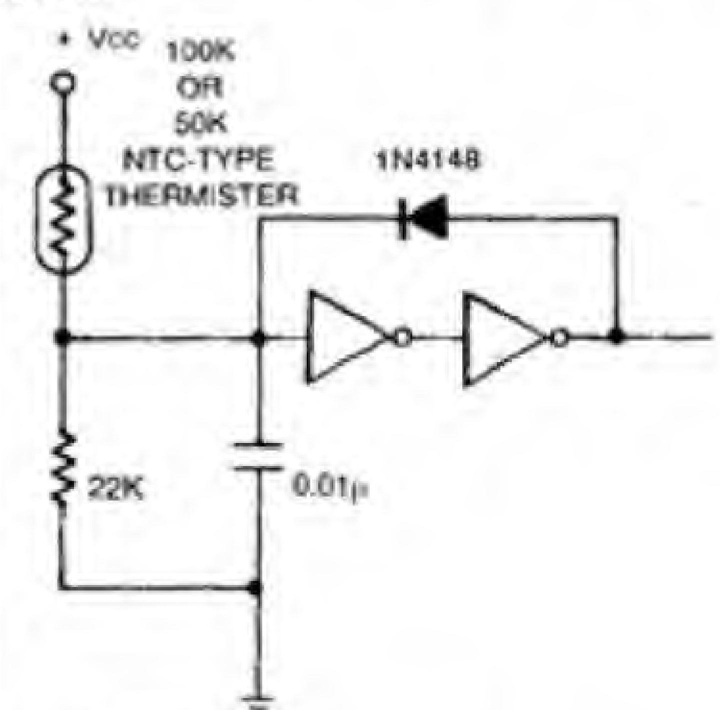
In the power supply section I think the author unnecessarily used a relay for battery back-up. Perhaps a single DR50 germanium diode in series with battery would have sufficed.

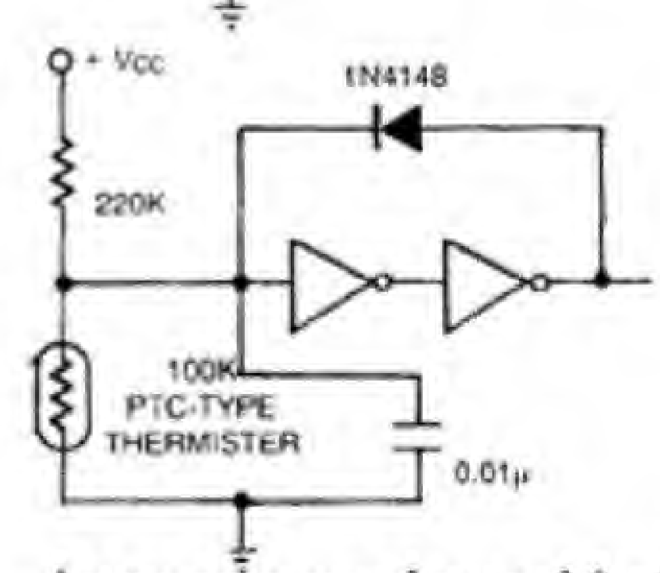
S. RAVI KUMAR
Jagtial (Karimnagar Dist.)

The author, Mr Kalpesh Dalwadi, replies:

A failed starter may be used only if the capacitor in parallel with bimetallic strip has failed and not the bimetallic strip itself.

A thermistor (NTC type or even PTC type, as shown below) can be used.





An op-amp may be used for better results, such as sensitivity. Thermistors will need such adjustments.

Using a loudspeaker instead of buzzer will need extra circuit to generate alarm sent through speaker. This will unnecessarily make the circuit more complicated.

Use of DR50 is not feasible as the buzzer ringing circuit has to be connected at the output at times of power failure. Use of DPDT relay kills two birds with a single stone.

Spectacular Spectra

Uttiya Chowdhury

Every electronics enthusiast dreams of making a hi-fi deck at least once in his life time. While he dreams, he plans, "the deck set will have excellent sound quality and wattage. It will be equipped with a 10-band graphic equaliser. Each band of the graphic equaliser will be accompanied by a 10-level spectrum analyser. And when lights in the ten bands of the spectrum analyser will dance with the beats of drum and throbs of cymbals, what a great display will it be!" But when he comes back to reality and faces the great expenses involved, he has to omit a lot of features. He comes to realise that the deck he can afford to make has so few attractions that it is hardly worth making. He abandons the idea after realising that his dream calls for a loaded wallet which unfortunately he doesn't have.

But why sigh? Here is a project to encourage those enthusiasts who would like to realise their dreams. I'll deal with the spectrum part of it. Yes, introducing to you, a 10-band, 10-level, spectacular super spectrum analyser at a down-to-earth cost!

One IC 3914 is necessary for a 10-level spectrum analyser for one input channel. So a 10-band level spectrum analyser conventionally built requires ten such ICs. But LM3914 is expensive, and ten such ICs will certainly be outside our limited budget.

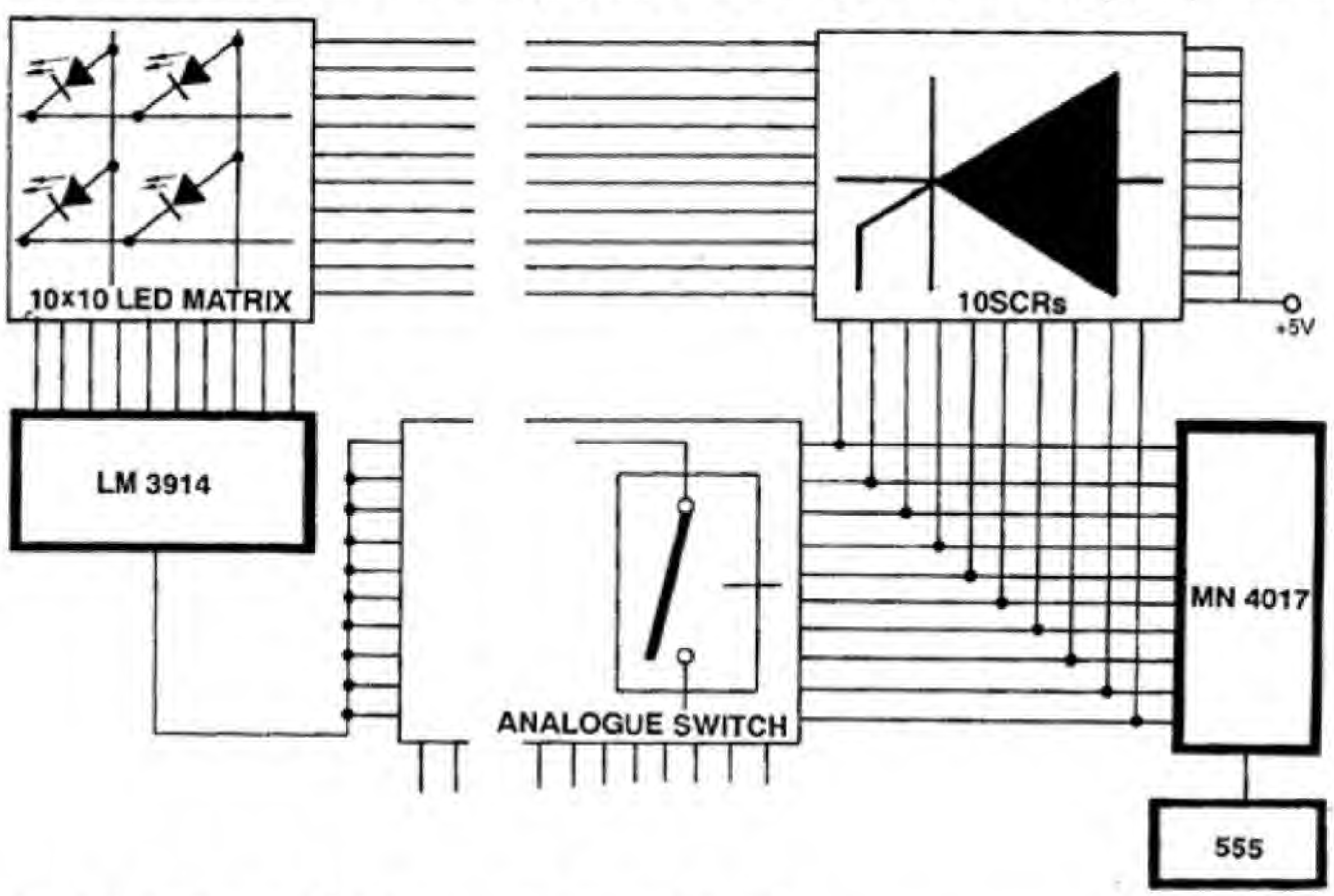


Fig. 1: Block diagram of the spectacular spectra display.

Principle

The solution for making such an eye-catching project lies in persistence of vision, i.e. if a person sees something, its image remains in his brain for about 0.1 second. For instance, if a bulb blinks at a rate of more than ten times a second, it appears as if the bulb is continuously lit.

The visual effects in movies and television etc are based on this principle.

Each column in this 10-column spectrum analyser will show the level of a particular frequency. The display shall show only one such column at a time. We shall display the columns one after another, and after displaying the tenth column we shall show the first column. But we finish this entire process in less than 1/10 second, so that each column is shown more than ten times a second. It will thus appear as if all the columns are being lit at a time.

Circuit

The display matrix is the easiest part. Here all we have to do is to solder 100 small LEDs in a 10x10 matrix. The PCB should be made as shown and the LEDs should be soldered on it such that all the anodes go to the columns and all cathodes go to the rows. You can, alternatively, buy a 10x10 readymade LED matrix.

Test the matrix by giving positive supply to the columns and negative to the rows. If you give positive to the nth column and negative to the mth row, the mth LED in the nth column should be lit. Check all the LEDs in this way because any mistake here will be hard to correct later. Faults may be caused by putting the LEDs in the wrong way, bad soldering and of course by bad

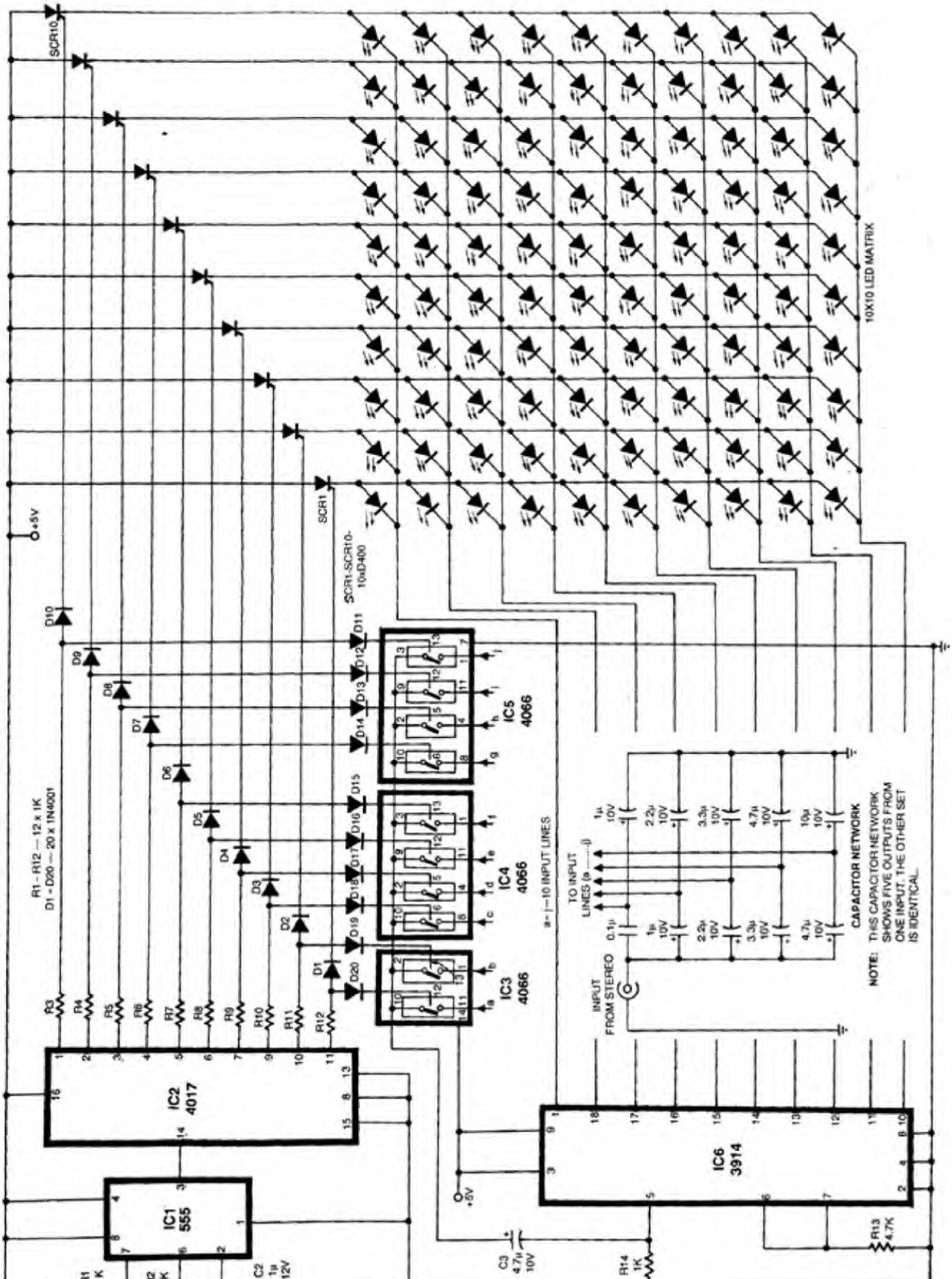


Fig. 2: Circuit diagram of the spectrum analyser.

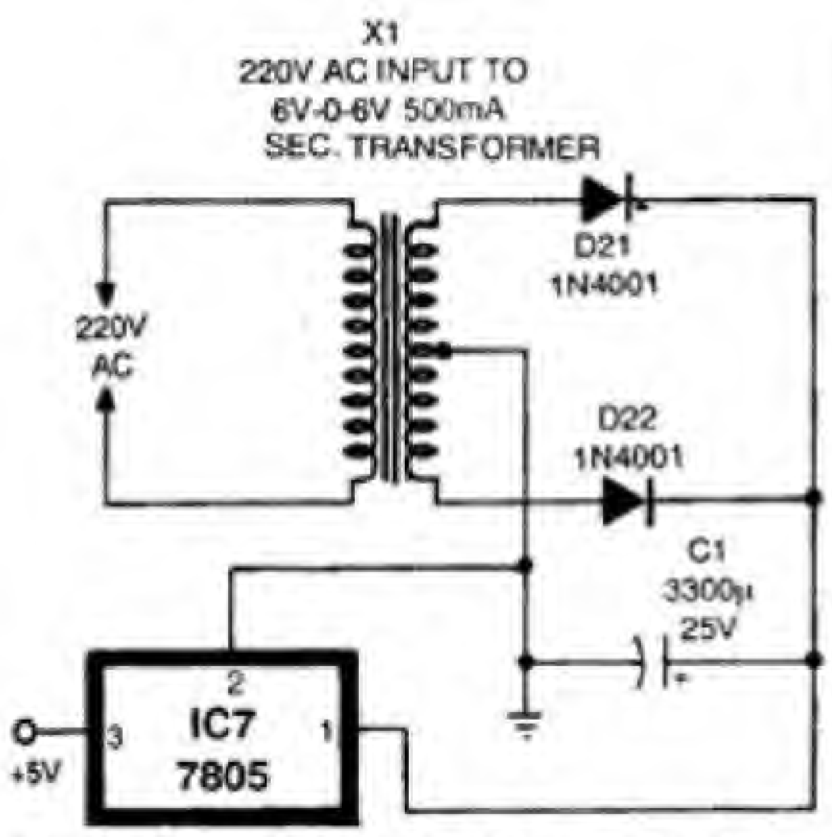


Fig. 3: Circuit for the power supply.

LEDs. Now you have a 10x10 matrix which may be useful in many other electronic projects as well which you'll probably make in future.

The main circuitry may be divided into two parts: the row drive and the column drive. The column drive gives ten output lines for the ten columns of the matrix and the row drive gives ten outputs for the ten rows. The row drive will give negative signal and the column drive will give positive signal for lighting the LEDs in the matrix.

Let's make the row drive first with IC3914, two resistors and a capacitor. LM3914 is used here just as in a one-band spectrum analyser. The IC has ten op-amps, each of which has two differential inputs and one output. One of the inputs is non-inverting while the other is an inverting input. The voltage at the output line goes high when voltage at the non-inverting input is higher than that at the inverting input.

Now we have ten op-amps with their inverting inputs getting 0, 0.5, 1....4.5 volts, respectively through a chain of ten resistors in series. All the non-inverting inputs are shorted and are getting the input signal. So, when the input signal is 0 volt, none of the op-amps will have a high output, and so none of the outputs will be active.

Let's imagine that the input voltage is growing higher. When the input voltage crosses 0.5 volt limit, both the first and second op-amps will be active. The reason is, the non-inverting input of the second op-amp is getting more than 0.5 volt whereas the inverting input is getting 0.5 volt, which is less than the voltage in the non-inverting input. Thus, when the input signal crosses 1, 1.5, 2, 2.5 ...... 4.5 volts respectively, the 3rd, 4th, 5th, ... 10th op-amps become active. Thus, 10 op-amps put in this fashion can show the input voltage limit, just as a mercury thermometer shows the temperature.

Since the op-amp compares the voltage between its two input pins, it is called a comparator. But there is a difference between an actual comparator chain and the chain in LM3914. In actual comparators, the voltages in the outputs go high when they are active. But because of a different circuitry, the outputs of the LM3914 go low when they are active. So the outputs of the LM3914 are called 'active low' and the others 'active high' outputs.

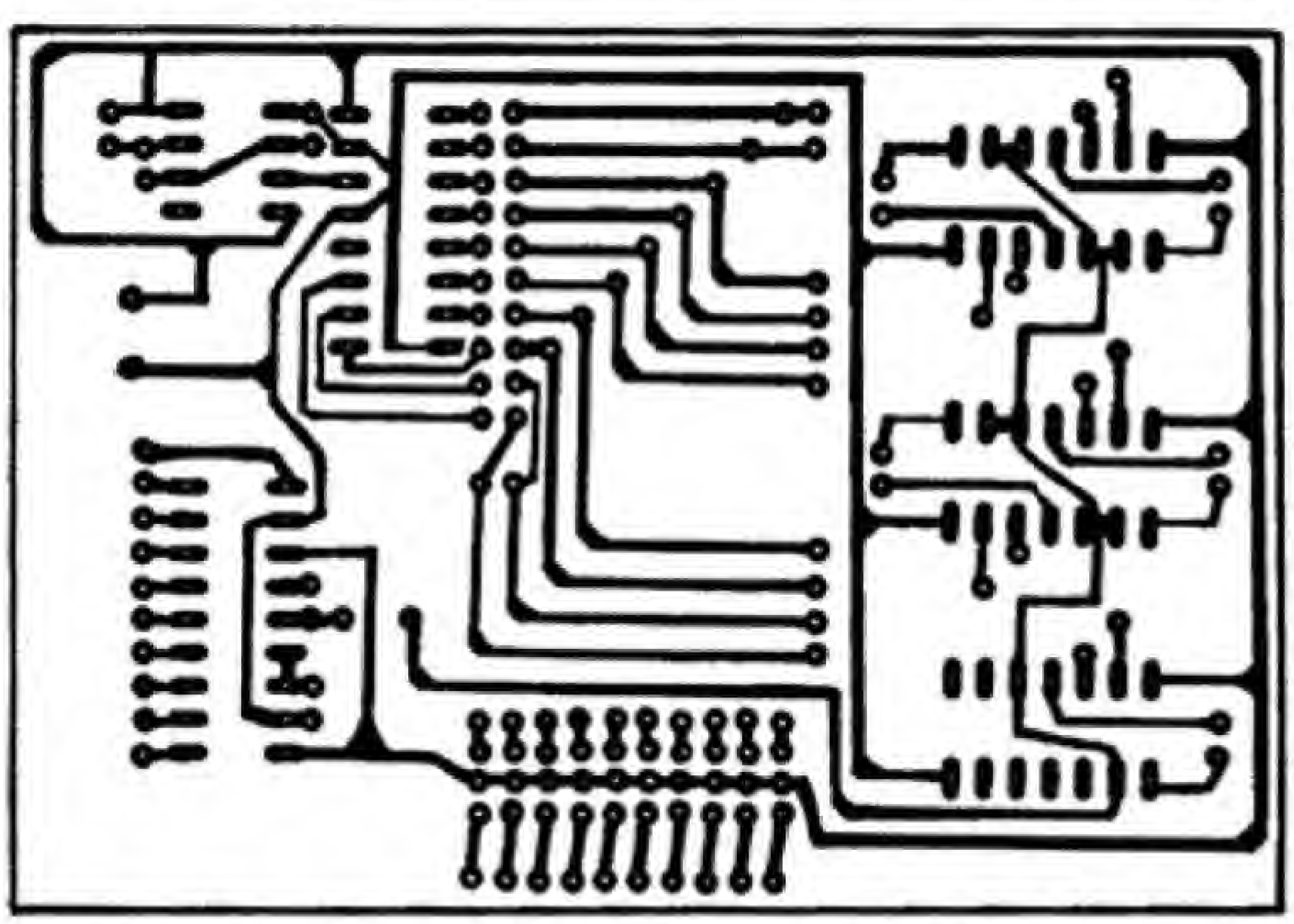


Fig. 4: Actual-size PCB layout for the spectacular analyser.

The LM3914 has an extra feature. In an actual op-amp chain, the first op-amp stays active when the second one is lit. But in the LM3914, there is a pin called mode selector. Putting this pin high (connected to positive) you select the bar mode and get a display as in an actual op-amp chain. But if you ground this pin, you select the dot mode where the previous op-amp goes inactive when the next one is lit. So in dot mode, there is only one output active at a time. We'll use the bar mode in our circuit. You can try the dot mode too, but I think you won't take it.

As shown in the circuit diagram, the ten outputs of the LM3914 are the row drive outputs. The input signal goes to the input pin after being filtered by a capacitor and a resistor. And another resistor is used which determines the LED brightness.

The column drive has a timer, a counter and some switches. Let's start with the timer which gives out electronic pulses.

The capacitor between pins 1 and 2 of the 555 determines its pulse rate and the two resistors at pins 6, 7 and 8 determine the proportion of the time the output remains high and the time it remains low.

Counter IC 4017 counts the number of square wave pulses passing through its input. The 4017 has ten outputs. Before any pulse comes, its first output stays high. When the first pulse passes by, the second output goes high. Thus when the nineth pulse passes by, the tenth output goes high. And when the tenth pulse passes, the counter returns to its first output and restarts the process.

In a 4017, only one output stays high at a time. Therefore it is called a mutually exclusive output counter. Besides, its outputs are active high.

The outputs are used to put some switches on and off. Here, we are using two kinds of switches—analogue and SCRs (silicon controlled rectifiers). Both of them have a pin called gate. The

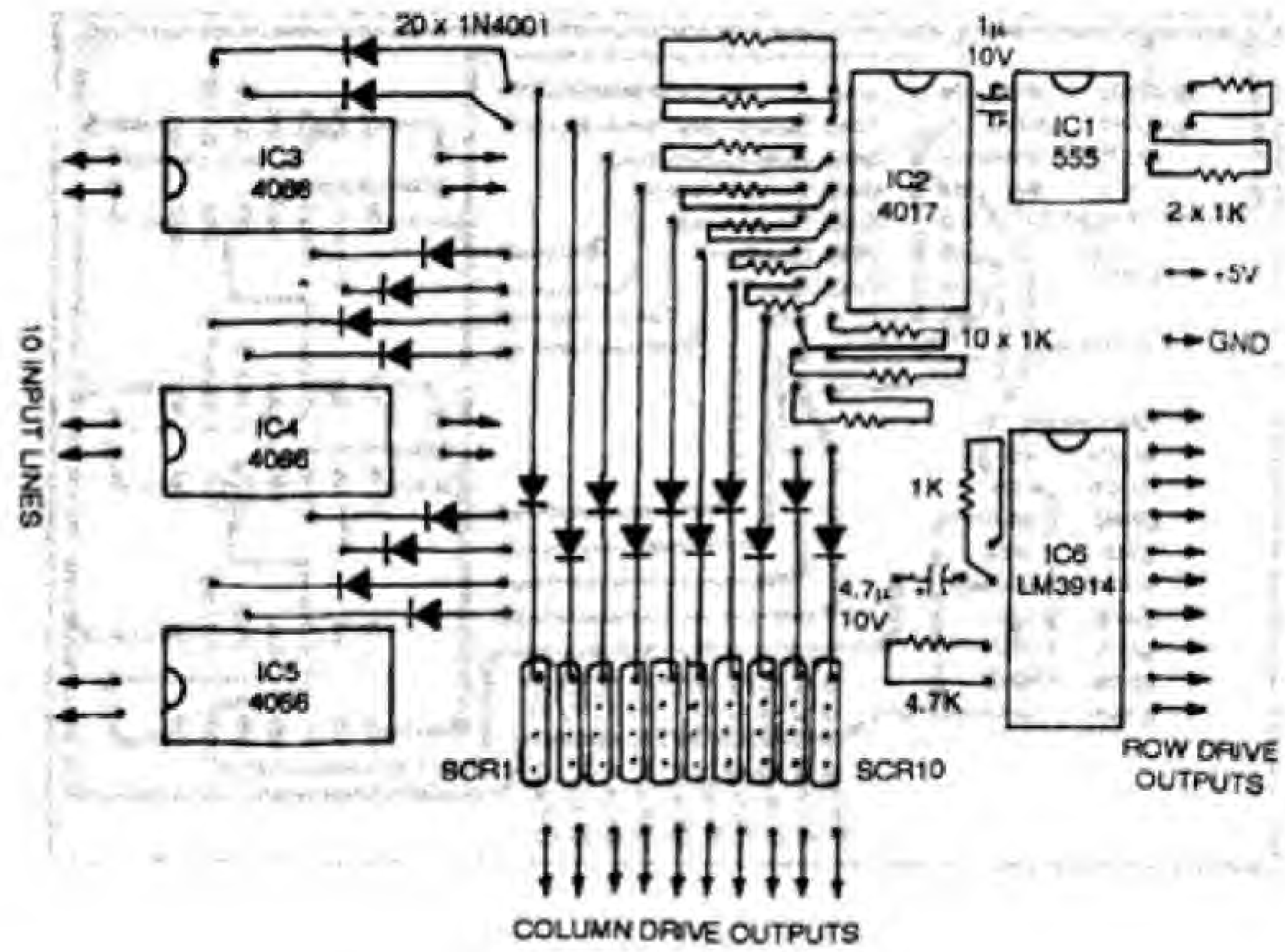


Fig. 5: Components layout for the PCB shown in Fig. 4.

switches are put on when the gate voltage goes high. The analogue switches are like mechanical switches, but the SCRs actually are rectifiers that are enabled to pass current only when the gate voltage is high.

We'll use 10 SCRs (D400) and 10 analogue switches. The analogue switches come in IC packages, such as IC 4066. Each of these ICs has four switches. The gates of the ten SCRs and the ten analogue switches are connected to the ten outputs of the 4017. Here ten resistors of 1k and ten rectifiers are used for safety.

The positive ends of the rectifiers (in the SCRs) are connected to the 5-volt power supply and the ten negative ends are taken as the ten columns drive outputs. So when the outputs of the 4017 go high, the gate voltage of the SCRs go high and the SCRs are enabled. So positive current can pass through the rectifiers and go to the

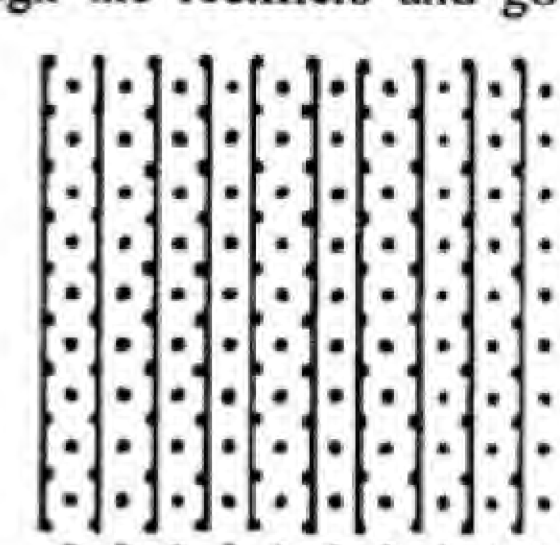


Fig. 6: Actual-size PCB layout for the LED matrix.

columns. This is necessary as the currents obtained from the outputs of the 4017 are insufficient for so many LEDs.

Now each of the ten analogue switches has two points. One of the points of each switch is shorted together and goes to the LM3914 input. Then remain the ten other points for the ten analogue switches. These points get the input signal from the graphic equaliser. A band equaliser gives us ten outputs (five from the right channel and five from the left channel). The outputs are to be taken from the output of the op-amps (741, TL084, LM338 etc) if the equaliser is made using op-amps. But if that is not the case, and you have only two channels (for stereo input), you can still divide them by a simple capacitor network.

Now its about time we got the simple algorithm of this complex circuit. The timer 555 is set such that it oscillates at a rate of more than 100 Hz (more than hundred pulses per second). Its output is fed to counter 4017 and after every ten pulses its outputs are repeated. When no pulse has passed, the first output is high. Then after 10 pulses it goes high again. Thus the first output is repeated after every 10 pulses. This is true for all the outputs. So the outputs will go high at a rate of more than 100/10, i.e. ten times a second.

Now, when the first output of the 4017 is high, the first SCR is put on and the first column gets positive current. So the analysis of the LM3914 is shown in the first column. That is because all of the columns are getting negative from the 4017, but only the first one gets positive from the SCR. At this time the first analogue switch is on and hence the LM3914 gets input from the first input source. So the analysis of the first source is shown in the first column. When the second output goes high, the second column is enabled, the second analogue switch is on and the LM3914 gets input from the second source. So the analysis of the second source is shown in the second column. This continues up to column ten and then the whole procedure is repeated.

So the circuit is doing an analysis of the ten input sources one by one, and is displaying the analysis at the ten corresponding columns one by one. But the rate of doing this is so high that it appears to us that the analysis of the ten sources is being done and displayed simultaneously.

The circuit diagram and the PCB layout are sufficient for assembling the spectacular spectra display. After assembling it, replace the 1µF capacitor at pins 1 and 2 of the IC 555 with a 47µF capacitor. I am sure you'll get the idea once you assemble the circuit and try it. Happy assembling and viewing! ❑

PARTS LIST

Semiconductos:		
IC1	—	NE555 timer
IC2	—	CD4017 counter
IC3-IC5	—	CD4066 analogue switch
IC6	—	LM 3914 spectrum analyser
IC7	—	7805, a 5V regulator
D1-D22	—	1N4001 rectifier diode
SCR1-SCR10	—	D400 SCR
Resistors (all 1/4 W, ±5% carbon, unless stated otherwise):		
R1-R12, R14	—	1-kilohm
R13	—	4.7-kilohm
Capacitors:		
C1	—	3300µF, 25V electrolytic
C2	—	1µF, 12V, electrolytic
C3	—	4.7µF, 10V electrolytic
Miscellaneous:		
LED1 To LED100	—	10 x 10 LED matrix

Readers' Comments:

With reference to the fascinating Spectra Analyser project published in EFY May '92 issue, I would like to make a few enquiries:

Can SCRs D401 be used in place of the ten D400 SCRs used in the circuit?

The cost of the circuit has increased considerably due to the SCRs. As these have been used as switches in the ciruit, can analogue switches like CD4066 be employed here? Or can transistors in switching mode be used here?

KULKARNI RAMESH D.
Pune

❑ I have found the circuit good but I see no use of diodes D1 through D20. Since the output of CD4017 remains high only, there is no need of safety.

UMESH MEHRA
Kota

The author, Mr Uttiya Chowdhury, replies:

Other SCRs (D401 etc) and transistors in switching mode (SL100, C1383 etc) can be used instead of D400 SCRs. Analogue switches like CD4066, however, can't be used as their maximum current capacity is small.

Diodes D1-D10 can be done without, but if the SCRs go bad and connect positive supply to the output of 4017, the IC may get damaged.

Clap-Operated Remote Control for Fans

Narpat Singh Rana

You should find this clap-operated remote control system quite useful in summers as it would enable you to control the speed of your fan or cooler, besides switching it on or off. Normally, a fan has three to five speeds but this remote control can control up to ten-step speed control fan. Besides, it provides visual indication of the speed of the fan.

This circuit may be considered in four parts: sound-operated trigger pulse generator, clock pulse generator, clock pulse counter and load operator, as shown in the block diagram (Fig. 1).

The trigger pulse generator is built around transistor BC148 which amplifies the audio signals in class-C mode. The clock pulse generator stage is based on NE555 IC while the clock pulse counter is based on the popular decade counter IC CD4017BE. The load operator stage is constructed in two ways. One method mentiond here is to use three BEL187 (or AC187) transistors, so that they could operate three separate relays. The other method, which excludes the relays and transistors, uses three triacs which have long life but include greater danger of electric shock.

The condenser microphone converts

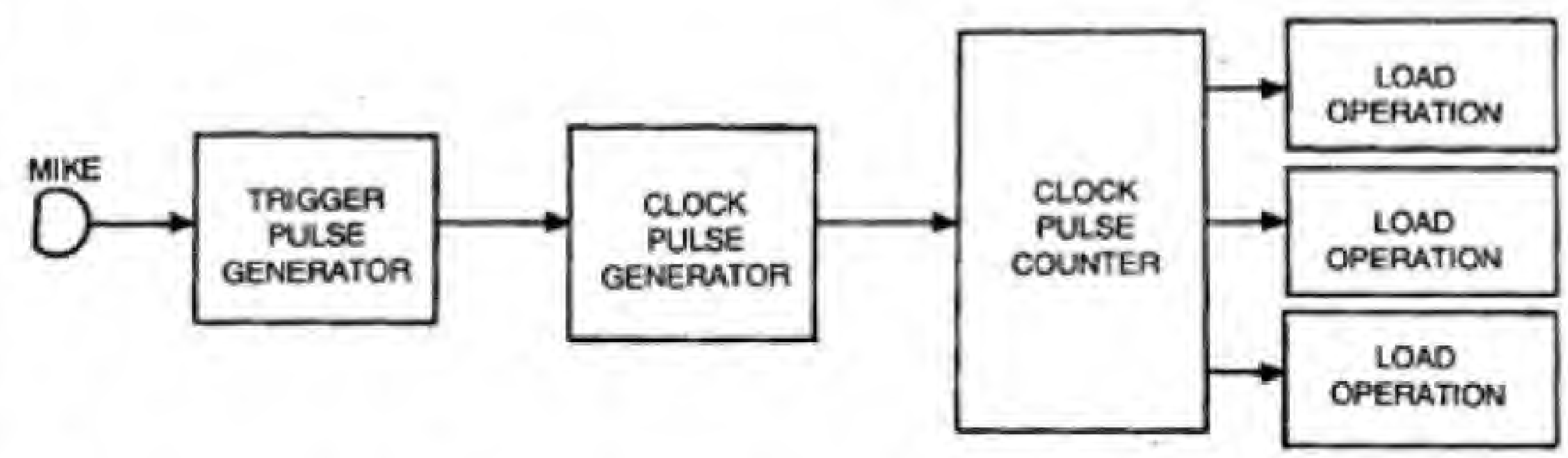


Fig. 1: Schematic block diagram for clap-operated remote control fan.

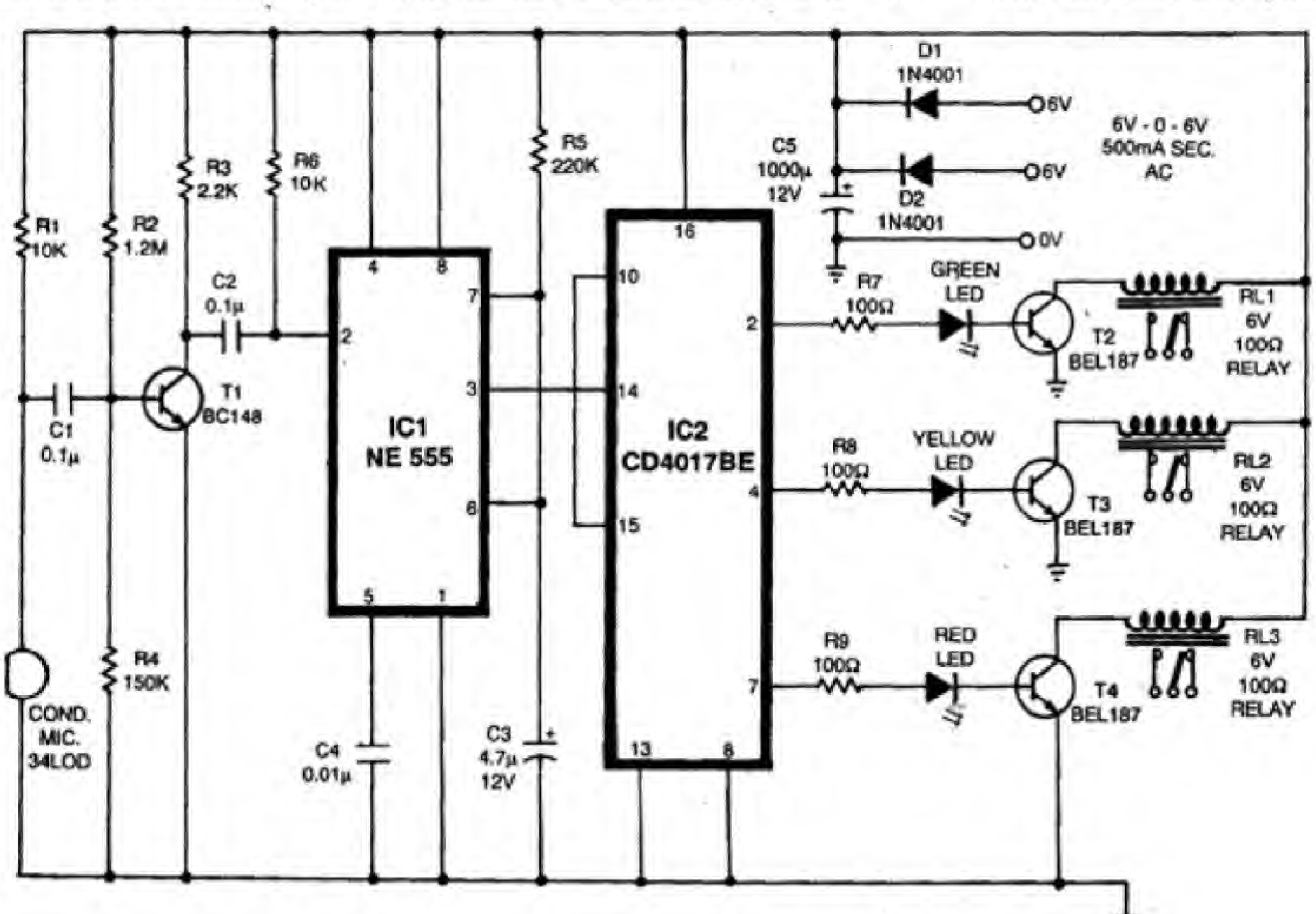


Fig. 2: Circuit diagram for the clap-operated remote control fan.

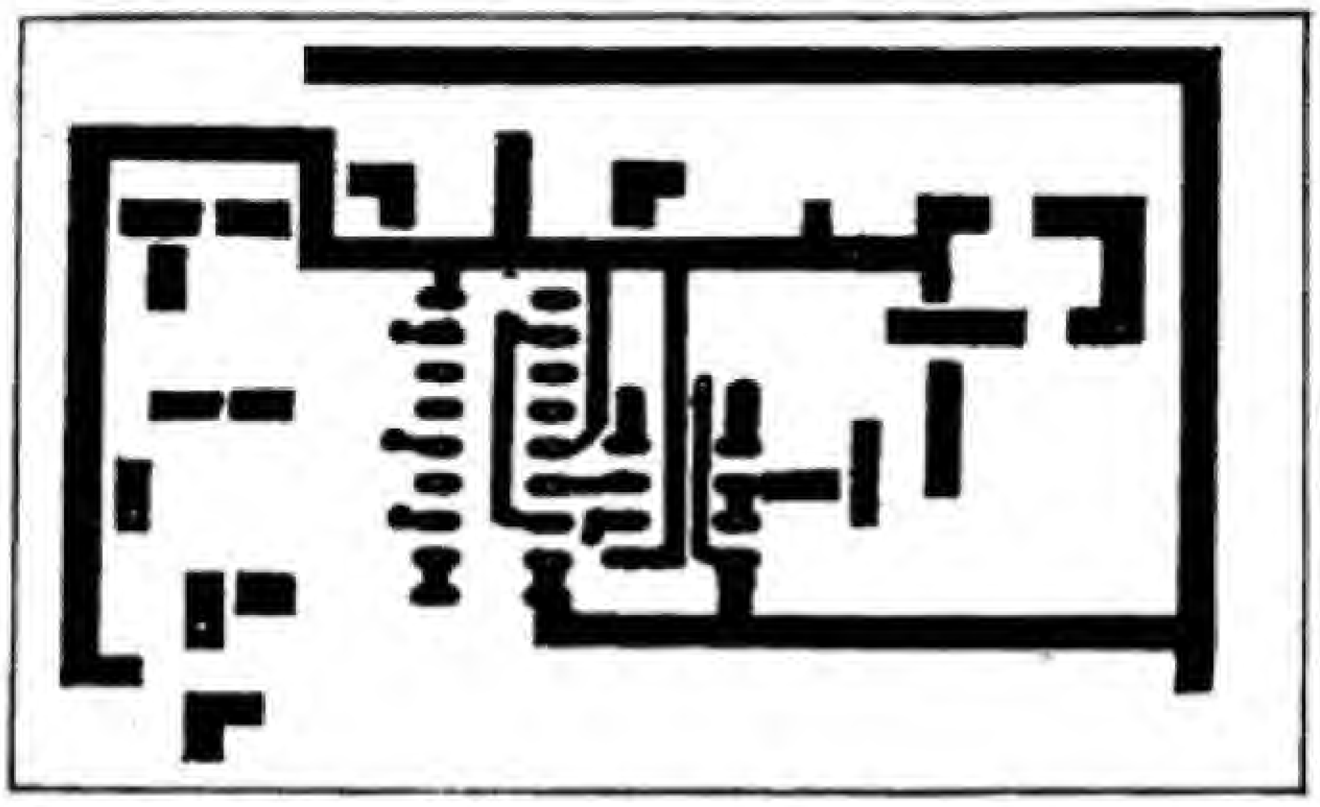


Fig. 3: PCB layout for the circuit shown in Fig. 2.

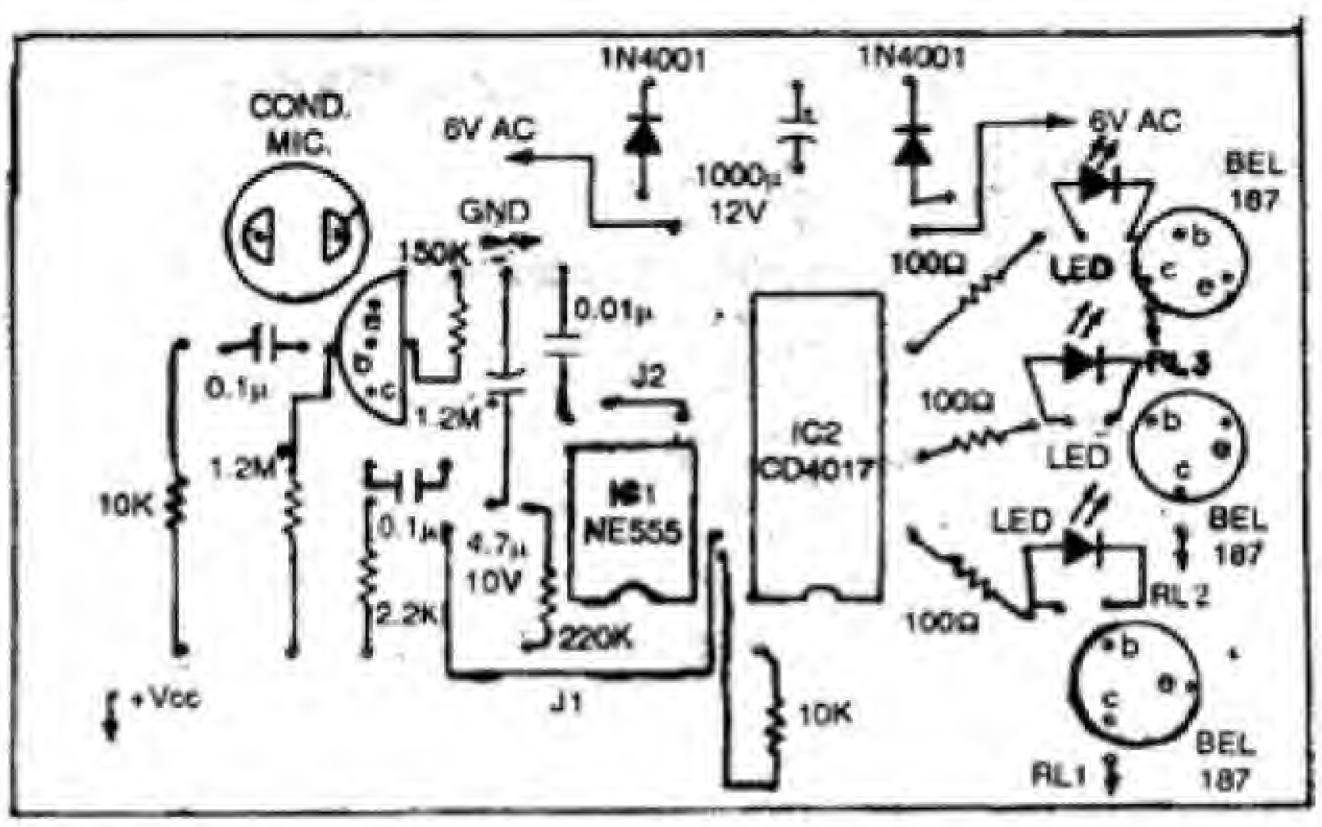


Fig. 4: Components layout for the PCB shown in Fig. 3.

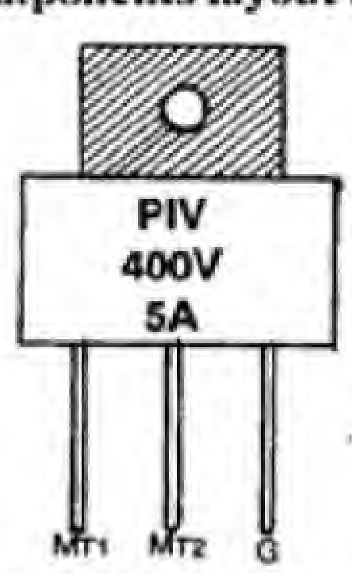


Fig. 5: Pin configuration of triac.

the sound of a clap into an electric signal and supplies it to the base of transistor BC148. The transistor provides a trigger pulse to pin 2 of monostable multivibrator IC NE555 timer. The duration for which the output of monostable multivibrator remains high is given by the relationship

T = 1.1R*C*.

In this circuit, the values of R* and C* are so chosen that the clock pulse duration is approximately one second, so that no more than one clap within one second can change the gear (and thus speed) of the fan.

The clock pulse is then applied to pin 14 of decade counter IC CD4017 which counts the clock pulses. This IC has ten outputs, viz, 0, 1, 2....9. The output number 0 (at pin 3) is high without any clock pulse applied to the IC. So we have used only output 1 at pin 2, output 2 at pin 4 and output 3 at pin 7, while output 4 at pin 10 is connected to reset pin 15.

Though all the ten outputs can be used to control ten separate relays or triacs, normally only three relays or triacs are sufficient for this job. The first relay or the first triac is to control the first gear while the second relay or the second triac is used to control the second gear, and the last relay or triac is used to control the third gear.

A 100-ohm resistance is used in series with each LED. Green LED indicates the first gear, while the yellow indicates second, and the red LED indicates the third gear. The fan is switched off on the fourth clap.

The circuit can be assembled on a general-purpose circuit board. IC sockets should be used to protect the ICs from the soldering iron's heat. Besides, the ICs can be replaced very easily if these are mounted on their IC sockets.

There is only one jumper used in the PCB of this circuit, which is from the collector of transistor BC148 via a 0.1µF capacitor to pin 2 of IC 555. ❑

PARTS LIST

Semiconductors:	
IC1	— NE555 timer
IC2	— CD4017BE decade counter
T1	— BC148 npn transistor
T2-T4	— BEL187 npn transistor
D1, D2	— 1N4001 silicon diode
Resistors (all 1/4W, ±5% carbon unless stated otherwise):	
R1	— 10k
R2	— 1.2M
R3	— 2.2k
R4	— 150k
R5	— 220k
R6	— 10k
R7-R9	— 100-ohm
Capacitors:	
C1, C2	— 0.1µF, 16V electrolytic
C3	— 4.7µF, 16V electrolytic
C4	— 0.01µF ceramic disc
C5	— 1000µF, 12V electrolytic
Miscellaneous:	
	— Condenser microphone 34LOD
	— Red LED
	— Green LED
	— Yellow LED
	— 6V-0-6V, 500mA transformer

Assembly with Triacs

There are only a few things to be kept in mind for making the remote control using triacs instead of transistors and relays.

1. Exactly at the same place where relay driving transistor BEL187s are, we have to mount the triacs. The gate G of the triac will be at the point of transistor's base, MT2 will be at collector point, while MT1 will be at ground. 2. Diodes 1N4001 and 1000µF, 12V capacitor is removed.

Rest of the circuit remains the same.

Readers' Comments:

The Clap Operated Remote Control for Fans in EFY May'92 issue is no doubt an excellent article, but it has not been fully explained. For instance, there are two jumpers (J1 and J2) in the circuit whereas in the last paragraph of the article only one is mentioned.

Besides, the article does not indicate how the input of fan is to be connected.

SAROSH MINOO DALAL
Bombay

❑ *I have a few querries:*

1. For assembly with triacs, how should the power be given to the circuit when it is transformerless?

2. Aren't current coils required in series with the triacs?

3. Is it advisable to use IC 4022 instead of 4017?

4. Is it possible to use an infra-red transmitter and a receiver instead of condenser microphone?

V.NARAYANAN
Akola

❑ As I wish to operate a relay by illuminating a torch using two cells, I have selected the second portion of the circuit (IC2 onward) and used an IC 555 circuit for triggering. But the operating range obtained is too low, which I wish to increase to about 10 metres.

SANTANU SAMANTA
Bankura (W.B.)

The author, Mr Narpat Singh Rana, replies:

Some confusion appears to have been created by excessive editing of my article. I'm therefore giving below the missing information.

The circuit may be powered after carefully assembling it. Green LED should glow on clapping once near the condenser microphone. On clapping again, yellow LED should glow and

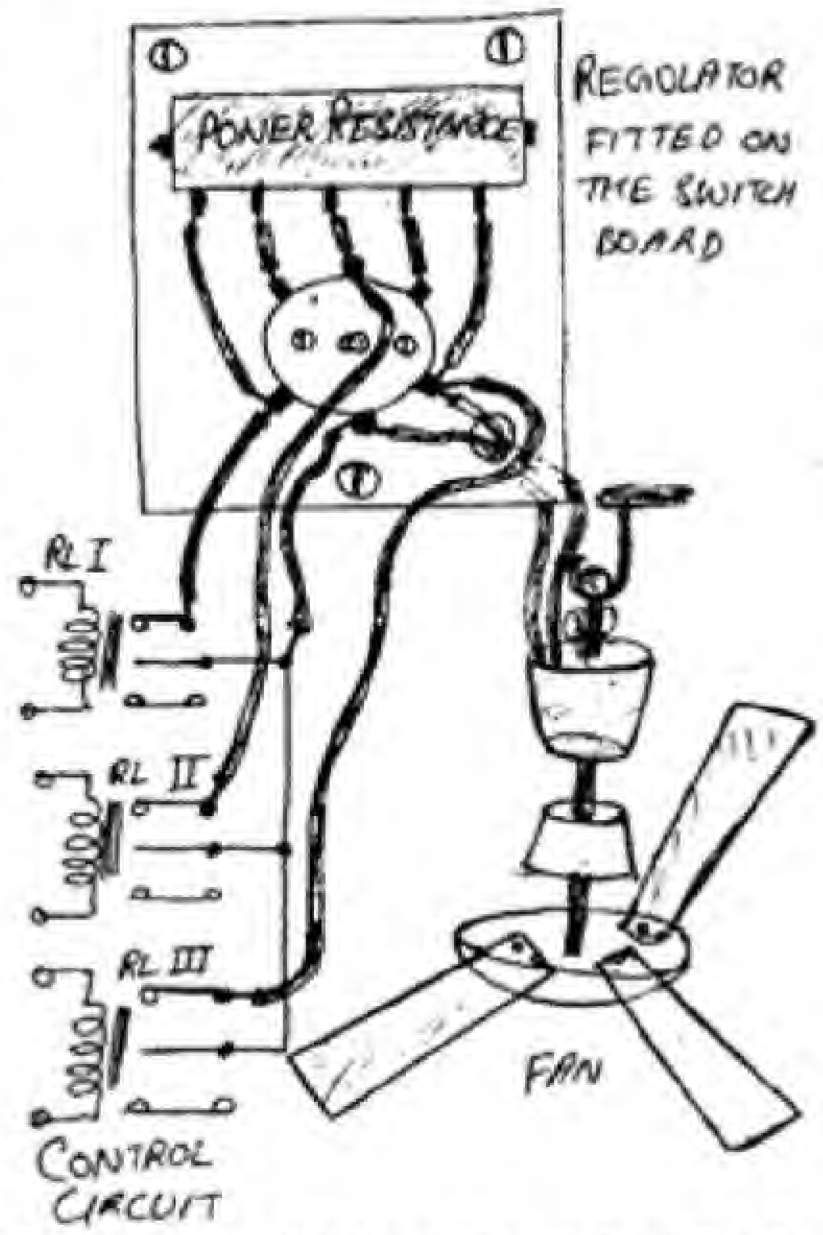


Fig. 1: Connecting the assembly to ceiling fan.

the second relay energise. On third clap, red LED should glow and the third relay energise. On fourth clap, the controlling circuit is reset.

The whole prototype, along with the relays, should be assembled in a transparent case so that the indicating LEDs are visible. The assembly should be fitted near the fan's switchboard.

The diagram given above shows how to connect the assembly to the ceiling fan.

In triac assembly, power to the transformerless circuit should be given using a circuit such as the one shown below.

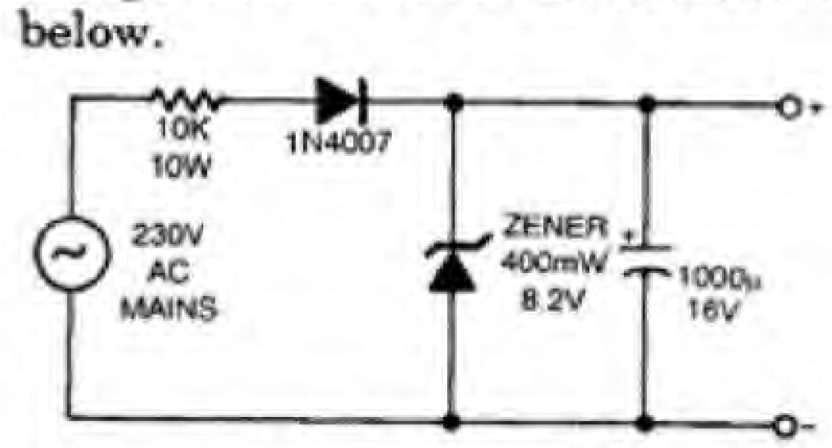


Fig. 2: Power supply for triac circuit.

It should be kept in mind that the lower terminal of the power supply is common, and so the circuit should not be touched when working, from the safety point of view.

There is no need of using current coils in series with triacs. But all the triacs should be mounted with proper heatsinks, if necessary.

It is not advisable to use CD4022 instead of CD4017 beacuse much more gear system could be used with CD4017, if necessary.

It is possible to use infra-red transmitter and receiver, but it is beyond the scope of this article.

To control just one relay with torchlight, only pins 15 and 4 of IC CD4017 should be used. To increase the range, 100k preset should be removed.

8W+8W Stereo Amplifier Module

Amrit Bir Tiwana

An endless variety of stereo amplifiers are available in the market. But the prices of good quality amplifiers, equipped with graphic equalisers etc, are not within the reach of all audio enthusiasts. The cheaper varieties are generally based on discrete transistors, and suffer from drawbacks such as uncontrolled hum, ineffective tone

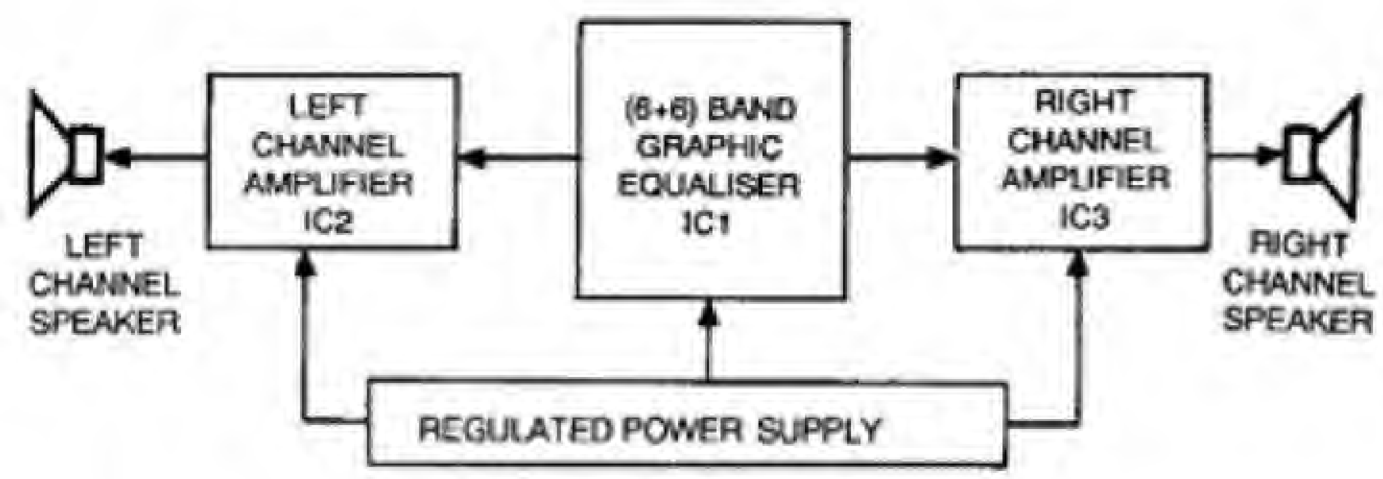


Fig. 1: Block diagram.

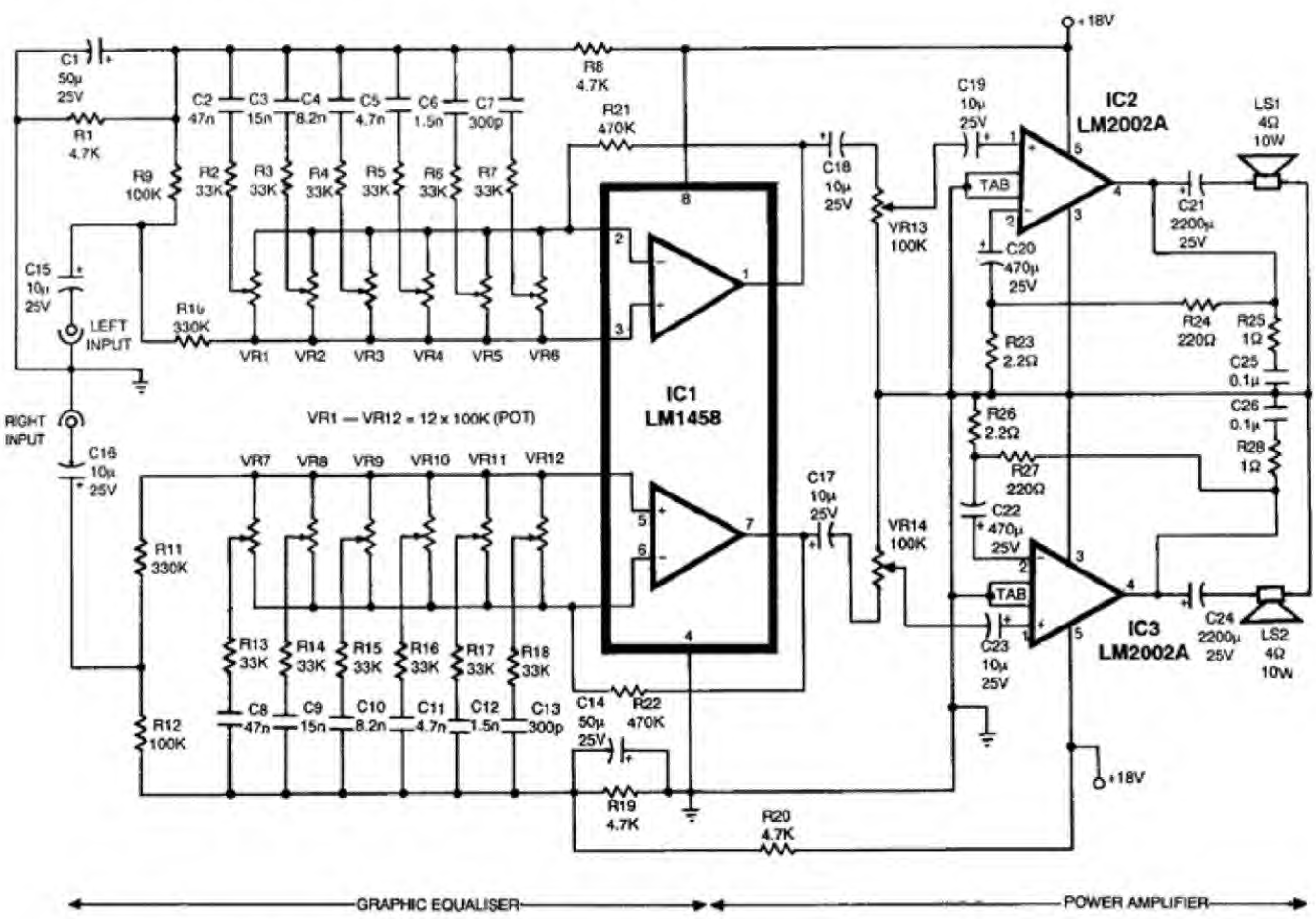


Fig. 2: Circuit diagram for 8W+8W stereo amplifier module.

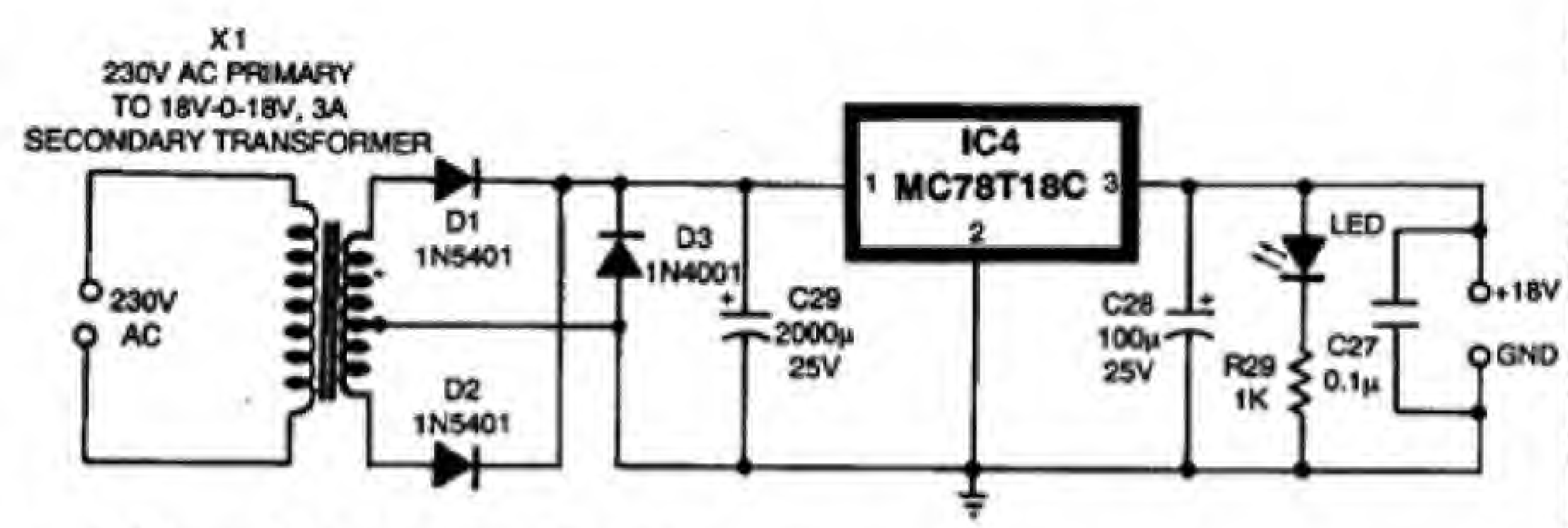


Fig. 3: Circuit for the power supply.

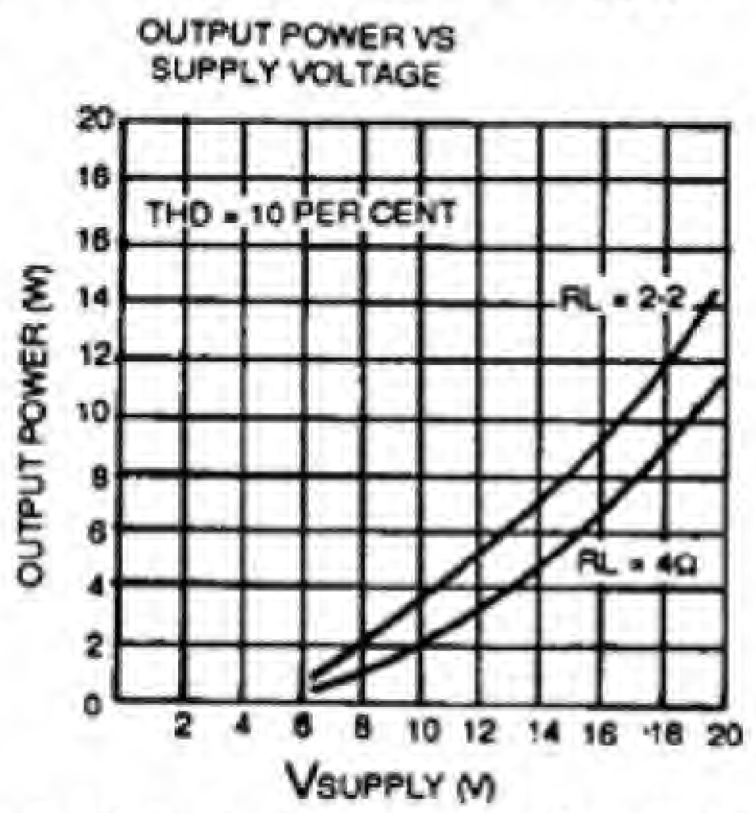


Fig. 4: Output power vs supply voltage.

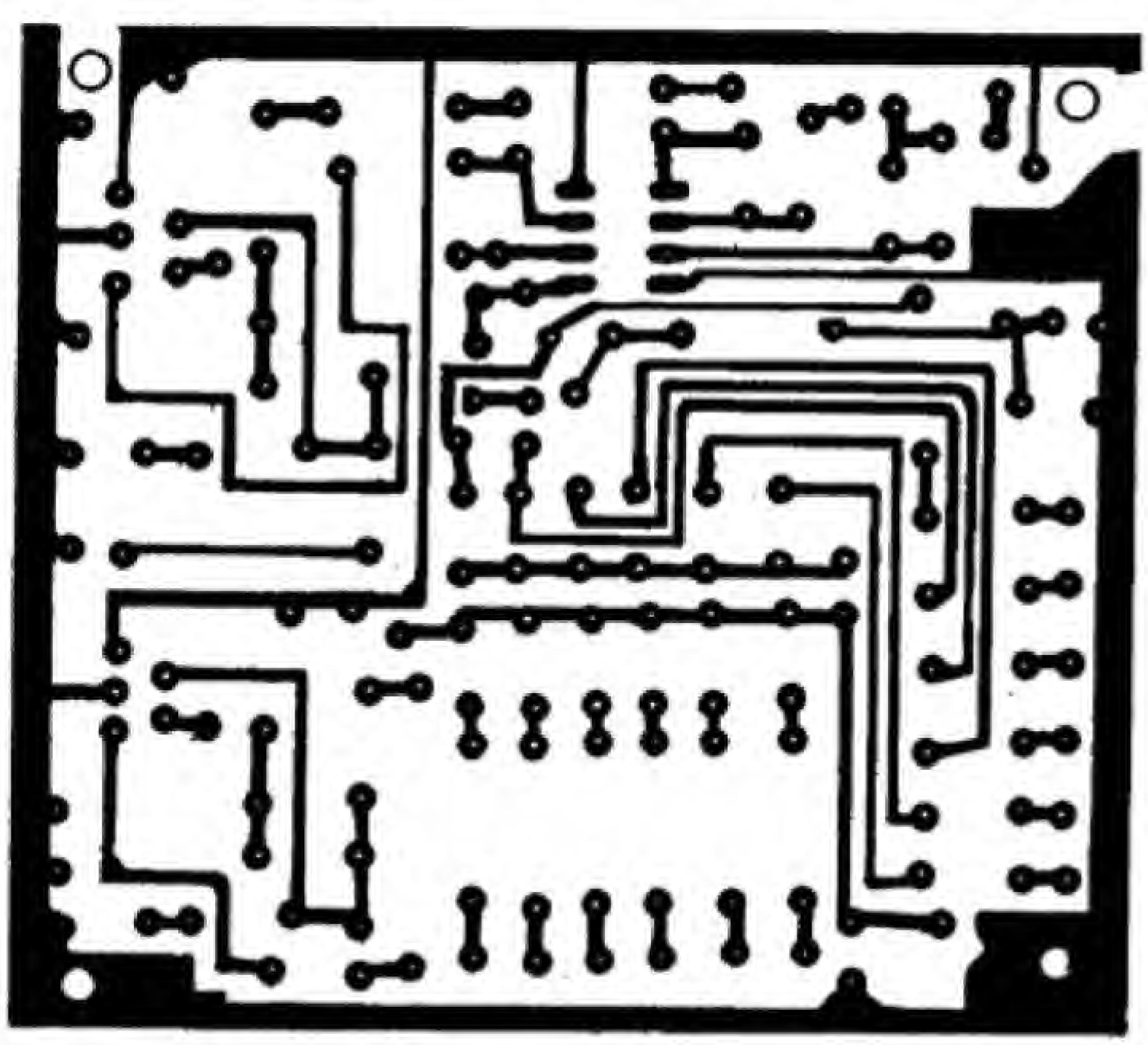


Fig. 5: Actual-size PCB layout for the circuit shown in Fig. 2.

controls, poor bass response, thermal runaway etc. The use of interstage transformers in such circuits reduces their versatility.

This article describes the funtional and constructional details of a compact and complete solidstate stereo amplifier module, which is capable of providing an output of over 8 watts into each channel. The module contains an inbuilt 6-band graphic equaliser, which can be used to control and blend frequencies and tones over a wide range, thus ensuring perfect sound reproduction.

The module can be used as an AF output stage of a record player, cassette player or just as an independent stereo amplifier itself. The system offers a high degree of flexibility as it can operate in environmental temperatures between 0° and 70°C, and operate off voltages in the 5-20V range. The system is internally protected against input and output shortcircuiting. The module can automatically protect itself on being accidentally connected to a high voltage supply line (up to 40V). The noise and distortion level is extremely low and no turn-on transients occur.

The main feature of the module is its low cost (which is less than that of a commercially available graphic equaliser kit itself!). The complete circuit costs just around Rs 200.

Working

The block diagram of the complete amplifier module is given in Fig. 1. The circuit of the complete module is given in Fig. 2. Each channel consists of an independent 6-band graphic equaliser, power amplifier and a common power supply.

The graphic equaliser is built around a dual op-amp LM1458. The gain of the op-amp at various frequencies is determined by the setting of the corresponding pot. The audio frequency spectrum is covered in six different bands of tone control. The frequency control pots and the corresponding frequencies controlled by them are listed in Table I. VR13 and VR14 serve as volume controls for the left and right channels respectively.

As the circuit provides excellent control over the freqeuncies, use of the conventional graphic equaliser which requires at least a dozen op-amps was deemed unnecessary.

The power amplifier section is built around two low-cost, monolithic power amplifier ICs LM2002A. The ICs are current limited and thermally protected. The input is fed to the non-inverting input pin 1 through the 10μF coupling capacitor. The output is coupled to the speaker through the 2200μF capacitor. The 1-ohm resistor and the 0.1μF capacitor, serially connected across the output terminal (pin4) and ground, help in noise reduction. At a supply voltage of 20 volts, each amplifier IC provides an output exceeding 9 watts into a load of 4 ohms, and about 1 watt at a supply voltage of 5 volts. The output power at different voltages may be calculated from the manufacturers' graph given in Fig. 4.

Power supply

It is preferable to operate the module at its upper voltage limits to obtain the maximum output power. The circuit can operate off voltages between 5 and 20 volts. The power supply circuit for the amplifier module is given in Fig

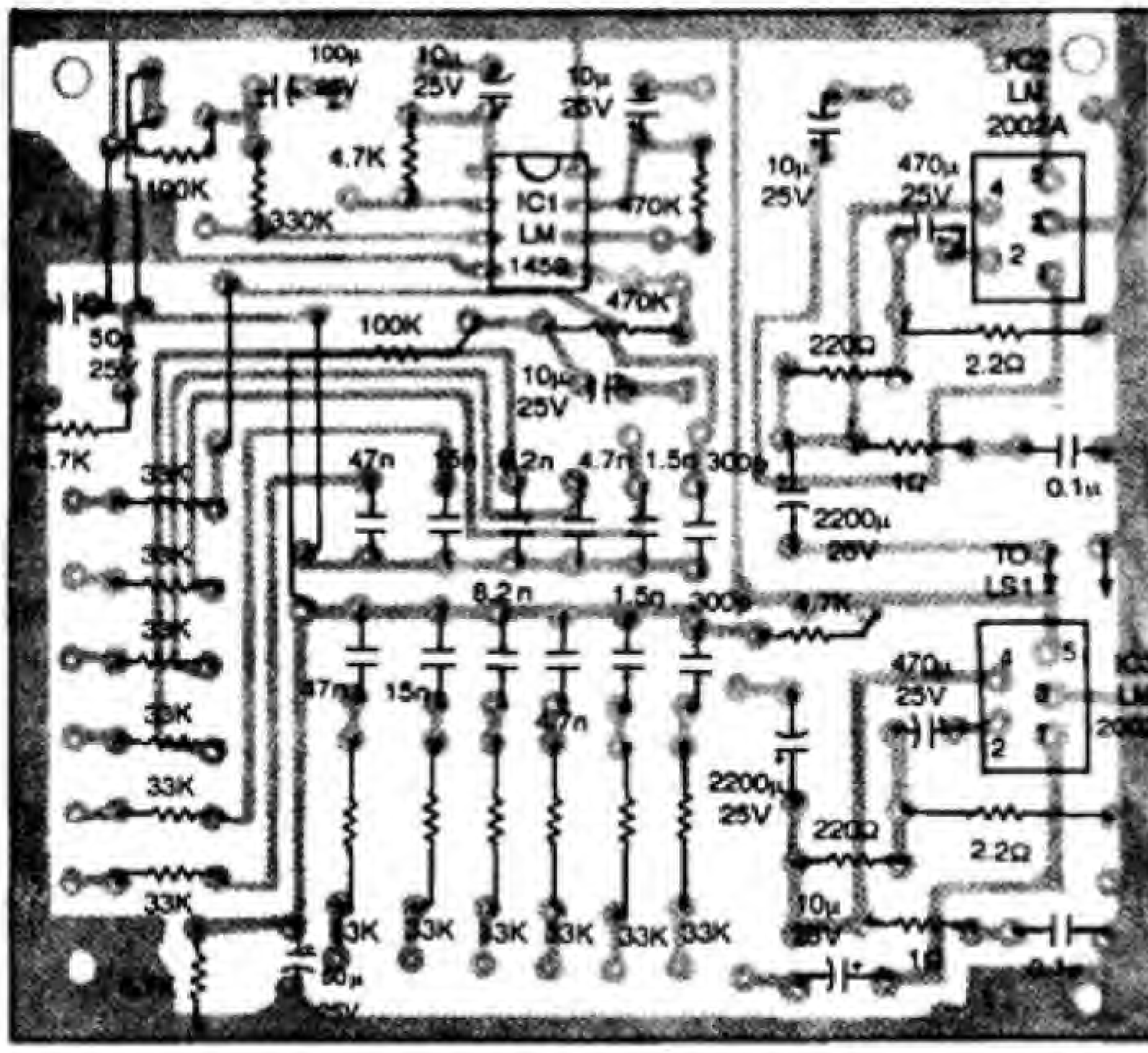


Fig. 6: Components layout for the PCB shown in Fig. 5.

3. The circuit is capable of providing an output of 18 volts with an accuracy of about±0.25 per cent. X1, D1, D2 and C29 drop the mains voltage to about 24 volts, which is then stabilised at 18 volts by IC4. The LED indicates the presence of output voltage.

Construction

The complete circuit may be assembled on a single PCB, pattern of which is given in Fig. 5, and the components should be mounted as shown in Fig. 6. Pin connections of all ICs and transistors are given in Fig. 7.

Tip temperature of the iron should not exceed 275°C under any condition. Shielded cable should be used for all input and output connections and colour coded ribbon cable should be used for connecting the pots. Proper heatsinks should be selected with the help of the manufacturers data shown in the graphs in Figs 8(a) and 8(b). The common heatsink should be bolted to the PCB at an angle of 90°.

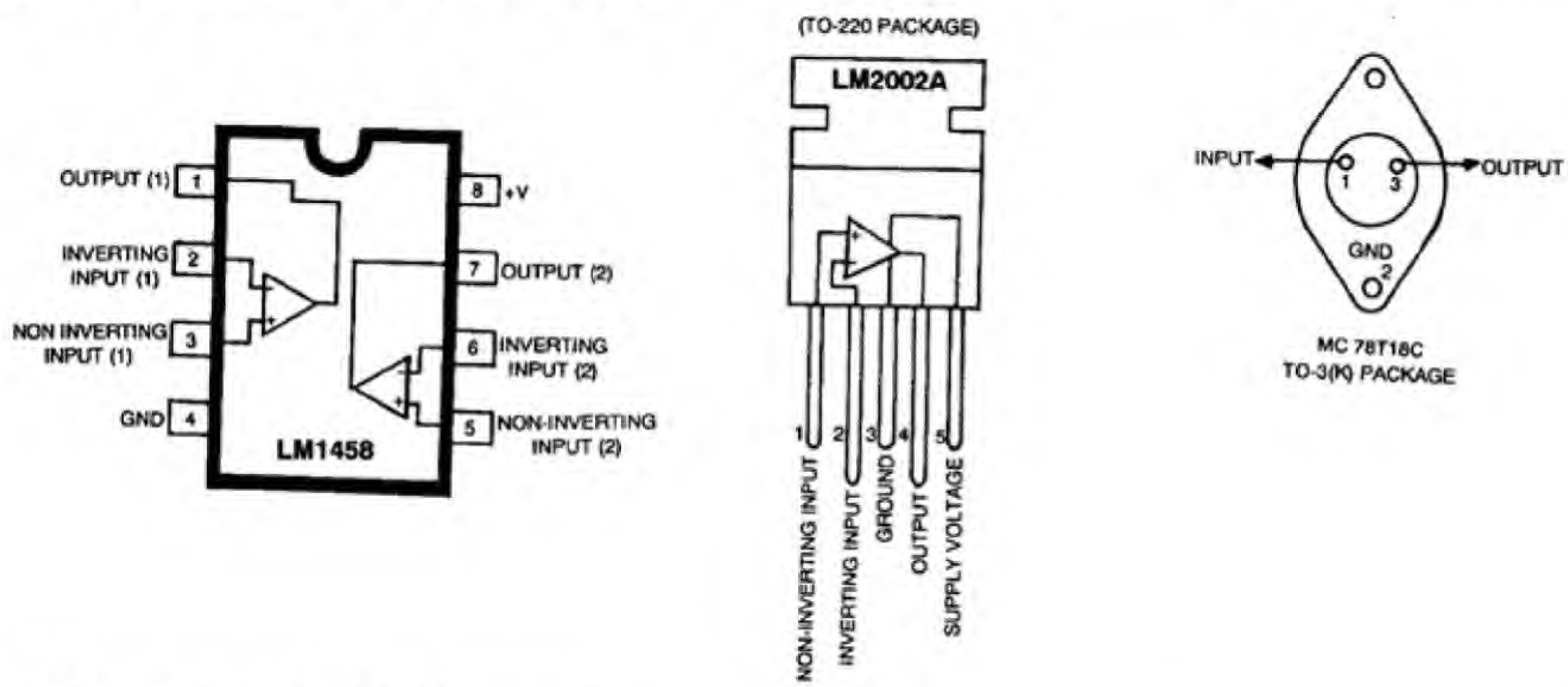


Fig. 7: Pin configurations of ICs and transistors.

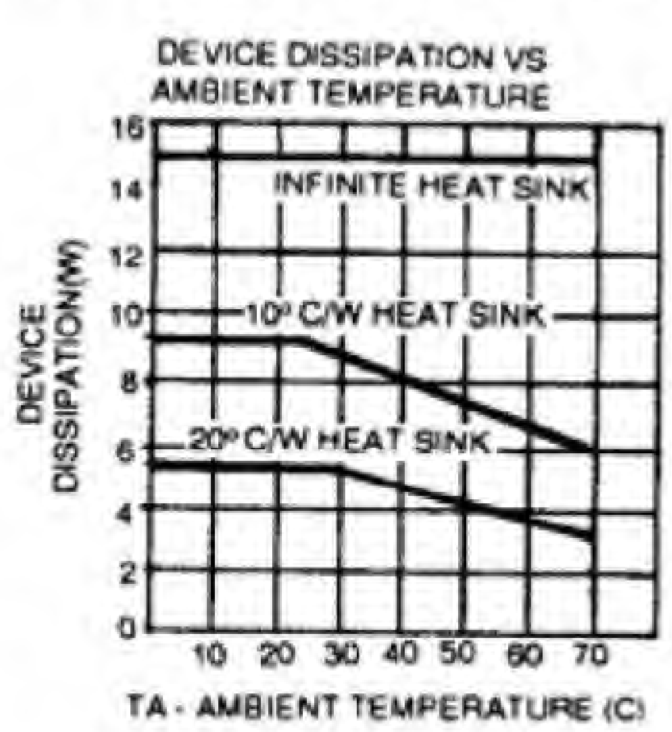


Fig. 8(a): Device dissipation vs ambient temperature.

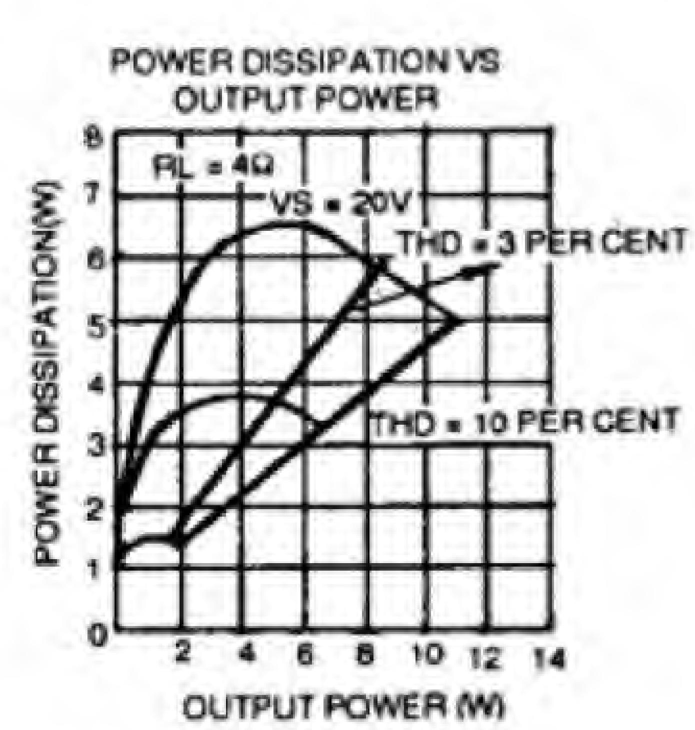


Fig. 8(b): Power dissipation vs output power.

If the module is used as an independent amplifier, it may be enclosed in a matallic cabinet. The cabinet itself may be used as a heatsink in this case.

Testing

After construction, the module should be tested for proper operation. The module should be switched on and an audio signal fed in, with the volume

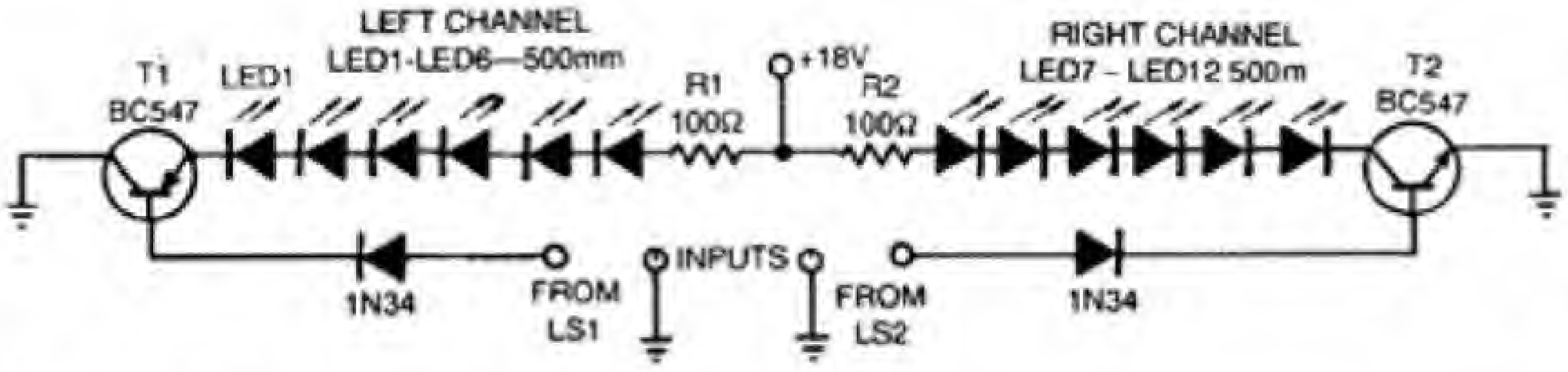


Fig. 9: Circuit diagram for LED dancing array (optional).

PARTS LIST

Semiconductors:

IC1	—	LM1458
IC2, IC3	—	LM2002A
IC4	—	MC78T18C
D1, D2	—	1N5401
D3	—	1N4001

Resistors (all 1/4W, ±5% carbon unless stated otherwise):

R1, R8, R19, R20	—	4.7-kilohm
R2-R7	—	33-kilohm
R9, R12	—	100-kilohm
R10, R11	—	330-kilohm
R13-R18	—	33-kilohm
R21, R22	—	470-kilohm
R23, R26	—	2.2-ohm
R24, R27	—	220-ohm
R25, R28	—	1-ohm
R29	—	1-kilohm
VR1-VR14	—	100-kilohm potentiometer

Capacitors:

C1, C14	—	50μF, 25V electrolytic
C2, C8	—	47nF ceramic
C3, C9	—	15nF ceramic
C4, C10	—	8.2nF ceramic
C5, C11	—	4.7nF ceramic
C6, C12	—	1.5nF ceramic
C7, C13	—	300pF ceramic
C15-C19, C23	—	10μF, 25V electrolytic
C20, C22	—	470μF, 25V electorlytic
C21, C24	—	2200μF, 25V electrolytic
C25-C27	—	0.1μF ceramic disc
C28	—	100μF, 25V electrolytic
C29	—	2000μF, 25V electrolytic

Miscellaneous:

— Two 4Ω, 10W speakers
— 18V-0-18V, 3-amp sec. transformer
— LEDs

controls at 'maximum' position. Let it remain on for about 10 minutes and then check whether the tab temperature remains below 40°C. If not, check for improper contact within the heatsink, and apply some heatsink compound if necessary.

TABLE I

Control Frequency	Control Potentiometer	
	Left Channel	Right Channel
100Hz	VR1	VR7
300Hz	VR2	VR8
600Hz	VR3	VR9
1kHz	VR4	VR10
3kHz	VR5	VR11
16kHz	VR6	VR12
Volume	VR13	VR14

Now, feed in an audio signal from a tape recorder and check the graphic equaliser for proper boost/cut in the corresponding frequencies. If proper response is not obtained, check for open wires. If hum persists, check for leaky capacitors, or defective rectifier diodes, in case the mains supply circuit is used.

Useful hints

1. The circuit may be used with the less commonly used 2-ohm speakers in order to obtain higher output volume.

2. The LED dancing arrays, the circuit of which is given in Fig 9, may be added to the main module. The LEDs flicker with a brightness level which is dependent upon the output power.

3. The quality of the speakers must not be compromised as the quality of the output mainly depends upon the speakers. The prototype used 15cm, 10-watt 'Philips' speakers.

4. Active or passive crossover systems may be used at the outputs; this would facilitate the use of different speakers for different frequency ranges.

5. The module may be used as a stereo cassette/record player, after feeding the input through a suitable pre-amplifier. ❑

I have assembled the circuit of '8W+8W Hi-Fi system with 6+6 Band Graphic Equaliser' published in EFY June '92 issue and it is giving a lot of problems as follows:

On increasing the volume a lot of noise is heard. Only at very low volume the circuit gives better results.

Secondly, in the circuit the common line is connected to VR13, VR14, LS1 and LS2. When I switch on the set a crackling sound is heard continuously and ICs get heated. Whereas on disconnecting the common line from LS1 and LS2, I am getting slightly better results at low volumes. Also, Graphic Equaliser part is not working very satisfactorily.

G.K. BISWAS
Calcutta

The author, Mr Amrit Bir Tiwana, replies:

The main problems are most probably due to long earth wire loops, high input signal voltage and probable use of non-shielded wires at input terminals. Since the design of the circuit was tested by me, EFY lab, and so many EFY readers, try to check the above facts and you will get good results.

Make Yourself Automatic Music Search System

T.S. Shankar

Automatic music search system, popularly called AMSS*, is nowadays incorporated in many commercially available cassette recorders. With AMSS one can skip the present music or go to the starting point of the presently played music by pressing 'Cue (FF)' or 'Rew' keys. This reduces repeated cueing and rewing of tape in order to reach the desired point of the tape.

AMSS does not require elaborate circuitry, but the mechanical modifications necessary in the cassette deck mechanism alienate an average electronics enthusiast. In this article, it will be shown that the mechanical modifications are not as complex as imagined and that the AMSS can be implemented in almost all tape decks commercially available today.

To include the AMSS feature in your cassette deck, however, the following requirements are to be met:

1. Your deck should have Cue and Rew facilities, which are seen in almost 60 per cent of deck mechanisms. If you are buying a new recorder, ensure that its deck mechanism has these facilities.

2. The deck should be soft touch control type. This is not absolutely important, but the pressure, or rather the force required to press a key to function during Cue or Rew should not be a 'hammer touch' one.

3. Your deck should be able to incorporate the additional components of this project, such as relay etc, without disturbing the normal operation of the deck.

The idea of AMSS is straightforward. Holding the FF (or Cue) key or Rew key while still playing the cassette and releasing the key only when a gap in music is noticed in the tape. That's all, and nothing more.

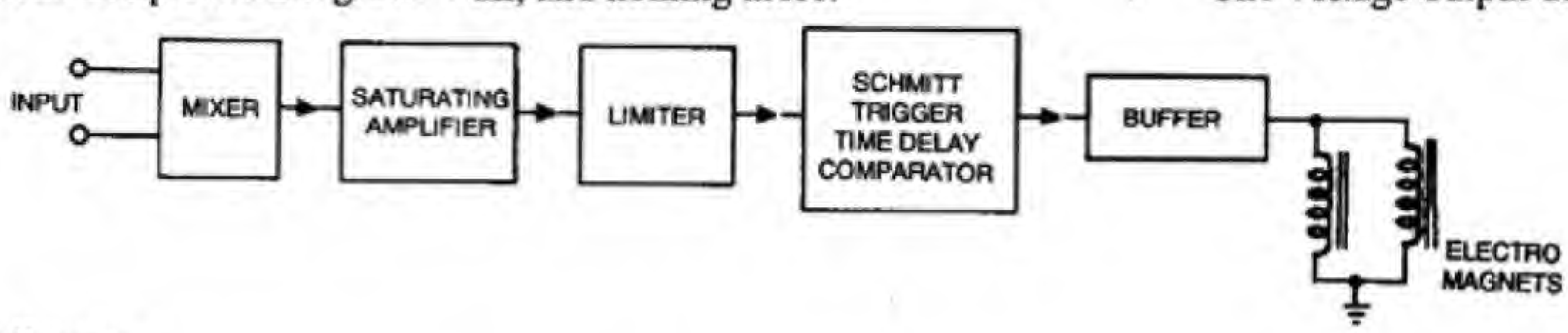


Fig. 1: Block diagram

The circuit

The block diagram is shown in Fig.1. The left and right channel signals are mixed to form a single signal in the mixer block. This signal is amplified by a voltage amplifier—the saturating amplifier. The amplifier's output is limited to a constant value by a limiter block and fed to a schmitt trigger cum time delay comparator, and finally given to an electromagnet through a buffer.

Fig. 2. shows the complete circuit diagram. The inputs are derived from the outputs of preamplifiers of the existing cassette recorder circuit and mixed through R1 and R2 (47k) resistors. The mixed signal is attenuated by preset VR1 to an optimum level. This attenuation is necessary because the saturating amplifier should be over-driven but not excessively.

The saturating amplifier is nothing but a voltage amplifier wired around IC TBA810 in a conventional fashion, but with a higher load resistor. The high value of load resistor makes the power amplifier to closely approach the characteristics of a voltage amplifier. Any other voltage amplifier design can be substituted, but the prototype used the 810 circuit.

The voltage output across load resistor R6 is nearly equal to supply voltage whenever the tape is Cued or Rewed. This AC voltage is rectified by diode D2, the current through which is limited by resistor R7 and filtered by C10.

Capacitor C10 forms a memory-like element because it stores charge as long as signal is present. When there is a gap in the music, the voltage across the load drops suddenly, but the voltage across C10 drops slowly as it has only one discharge path, i.e. through high value of R9.

The combination of R9 and C10 de-

* AMSS is also called Automatic Programme Search System (APSS) or Tape Program Sensor (TPS) or Music Quick Jump System (MQJS).

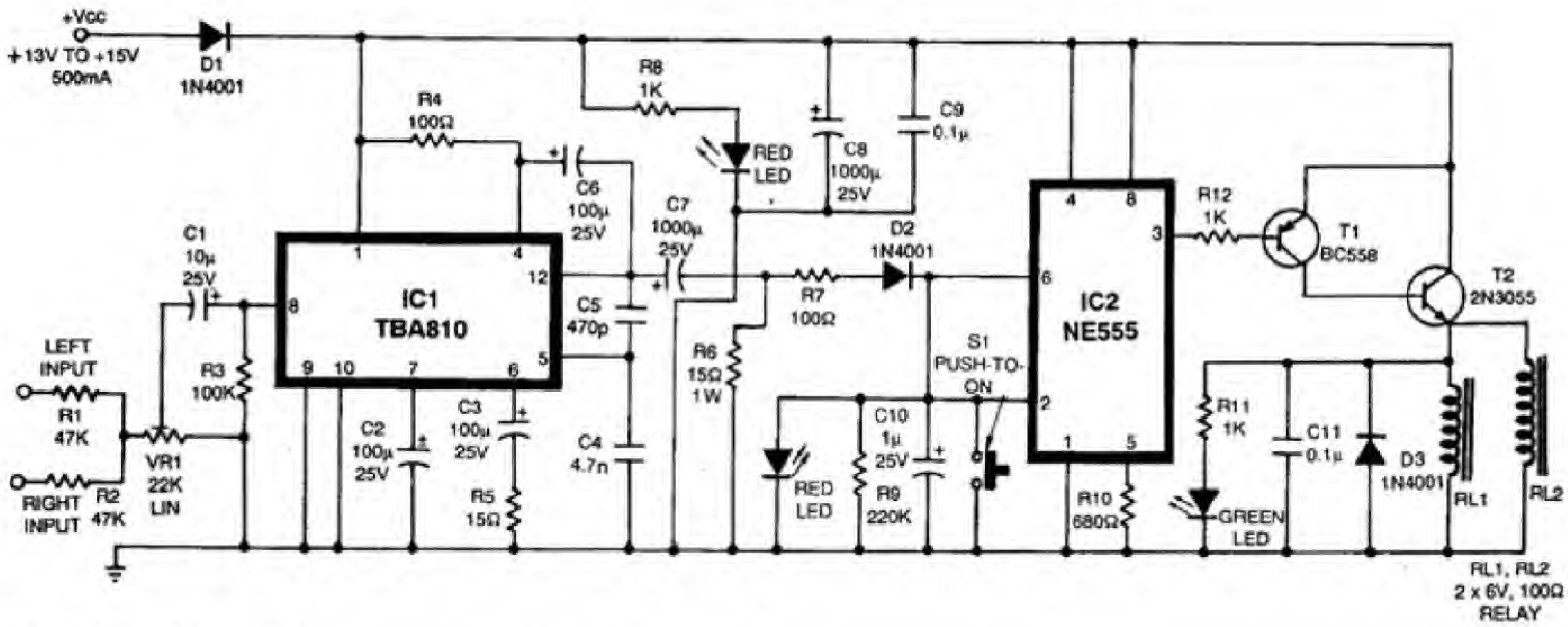


Fig. 2: Circuit diagram for the automatic music search system.

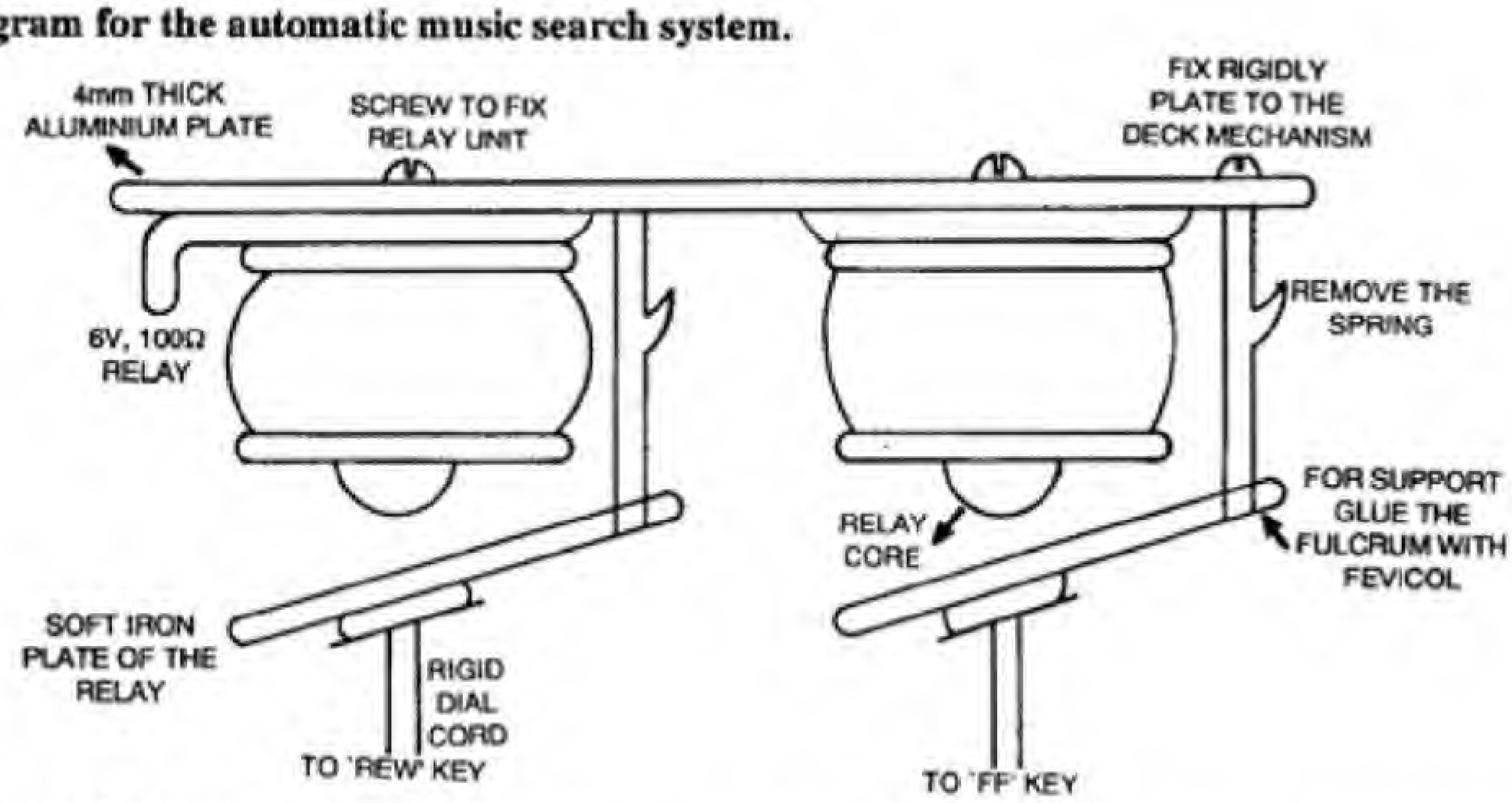


Fig. 3: Use of relays as electromagnets.

cides the time width of gaps in music which should not be altered. These values have been selected after trying the values in almost hundreds of music albums. The gap works for all types of music.

IC 555 is wired to work as comparator as well as schmitt trigger. Its comparator voltage is kept very low by R10, a 680-ohm resistor, and the input is simultaneously given to pins 6 and 2 for comparing. As soon as C10 discharges sufficiently, the output pin (pin 3) of IC2 goes high, driving off the 'complementary pair' formed by transistors T1 and T2. This removes power from the relay (which in this circuit is used asrr an electromagnet) and the electromagnet (relay) releases the FF or Rew key to continue to play from that point of the tape.

At pin no. 2 of IC2 there is a red LED. (It should be only a red LED, because it functions as a 1.65-volt regulator in this circuit). This fixing of the max. voltage across C10 ensures correct operation of the circuit, independent of the recording level of the tape.

A word about the relay. The relay is 6V, 100 ohms type critically. But the supply voltage is between 13V and 15V. This is done purposefully. When T2 saturates, it almost sources 150 mA through relay RL1 and makes it a very powerful magnet—powerful enough to hold the FF or Rew keys. This may heat up the relay and increase residual magnetism, but both the side effects can be ignored absolutely.

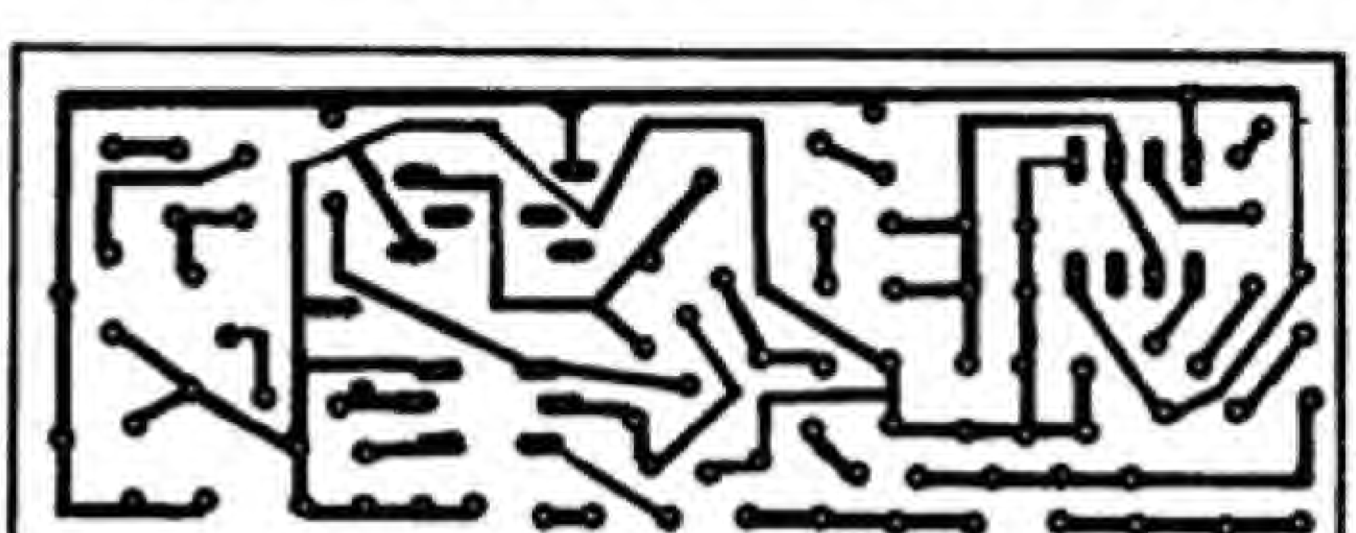


Fig. 4: Actual-size PCB layout for the circuit shown in Fig. 2.

Construction

Assembly of the electronic circuitry being simple, there is hardly anything to be said about it. However, construc-

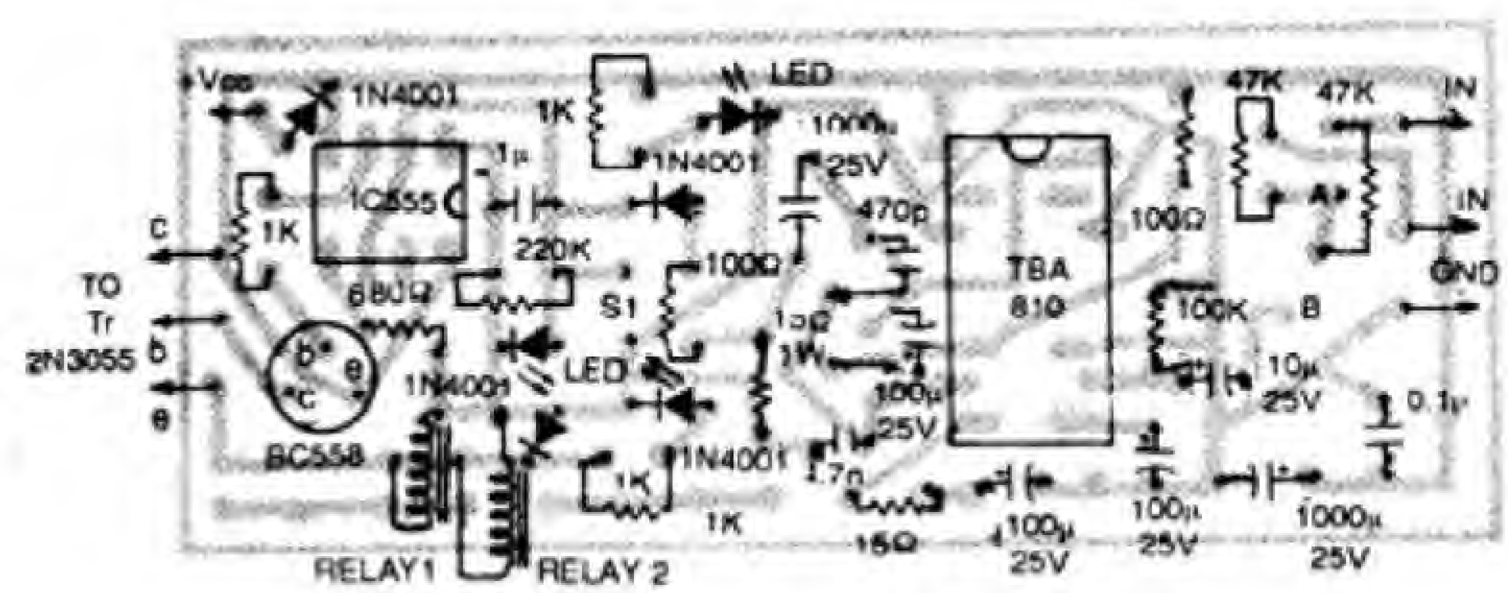


Fig. 5: Components layout for the PCB shown in Fig. 4.

tion of the mechanical portion of the project is a bit time consuming and you may have to have patience while dealing with the fittings.

In the circuit diagram RL1 and RL2 are shown as a single inductor for simplicity. But it is a parallel combination of 6V, 100-ohm relays—one for holding the FF key and the other for Rew key.

PARTS LIST

Semiconductors:

IC1	—	TBA810
IC2	—	NE555
T1	—	BC558
T2	—	2N3055
D1-D3	—	1N4001 silicon diode

Resistors (all 1/4W, ±5% carbon unless stated otherwise):

R1, R2	—	47-kilohm
R3	—	100-kilohm
R4, R7	—	100-ohm
R5, R6	—	15-ohm, 1 watt
R8, R11, R12	—	1-kilohm
R9	—	220-kilohm
R10	—	680-ohm
VR1	—	22-kilohm linear

Capacitors:

C1	—	10µF, 25V electrolytic
C2, C3, C6	—	100µF, 25V electrolytic
C4	—	4.7nF ceramic
C5	—	470pF ceramic
C7, C8	—	1000µF, 25V electrolytic
C9, C11	—	0.1µF ceramic
C10	—	1µF, 25V electrolytic

Miscellaneous:

RL1, RL2	—	100-ohm, 6V relay
	—	2 x Red LED
	—	Green LED
S1	—	Push-to-on switch
	—	Soft touch deck mechanism

Fig. 3 shows how to use relays as electromagnets. Remove the cover and terminal bases of the relays and fix them to a 4mm or so aluminium sheet as shown. Now fix the aluminium plate to the deck mechanism or close to it firmly. The restoring springs of the relays should be removed and the fulcrums should be glued with Fevicol for support. Even with the glue dried, the relay arms should move freely, to and fro. Now link the FF key to the arm of one relay and Rew key to the arm of the other with dial cords used in radios in such a way that, whenever the keys are pressed, the corresponding arm moves a bit closer to the electromagnet. See that the link cord is untwisted and tight.

When FF key is pressed during 'play', the arm of the relay moves forward towards the electromagnet. Meanwhile, the signal is amplified, processed and fed to the electromagnets. As now the arm is much closer to the electromagnet, it is drawn powerfully towards it and held as long as the electromagnet gets supply. The electromagnet holds the key even if you release your finger. It releases the key only when the circuit senses a gap in the music. When one electromagnet is operative, it does not cause the pulling of the other key, because the aim of the other key is far beyond the range of its corresponding electromagnet.

If your deck has a leaf switch which operates during FF and Rew only, then it may be used in series with the supply rail to avoid unnecessary current drain during normal operation. ❑

Readers' Comments:

For constructing the Music Search System (EFY, Jun.'92) I took output of record level indicator amplifier (built around TBA810 in my tape recorder) to give input to IC2. But whenever there is a beat in the music the relay starts chattering.

The author has not mentioned anything about push-to-on switch S1 at pin 2 of IC2!

Besides, I found the relay coils heat up with the supply mentioned by the author.

T.SURENDRA
BITS, Pilani

The author, Mr T.S.Shankar, replies: Input to the circuit should be given only from the output of a preamplifier and not from a power amplifier. Otherwise, the relay chattering can't be avoided.

Switch S1 is meant to cancel out the search function while it is operative.

As we are supplying 12V to a 6V relay coil, the coil may get slightly warm. Since it dissipates more than 1.4 watts, it can never get overheated. Mr Surendra's relay coil must be 4.5V or 3V rated.

Digital Volume Control

R.Ravi Chandran

Most modern TVs and VCRs have a digital volume control for either incrementing or decrementing the volume. In digital control you have to press a switch instead of rotating a knob like in old sets. This versatile digital volume control circuit can be used for taperecorders, amplifiers, TVs etc.

In the circuit IC 555 is used as an

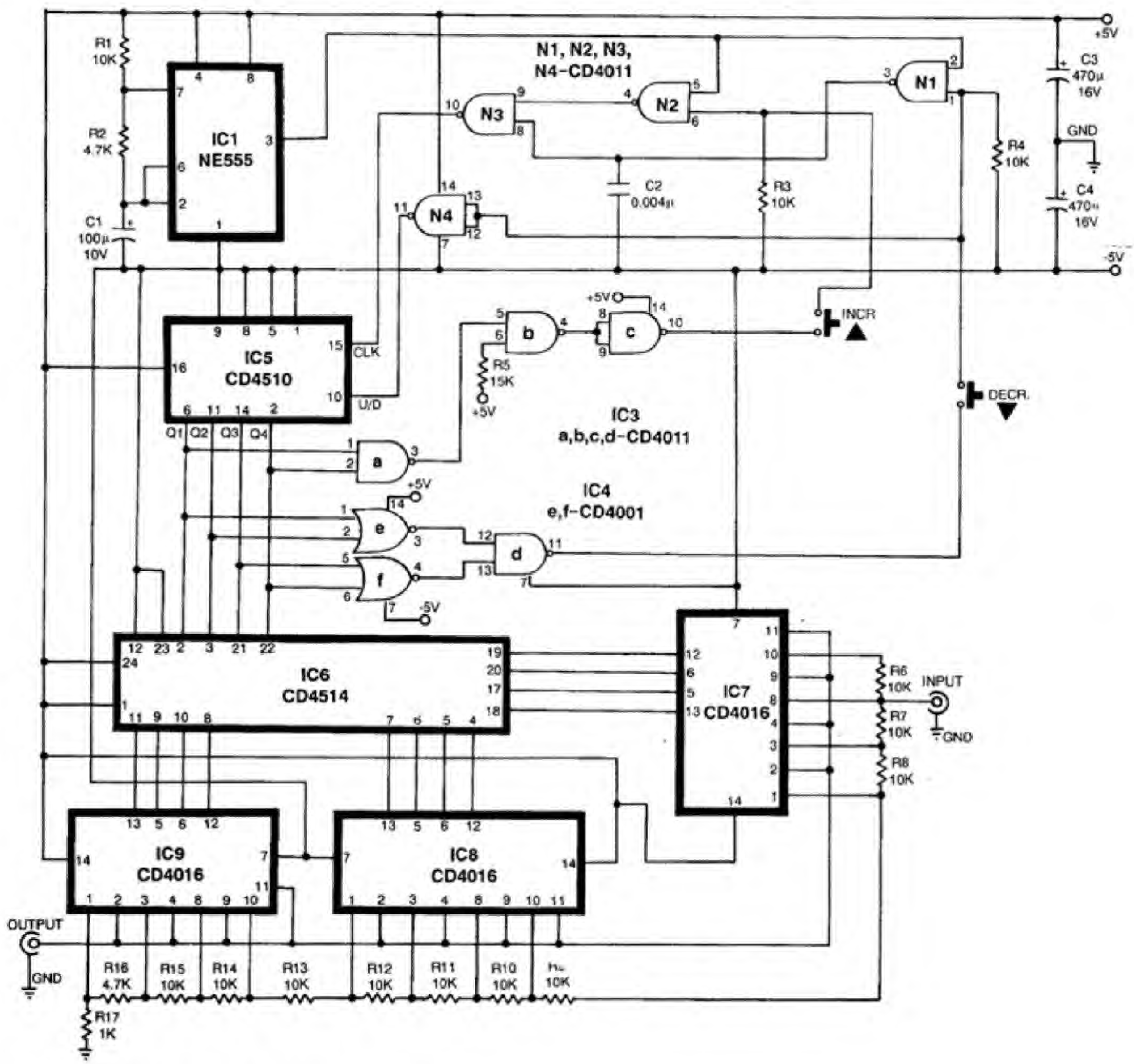


Fig. 1: Circuit diagram of digital volume control.

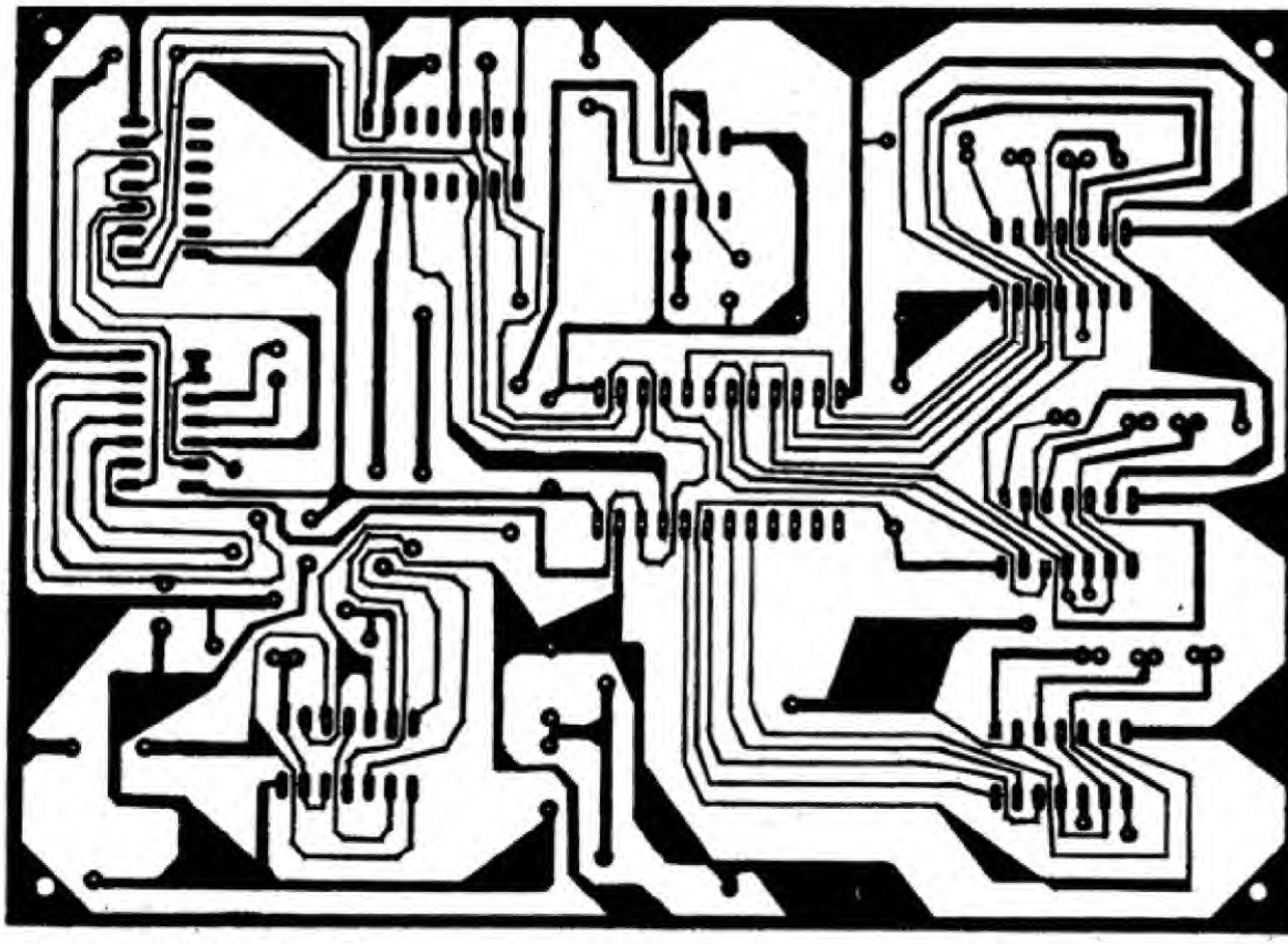


Fig.2: Actual-size PCB layout for the circuit shown in Fig. 1.

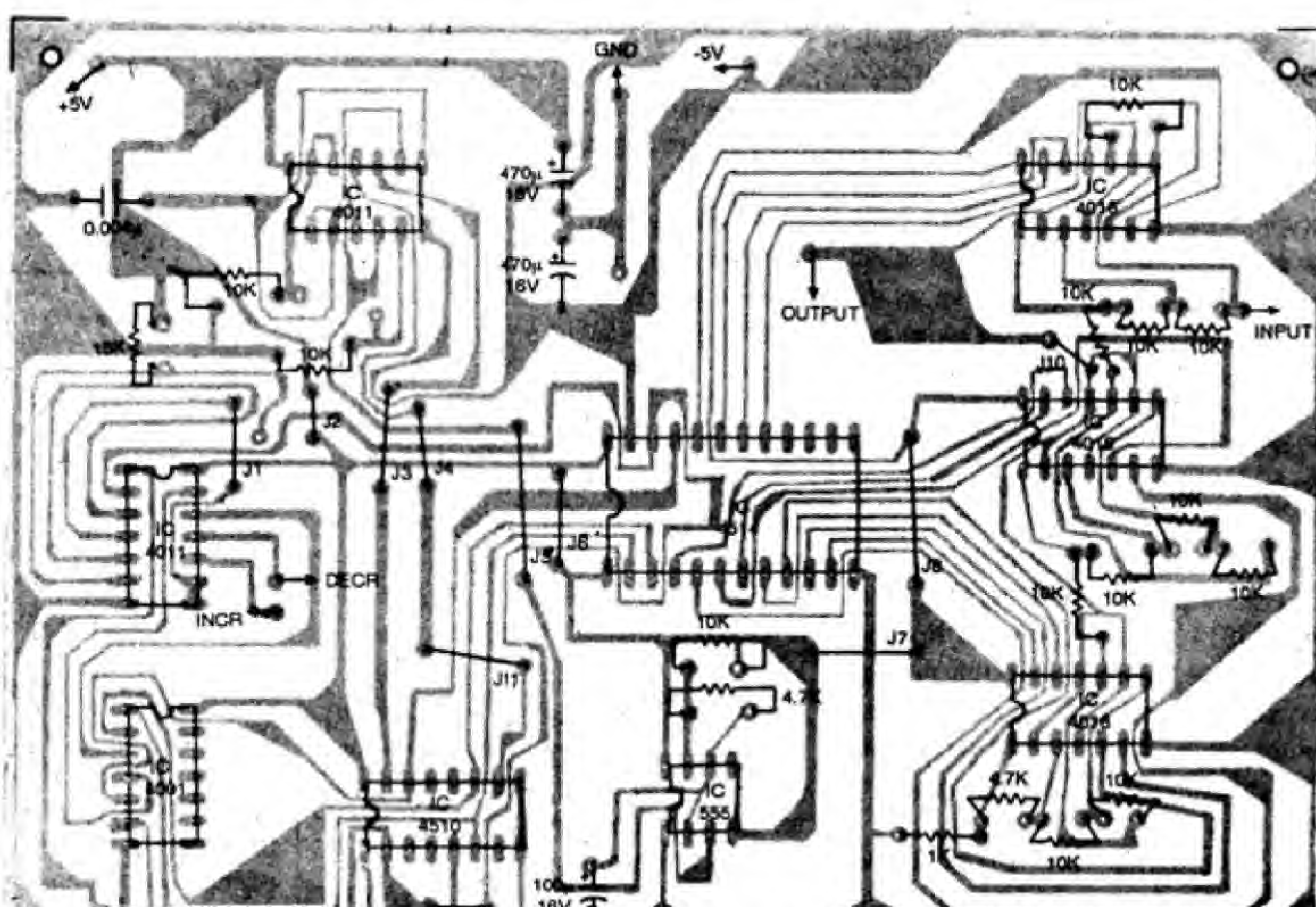


Fig. 3: Components layout for the PCB shown in Fig. 2.

PARTS LIST

Semiconductors:

IC1	—	NE555
IC2, IC3	—	CD4011
IC4	—	CD4001
IC5	—	CD4510
IC6	—	CD4514
IC7, IC8, IC9	—	CD4016

Resistors (all 1/4W, ±5% carbon, unless stated otherwise):

R1, R3, R4, R6-R15	—	10-kilohm
R2, R16	—	4.7-kilohm
R5	—	15-kilohm

Capacitors:

C1	—	100μF, 10V electrolytic
C2	—	0.004μF ceramic disc
C3, C4	—	470μF, 16V electrolytic

Miscellaneous:

S1, S2	—	feather touch switches
	—	Shield wire

astable multivibrator, which produces a clock pulse of 1 Hz frequency at pin 3. This clock pulse is fed to the counter (IC 4510) through a combination of gates. Normally, N1 and N2 will not allow any clock pulse because one of its input is connected to ground through 10k resistor.

When the INCR or DECR switch is pressed, the corresponding gate allows the clock pulses to the counter through the gate N3. N4 gate is used to select the counter IC 4510 in up-down mode. Pin 10 of IC 4510 is normally high but goes low on decrementing the volume.

Each time the INCR/DECR switch is pressed, the count of the counter is incremented or decremented accordingly. This counter has four outputs which give 16 combinations.

The outputs of IC 4510 are fed to the IC4514, which is a 4-16 line decoder. It has 16 output lines that go high according to any of the 16 possible combinations of inputs. However, we have used only 12 combinations out of 16.

All the outputs of the decoder are connected to three 4016 ICs, which are SPST switches. Each IC contains four SPST switches, which turn on when the

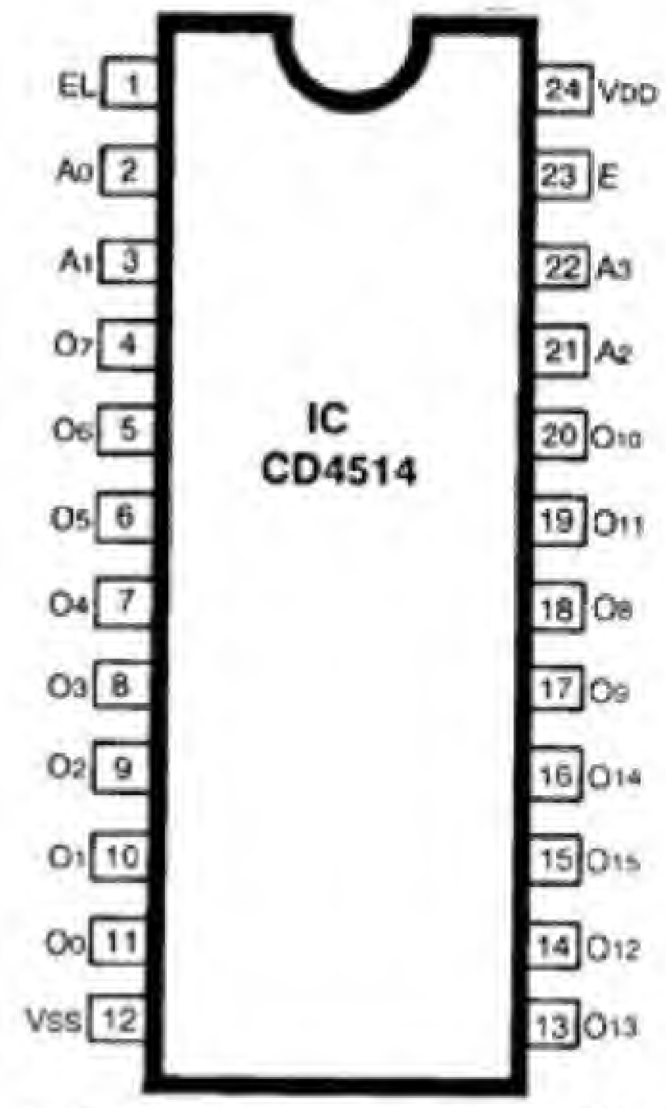


Fig. 4: Pin configuration of IC CD4514.

corresponding input is high. Hence, by using three such ICs we have 12 different outputs. One terminal of each switch is connected to a resistive network, and the other terminal is connected to one common output line. When INCR switch is pressed, the resistance between input and output (in case of taperecorder 'input' is the output point of preamplifier and the 'output' is the input point of power amplifier) decreases and so the volume increases. The reverse is the case when the DECR switch is pressed.

Till now gates a, b, c, d, e, f do not come in the picture. Now we will discuss the advantage of using these gates. If we keep on pressing the INCR switch, the counter's count will increment. But after 16 steps it will repeat the count. The same holds true for the DECR switch. It means after getting maximum/minimum volume, you will again get minimum/maximum volume, and this is the most irritating aspect of the circuit.

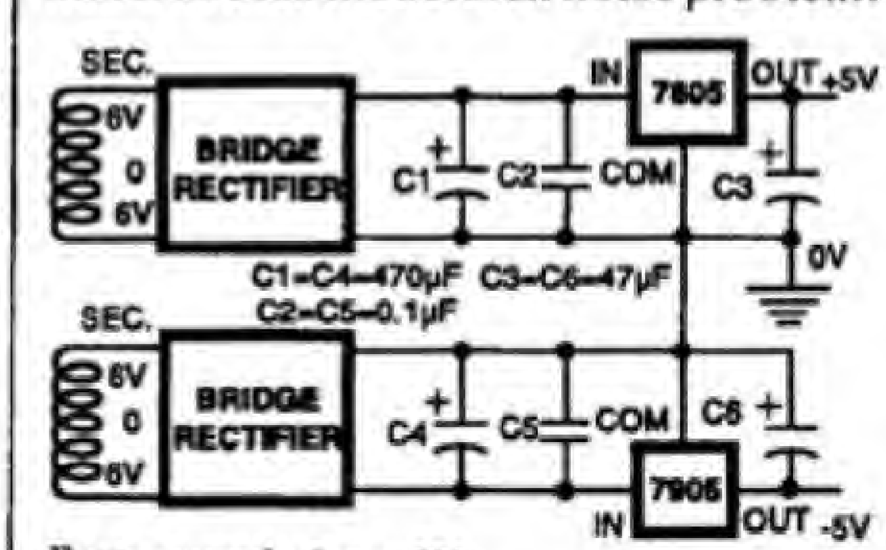
Gates a to f provide solution to this problem. Consider that the volume is maximum. At this time the count is 1, 1 1, 1 (Q1 to Q4 all high). This is the only case out of the 16 possible cases when Q1 and Q4 bits are high, and we shall utilise this condition. As soon as Q1 and Q4 go simultaneously high, the output at pin 10 of gate C will go low. As a result no high going pulse will occur by pressing the INCR switch.

Hence, there is no affect of pressing the INCR switch in case of maximum volume. This is what we need. In case of minimum volume, the output of counter is 0, 0, 0, 0 (Q1 to Q4 all low). This is the only case (out of 16 possible cases) when Q1 to Q4 are low. Now for this condition, outputs of gate e and f will be high, which is the input of NAND gate d. A low output at pin 11 ensures that there is no effect of pressing the DECR switch. So once the volume is minimum, the DECR switch is made ineffective and the volume remains minimum until we press the INCR switch.

Power supply

The circuit works on +5V and -5V DC. The circuit uses a 6V-0-6V, 500 mA transformer with AC input. Bridge rectifier and 1000μF, 25V capacitors are used for rectifying and filtering. Regulators 7805 and 7905 are used to generate +5V DC and -5V DC respectively.

The main advantage of the circuit is that it avoids the scratch noise problem.



Power supply for ± 5V

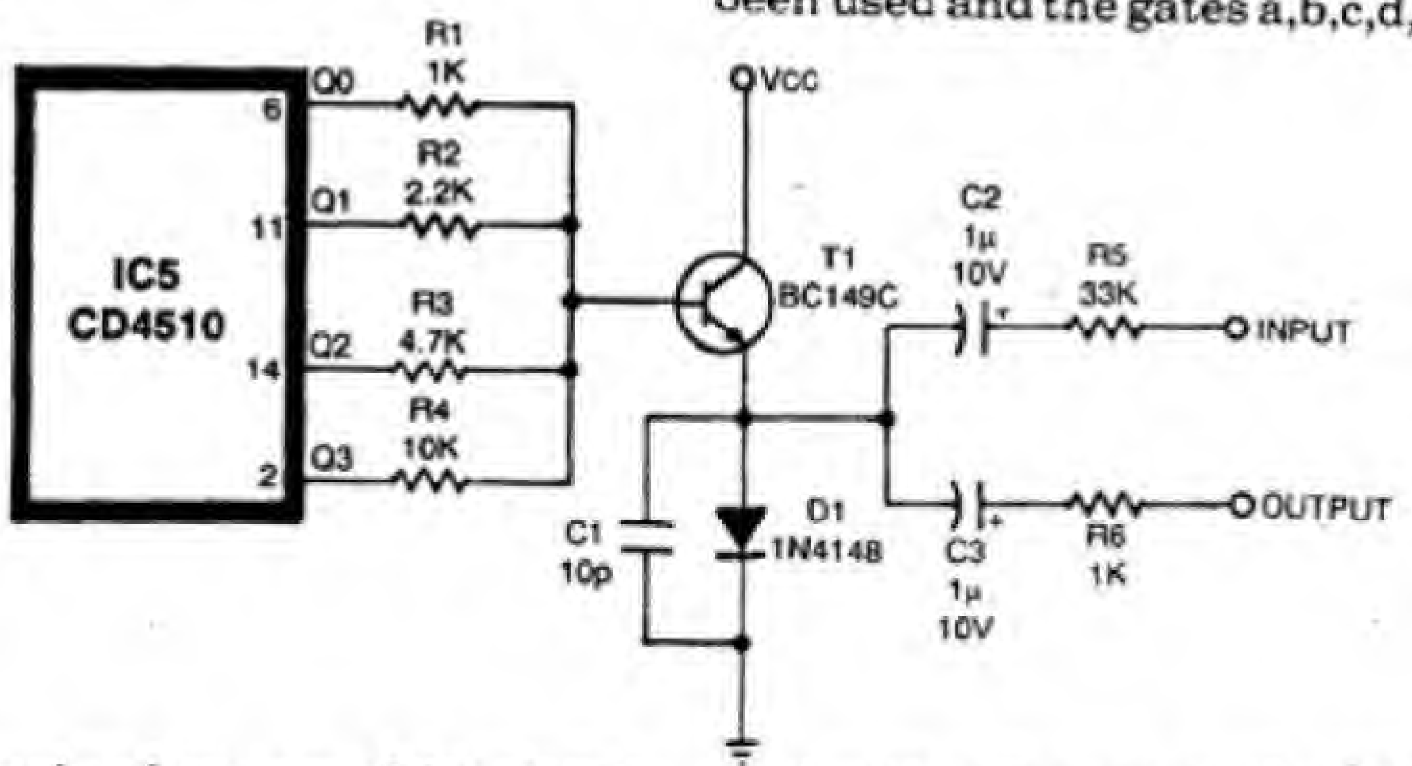
Useful hints

Remember that there are 12 steps from minimum volume to the maximum. For each step, certain resistance comes into picture. If you want a particular output at each step, use a 100k preset for each of the resistor network. Adjust the corresponding preset for a particular step. Once you adjust all the presets, your circuit is ready for giving a predetermined output at each step.

For stereos, you have to use one more circuit for controlling the volume of the second channel. ❑

Readers' Comments:

The circuit of the 'Digital Volume Control' published in EFY Jul.'92 issue can be greatly simplified by removing the four most expensive ICs (IC6-IC9) and using the following circuit instead.



The main advantage of this circuit is that it gives sixteen steps instead of twelve and the distortion is very low.

T.S. SHANKAR
Hyderabad

The author, Mr R. Ravichandran, replies:

Your circuit will work fine for the first two steps. On the third step, i.e. for 0011, 2.2 kilo-ohm and 1 kilo-ohm resistors will come in parallel and the resultant will be less than 1 kilo-ohm. The volume output will be lesser in this case. This is repeated for the other steps also. Hence, this circuit does not give a linear output.

'Digital Volume Control' project published in July issue is somewhat different from all the DVC circuits published earlier in EFY. The author may please clarify:

1. For stereo channel (where dual pot is used) is one more identical circuit required or can I save some ICs?

2. Do we require one more IC 4016 for remaining 13th to 16th step?

3. How to get visual indication for min-max volume by connecting LEDs at output pins of IC6?

4. Suppose we switched off the power supply when output of CD4510 is 1001, what will be the output of IC5 when we again switch on the circuit?

SAINI G.S. HAPYE
Mohali

❑ Only 12 outputs of IC 4514 have been used and the gates a,b,c,d,e,f are used with reference to the 16th output. What about the counts from 13th to 15th? Won't the output come suddenly to the minimum as output of IC 4514 changes from 12th to 13th count on pressing INCR switch?

Why two different types of regulator ICs (7805 and 7905) have been used in power supply instead of two of the same type?

What is the total cost of the project?

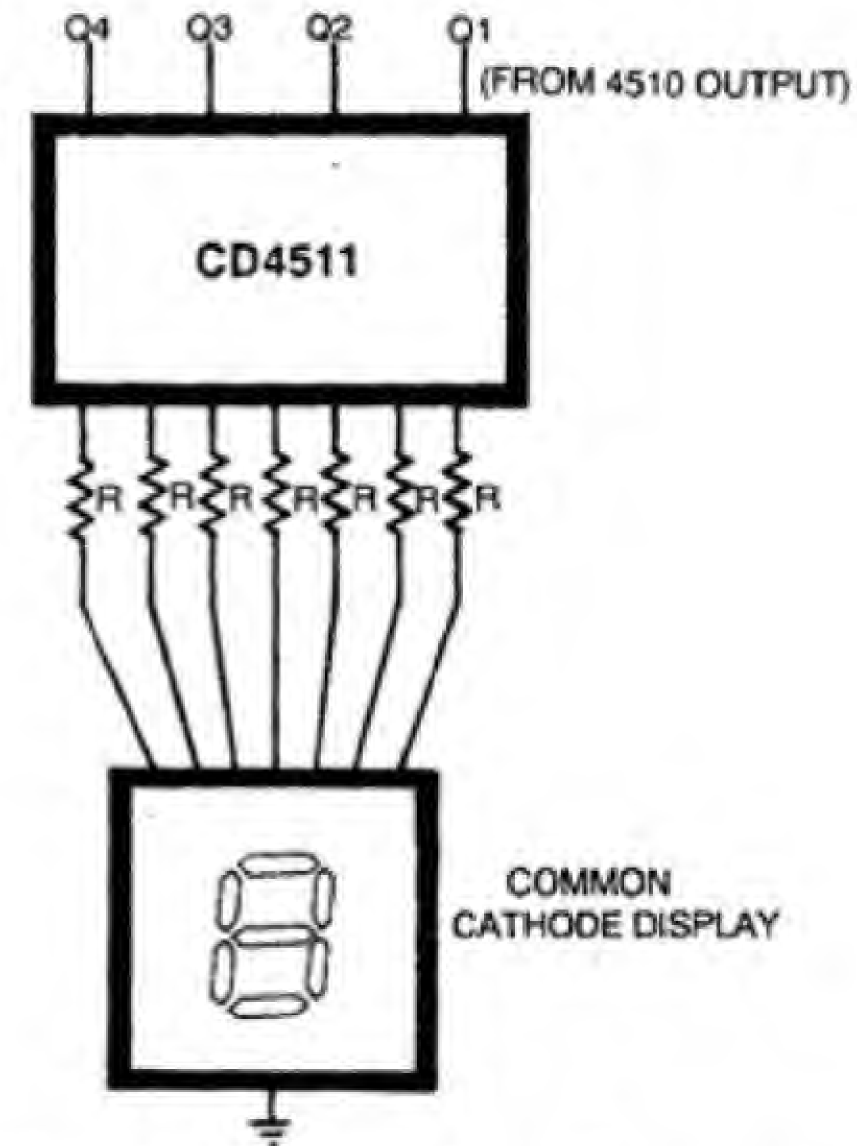
RAJEEV DWIVEDI
Lucknow

The author, Mr R. Ravi Chandran, replies:

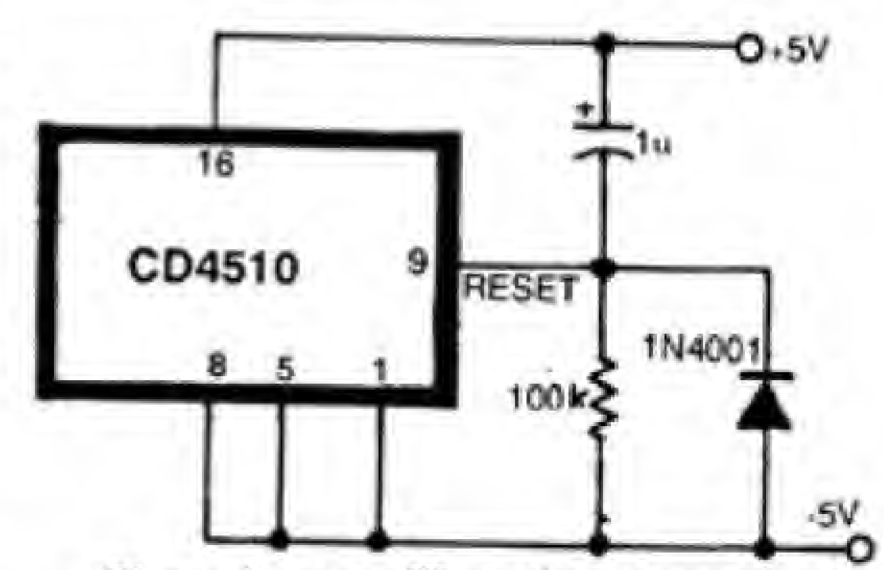
For stereo, connect three more 4016 ICs in parallel to IC7-IC9.

Additional steps are not possible as we are using 10-step counting. After 9th step INCR button is disabled by IC3(a).

One can use the following circuit for visual indication:



The changes in volume, if any, can be avoided (after switching 'off' and 'on') by connecting reset line of 4510 through R-C network.



The volume will not increase above 1001 and will not decrease below 0000, since IC3(a) senses the 1001 and IC4 (e,f) senses the 0000. This will avoid sudden change in volume also.

We are using CD4016 for analogue signal switching. So we should give both +5V and -5V supply, and the signal level should not exceed the IC supply voltage.

The cost of the project is around Rs 150.

Tech Editors Note:

1. Please note that the volume control is meant only for 10-step control (0 through 9)

2. Tactile switches should be used for INCR. and DECR. function for bounceless operation.

Cook Timer

R. Raghunathan

After going through this you will start wondering what you have been doing without this. Yes, a simple kitchen timer with 14 possible settings—the minimum being 2.5 minutes and the maximum 45 minutes. What is more, the repeat accuracy is in direct proportion to your patience in setting a preset. In any case, an accuracy of two to three per cent is easily achievable, and for domestic needs even this is luxury.

Well, we basically being smart, will do neither of the above. We operate a 7555 (CMOS timer) in astable mode at a frequency of 54.6 Hz (clock pulse duration 0.018 sec). We then divide this 16384 times(!) in a single CMOS binary counter 4060B and get a basic clock pulse duration (BCPD) of five minutes. This pulse is inverted and fed to a decade counter 4017B (CMOS once again) and starting from 5, we can

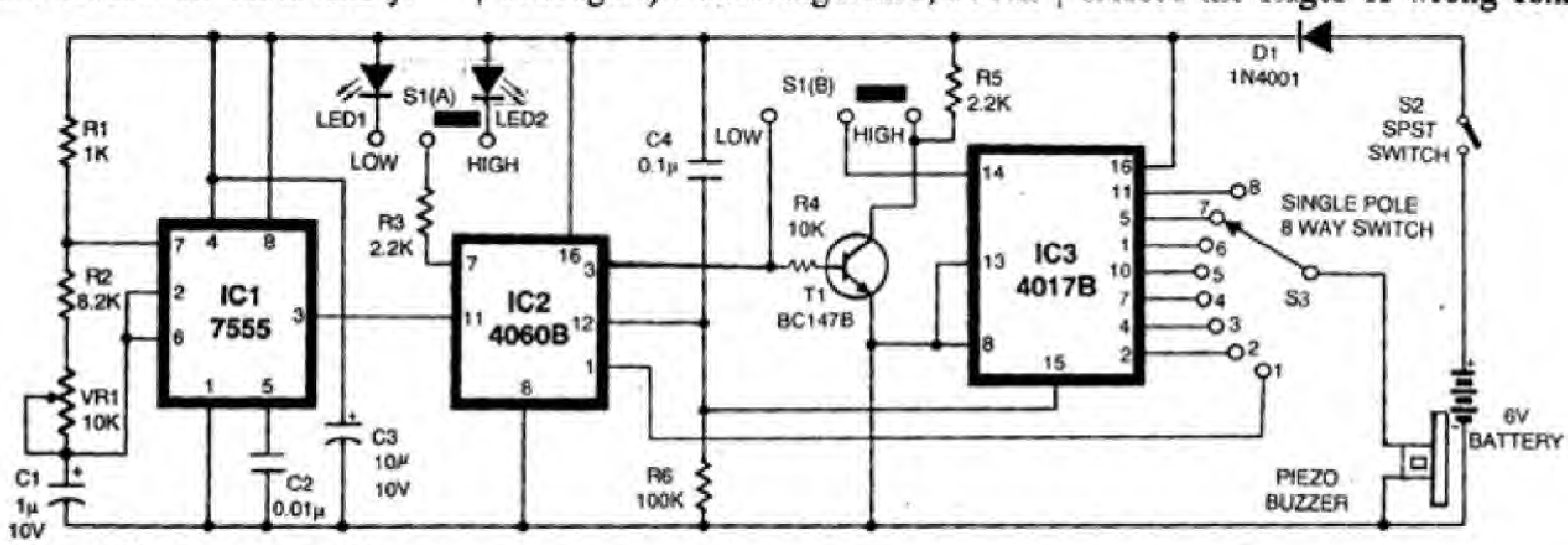


Fig. 1: Circuit diagram for cook timer.

To set a delay of 45 minutes, a timer in the monostable mode would have been sufficient. But the repeat accuracy would suffer due to the use of bulky electrolytic capacitors. And by the time you satisfactorily finish setting the timing preset, you will start wondering why you need a timer at all (each trial will need 45 minutes!). Alternatively, if you want to take life easy (without any trials), you have to spend a fortune on crystal-based clock generators and introduce a gang of ICs to divide and bring the clock pulse to humanly recognisable timing durations.

The author is working with Vickers Systems International Ltd, Madras as a Senior Application Engineer.

get a maximum interval of 45 minutes in steps of 5 minutes. This will be the 'high' range.

For the 'low' range, starting from 2.5 minutes to 42.5 minutes, all we do is to directly feed the clock pulses from 4060B to 4017B without inverting. The Q14 output of 4060B, after switch on will go high after 2.5 minutes (remember the BCPD is 5 minutes) and accordingly the Q1 output of 4017B will go high. Thereafter each successive output of 4017B will go high in intervals of 5 minutes up to 42.5 minutes (Q9 output). Thus with a basic clock pulse of 5 minutes, we get a resolution of 2.5 minutes, in two ranges—High and Low.

The circuit can be assembled on a general-purpose PCB as there is not much complication, or the suggested PCB layout can be used. If you are sure you won't make mistakes, D1 can be omitted. Just to safeguard against reverse polarity, it drops 0.7 volts out of the available 6 volts.

Calibration

It's presumed you have already crossed the stages of wrong connections, dry solders, missed components etc.

(a) Insert all three ICs in their socket, (Hope you have used IC sockets. All ICs are CMOS and they need lot of respect).

(b) Set a value of 4.5k in preset 'P1' before soldering in place. For this, the single turn presets are totally banned. Use a good multiturn helipot.

(c) Switch-on 'S3' to test position (No. 1). S1 should be in 'Low' position

(d) Have a stop watch (or an ordinary clock with seconds indication) handy; if you believe in god, pray and then switch 'S2' on. Following should happen:

(1) LED should blink at a rate of 3.4 Hz.

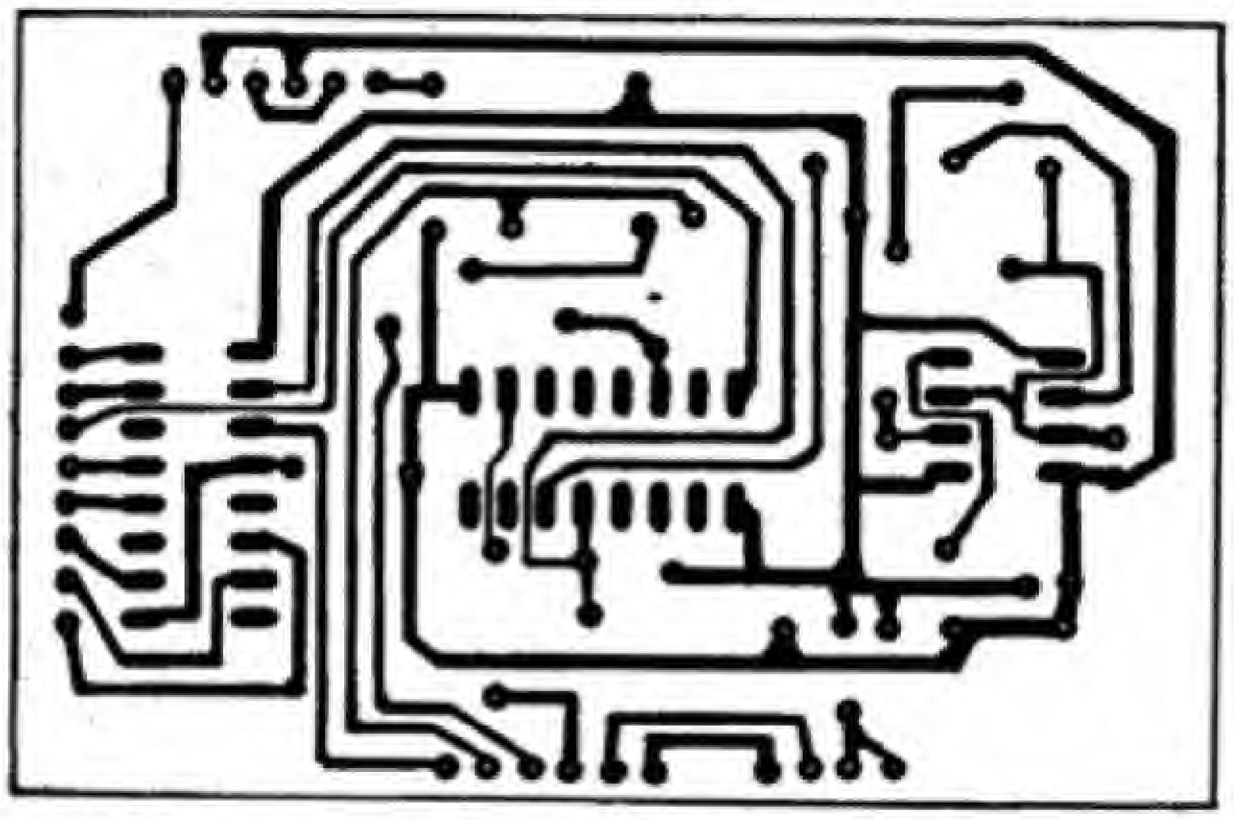


Fig. 2: PCB layout for the circuit shown in Fig. 1.

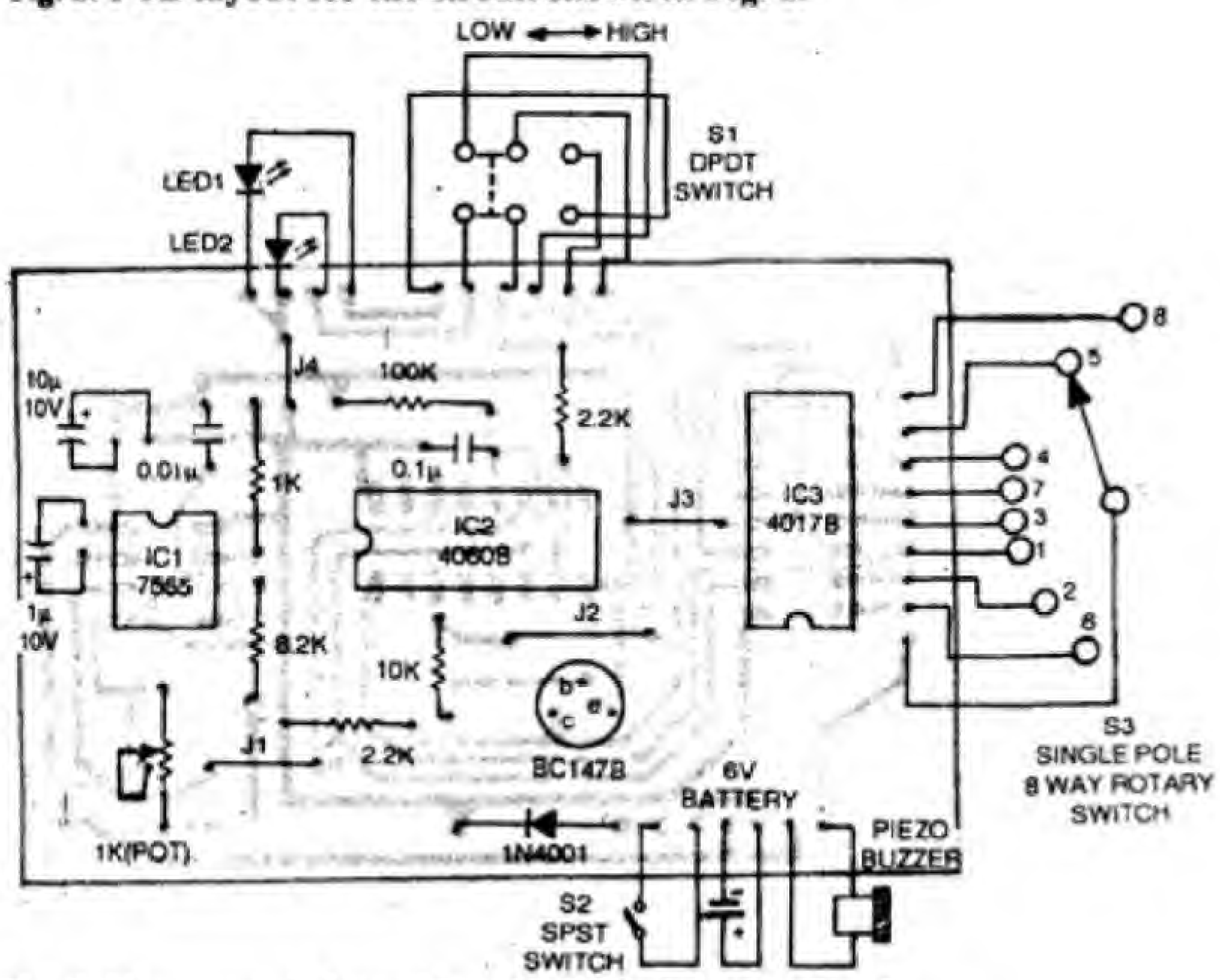


Fig. 3: Components layout for the PCB shown in Fig. 2.

(2) After about 38 seconds the buzzer should sound.

If the buzzer does sound, the calibration for all the fourteen settings is over and you are the proud owner of a useful timer. Invariably, a few trials and minor adjustments on VR1 (1/4 to 1/2 turn at a time) may be needed. Once you are satisfied, switch S3 to position '2' and switch-on S2. You should now time 150 secs. If you get this, no more verification is required.

Calibration using an oscilloscope is very simple, assuming that setting up the scope is easy. After patiently selecting the right time base, scale etc on the scope, measure the frequency from pin 3 of 7555 and set it to 54.61347 Hz. Obviously, if you can lay your hands on a frequency counter life will be much easier and pleasant.

Operation

Select the High or Low range and the exact time you need on S3. Switch-on S2. At the end of set timing, the buzzer will sound. Switch-off S2. When the timer is 'on' you can at liberty increase the setting in S3 but never touch S1. To alter S1, first switch-off S2.

Hints

(a) The circuit draws about 2mA during 'on' condition. Depending on the piezo buzzer, this will increase when the buzzer sounds.

(b) Do not replace 7555 with ordinary NE555 as the current consumption will shoot up. Also do not lower the value of R3. This also will affect the current drawn.

(c) C1 should be tantallum and VR1 should be multiturn pot. Save on these and you will end up wasting a lot of time in calibration.

(d) With a current of 2mA, the four pen torch cells should at least last a year and a half. Hence, resist the temptation to use the timer through a battery eliminator. If you cannot, go ahead, but remember to retain the battery back-up or else a supply failure in the middle of timing can lead to unpleasant consequences.

(e) For BCPD other than 5 minutes use the following formula:

$$F1 = \frac{16384}{BCPD} \qquad \begin{array}{l} \text{F1 IN Hz} \\ \text{BCPD in seconds} \end{array}$$

Once F1 is known, setting up 7555 to operate at that frequency is all that is to be done by you. For calibration, put S3 in position 1 and set VR1 for a time equal to BCPD/4 secs.

(f) Finally, during calibration don't waste time in trying to get exactly 38 secs or 150 secs. Error of ±2 secs. in 150 secs is quite acceptable. An accuracy of ±1.3 per cent is more than enough for the domestic front. ❑

PARTS LIST

Semiconductors:

IC1	—	7555
IC2	—	CD4060B
IC3	—	CD4017B
T1	—	BC147 npn silicon

Resistors (all 1/4W, ±5% carbon, unless stated otherwise):

R1	—	1-kilohm
R2	—	8.2-kilohm
R3, R5	—	2.2-kilohm
R4	—	10-kilohm
R6	—	100-kilohm
VR1	—	10-kilohm linear potentiometer

Capacitors:

C1	—	1.0µF, 10V tentalum
C2	—	0.01µF ceramic disc
C3	—	10µF, 10V electrolytic
C4	—	0.1µF ceramic disc

Miscellaneous:

S1	—	DPDT switch
S2	—	SPST switch
S3	—	Single pole 8 way rotary switch
	—	Intermittent tone piezo buzzer

Readers' Comments:

The article 'Cook Timer' in July'92 issue of EFY is very good. Please convey my thanks to the author.

But, in fact, the circuit has been made more complicated using IC1 7555 as the pulse generator.

I wonder why the author did not use the superb facility of on-chip oscillator available in IC2 4060B?

KALPESH T. DALWADI
Bharuch

❑ The most interesting aspect of the project is the binary counter 4060B which drives pulse 16,384 times. The author is requested to give more useful information about the counter, including the role of pins 01, 12 and 13 of decade counter CD4017.

HEMANT SHARMA
Guwahati

The author, Mr R. Raghunathan, replies:

The idea to use on-chip oscillator of IC4060B is good. It will definitely bring down the component count. But, in the bargain, the circuit would lose its frequency stability when the supply varies. That was the single reason for using 7555—the industry workhorse. The oscillating frequency of 7555 is completely independent of the supply voltage variations.

Mr Kalpesh's idea can give excellent results with a regulated supply but when battery supply is used it is better to include 7555.

4060B is a versatile IC having an on-chip oscillator and 10 binary outputs. When an external clock signal is available it can be fed to pin 11 and binary divisions of 2^4 to 2^{14} are available as outputs, as shown. Alternatively, a capacitor and resistor can be connected, as shown, to pins 9 and 10 and the on-chip oscillator will oscillate at a frequency of 2.2xRxC (R in ohms and C in farads). The frequency will then be divided and available as outputs. But in this case, the frequency will slightly vary with supply variations and hence a regulated supply is recommended. Pin 12 is a reset pin which when held high resets all outputs to low, and blocks the oscillator.

IC 4017

Pin 1 to pin 7: Outputs Q5, Q1, Q0, Q2, Q6, Q7 and Q3 in that order.

Pin 8: Ground

Pin 9 to pin 11: Outputs Q8, Q4, Q9 in that order.

Pin 12: Carry out. Goes high after 9 clock pulses for a duration of 1 clock pulse. Used for cascading.

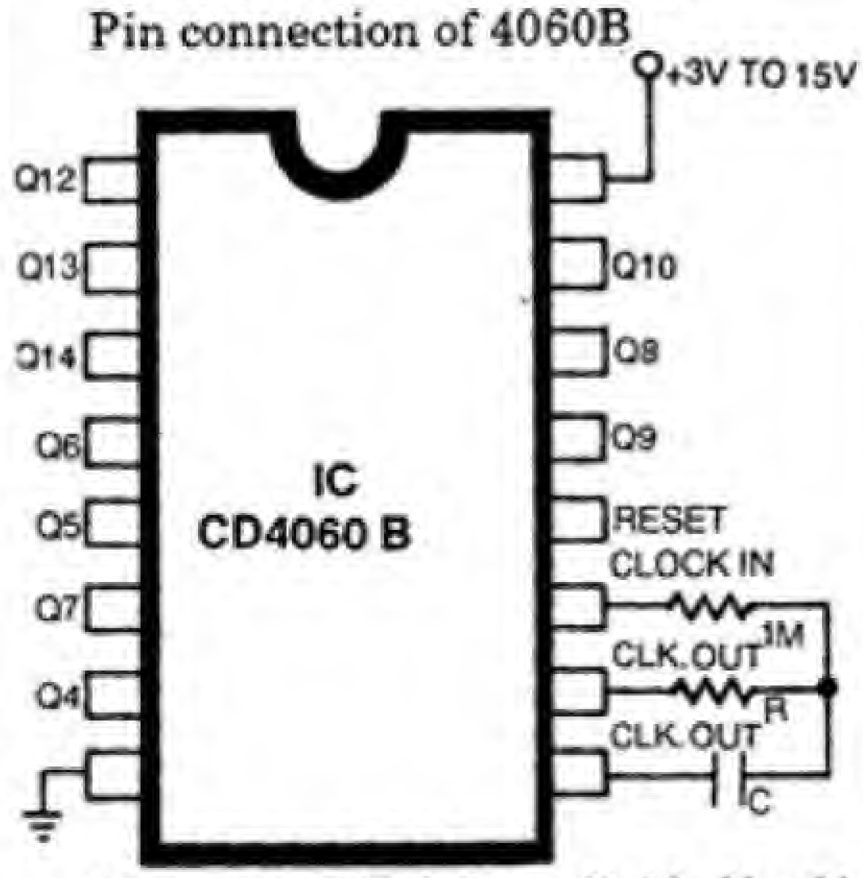
Pin 13: Clock enable. Counting is possible only when this pin is low.

Pin 14: Clock input.

Pin 15: Reset pin. When this is taken low all outputs are reset to zero. During counting this is to be high.

Pin 16: +Vcc (3 to 15 volts)

Pin connection of 4060B

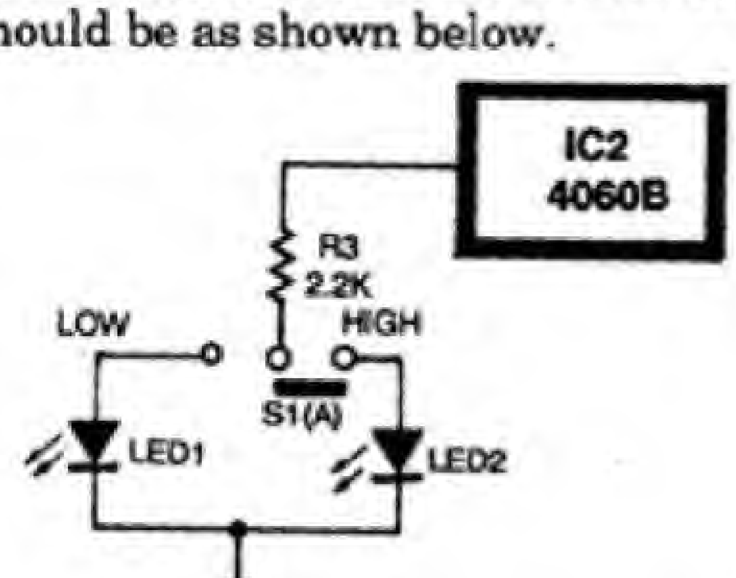


Note: Q4 - Clock freq. divided by 2^4

|
|
|

Q14 - Clock freq. divided by 2^{14}.

I would like to make a few corrections in the circuit of 'Cook Timer' published in EFY Jul.'92 issue. In the circuit LED1 and LED2 connections should be as shown below.



PUNAM KOTHADIYA
Pune

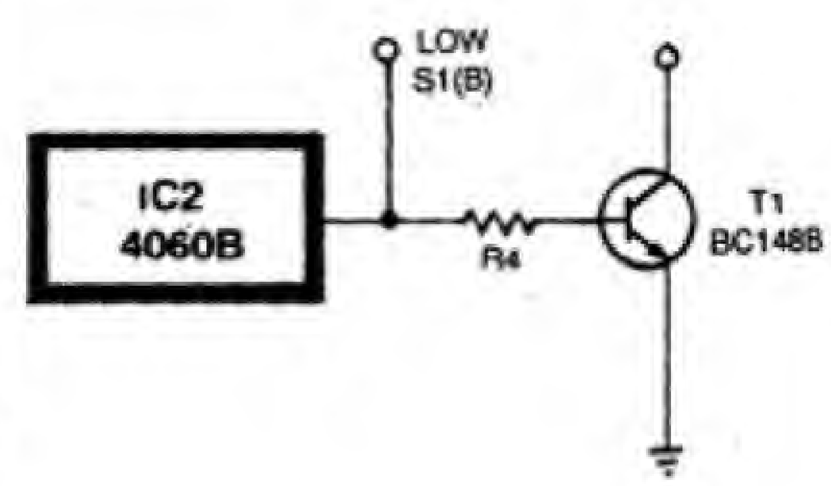
The author, Mr R. Raghunathan, replies:

Mr Kothadiya's suggestion is right. LEDs can be connected as shown by him in which case the IC will be sourcing the LEDs. Otherwise connections can be made as shown in the circuit diagram in the article with just the direction of the LEDs reversed.

There are further corrections also which should be made.

1. In the circuit diagram, position of resistor R4 is to be taken as shown in the figure (below). However, the PCB layout is properly drawn.

2. The value of VR1 should be read as 10k in the components layout where it is marked 1k.



Variable Speed Multi-Output Running Mode 'LED' Display

Inderpreet Singh

The circuit is a transistor transistor-logic (TTL) compatible running light display with a maximum of 15 outputs and is capable of driving up to 75 LEDs for display. The circuitry employs TTL devices and ICs. Power dissipation of the logic circuit is in milliwatts.

The circuit is based on digital logic having 4 inputs (hexadecimal) and 15 outputs which drive the output transistors. This logic circuit consists of six ICs—three quad 2-input OR gates and three quad 2-input AND gates.

If A, B, C and D are the inputs to this logic circuit and Y1, Y2, Y3.....Y15 are the outputs, then the outputs can be expressed in terms of boolean equations as follows:

Y1 = A+B+C+D
Y2 = A+B+C
Y3 = (A+B)+CD
Y4 = A+B
Y5 = (A+BC) +BD
Y6 = A+BC
Y7 = (A+BC) (A+D)
Y8 = A
Y9 = A(B+C)+AD

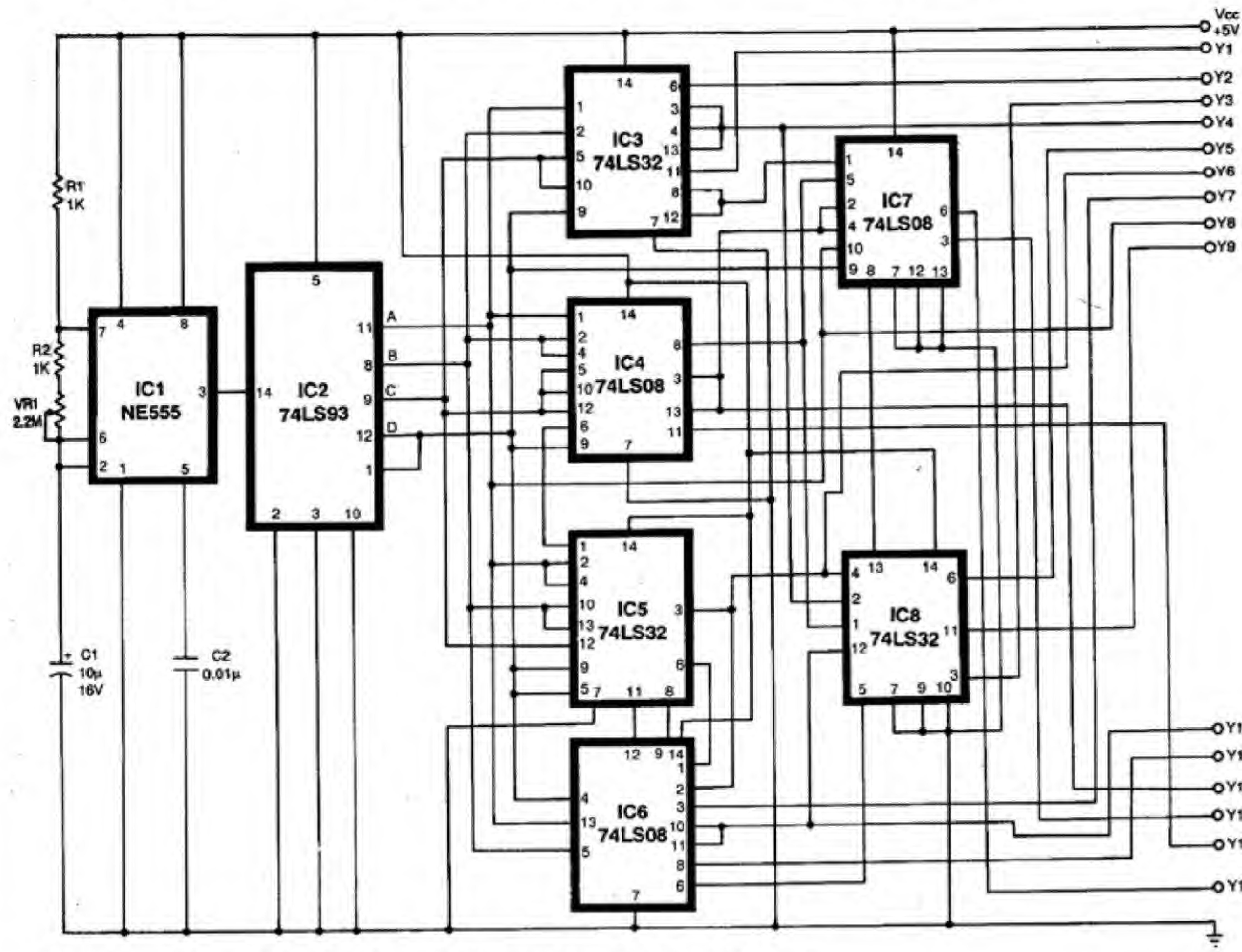


Fig. 1: Circuit diagram of variable speed multi-output running mode LED display.

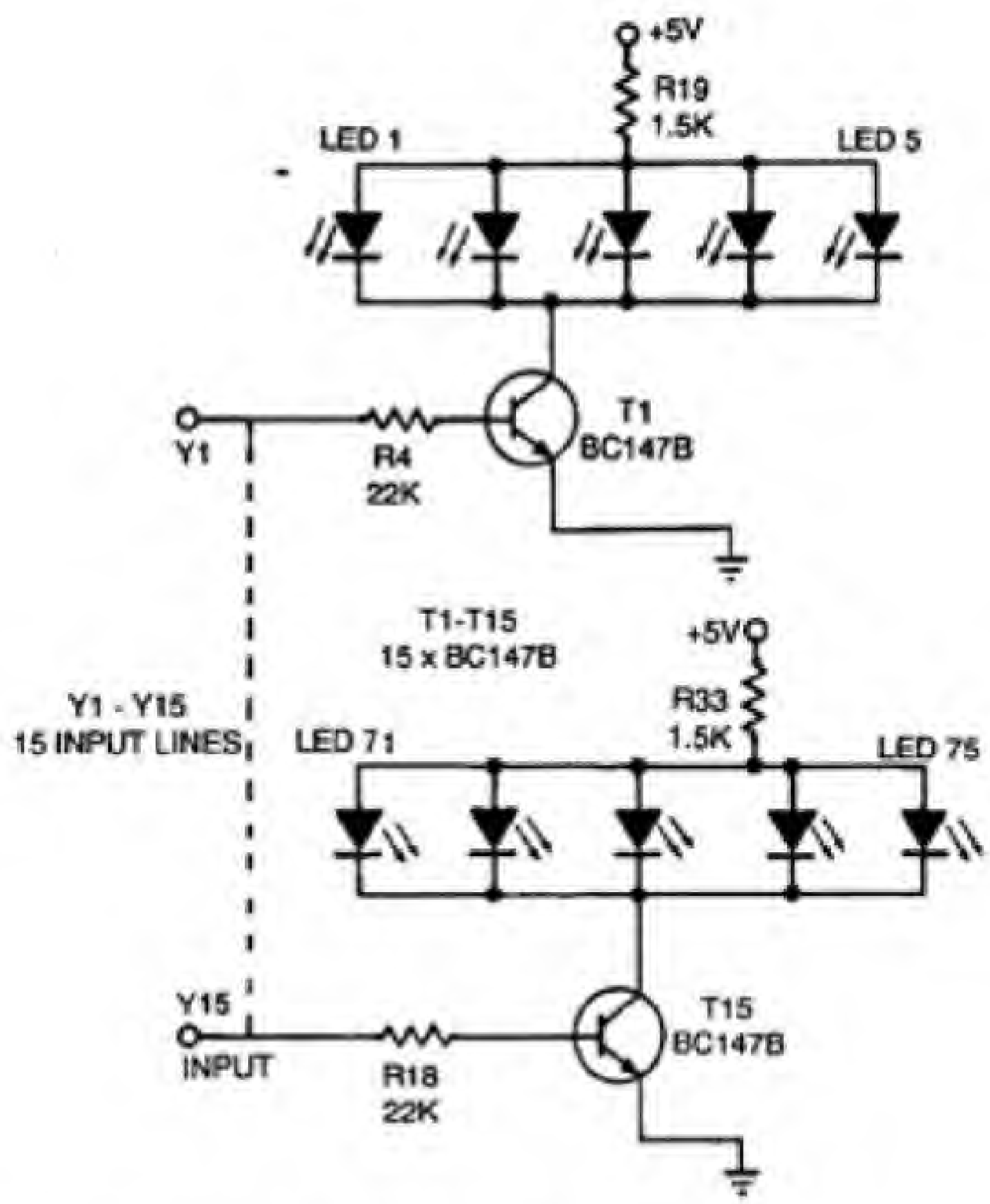


Fig. 2: Circuit diagram for driver circuit.

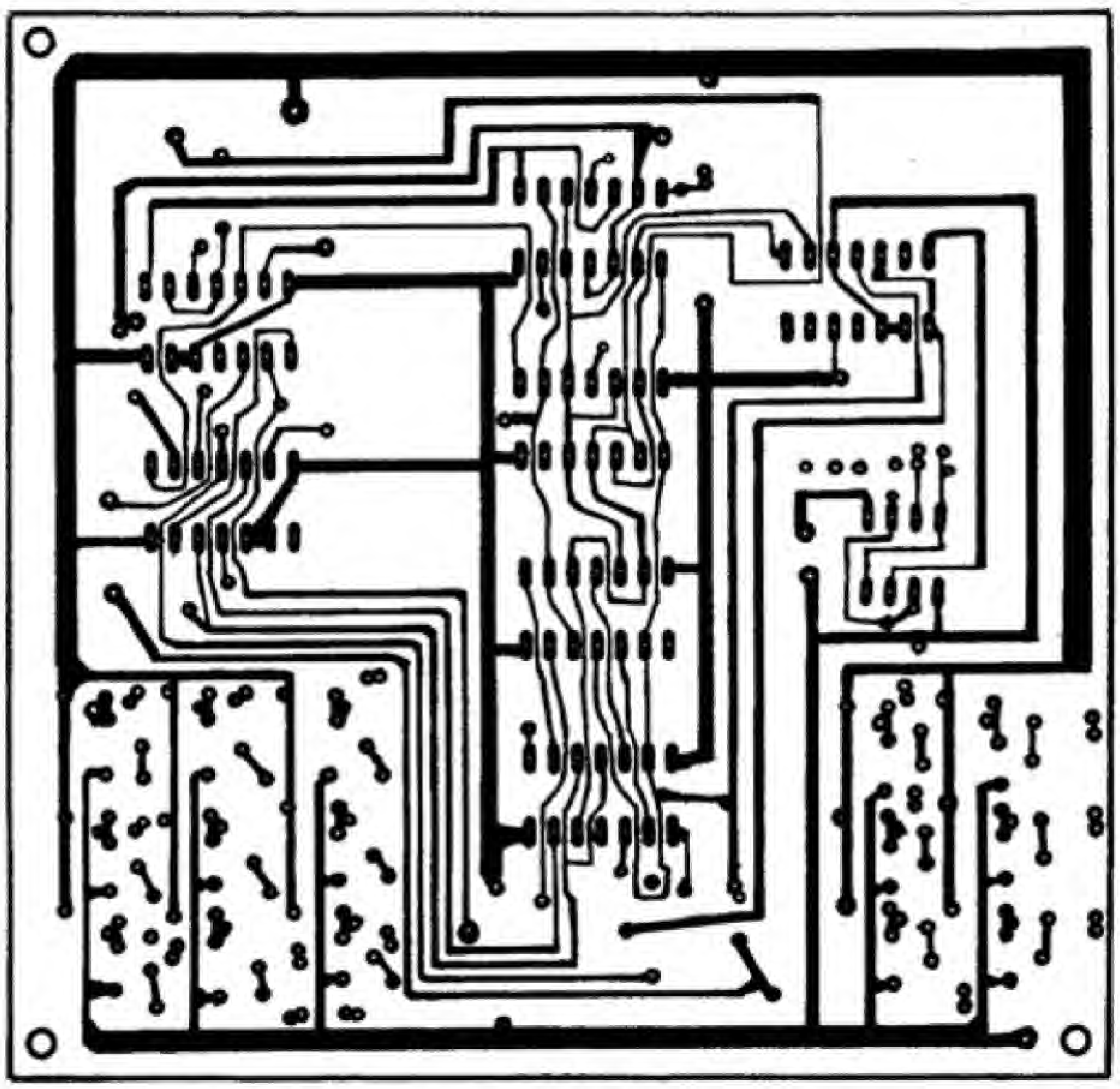


Fig. 3: PCB layout for the circuit shown in Fig. 1.

Y10 = A(B+C)
Y11 = A(B+C) (B+D)
Y12 = AB
Y13 = AB(C+D)
Y14 = ABC
Y15 = ABCD

Here 'A' is the most significant bit (MSB) whereas 'D' is the least significant bit (LSB).

PARTS LIST

Semiconductors:

IC1	— NE555 timer
IC2	— 74LS93 binary counter
IC3, IC5, IC8	— 74LS32 quad 2-input OR gate
IC4, IC6, IC7	— 74LS08 quad 2-input AND gate
T1-T15	— BC147B npn silicon transistors

Resistors (all 1/4W, ±5% carbon, unless stated otherwise):

R1, R2	— 1-kilohm
R3	— 220-ohm
R4-R18	— 22-kilohm
R19-R33	— 1.5-kilohm
VR1	— 2.2-megohm linear pot

Capacitors:

C1	— 10µF, 16V electrolytic
C2	— 0.01uF ceramic disc

Miscellaneous:

— LEDs

Clock pulse generator and decade counter. The clock pulse generator and decade counter are shown in the circuit diagram. The clock pulse generator is a timer chip (IC1) with a variable duty cycle, which can be achieved by varying the potentiometer VR1. The mathematical formula for frequency of oscillator is shown in the formula.

$$f = \frac{1.44}{[R1+2(VR1+R2)]C1}$$

where, R1, VR1 and R2 are in ohms, C1 in farads and f in Hz.

Here IC1 is operating in astable mode. IC2 has been used as a 4-bit binary counter having four outputs A, B, C and D with clock input pin 3. Reset input pins 2 and 3 are grounded, while pin 12 is connected to pin 1. Outputs from IC2 are obtained from its pins 8, 9, 11 and 12 respectively.

Main logic circuit. This part of the circuit has three AND and three OR gates. All ICs are TTL compatible. The source and sink current per gate is 0.4 mA and 4 mA respectively.

Driver circuit . This consists of a series of 15 npn transistors (one for each output). The circuit is designed in such a way that 5 LEDs can be connected in parallel of a transistor, as

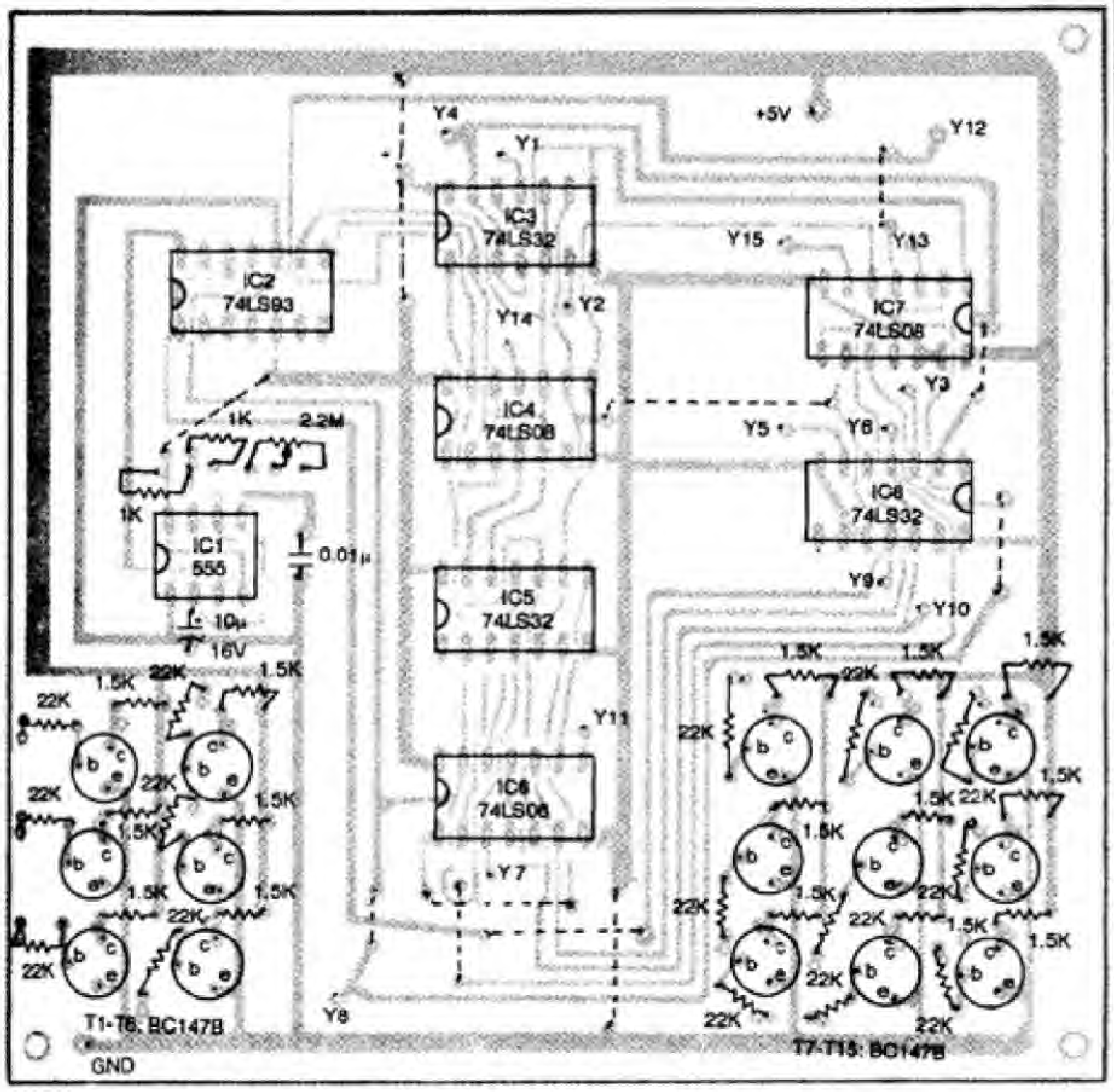


Fig. 4: Components layout for the PCB shown in the Fig. 3.

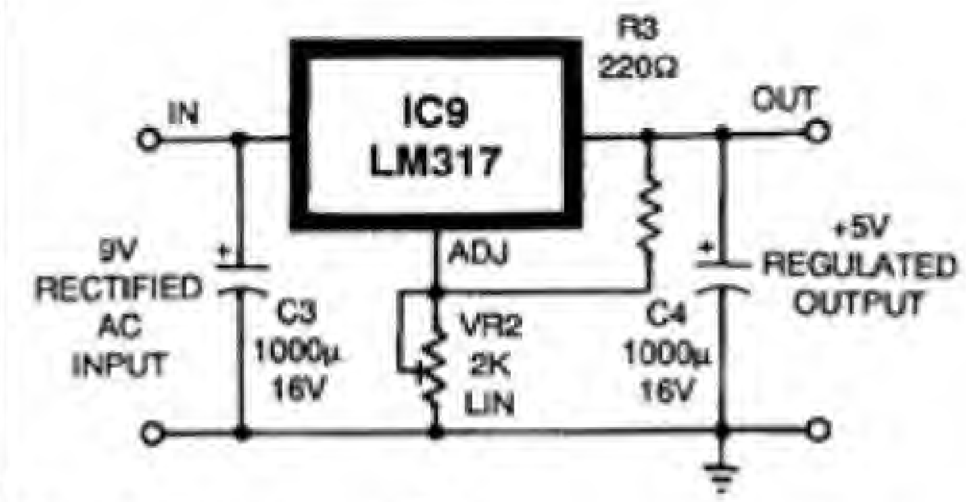


Fig. 5: Power supply.

shown in Fig. 2.

Power supply unit (PSU). A 5V regulator chip can be used, if current consumption is less than 200 mA. If it exceeds 200 mA, then another IC LM317 can be used with proper heatsink.

All the ICs can be assembled on a single sided PCB with IC sockets. Each of the 'Y' output should be connected externally through wires, to the base of a transistor in sequential order on PCB. The potentiometer can be fixed on the front panel in order to control the speed of display. Speed can be varied from 10 milliseconds to 16 seconds.

The cost of the entire circuit will be about Rs 125 which is quite reasonable. ❑

Editor's Note: Refer Fig. 2. To get adequate illumination from the 5 LEDs connected in parallel, the value of series resistors (R19 to R33) may be reduced to about 82 ohms in place of 1.5k ohm suggested by the author.

CMOS Pocketable Timekeeper

Amrit Bir Tiwana

To avoid getting late to offices, interviews, appointments etc here is a project which builds into a fine CMOS-based timekeeper. The timekeeper gives an alarm just minutes before the expiry of the selected time.

The timer which is based on two low-cost CMOS chips and a couple of discrete components, works on a flat PP3 or Eveready 216 type battery. It is small enough to fit into the corner of a shirt pocket. The inclusion of the 15 minutes and 4-hour timings in addition to the standard 1 and 2-hour timings makes it even more versatile.

To use the timekeeper just switch it on to the desired range and put it in your shirt pocket. A small LED will flash after every few minutes to indicate that the unit is working properly. Just before the selected time the timekeeper will sound an alarm, enabling the user to reach his destination in time. This unit can also come in handy for monitoring parking time (a practice prevalent abroad) for vehicles to avoid unnecessary fines. When not in use, the unit can simply be turned off by using a slider switch.

Besides two CMOS chips the unit uses just one semiconductor and a piezo speaker instead of the conventional self-oscillating piezo buzzer. Its low current consumption gives the battery a long life.

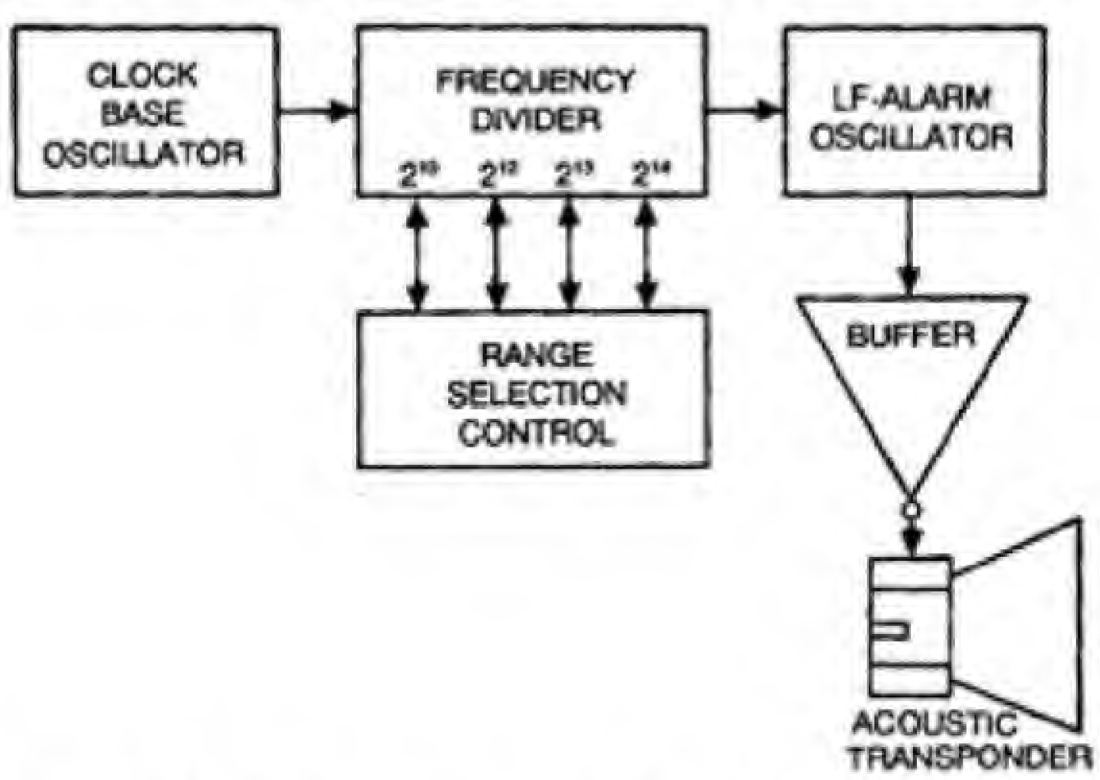


Fig. 1: Block diagram of CMOS pocket sized timekeeper.

Working

The circuit shown in Fig. 2 can be easily understood from the block schematic given in Fig.1. The circuit may be divided into a few main sections, the

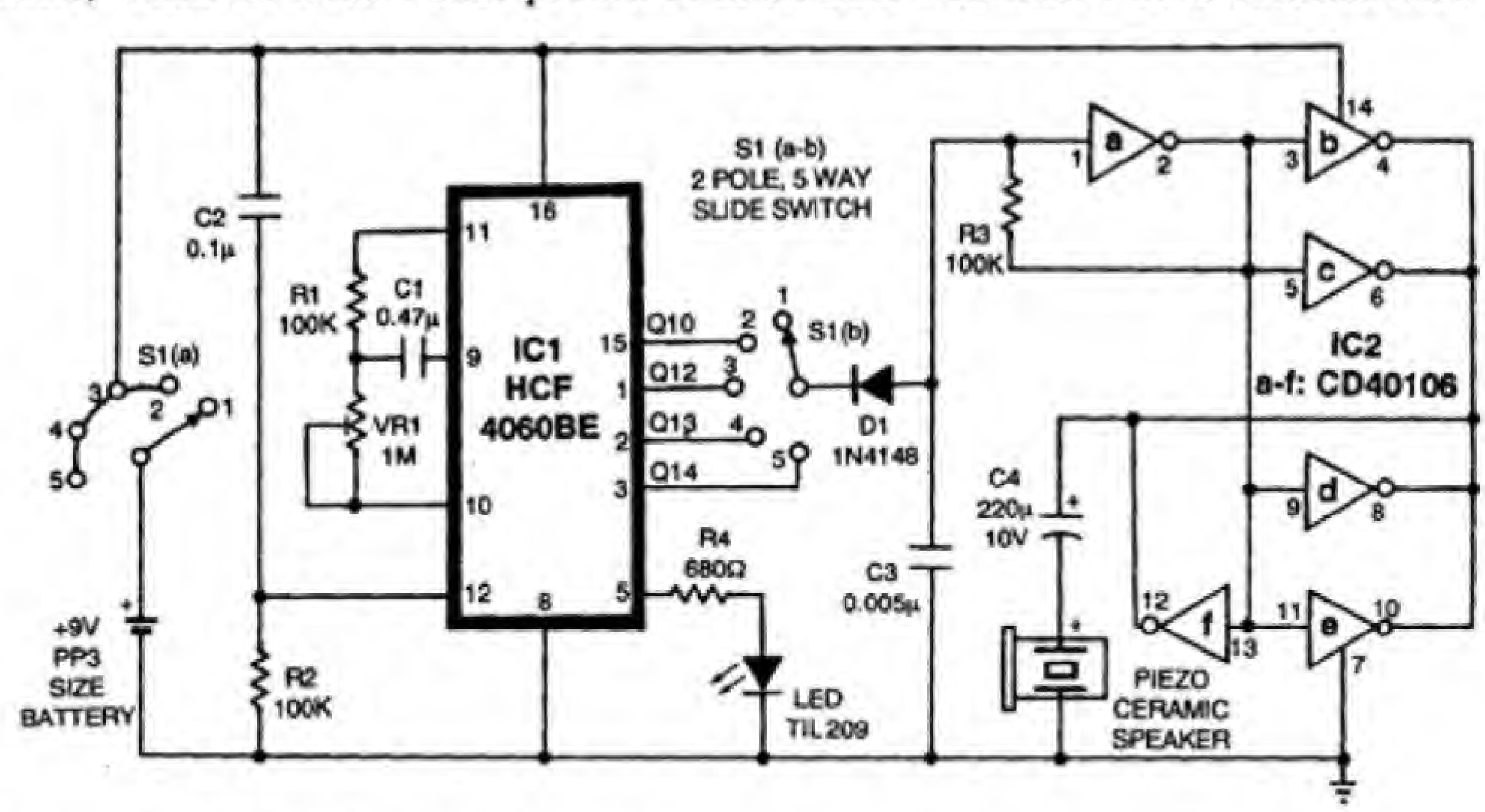


Fig. 2: Circuit diagram of CMOS pocket sized timekeeper.

TABLE I

Position of S1	Range	Timing cycle duration	Free time*
5	4 hrs	1 4058.1 seconds	6 minutes
4	2 hrs	7030 seconds	3 minutes
3	1 hr	3515 seconds	1.5 minutes
2	15 minutes	879 seconds	not significant
1	off	off	off

*Free time refers to the time before the actual time lapses and the buzzer sounds.

first of which is an oscillator.

The output of oscillator is fed to the frequency divider (time period multiplier), which divides the basic frequency by 1024, 4096, 8192 or 16384. The oscillator frequency is adjusted in such a way that these divisions give time periods of 15 minutes, 1 hour, 2 hours and 4 hours respectively. This is followed by an AF oscillator and a buffer. The buffer boosts the output current to drive a piezo ceramic speaker.

The circuit, as shown in Fig. 2, is based on a HCF 4060BE oscillator cum binary counter cum frequency divider. The chip has an in-built oscillator based on three inverters. R1, VR1 and C1 set the oscillator frequency precisely at 1.1655Hz. This basic oscillator generates a pulse of 2.2 R2 C1 seconds. This time period is fed to the counters, and the division factor is selected by pole 'b' of switch S1.

In position 1 it remains off and in positions 2, 3, 4 and 5 it is switched on to 15 minutes, 1 hour, 2 hours and 4 hours range respectively. The moment the power is applied, the counters are reset to zero by the power-on-reset circuit based on R2 and C2.

The AF oscillator is built around the hex trigger gates of the CD4016 chip. The first inverter gate is wired as an AF oscillator which oscillates at about 2 kHz. The timing components R3 and C3 determine the oscillative frequency. The remaining gates are used to buffer the outputs and to enable the piezo buzzer to be driven directly.

The time base pulses are counted by the internal counters as shown in Table I. When the selected output count is reached, the output goes high and the switching diode begins to conduct. This introduces capacitor C3 in the circuit and the alarm is activated through the piezo speaker.

Design considerations

The circuit has been optimised for very low current consumption, and minimum operational expenditure. Only CMOS ICs have been used to keep the current very low, even when the circuit is undergoing its timing cycle.

PARTS LIST

Semiconductors:

IC1	— HCF4060BE
IC2	— CD40106, hex inverter
D1	— 1N4148

Resistors (all 1/4 watt, ±5% carbon, unless stated otherwise):

R1, R2, R3	— 100-kilohm
R4	— 680-ohm
VR1	— 1-megohm linear

Capacitors:

C1	— 470nF styroflex or polyster
C2	— 100nF ceramic disc
C3	— 5nF ceramic disc
C4	— 220µF, 10V electrolytic

Miscellaneous:

	— 27mm, piezo speaker with low profile body
S1	— Two-pole, five-way slide switch
	— LED TIL209

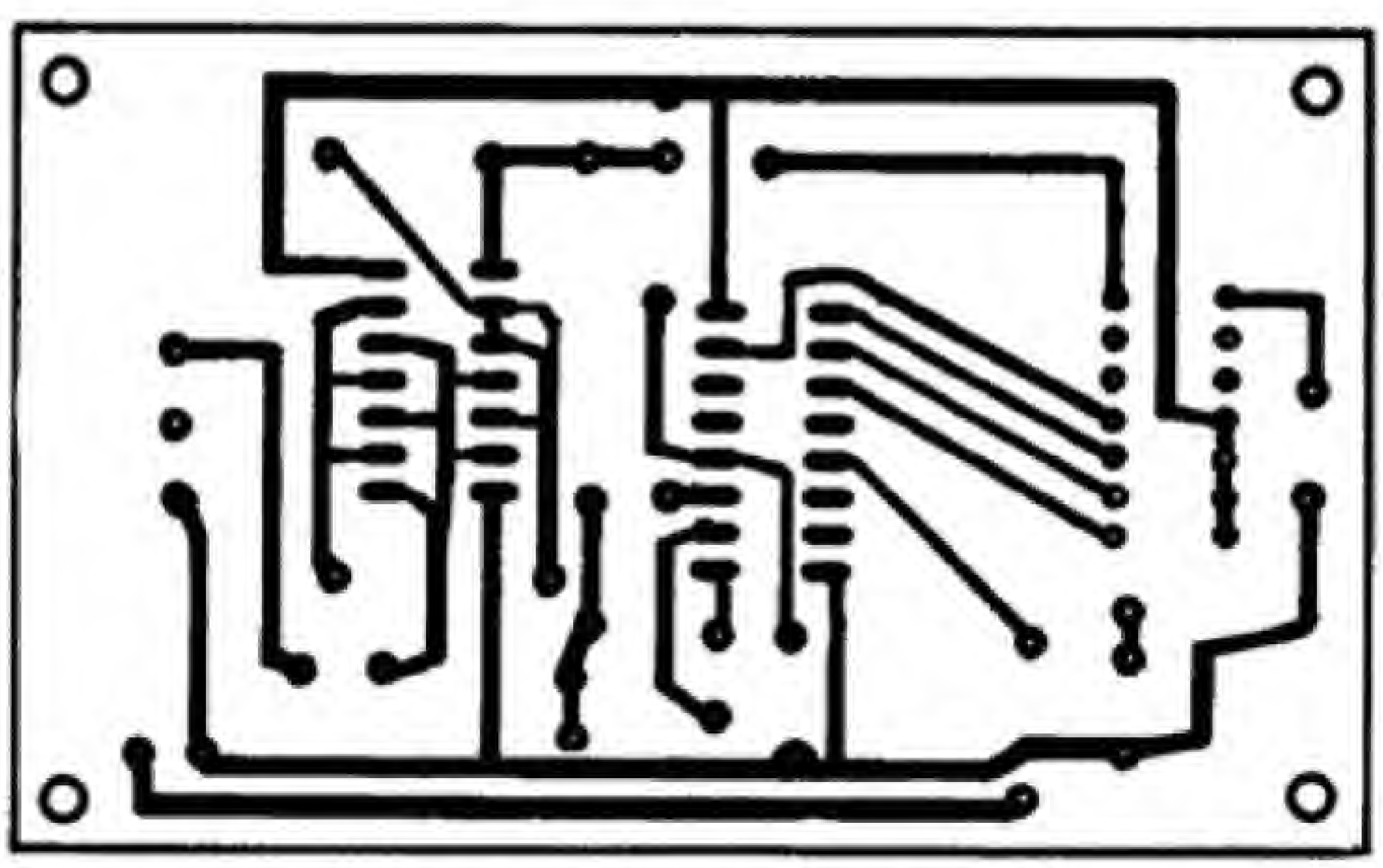


Fig. 3: PCB layout for the circuit shown in Fig. 2.

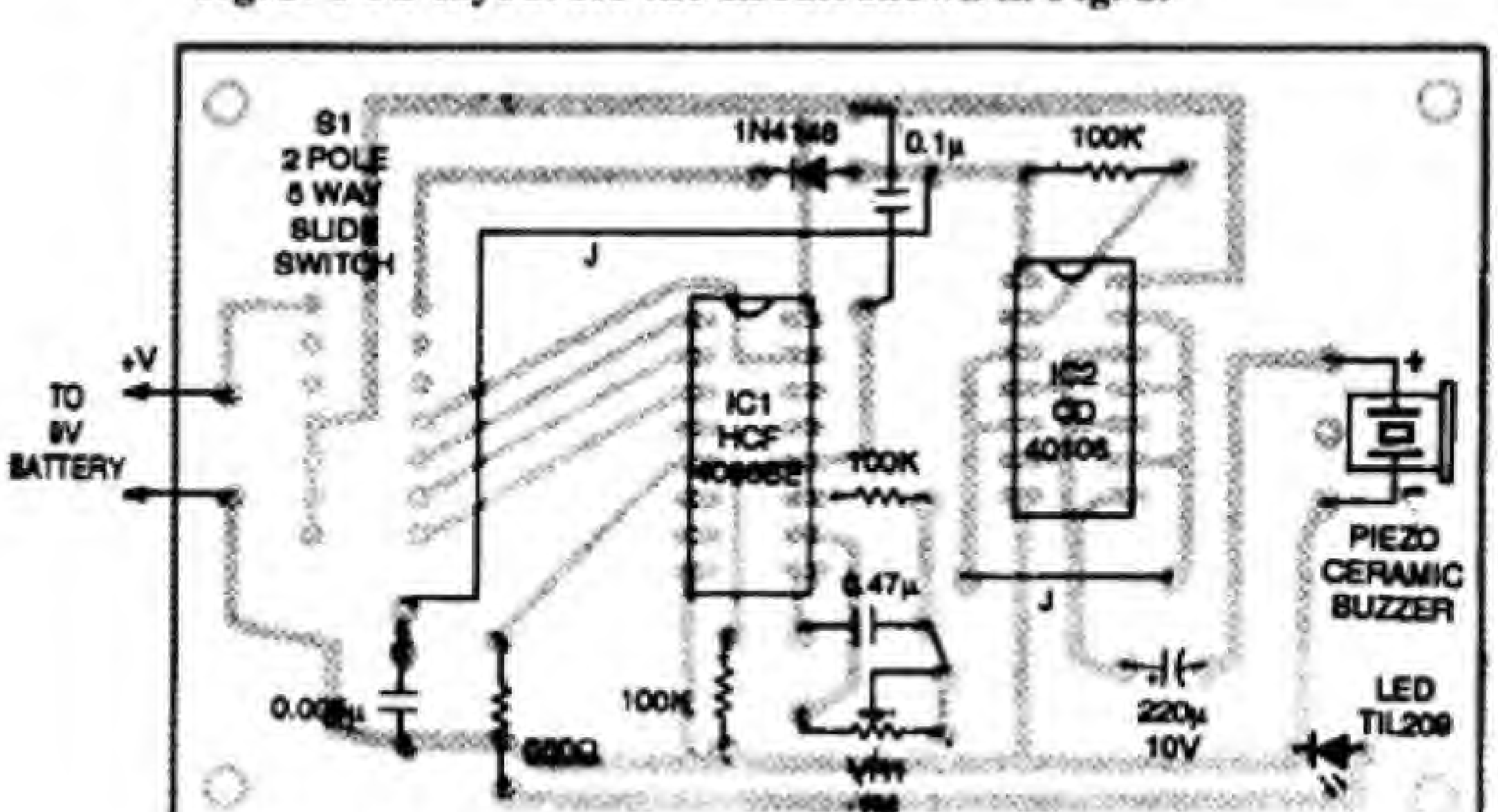


Fig. 4: Components layout for the PCB shown in Fig. 3.

Many readers would argue that a simple conventional piezo type buzzer would eliminate the second IC from the circuit, if a single driver transistor was used along with. But, a simple piezo buzzer and a silicon driver transistor also consumes several milliamperes of current, even in quiescent state, and at the same time increases the profile/thickness of the device. Instead of keeping the LED permanently on, it has been designed to flash at a low frequency, once every few minutes. No conventional decoupling capacitor has been used. Current remains in the microampeer region in quiescent state. The maximum current when the alarm is sounding is a few milliamperes.

Construction

The complete timekeeper can be assembled on a piece of veroboard or a breadboard or stripboard, but the best would be use the PCB shown in Fig. 3. The PCB has been made according to the 'all-on-one-board' concept which lends a lot of reliability by avoiding most external connections and thus eliminates chances of failure due to snapping of wires.

Begin the construction by soldering the resistors, followed by the capacitors and the LEDs, diodes and IC sockets. Don't try soldering an IC directly unless you trust your skill in soldering. All components should be soldered as shown in Fig. 4. Next, connect the piezo speaker to the PCB and glue it into position using a rubber based adhesive. Now connect the switch and then solder/screw it on the PCB using multiple washers or spacers. Soldering it directly will only reduce its height above other components, and hamper in its easy fixation in the cabinet. Now connect the battery lead.

The circuit can be enclosed in any kind of cabinet, just anything from a small pocket radio's to an old calculator's. We used a playing cards-box sized enclosure. Before fitting the PCB, suitable holes must be drilled in the cabinet for the switch, LED and piezo speaker. Note that a rotary switch can be used instead of a slide type.

Switch on the circuit to the desired range. It will automatically start its timing cycles. To be sure that it is working properly watch the LED flash and tuck away the timekeeper in your pocket. The components are selected to trigger the alarm a few minutes before the set limit as shown in Table I.

This pocket-sized timekeeper would cost about Rs 75, saving you both time and money! ❑

Readers' Comments:

1. Since the author is stressing on power consumption, a push-to-on switch can be connected in series with the indicating LED.

2. As the circuit is not meant to produce sound for a long period, the piezo buzzer can perhaps be connected directly to the output of IC1. This would make the circuit compact and cheaper by eliminating IC2.

NARENDRANATH BHOWMICK
Nowgong (Assam)

Electronic Number Shooting Game

A. Jeyabal

TV and video games have become very popular, both with children and grown-ups. These games provide good recreation as the animated figures make the player feel as if he is actually playing with another human being.

The circuit described here is the basic circuit for all electronic games of this kind. Once you assemble it only a little imagination is required to make other games.

In this circuit, costly and not easily available LCD panel is avoided and only LEDs are used for display. For low static power dissipation, fully CMOS ICs are used.

The game and how to play it

Like all electronic video games this one also tests one's reflex action, i.e. the speed with which one reacts. The quicker one acts, the faster one scores over the opponent.

Nine switches are used in 3x3 matrix form. In the same way, nine LEDs are fixed in identical places (Fig. 7). These LEDs are lit one by one at random. The player has to press the switch of identical place where the LED glows. If the switch is pressed before the LED goes off the player scores one point.

The circuit

Fig. 1 shows the block diagram of the circuit. The pulse generator produces positive clock pulses to run the random number generator and for the proper operation of debouncer and foul play checker circuit.

Ten outputs of the random number generator go high one by one on every positive clock pulse. The outputs are buffered before connection to the LEDs of the display circuit for good illumination. The triggering circuit contains nine switches for shooting (triggering) the number in this game. The circuit may have only one or a few switches in other games. A debouncer and a foul play checker circuit prevents the player from using unfair means. It also shapes edges of the trigger pulses.

One output is taken from debouncer circuit to the counter/driver circuit for the scoreboard.

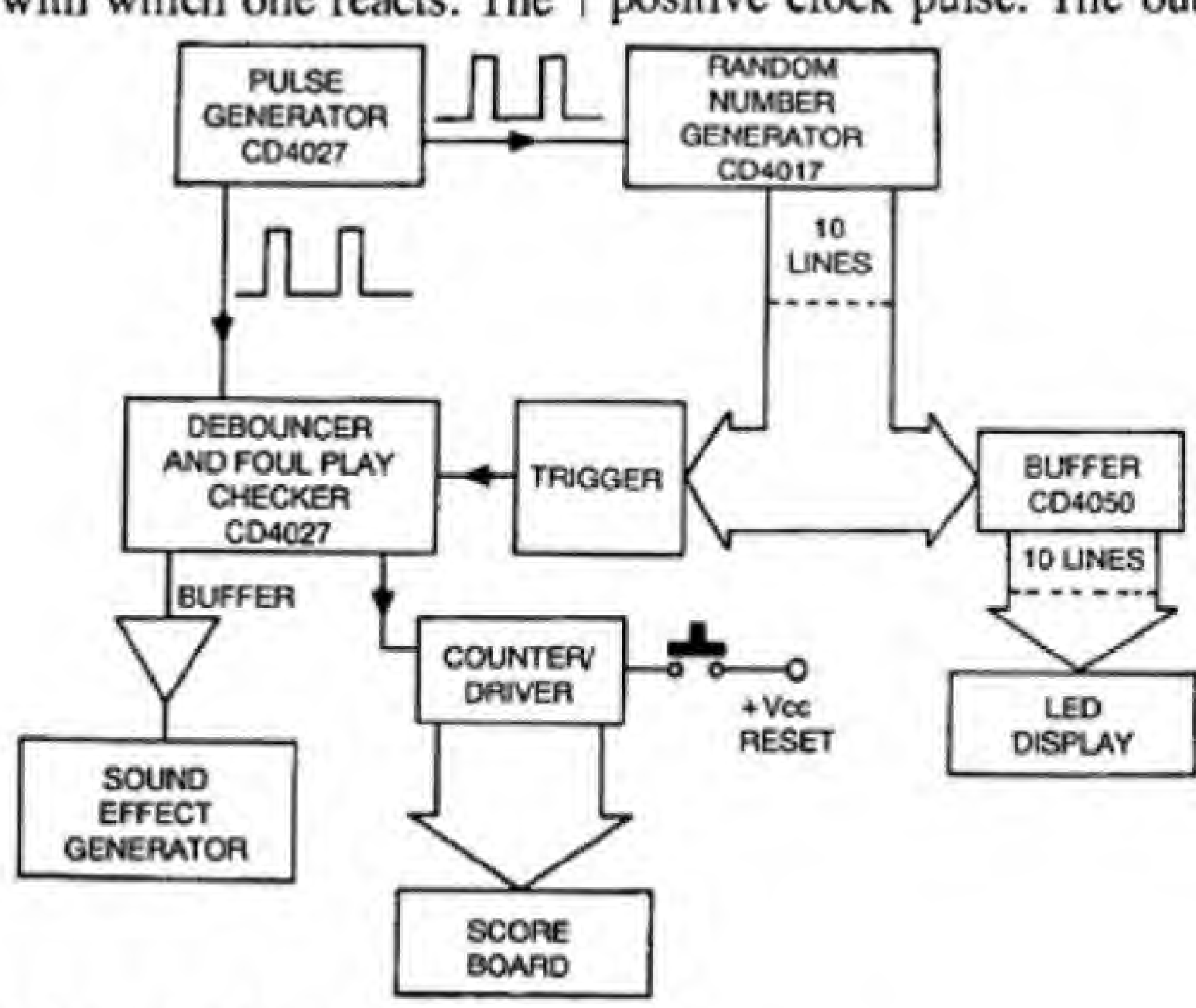


Fig. 1: Block diagram for number shooting game.

Clock pulse generator circuit

Let us first see the requisite of the clock pulses. It takes us some time (fraction of a second) to react to an action. The reaction time varies from individual to individual. If a period of one second (that is LED glow period) is allowed as reaction time, the player would surely shoot all the randomly generated numbers. If it is 0.5 second then the player has to show some skill. A challenge begins when the set time period is 0.3 seconds. With this setting, one has to press three switches (of course the correct one) every second. Below 0.3 seconds more swiftness is required to score more.

So, for our game, a maximum variable period of one second between successive clock pulses is required. Usually, timer ICs, inverters, NAND, NOR or schmitt trigger NAND gates are employed to produce clock pulses. But here JK type flip-flop is used because of the foul play checker circuit. These

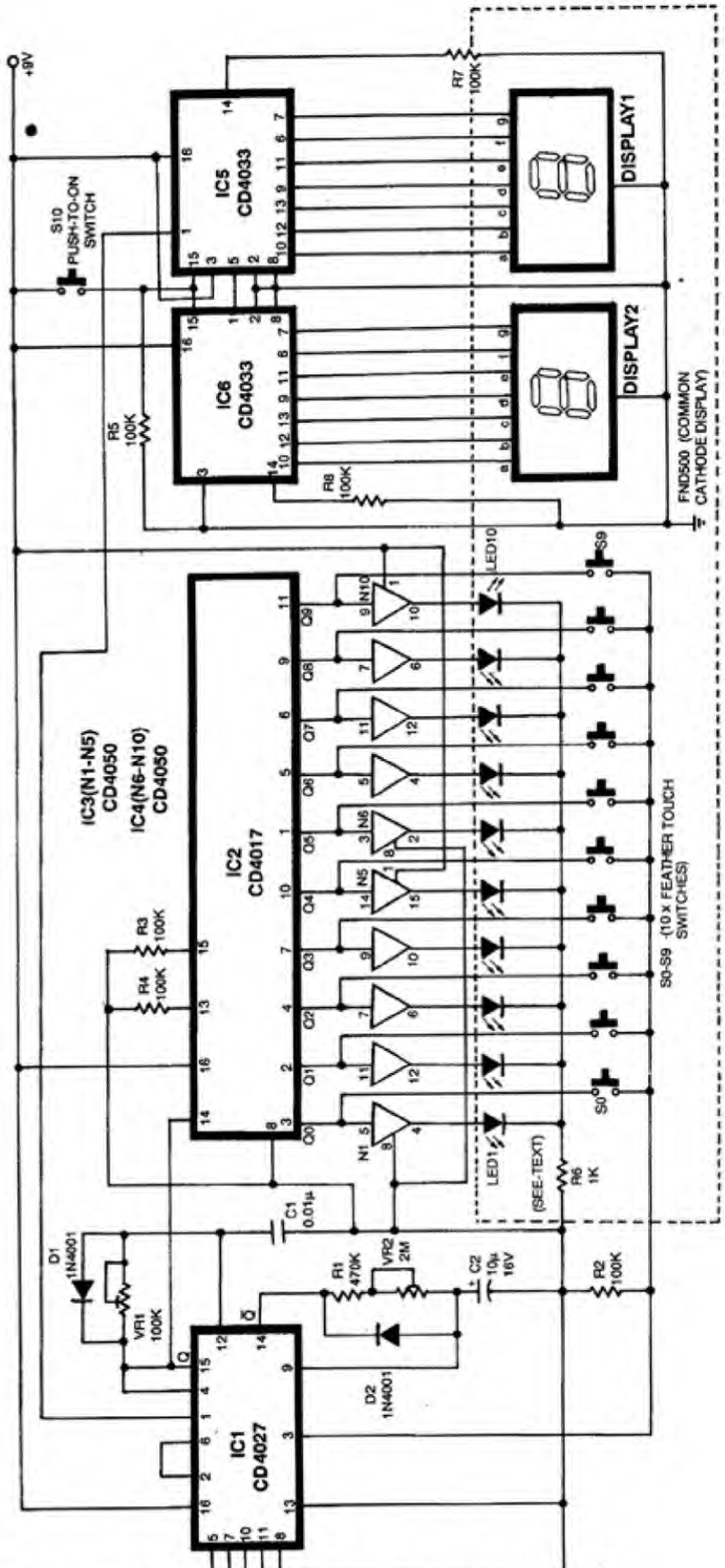


Fig. 2: Circuit diagram for shooting game.

PARTS LIST

Semiconductors:

IC1	— CD4027, JK flip-flop
IC2	— CD4017, decade counter/divider
IC3, IC4	— CD4050, hex buffer
IC5, IC6	— CD4033, decade counter/7-segment display driver
D1, D2	— 1N4001

Resistors: (All 1/4W, ±5% carbon, unless stated otherwise):

R1	— 470-kilohm
R2-R5, R7, R8	— 100-kilohm
R6	— 1-kilohm
VR1	— 100-kilohm linear potentiometer
VR2	— 2-megohm linear potentiometer

Capacitors:

C1	— 0.1µF ceramic disc
C2	— 10µF/16V electrolytic

Miscellaneous:

S0-S10	— Push-to-on switches
	— FND500 displays (two)
LED1-LED10	— LEDs

being two flip-flops in a single chip. So the unused flip-flop is wired as an astable multivibrator.

CMOS ICs for almost all their operations such as setting, resetting, changing states require positive going clock pulses. The output of CMOS IC2 is high and the LED stays lit until the arrival of the next clock pulse. The player has to shoot the number by pressing the correct switch before the beginning of the next clock pulse. Hence the period between the two consecutive pulses should be variable.

Fig. 2 shows the circuit diagram of number shooting game. The clock pulse generator circuit is wired around half of CD4027 (IC1) which is a dual JK type flip-flop. Suppose IC1's output Q (pin 15) is high and $\overline{Q}$ (pin 14) is low, then capacitor C1 charges through VR1. When the voltage across C1 crosses half of the power supply voltage, it resets the output Q to low and C1 discharges through D1. Now $\overline{Q}$ being high and Q low, C2 charges through VR2 and R1. When C2 reaches half of the power supply voltage it again sets Q to

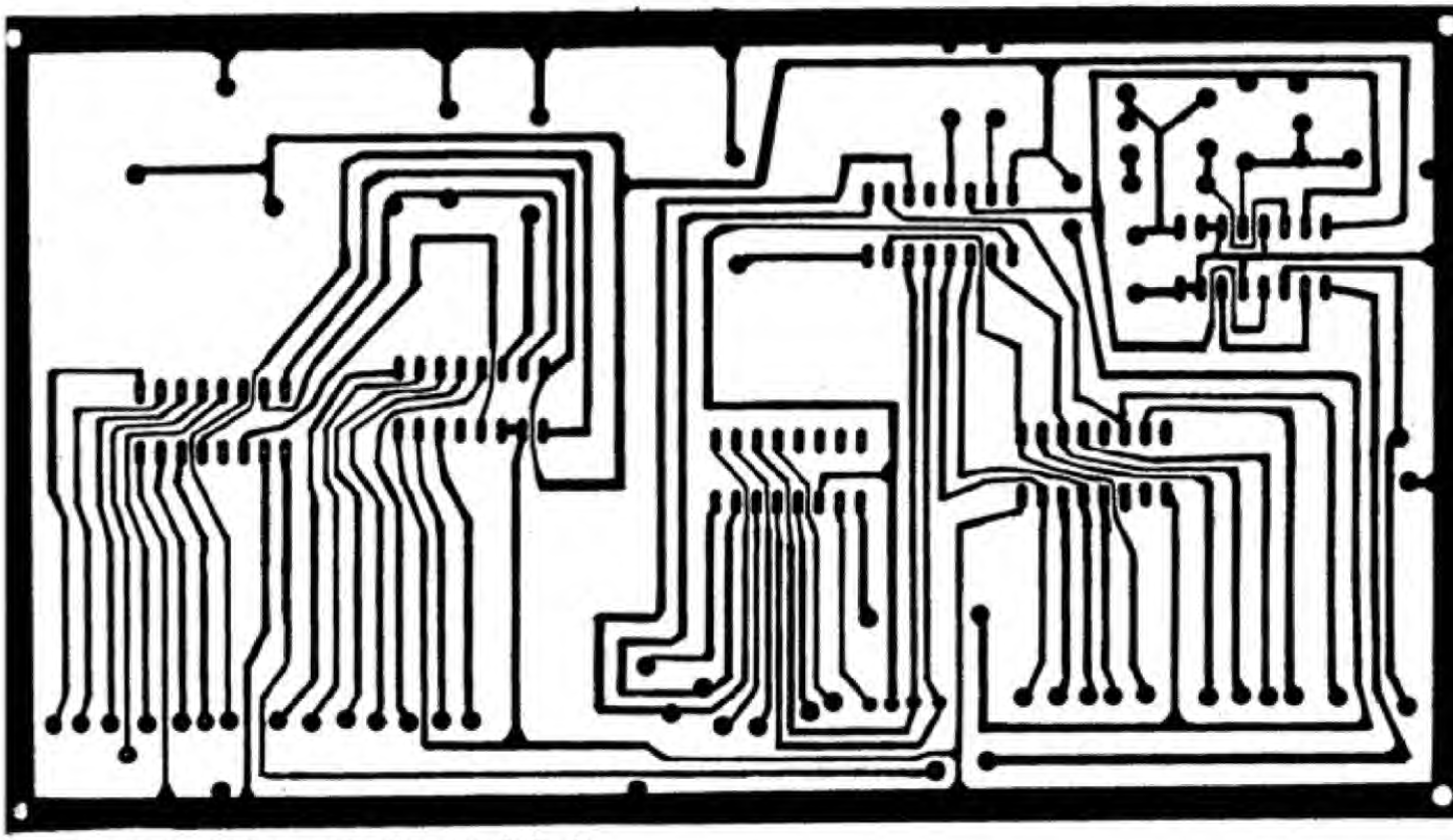


Fig. 3: Actual-size PCB layout for the control circuit.

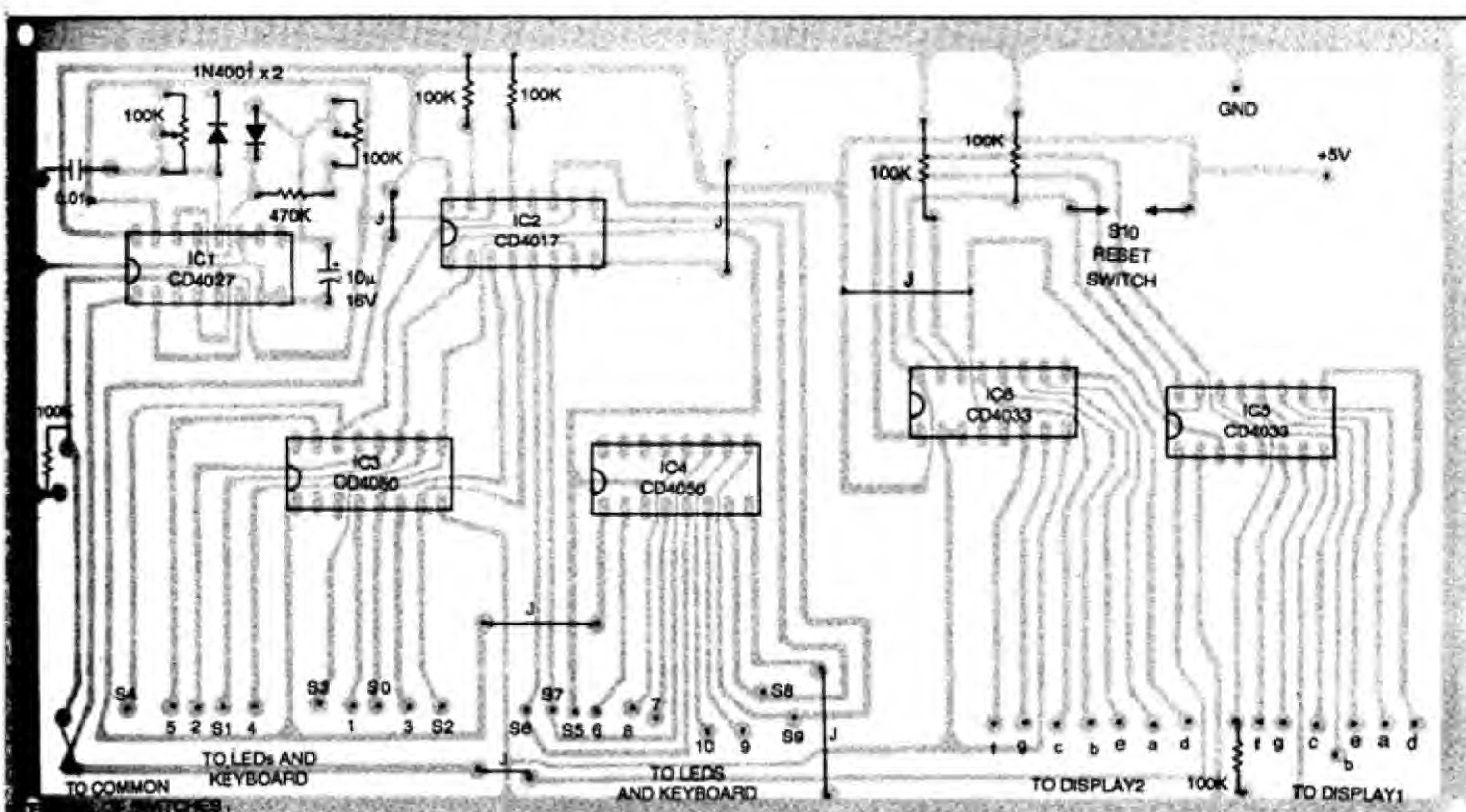


Fig. 4: Components layout for the PCB shown in Fig. 3.

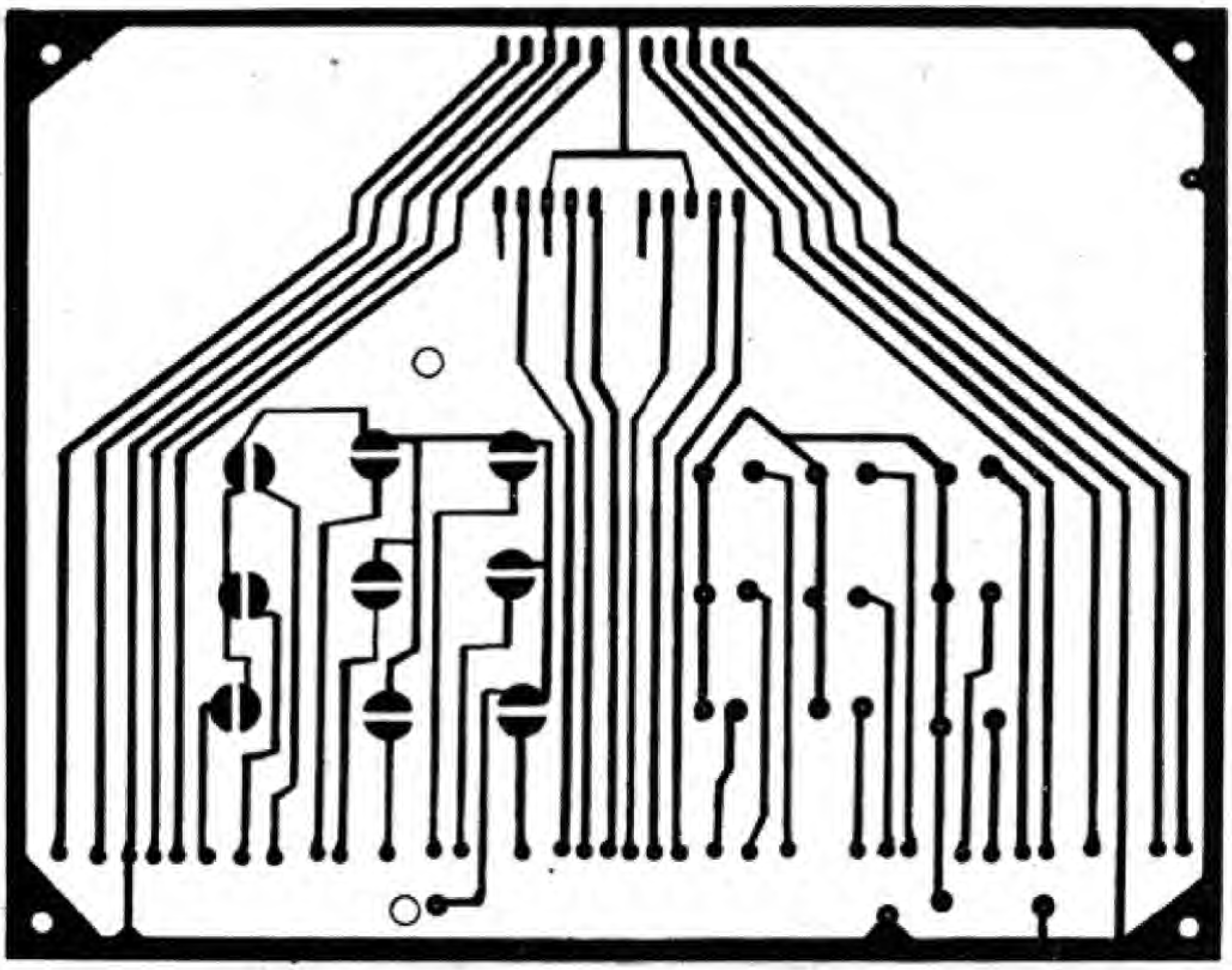
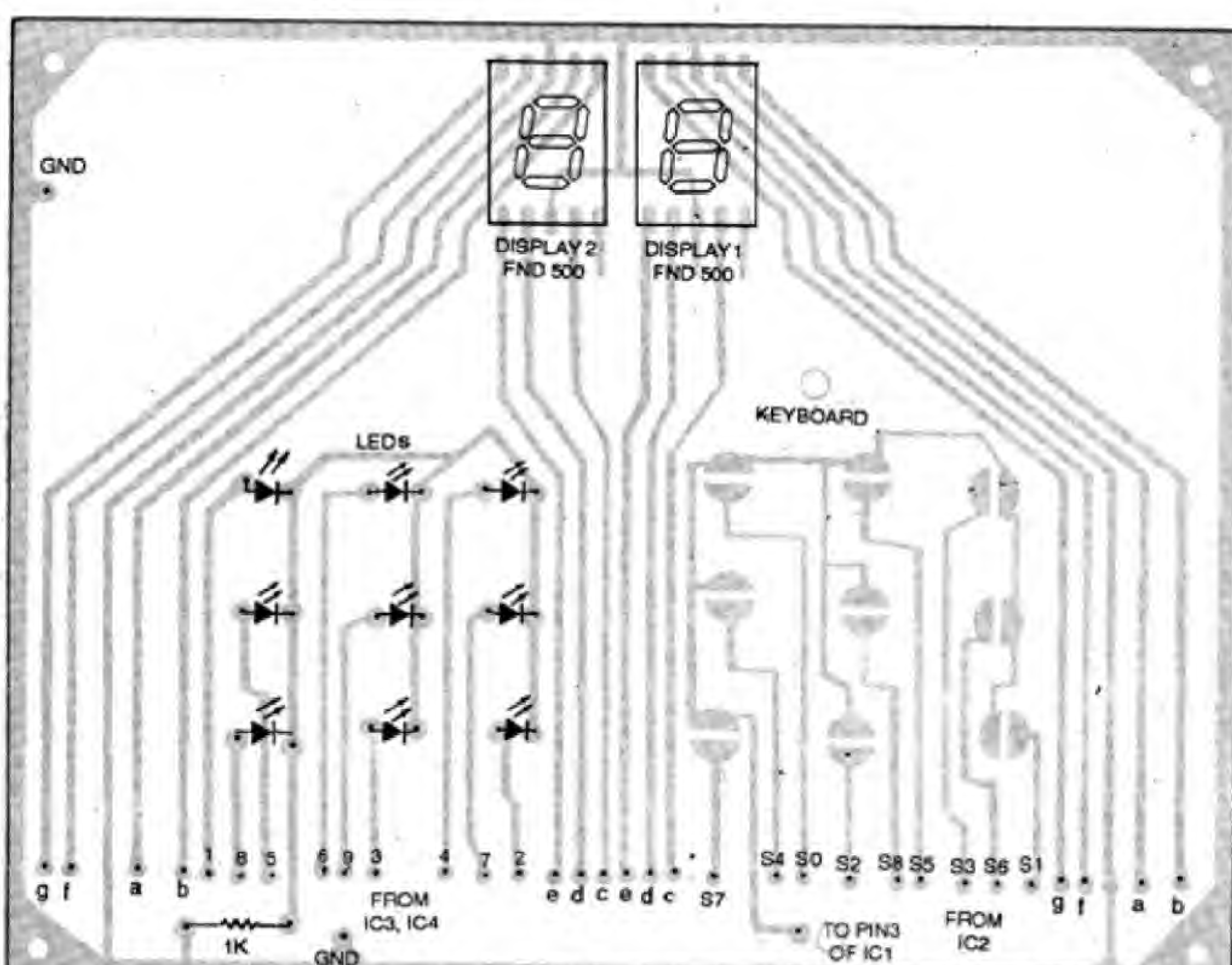


Fig. 5: Actual size PCB layout for dotted lines shown in fig.1.



'ig. 6: Components layout for the PCB shown in Fig. 5.

1	2	3
4	5	6
7	8	9

DISPLAY POSITION OF LEDs

Q0	Q5	Q3
Q4	Q8	Q6
Q7	Q2	Q1

Q OUTPUTS CONNECTED TO LEDs

S0	S5	S3
S4	S8	S6
S7	S2	S1

SWITCH POSITIONS

Fig. 7: Arrangement of switches and LEDs.

high and $\overline{Q}$ to low. Here C2 discharges through D2. Thus the cycle repeats. VR2 sets the low period and clock pulses are taken from output Q.

Random number generator, trigger, buffer, and display circuit

CD4017 (IC2), a decade counter/divider, is used for random number generation. Actually this IC does not produce any number. But its ten outputs go high one by one for every positive going clock pulse and each output remains high until the next clock pulse comes. So only one output remains high at a time.

The first nine outputs Qo through Q8 (and all ten outputs in other games) are buffered by CD4050 (IC3, IC4) and connected randomly to the nine LEDs placed and numbered in order. Thus random position here means random number generation.

In our case the numbers generated are 1,9,8,3,4,2,6,7 and 5, and the cycle repeats. One can connect the outputs to LEDs (after buffering) in any order.

One terminal of the triggering switches are connected to the outputs of IC2 and the common terminal is taken to the debouncer circuit (pin 3 of IC1).

The 100k resistors connected to reset terminal (pin 15) and chip enable (pin 13) of IC2 connect these pins to ground in this game. These pins can be used in other games.

The LED current limiting resistor R6 of 1k is chosen to get optimum illuminance of LEDs. Its value may be increased or decreased. But do not try to approach the maximum current limit of LEDs or IC 4050.

Debouncer and foul play checker circuit

All mechanical switches when activated bounce before coming to the steady state and produce spurious pulses that result in erratic operation of the circuit.

One may try foul play by pressing a switch before the identically positioned LED lits or pressing the switch repeatedly in an effort to score more points.

So for a fool-proof system, the circuit requirements are:

(a) The spurious pulses must be ignored.

(b) Only one point must be given even if one triggers several times during the LED's lit period.

(c) The triggering before any LED lits must be ignored.

All these conditions are easily met by the JK flip-flop. Once the clock pin 3 of IC 4027 is triggered positively its output at pin 1 goes high and activates the counter. At the same time the output at pin 2 (which is connected to pin 6) goes low. As pin 5 input is also low the IC is inhibited and ignores further pulses (requirements a and b).

The output changes the state only on positive going pulse. Suppose one keeps pressing the switch and waits for the respective LED to lit. When any output of IC2 is high the clock input of IC 1 (pin 3) gets high as the corresponding switch is kept pressed. But Q output of IC1 will not change its state. Because the reset pin (pin 4) is also receiving positive clock pulses from the clock pulse generator, it overrides all output at pin 1 to low state.

Though the reset pin goes low when the switch is kept pressed, the output will not go high as only the positive going clock pulse will change the output, i.e triggering after the LED is on.

Counter and scoreboard

Any CMOS compatible counter and display may be used, but here (CD 4033) a decade counter/seven-segment driver and common-cathode LED display is used. The 100k resistor connected at lamp test terminal (pin 14) is useful for checking the display. When this terminal is high the display should light up all segments. Switch S10 is used for resetting the counter.

Sound effect generator

When a successful shooting is announced by a sound, it is more exciting. Sound generation can be obtained if the output of debouncer JK flip-flop is buffered before being connected to the piezo buzzer. It may also be connected to the gun sound generator or any other circuit like it.

Construction

The soldering sides of the PCBs and the component layouts are shown in Figs 3, 4, 5 and 6. All measures have been taken to make the design flexible and to suit all similar games. For this reason the reset and clock enable pins of IC2 are grounded through 100k resistors. Besides, two PCBs are being recommended, one for the control circuit (which should remain common) and the other for display and switches.

As the PCBs are small they can be fixed easily on available plastic cabinets. You will be surprised to see that many games can be played simultaneously. So wait until you decide on the number of games you prefer. Then choose the cabinet.

Nine LEDs and switches are arranged in a rectangular shape. However, all the ten outputs (including output Q9 of IC2) can be used to get any shape. And don't forget that the arrangement of LEDs and switches must be identical.

LEDs of any shape and colour can be used but the flat type will give a better look. For triggering, switches of any type, from membrane to simple push-to-on or even switch pad of a worn-out calculator, would serve the purpose.

CMOS Digital Clock With On-Off Timer

Rameshwar

The circuit presented here can be used to control any instrument for a particular time duration in your absence. The circuit is very efficient and simple to construct. It is based on CMOS decade counter CD4017 and NAND gates CD4011 and CD4012. These ICs are easily available and are quite cheap.

The heart of this digital clock is a time counting circuit. For the seconds counter, CD4017 has been used as divide-by-ten (IC6) and divide-by-six (IC5) counters for unit and tens digits respectively. The minutes counter (IC4 and IC3) is identical to the seconds counter. For counting hours, IC 4017 has been used in divide-by-ten (IC2) and divide-by-three (IC1) counter mode for unit and tens counters respectively. The clock counts in the 24-hour mode. A very simple circuit using 2-input NAND gate (1/2 IC 4011) has been used to reset the hours counter at the 24th hour.

Another counter (IC7 and IC8) has been provided to produce 1Hz frequency for the seconds counter. This divides the input by a factor of 50. It consists of two 4017 ICs. Base frequency (50 Hz) for this counter can be obtained from mains frequency. This counter can be eliminated by giving 1Hz pulse to seconds counter from any other source such as a quartz clock. LEDs are used to display the time on an analogue scale as shown in Fig.4. For example, to indicate the time 23:49:36 hrs, the sixth LED of unit and third of tens on seconds scale; ninth LED of unit and fourth of tens on minutes scale; and third LED of unit and second of tens on hours scale will glow.

To adjust the clock time, two clock set switches have been provided. By pressing 'slow' (S11) and 'fast' (S10) switches, minute advances at a rate of 1 per second and 10 per second respectively. To reset the clock, a reset switch (S9) has been provided. A start/stop switch (S12) is provided to stop and start the counting of time. The clock can be used as a stop clock with the help of S12 and start/stop switches.

For setting and detecting the On-Off time, a very simple circuit has been used. It consists of eight rotary switches—four single-pole 10-way, two single-pole 6-way and two single-pole 3-way type. IC 4012 is a dual 4-input NAND gate and IC 4011 is a quad 2-input NAND gate.

'On' time can be selected by switches S5, S6, S7 and S8 while 'off' time can be set by switches S1, S2, S3 and S4 by keeping them at required positions.

NAND gate N5 will detect the 'on' time by keeping its output low only at previously set 'on' time. Second NAND gate N6 will detect the 'off' time by keeping its output low at previously set off time. The outputs of N5 and N6 are inverted by N3 and N4 respectively to obtain high output for driving a R/S flip-flop which can be used to control a relay circuit.

Here CD4017 (IC9) has been used as the R/S flip-flop. The output has been taken from Q1 (pin 2). The set signal is fed to clock input (pin 14) and reset input is fed to reset pin (pin

PARTS LIST

Semiconductors:

IC1-IC9	— CD4017 decade counter
IC10	— CD4011 quad 2-input NAND gate
IC11	— CD4012 dual 4-input NAND gate
T1	— SL100B npn transistor
D1-D4	— 1N4001 silicon diode

Resistors (all 1/4W, ±5% carbon unless stated otherwise):

R1-R4, R7, R8	— 1-kilohm
R5	— 4.7-kilohm
R6, R9-R16	— 100-kilohm

Miscellaneous:

RL1	— 12V, 100-ohm SPST relay
S1, S3, S5, S7	— Single pole, 10-way rotary switch
S2, S6	— Single pole, 6-way rotary switch
S4, S8	— Single pole, 3-way rotary switch
S12	— On/off toggle switch
S9-S11	— Push-to-on switch
	— LEDs (45 nos)

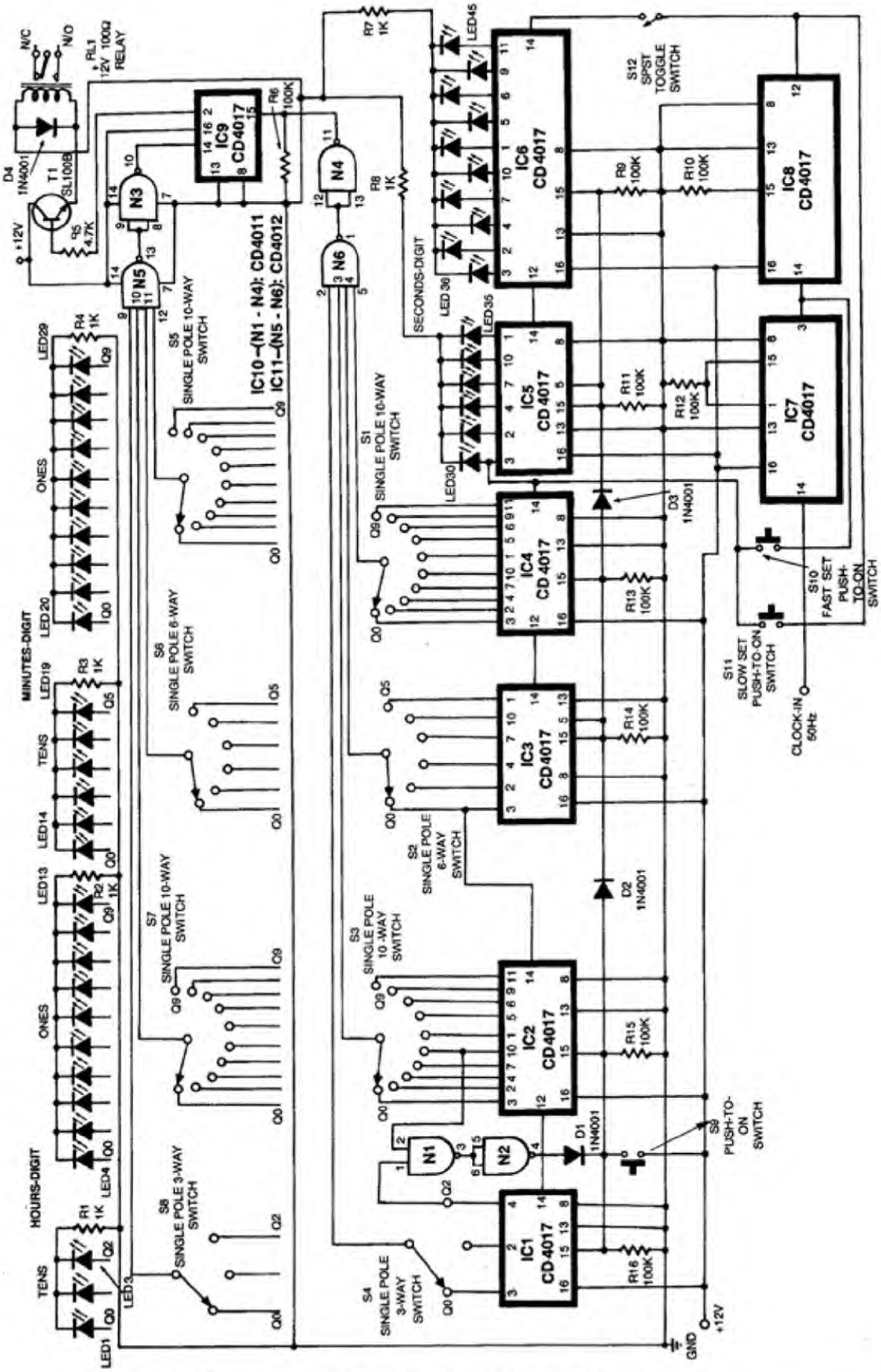


Fig. 1: Circuit diagram for the digital clock with on-off timer.

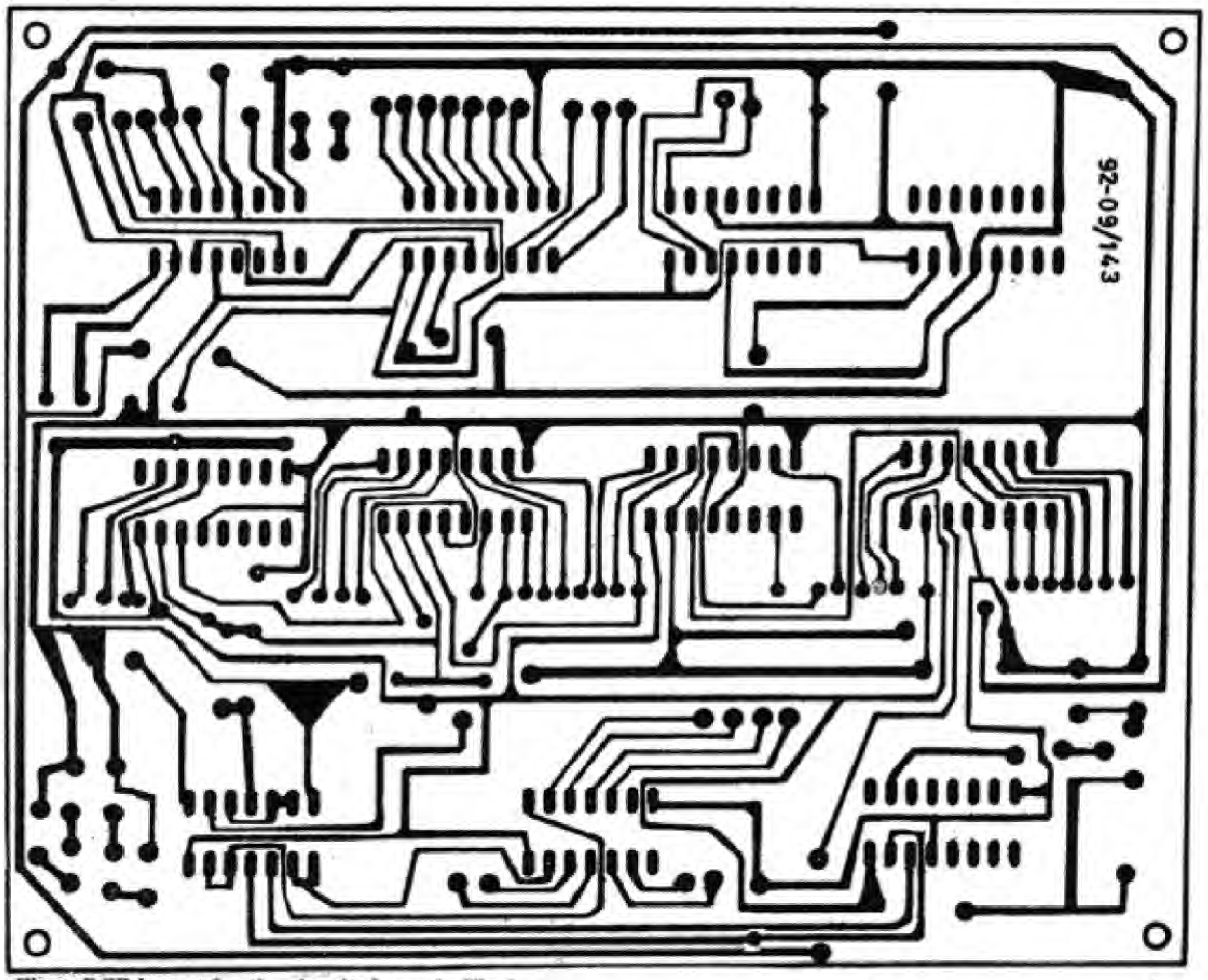


Fig.2: PCB layout for the circuit shown in Fig.1.

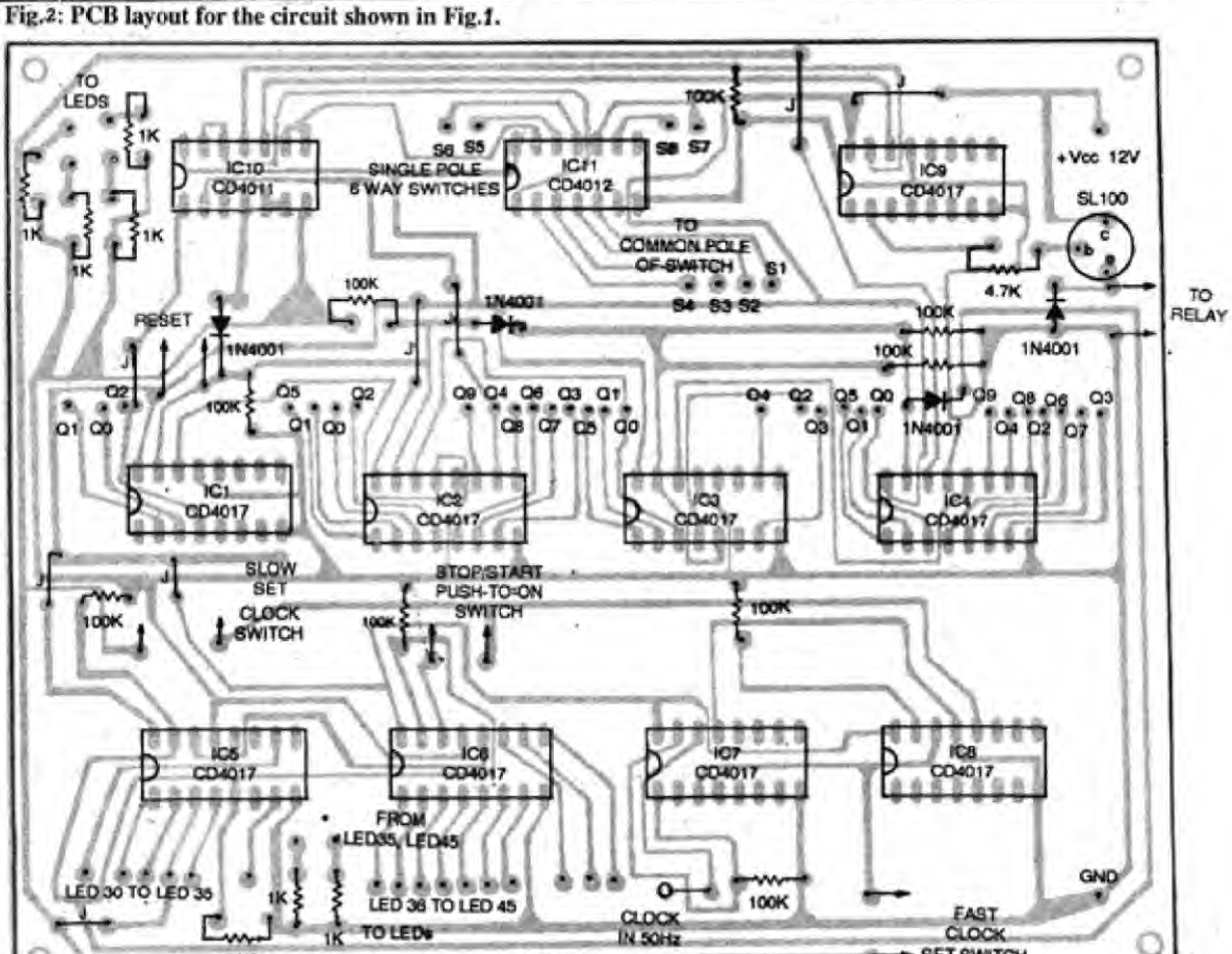


Fig. 3: Components layout for the PCB shown in Fig. 2.

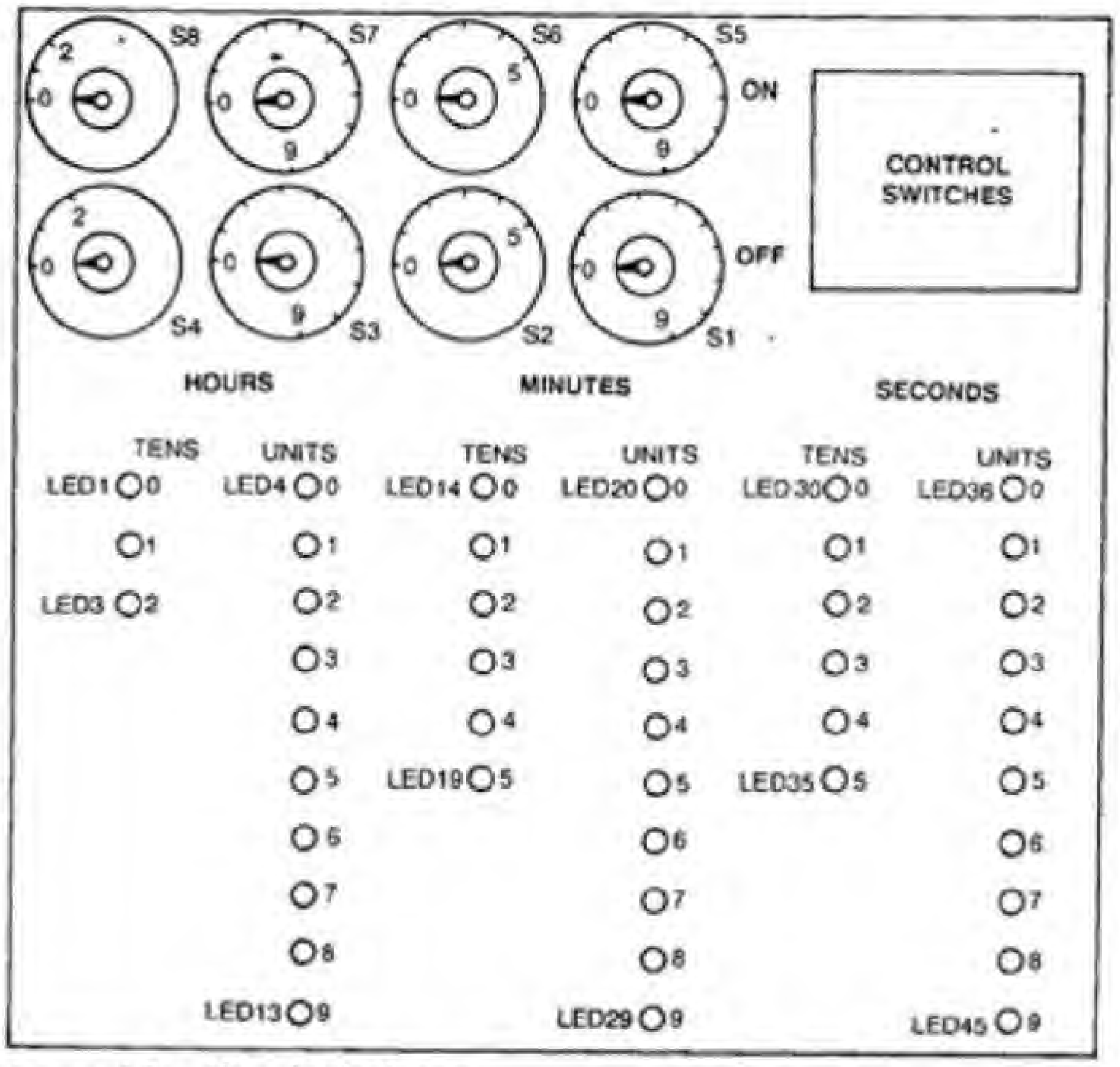


Fig. 4: Front panel for the clock timer.

15). When the supply is received, Q0 becomes high while Q1 to Q9 remain low. When time reaches the 'on' set time, a positive going pulse appears at pin 14 and IC 4017 counts one. So Q1 becomes high, energising the relay. After the lapse of the operating time, 'off' set time provides a positive voltage to the reset pin . As a result the IC and Q1 become low, de-energising the relay. Now the flip-flop is ready for the next cycle. A proper rating triac may be used in place of relay.

This circuit can be used with a 12V unregulated power supply. The complete digital timer can be assembled on a piece of veroboard or a breadboard or stripboard, but the best would be to use the PCB shown in Fig. 2. The PCB lends a lot of reliability by avoiding most external connections and thus eliminates chances of failure due to snapping of wires.

Begin the construction by soldering the resistors, followed by the capacitiros, diodes and IC sockets. Never solder an IC directly unless you trust your skill in soldering. All components should be soldered as shown in Fig. 3. Next, connect all the rotary switches and LEDs on a general-purpose board as shown in Fig. 4. Make connections between PCB and the general-purpose board as per circuit diagram. The circuit would cost around Rs 200.

❑

Readers' Comments:

I wish to draw the attention of the author of 'CMOS Digital Clock with On-off timer' published in EFY Sep.'92 issue to the following:

1. Pin 14 of IC4 is connected to pin 3 of IC5. It should be connected to pin 1 of IC5. Since IC5 receives pulses after every 10 seconds from IC6 (pin 12) and counts up to sixth pulse, it will give a pulse after every minute to IC4 that counts up to 10 minutes. Now pin 1 of IC5 will go high after 60 seconds and till that time pin 3 of IC4 will remain high. After another 10 seconds IC5 receives input pulse from IC6 and drives LED30 at pin 3 which is connected to pin 14 of IC4. This pulse is counted by IC4 and gives 1 minute indication at pin 2 through LED 21 but every minute will be indicated 10 seconds later.

2. Similarly, IC3 receives every 10 minutes pulse from IC4 and drives IC2. Here also after counting till 60 minutes IC3 gives a high at pin 3 and sends a pulse after another 10 minutes, so actually IC2 will count an hour 10 minutes later.

3. Why are the resistors R9-R16 (100k) used?

UMESH MEHRA
Kota

❑ I am interested in assembling the circuit of CMOS digital clock. But I would like to know whether the displays can be used instead of LEDs and how these can be used.

VIDHESH PANDEY
Unnao (U.P.)

The author, Mr Rameshwar, replies: The connection of pin 14 of IC4 to pin 3 of IC5 is correct. Actually, IC5 counts through Q0 to Q6, i.e. through pin 3, 2, 4, 7, 10, 1 and 5 but it displays only Q0 to Q5. Q6 (pin 5) has been used to reset IC5 at count 60. So instead of Q6, Q3 becomes high as clock should show '00' instead of '60' seconds. It is correct that IC5 will receive pulses after every 10 seconds from IC6 but it will take only 50 seconds to count through Q0 to Q5 as initially Q0 will be high to indicate '0'. Hence only pin 3 of IC5 can provide 60 seconds pulse to IC4 and the same is true for every hour count.

Resistors R9-R16 have been used to keep reset pins at ground potential so as to enable the counters.

Regarding Mr Pandey's question, it is advisable to use same display system as it is specially designed for LED's display.

However, the seven-segment displays can also be used by converting decimal outputs of IC1 to six-into-seven segment format. This can be done by following two methods.

1. By decoding decimal outputs into seven-segment format with the help of diode decoding matrix.

2. By encoding the decimal output into BCD format and then decoding this into seven-segment format with the help of respective ICs.

The construction project in EFY Sep.'92 issue wasn't very impressive. Besides, the information regarding the cost of the unit appears to be false. The switches alone cost Rs 270 in Bombay, as against the total cost of Rs 200 mentioned for the complete project.

KALPESH DALWADI
Bharuch

❑ The method of coupling 50Hz base (mains) frequency to the input of IC7 (pin 14) has not been given.

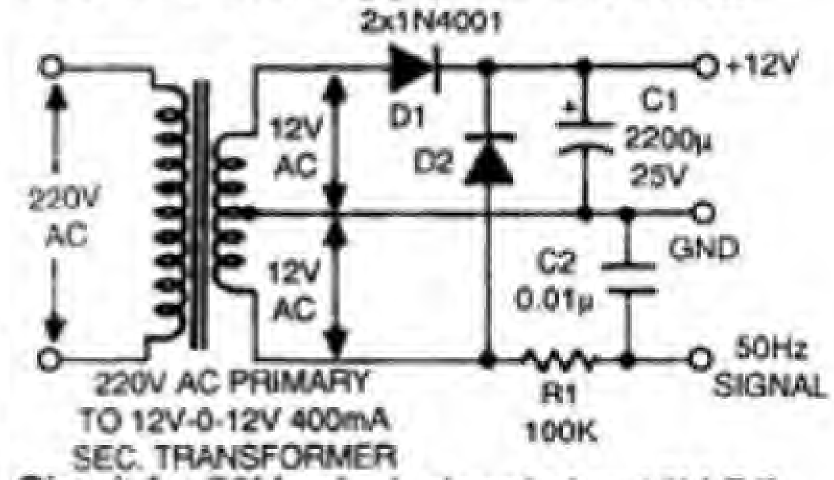
ROY VERGHESE
Kunnamhulam

❑ The article is good but please give a detailed circuit for converting the mains frequency to the clock frequency required for IC7.

SAMRAT BARTAKKE
Satara

The author, Mr Rameshwar, replies: As the circuit was designed way back in June '91, there may have been some escalation in costs.

I did not include the coupling part of the circuit as it is quite common to use the mains for deriving the clock frequency. However, I'm giving here a simple circuit for a 50Hz drive signal as a 12V DC supply for the clock.



Circuit for 50Hz clock signal plus 12V DC.

As the circuit uses CMOS ICs, any logic signal of 3 to 12V can drive this clock with a current of less than a milliampere.

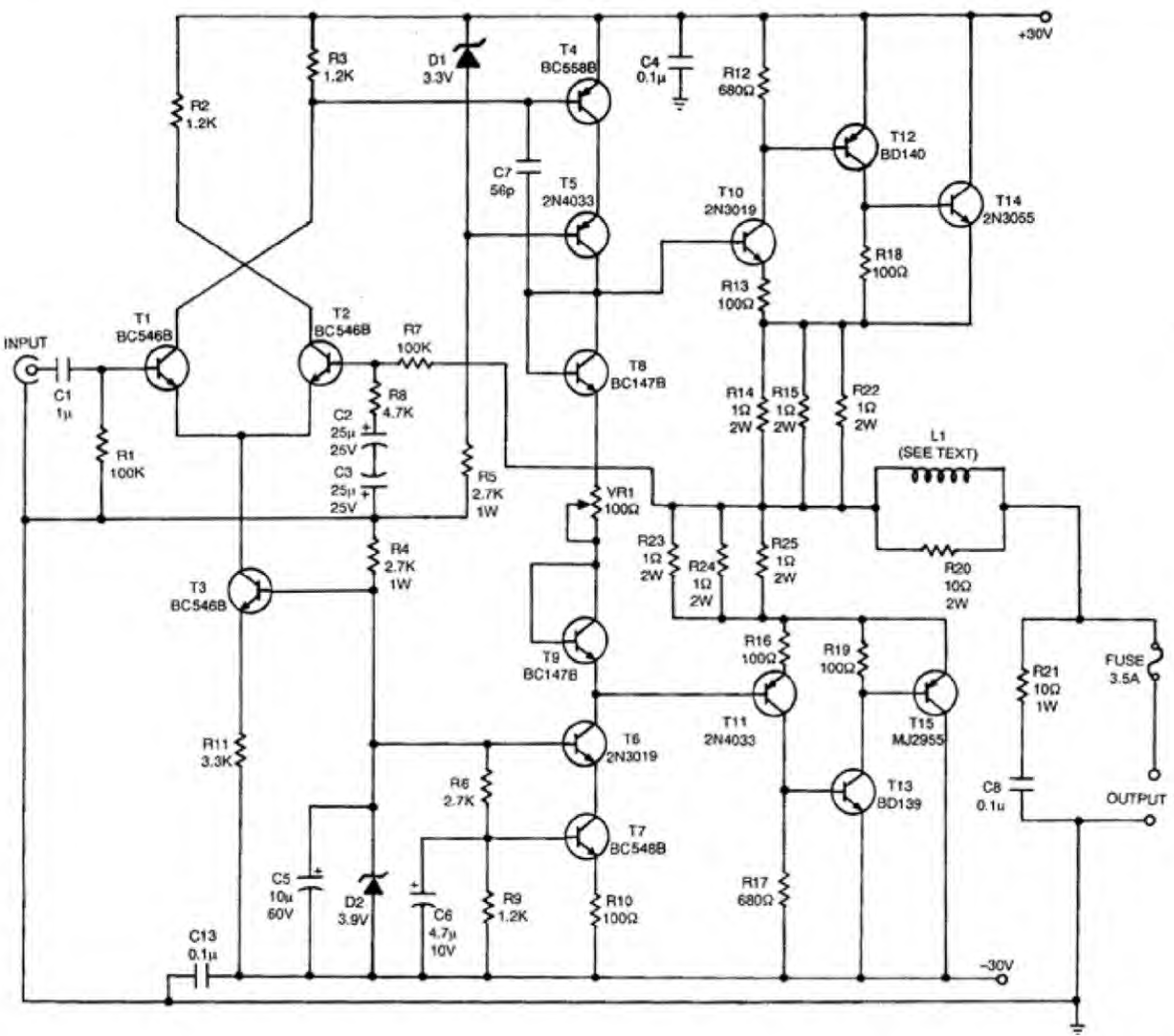
If you wish to give 1Hz pulse to the seconds counter then the fast-set switch cannot be provided, and also IC7 and IC8 would not be required. Fast-set switch can be provided with another fast signal source which may be produced with the help of a 555 timer IC.

70/40 Watts Hi-Fi Amplifier

C. Sanjay

This is one amplifier you may never have to replace by a better one. This amplifier gives a high output and at the same time has good specifications. The amplifier should be constructed in a standard 48cm (19-inch) cabinet to suit any rack. You can add this as one of the components to your 'professional' stereo system. A look at its specifications (see box) will show you how good a real hi-fi amplifier can be!

The circuit. The input is given to the base of transistor T1 which along with transistor T2 forms a differential



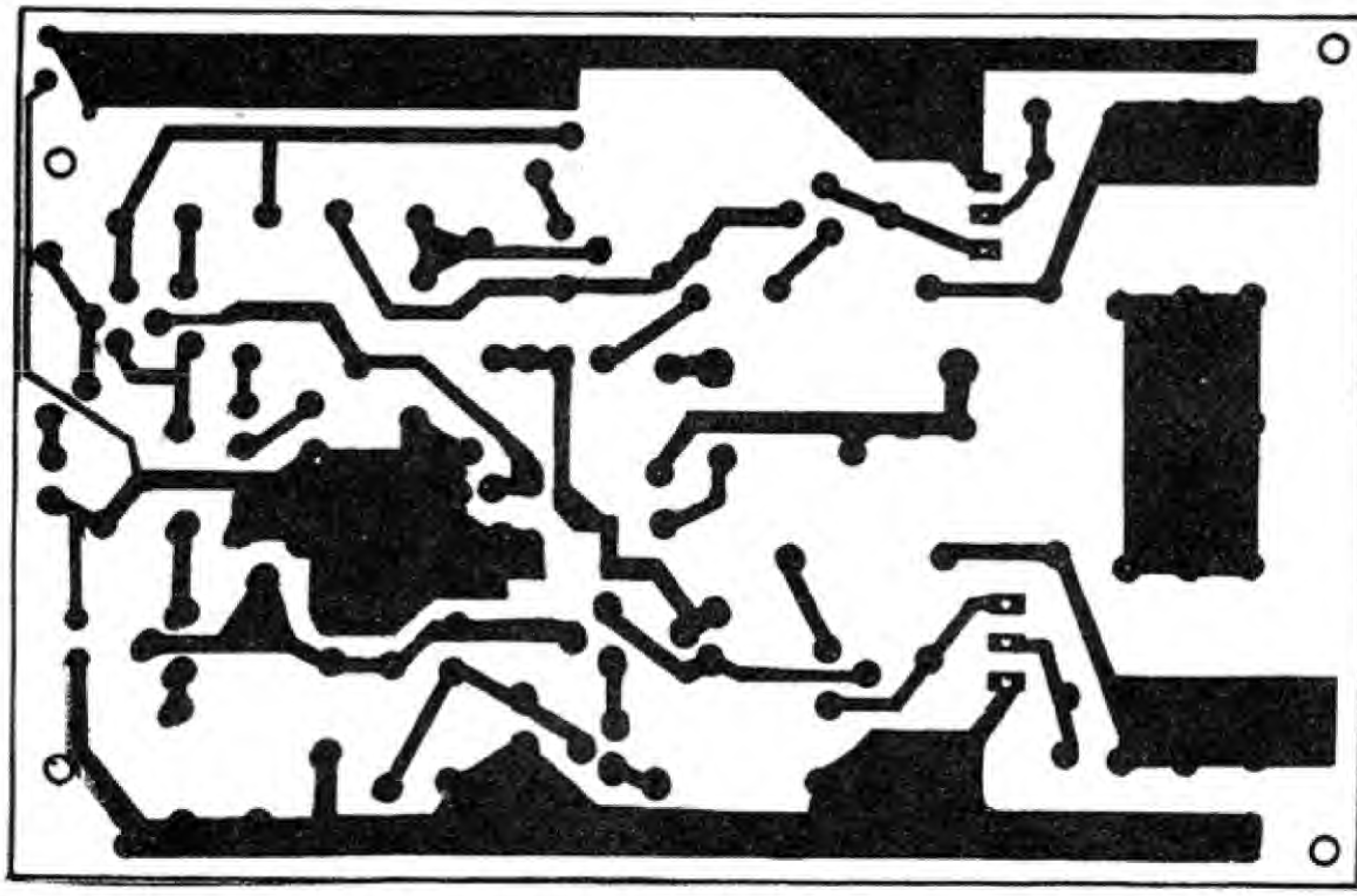


Fig. 2: PCB layout for the circuit shown in Fig. 1.

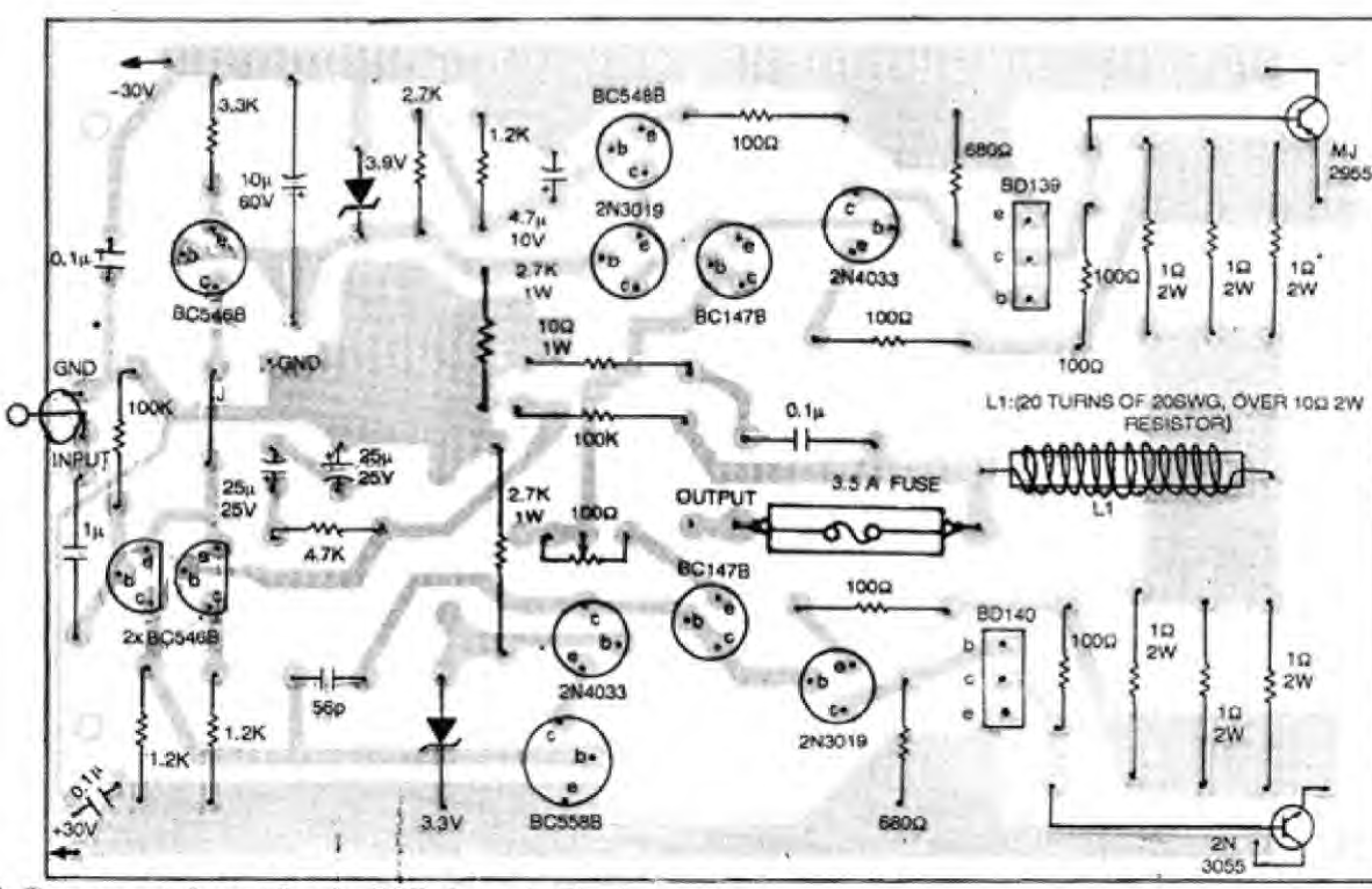


Fig. 3: Components layout for the PCB shown in Fig. 2.

pair whose current is maintained by T3. As a result, the output capacitor, generally used in amplifiers, is not used here, and a dual supply is also employed.

T1 drives transistor T4 directly which along with transistor T5, forms a cascaded pair in which all the power is dissipated by transistor T5 while the gain is that of T4's. The constant current source for T4 and T5 is provided by transistors T6 and T7 which are again cascaded for better results.

Transistors T8 and T9 act like diodes which compensate for the temperature coefficient of transistors T10

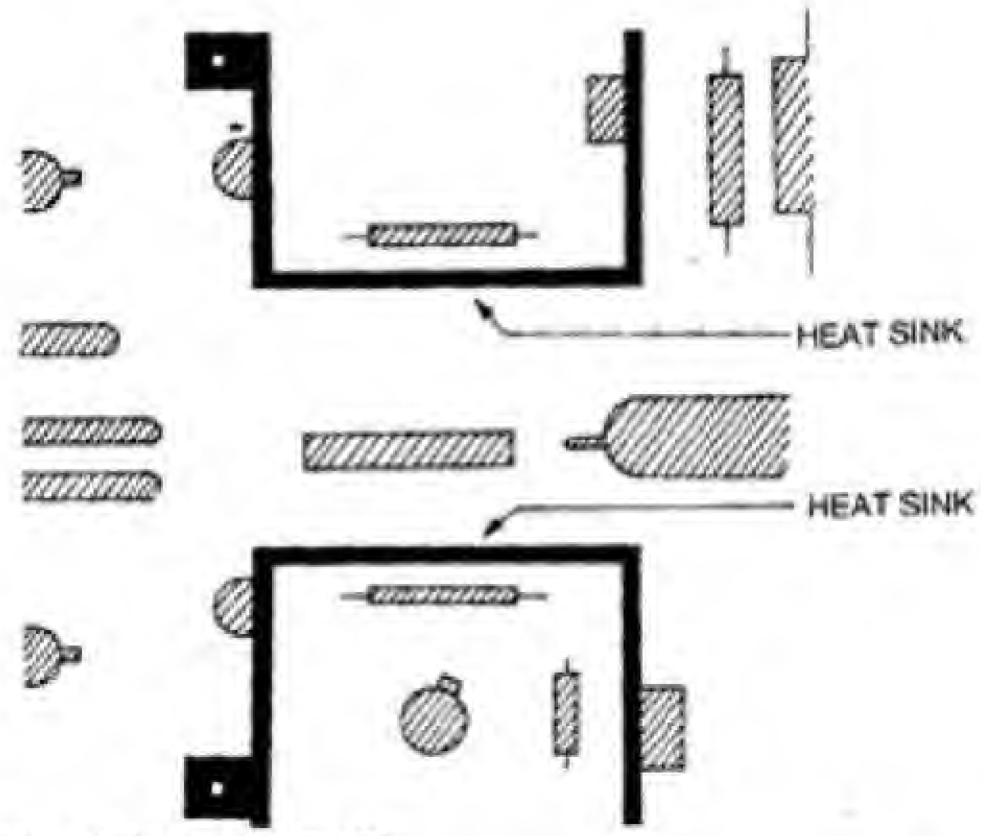


Fig. 4: Position of heatsinks on PCB.

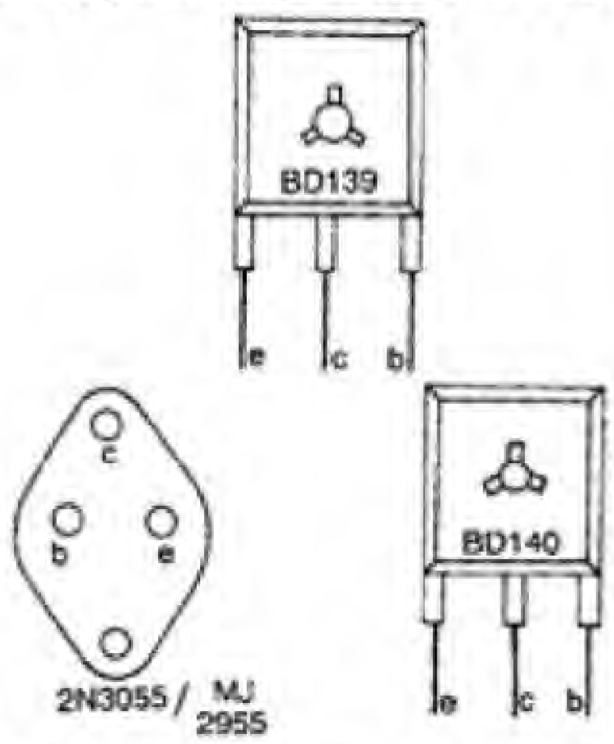


Fig. 5: Pin configuration of transistors.

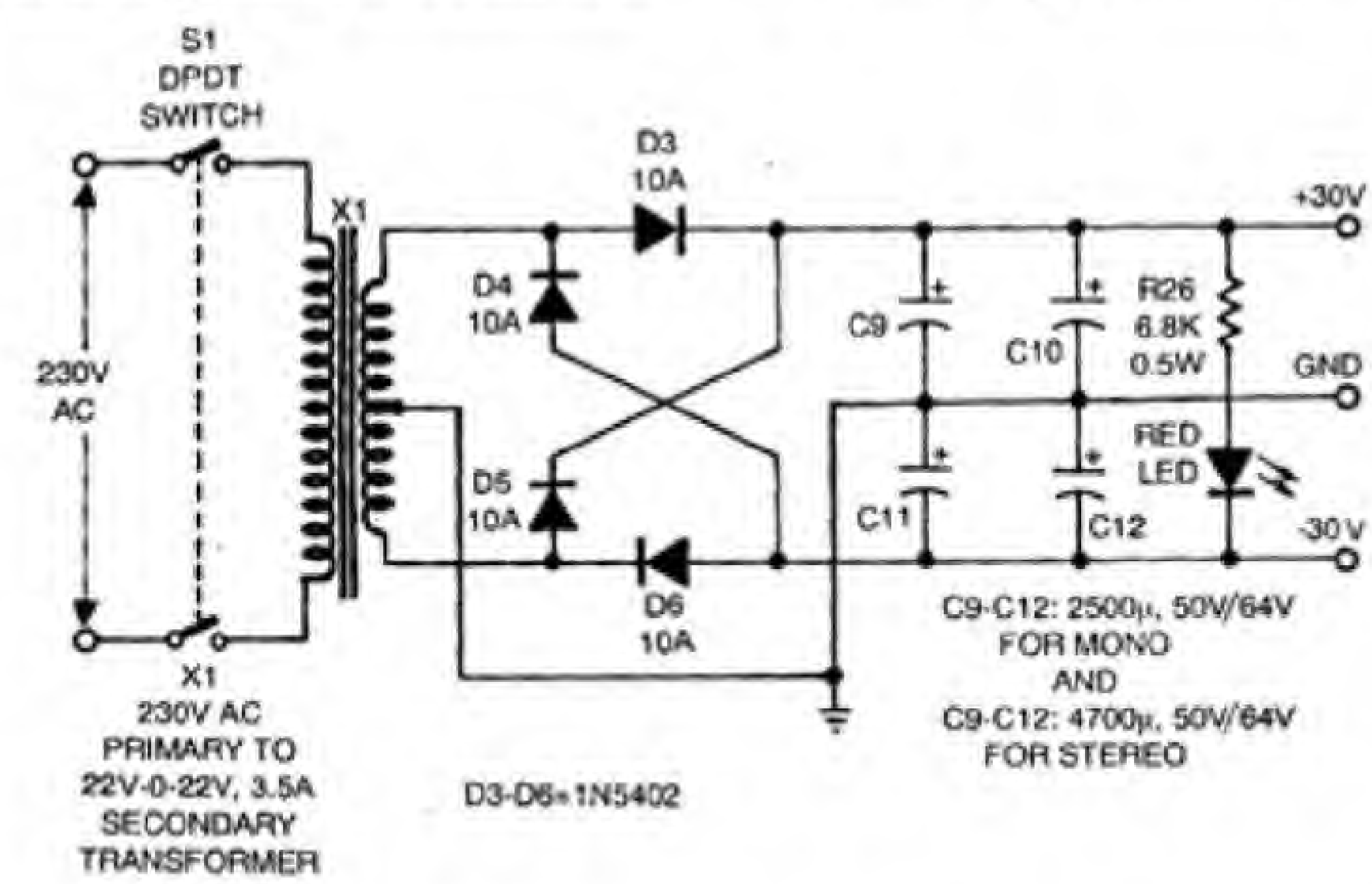


Fig. 6: Circuit for the power supply.

and T11. Transistors T10, T12 and T14 form a triple darlington pair like T11, T13 and T15. The output current is now changed greatly by a small change in the VBE of T10 or T11. As the output consists of triple darlington pairs, the current through T4 and T5 is kept at a low value of about 6mA.

Coil L1 is used to prevent distortion in the amplifier when capacitive loads are connected to the output. A fuse is added in series with the loudspeaker so that the fuse blows off if there is any DC voltage across the speaker. The gain is given by (R7+R8)/R8 and is approximately 32 here.

Construction. First solder the resistors and then the capacitors. Thereafter, solder all the transistors except T12 and T13. Now wind 20 turns of 20 SWG wire around resistor R20 and solder the ends of the wire to the leads of the resistor. Insert R20 into the PCB and solder it.

Now bend the leads of T12 and T13, as shown in Fig. 7, and insert it into the PCB and fix the transistors to the heatsinks on the PCB. Solder the transistors carefully and then cut off their leads. Next, bend T8 and T9 slightly towards the heatsinks and stick them to the heatsinks with some tape and heatsink compound.

The front panel, when the amplifier is completed, will not have any controls except the power on/off switch. Use anodised aluminium panel, if available. If it is not available, you can make a good panel yourself by rubbing a scratchless aluminium plate with fine sand paper. When you do this, make sure that your strokes are in the same direction. Spray on it afterwards.

The layout inside the cabinet is not given here so that you may arrange PCBs as you like. But be careful while fixing the power transformer. Fix it 8 to 10 cms away frόm the PCB and divide the cabinet into two portions

PARTS LIST

Semiconductors:

T1-T3	—	BC546B
T7	—	BC548B
T8, T9	—	BC147B
T4	—	BC558B
T5, T11	—	2N4033
T6, T10	—	2N3019
T12	—	BD140
T13	—	BD139
T14	—	2N3055
T15	—	MJ2955
D1	—	3.3V, 400mW zener
D2	—	3.9V, 400mW zener
D3-D6	—	1N5402, 10A diodes

Resistors (all 1/4W, ±5% carbon, unless stated otherwise):

R1, R7	—	100-kilohm
R2, R3, R9	—	1.2-kilohm
R4, R5, R6	—	2.7-kilohm, 1W
R8	—	4.7-kilohm
R10, R13, R16, R18, R19	—	100-ohm
R11	—	3.3-kilohm
R12, R17	—	680-ohm
R14, R15, R22-R25	—	1-ohm, 2W
R20	—	10-ohm, 2W
R21	—	10-ohm, 1W
R26	—	6.8-kilohm, 0.5W
VR1	—	100-ohm potentiometer

Capacitors:

C1	—	1μF polyester
C2, C3	—	25μF, 25V electrolytic
C5	—	10μF, 60V electrolytic
C6	—	4.7μF, 10V electrolytic
C7	—	56pF ceramic disc
C4, C8, C13	—	0.1μF polyester
C9-C12	—	2500μF, 50V electrolytic (for mono) or 4700μF, 50V electrolytic (for stereo)

Miscellaneous:

X1	—	230V AC primary to 22V-0-22V, 3.5A secondary transformer
S1	—	DPST switch
L1	—	Coil having 20 turns of 20 SWG wire
	—	3.5A fuse
	—	LED

with an aluminium plate, keeping the transformer on one of its sides and the PCB on the other.

The dimmensions of the heatsinks are however shown in Fig.7 along with the procedure of bending.

Testing: After you are sure that you have made no mistakes, adjust VR1 to its minimum position and switch on the power. Now connect a milli-voltmeter across any of the 1-ohm resistors (R14, R15 and R22) and adjust potmeter VR1 for 16mV on the meter. This represents a current of 500mA.

Connect the output of the source and adjust its level control so that the output is 2 watts. Connect a dummy load instead of a speaker and leave it like that for about six hours. Thereafter, check the transistors. They should not be more than just warm. The power transistors are allowed to get a little hot.

If everything has gone well, it means that you have completed your first professional amplifier. ❑

SPECIFICATIONS

Output power (1 kHz, 0.7% THD):	73W into 4-ohm and 44W into 8-ohm
Offset voltage:	Less than ±40mV
Input impedance:	100k
Harmonic distortion:	0.015%
Intermodulation distortion (70W):	0.02%
Frequency range:	10Hz-30kHz, ±2dB
Signal-to-noise ratio (out = 100mW):	Over 72dB

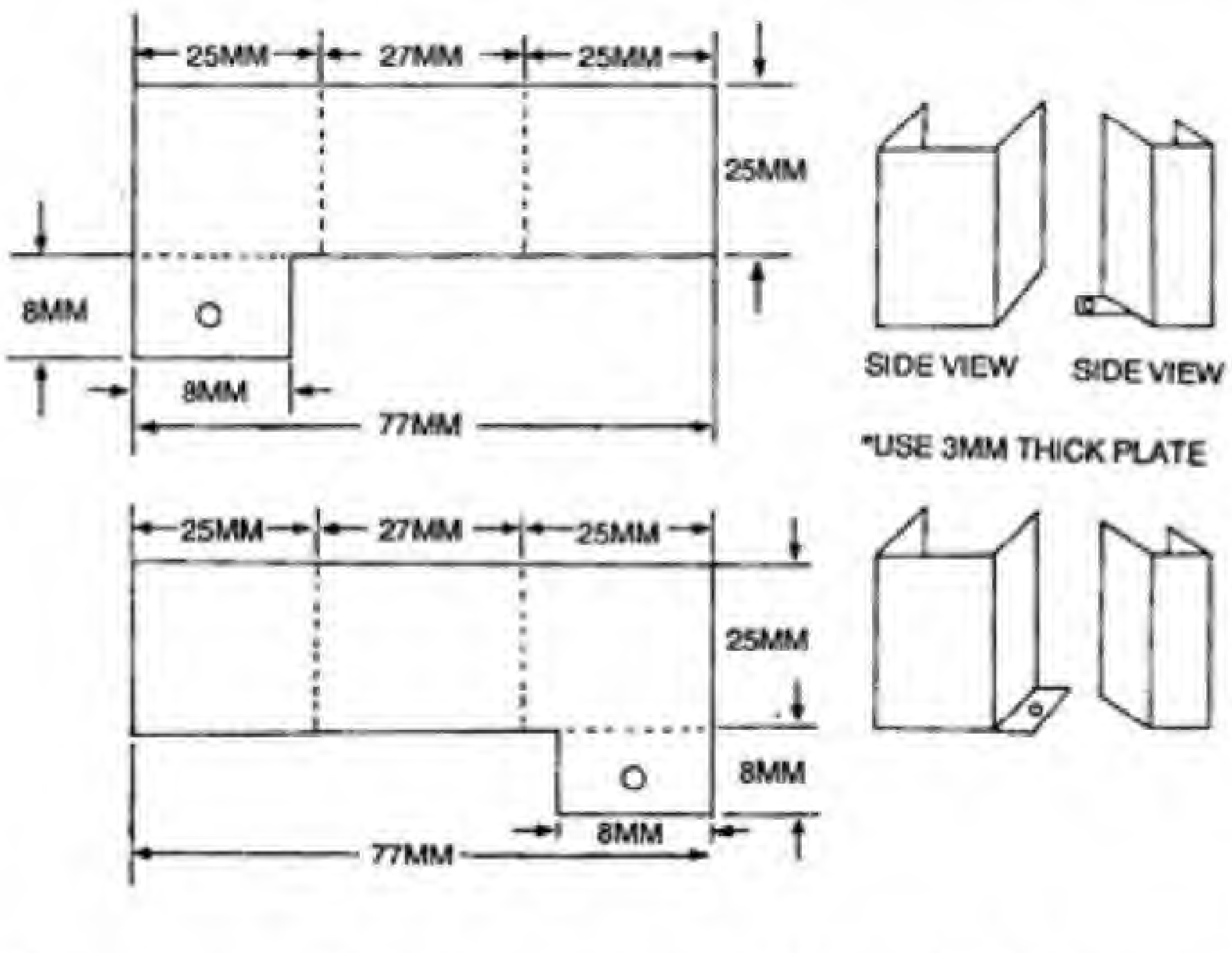


Fig. 7: Dimensions and bending procedure of heatsinks for transistors.

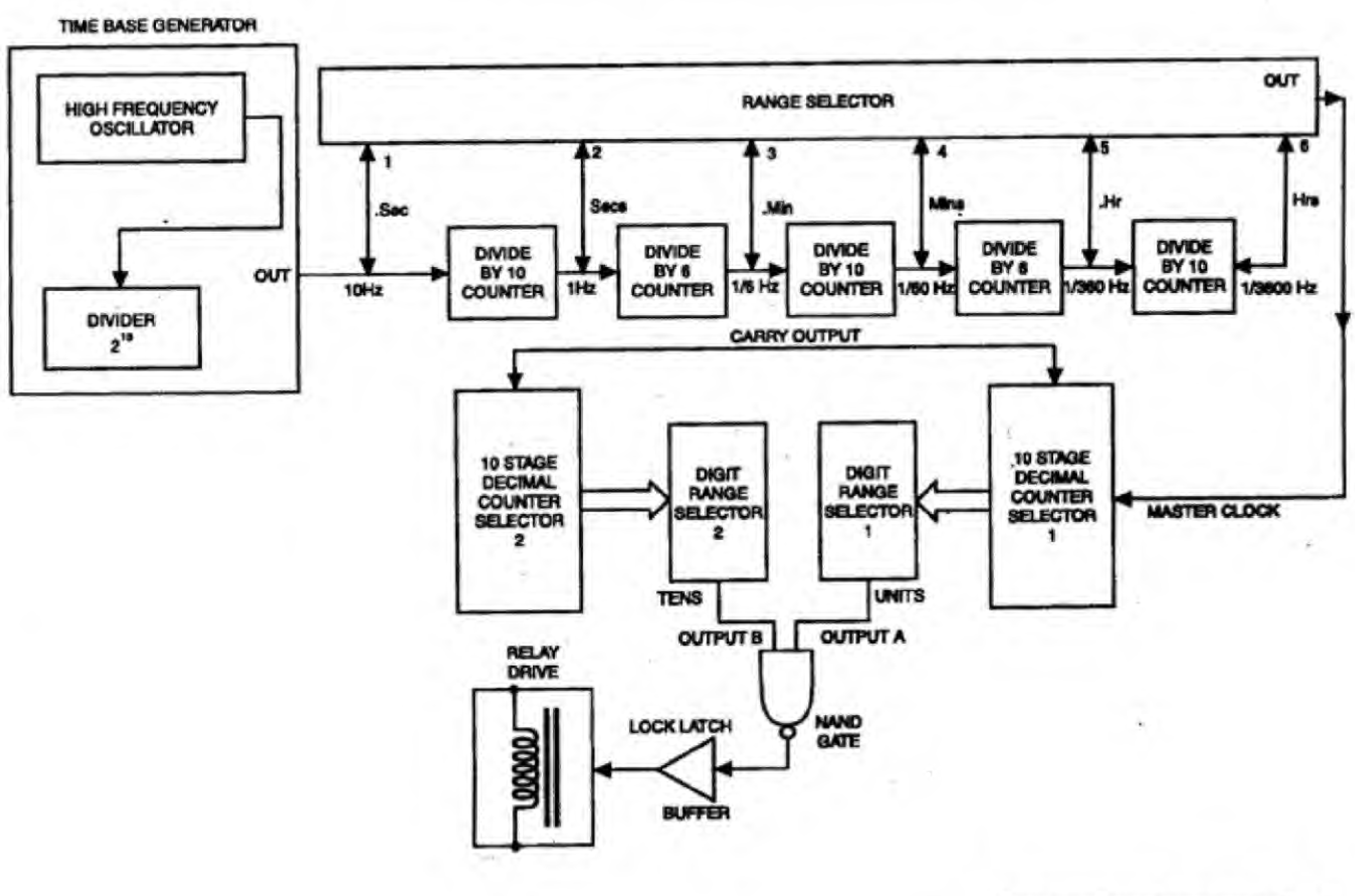
The Universal Timer

Amrit Bir Tiwana

The timing of events and processes is becoming an ever increasing necessity in virtually every automation task, not only in the industrial sphere but even in the domestic sphere. No wonder timers are often referred to as the first step towards automation.

This universal timer offers an 'ultrawide' timing range which can be set with pin point precision anywhere from one-tenth of a second to hundred hours! Dispensing with the ever-problematic analogue dial, this timer is built around common CMOS chips, and features 'autolatch' facility plus such a low current consumption that most multimeters would fail to detect it. All these features make it all the more versatile.

Readers are quite familiar with timers and must be well acquainted with the ubiquitous 555 timer which probably stands as the most widely used (rather overused) timer chip. It is indeed a versatile device if the delays required are less than about quarter of an hour. But for greater delays the 555 fails miserably.



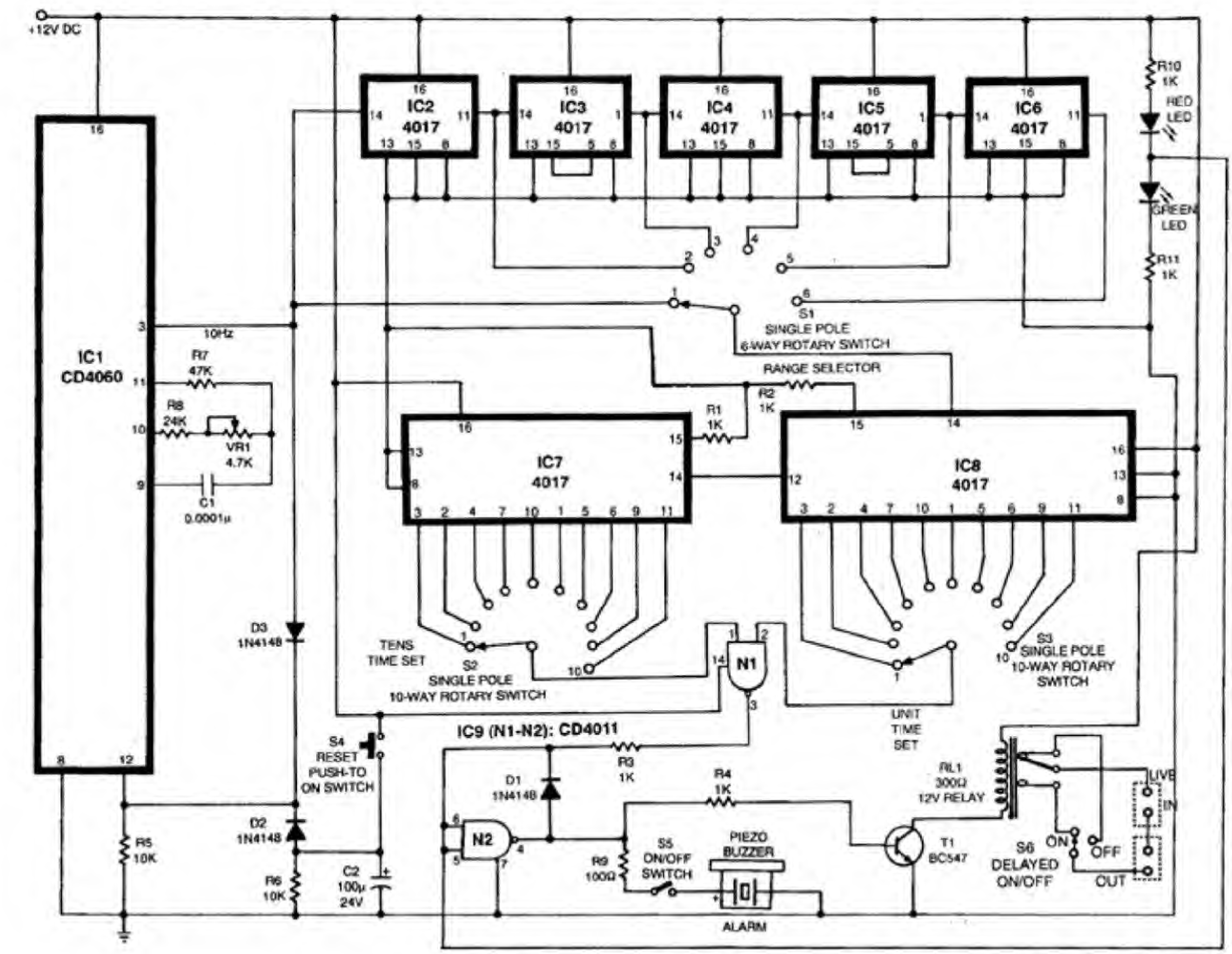


Fig. 2: Circuit diagram for the universal timer.

Then, obviously, there are two options left. One, to use a microprocessor based timer which is not only costlier, but is much cumbersome to use as well, since most microprocessors are 'specialised'. The second option is to resort to digital electronics and keep on dividing the basic timing again and again! And that seems to be the most sound idea as it enables implementation of fairly large delays, which sometimes are not quite possible even with microprocessors. That's how this design works as well.

The universal range of applications this timer can be put to are evident from the specifications (see box). The timer dispenses with the usual linear knob setting control that can hardly ever be calibrated correctly. This timer instead uses a combination of two thumbwheel/rotary switches along with a range selector with 600 possible settings, which enables it to be adjusted directly with pin-point precision.

The PCBs used for the timer have been designed on an IBM compatible PC-XT, using powerful PCB CAD software to ensure maximum miniaturisation. For readers' convenience the PCB can be had readymade from EFY associates (Kits'n' Spares, New Delhi).

Even with one of the widest ranges ever provided on a timer, this timer still keeps the cost factor the narrowest at about Rs 140.

Working

The working of the circuit can be understood from the block schematic in Fig. 1. The actual circuit is shown in Fig. 2.

The 4060 oscillator generates a high-frequency signal of the order of several kilohertz, which is precisely adjusted

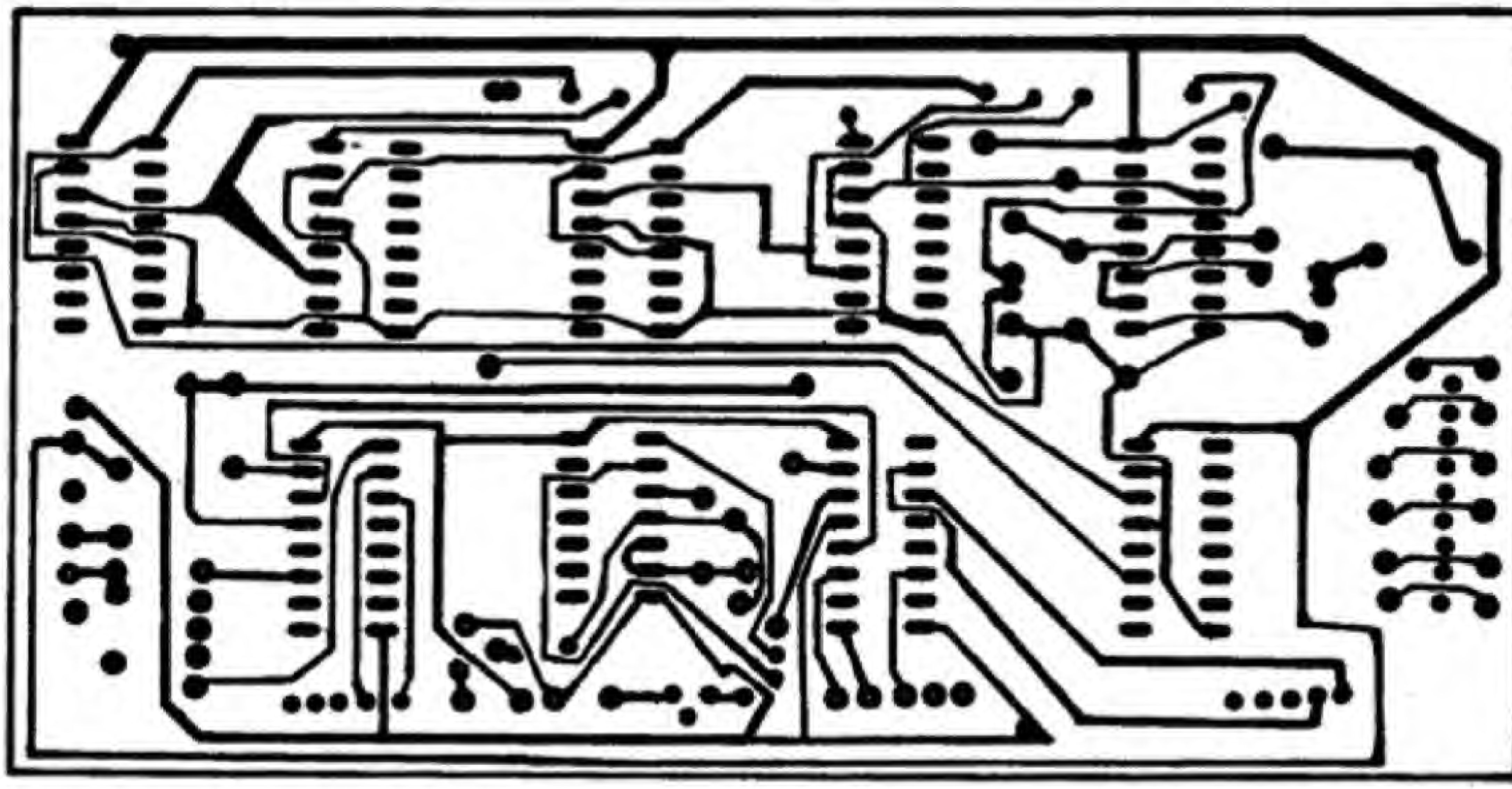


Fig. 3: Solder side PCB layout for the circuit shown in Fig. 2.

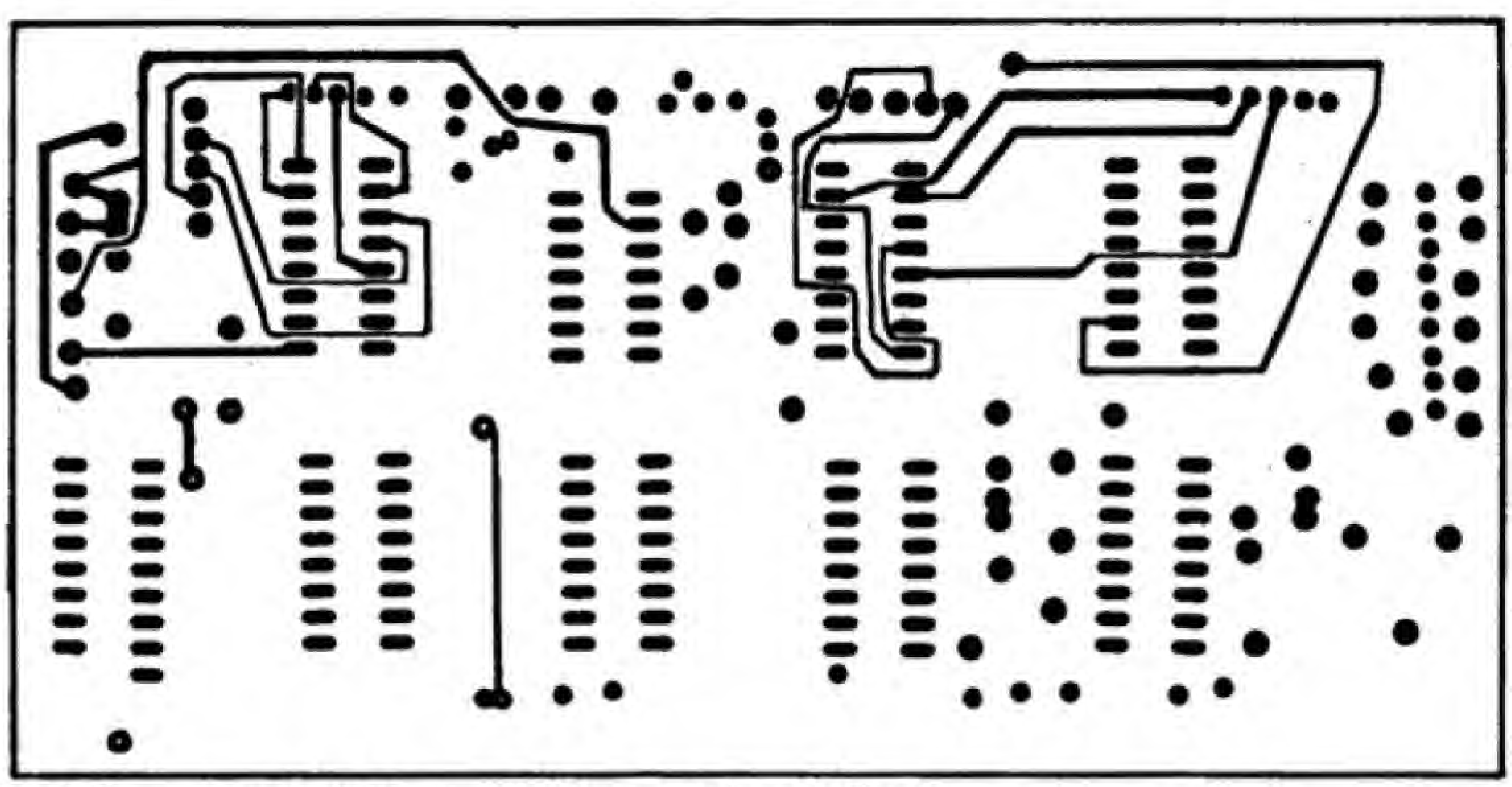


Fig. 4: Component side PCB layout for the circuit shown in Fig. 2.

to remove device imprecision errors, using preset VR1. The oscillator inside the 4060 chip oscillates to give a timing period equal to 2.2 x Timing Resistor x Timing Capacitor (in farads). This basic frequency is divided by all the internal dividers inside the chip, i.e. by a factor of 16384 or 2^{13} times. This in turn provides a 10 Hz frequency with a very high degree of precision.

The same frequency is simultaneously divided by 10, 6, 10, 6, 10 by the set of five 4017 counters wired in maximum mode and divide-by-six decimal mode respectively. The output is tapped by the range selector at each stage.

This provides time periods of 0.1 sec, 1 sec., 0.1 minute, 1 minute, 0.1 hour, 1 hour respectively. These, in turn, provide a precise master clock frequency, which is fed to the two 'serially' connected counters, again two 4017 chips. When IC8 counts ten master pulses, IC7 counts one. Switches S2 and S3 provide control over the timer setting, the range for which is selected via switch S1. S2 provides 'tens' digit control and S3 controls the unit digit settings.

The output of both switches are taken and fed to a NAND gate-the much popular 4011 quad NAND chip. This gate changes state when both of its inputs assume high state, i.e. when the preset time is reached. This, in turn, latches the next gate with the help of 'feedback' diode 1N4148. The following transistor buffer drives a relay whose outputs control the load. The relay contacts can be selected to switch the load 'on' or 'off' after the preset time. The audio alarm is also driven in a

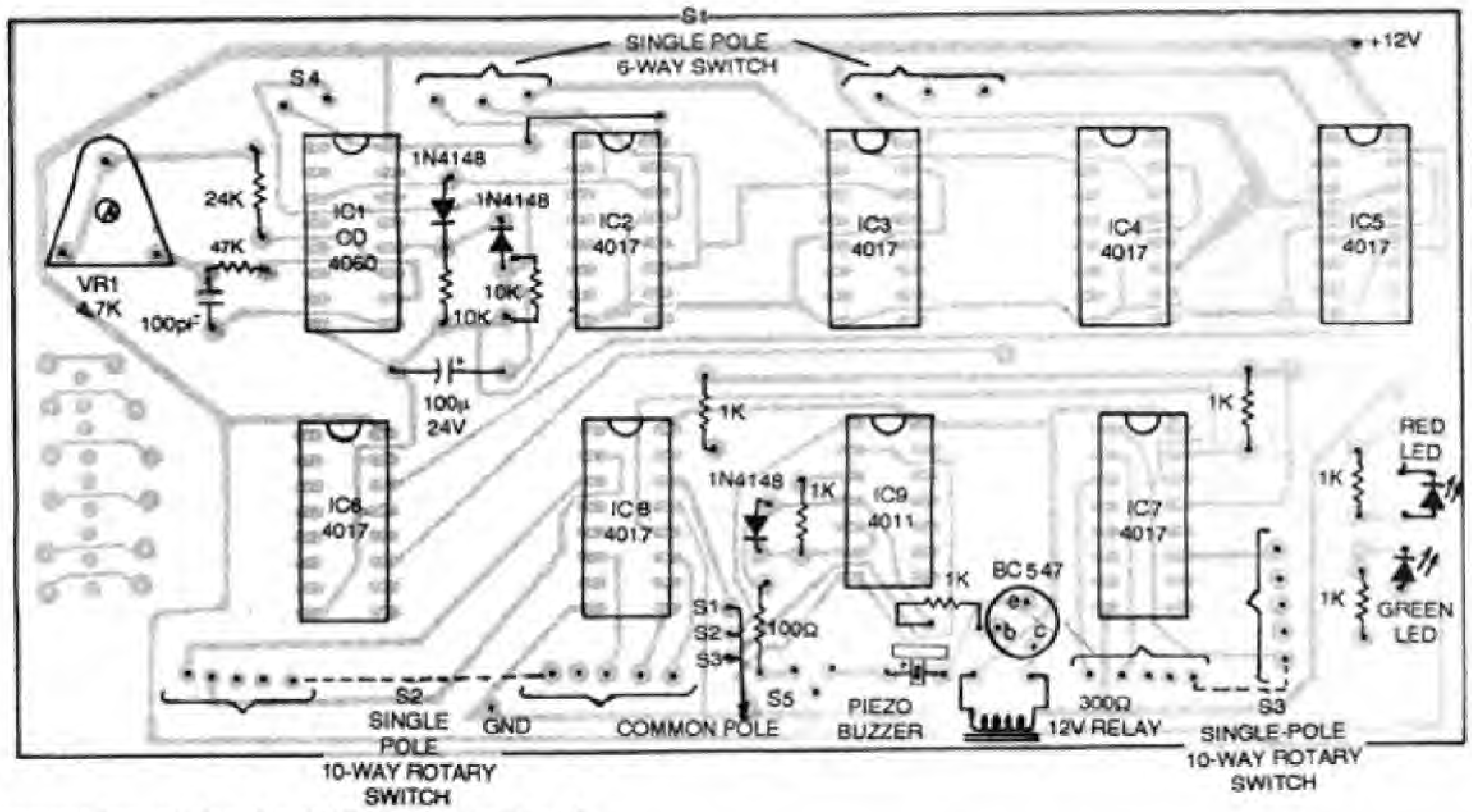


Fig. 5: Component layout for the PCB shown in Fig. 3.

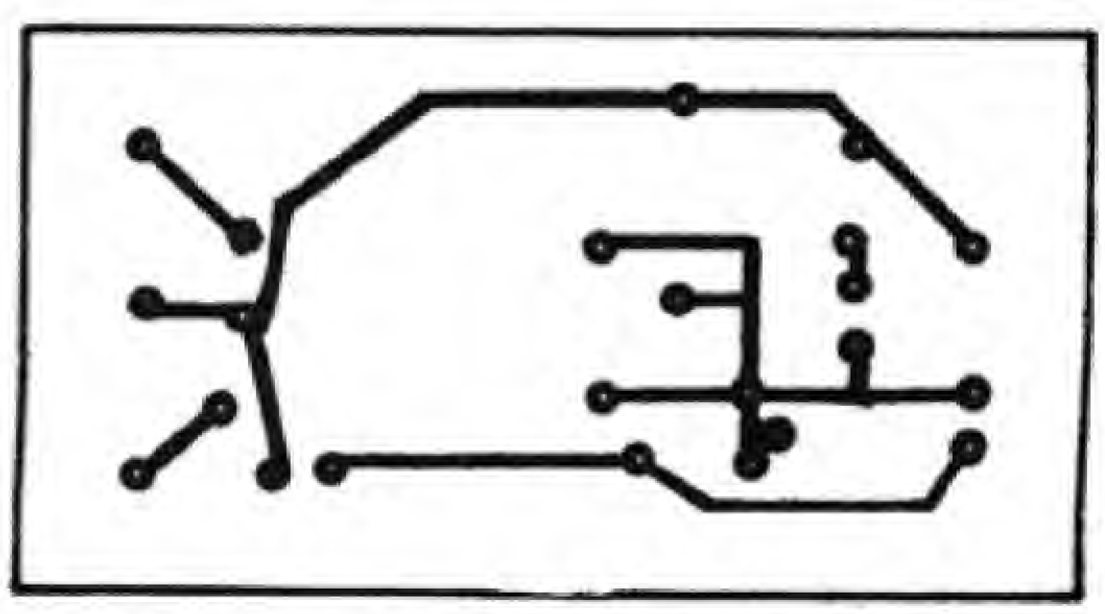


Fig. 6: PCB layout for the circuit shown in Fig. 8.

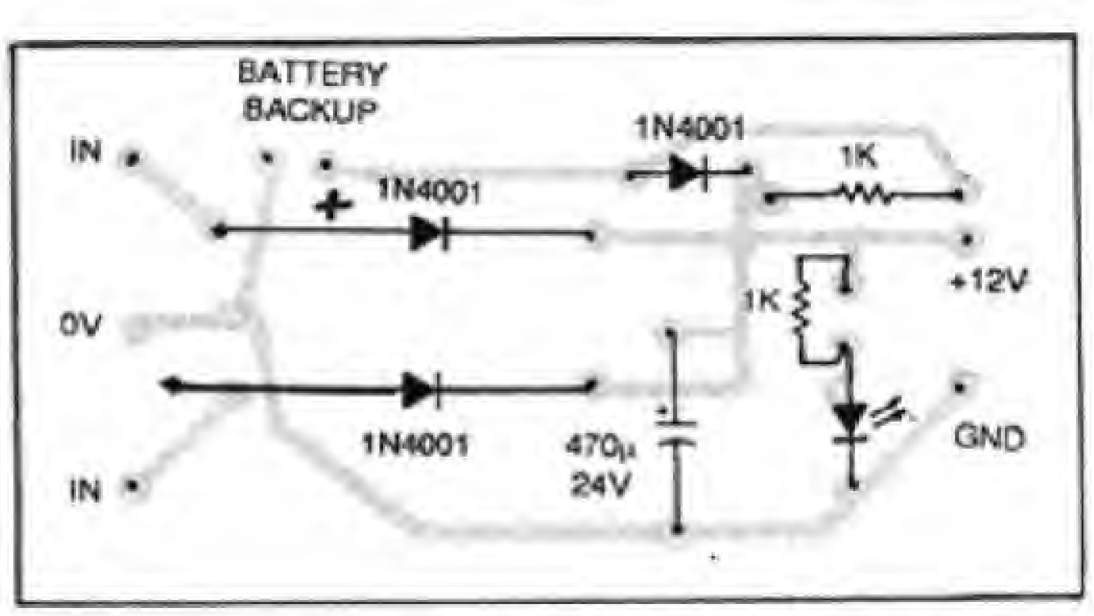


Fig. 7: Components layout for the PCB shown in Fig. 6.

similar way, and the same may be disabled by the corresponding switch S5.

The entire circuit/cycle may be reset by pressing the reset control or by interrupting power supply to the circuit.

Power supply

The circuit, owing to its low current intake, may be run on batteries, or on mains—using the circuit shown in Fig.8. The power supply need not be regulated but may include a 7812 regulator, if desired. It is strongly suggested to use the 18-volt version of the CMOS ICs, and not the 15-volt type, and then run the whole circuit on 15 volts rather than 12 volts, to improve accuracy of the oscillator.

The batteries included for back-up during power failure are a must. It should be wise to opt for rechargable batteries. In that case, the Varta make 9-volt flat battery would be a better and a lower-cost choice as compared to a set of few Ni-Cd cells.

Construction

The circuit may be constructed on a double-sided PCB as shown in Figs 3, 4 and 5. The PCB, being very compact, allows the entire timer to be a compact unit. But the track spacing has been kept liberal to enable even a normal constructor to make the PCB himself.

The PCB must be cleaned to remove any dirt which may, otherwise,

PARTS LIST

Semiconductors:

IC1	—	CD4060
IC2-IC8	—	CD4017
IC9	—	CD4011
T1	—	BC547 npn transistor
D1-D3	—	1N4148
D4-D6	—	1N4001

Resistors (all 1/4W, ±5% carbon unless stated otherwise):

R1-R4, R10-R13	—	1-kilohm
R5, R6	—	10-kilohm
R7	—	47-kilohm
R8	—	24-kilohm
R9	—	100-ohm
VR1	—	4.7-kilohm linear

Capacitors:

C1	—	0.0001μF, ceramic
C2	—	100μF, 25V electrolytic
C3	—	470μF, 25V electrolytic

Miscellaneous:

X1	—	230V AC primary to 12V-0-12V, 500mA secondary transformer
S1	—	Single-pole 6-way rotary switch
S2, S3	—	Single-pole 10-way rotary switch
S4	—	Push-to-on switch
S5, S7	—	On/off switch
S6	—	SPDT switch
RL1	—	300-ohm, 12V relay
	—	Piezo buzzer
	—	LEDs
	—	9V flat battery

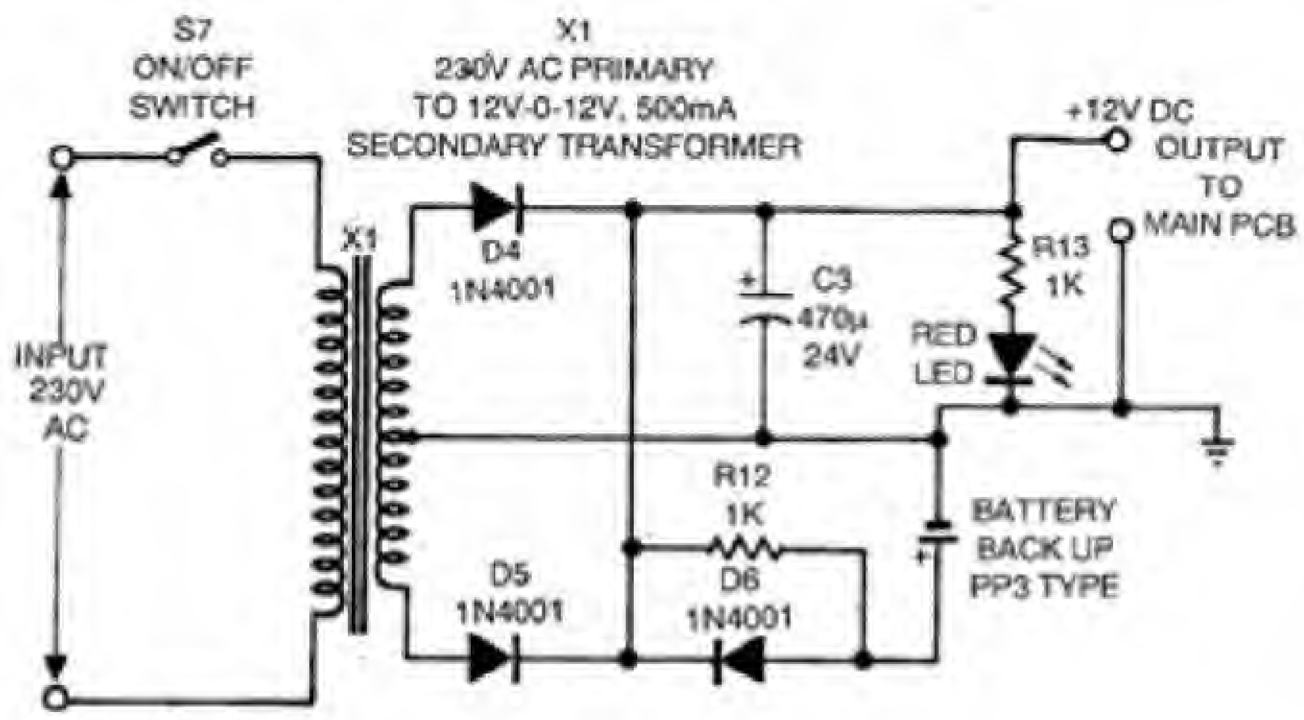


Fig. 8: Circuit diagram for the power supply.

lead to shoddy joints. First solder the resistors, then capacitors, and last semiconductors. It is strongly advisable to use the sockets for all the ICs. Or else, the PCB may get damaged in case even one chip turns out to be defective.

After the soldering is complete, check the positions of all polarised components, especially the ICs. Then recheck all joints which should appear shiny. If all seems fine, turn the PCB upside down and clean it with some petrol/spirit and, if feasible, give it a coat of varnish after the construction is com-

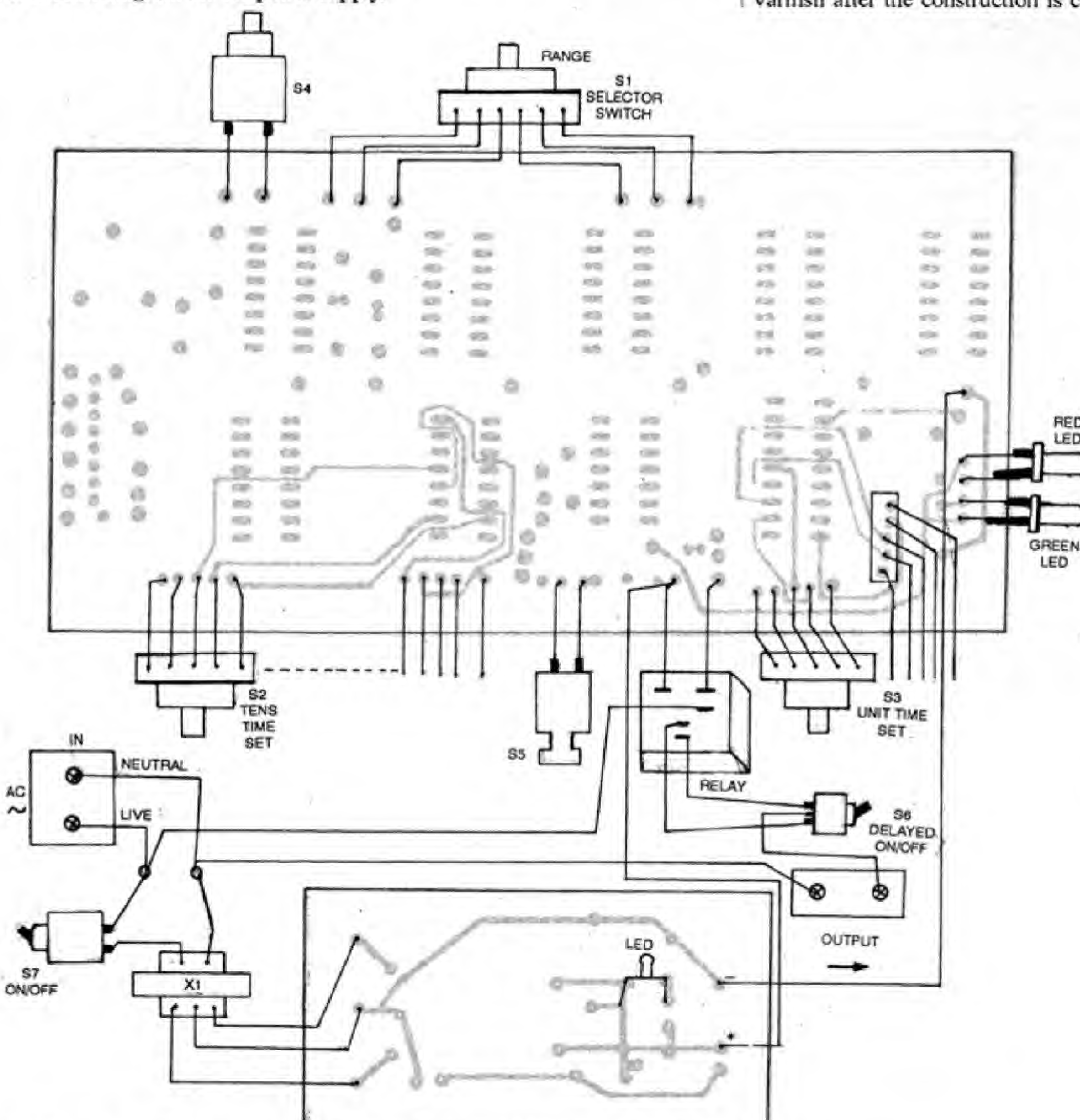


Fig. 9: Wiring diagram for the universal timer.

plete.

Next, select a suitable cabinet, and fix all controls on the panel then the relay towards the rear end. Better use a socket as found in most stabilisers.

Make all 'light' connections with the indicators using ribbon cable. It will be a good idea to insert cable ties or tape wiresets. 16-way ribbon cable connections are preferable. After all connections are made, proceed with the high-current connections by using the well insulated wires used for mains current. After these connections are complete, test for mains leakage with the help of a continuity tester.

If all is well, you may close the cabinet and turn on the mains/power supply. The power indicator will light up. Now open the enclosure again and put a load, i.e. connect a device to the timer and set it to a short period, say, a few seconds, and adjust VR1 till exactly that time delay is obtained. The accuracy on rest of the ranges will follow automatically. That's all the adjustment needed.

FEATURES	
Timing ranges:	1/10 to 9.9 second 1 to 99 seconds 1/10 to 9.9 minutes 1 to 99 minutes 1/10 to 9.9 hours 1 to 99 hours.
Design base:	CMOS integrated
Timing control:	Step ranged, direct, digital
Accuracy:	Max.= 100% Typical=98% in all cycles
Power requirement:	230V @50 Hz, or 14mA @12 Volts with indicators inactive and Relay deactiated.
Interange options:	100 settings.
Output power:	Any voltage, depends on relay rating. Typical 10 amperes @ 230V AC.
Displays:	Cycle status LED display.

Test run

After the timer is complete, it'll be a good idea to see how simple it is to operate. Suppose you have to record a movie after five hours and also need an alarm. The following steps are needed:

1. Connect the VCR to the timer.
2. Select the second last range using S1 (up to 9.9 hours).
3. Set S2 to 5 hours marking and S3 to zero setting.
4. Set delayed on using S4 and turn the alarm on using S5.
5. Turn the power on and press reset..

And that's it. ❑

Automatic Voltage Stabiliser

Shashi Babu Thawait

Conventional voltage stabilisers are used for feeding controlled voltage to refrigerators, TVs, VCRs etc where AC input varies predominently during peak loads. These stabilisers normally use one or two relays and voltage is available in two steps. In first step the output is 240V AC at 240V AC input while in second step the output is 240V AC at 220V or 210V AC input. If input goes below 220/210V AC, the output state varies but to a lesser extent.

The other type of stabilisers available in the market are the manual autocut kind. In such stabilisers the output voltage is changed manually with a rotary switch to maintain 240V AC output. In case input voltage exceeds 240V AC the output is automatically cut and with the help of manual switch voltage is again brought down to 240V AC. At the time of peak load, i.e. in evening time, this manual operation of stabiliser may have to be done frequently.

This circuit solves the above problems efficiently. With this circuit it is possible to keep the output voltage constant at 230V AC, even if the mains voltage goes as low as 170V AC.

This circuit energises one relay at a time from 170V AC upwards, and all relays are energised when 230V AC input is reached. Similarly, if supply input voltage decreases gradually from 230V, the relays are denergised automatically one by one so that the output voltage remains constant at 230V AC.

Working of the circuit

The power supply to this circuit is given through secondary of transformer X2. The 20V AC across two tapping is changed into DC with diodes and then filtered.

Transformer X1 senses the input voltage. The variations in AC input voltage are sensed by this transformer output. This voltage is rectified with the help of diodes D5 through D8, filtered and then fed to base of transistors T1 to T4 through trim pots VR1 to VR4. Zener diodes D13 to D16 are used for reference.

Transistor T1 conducts when its base voltage exceeds 2.6V (i.e. zener voltage, 2V + silicon diode conduction voltage, 0.6V), and relay RL1 is ener-

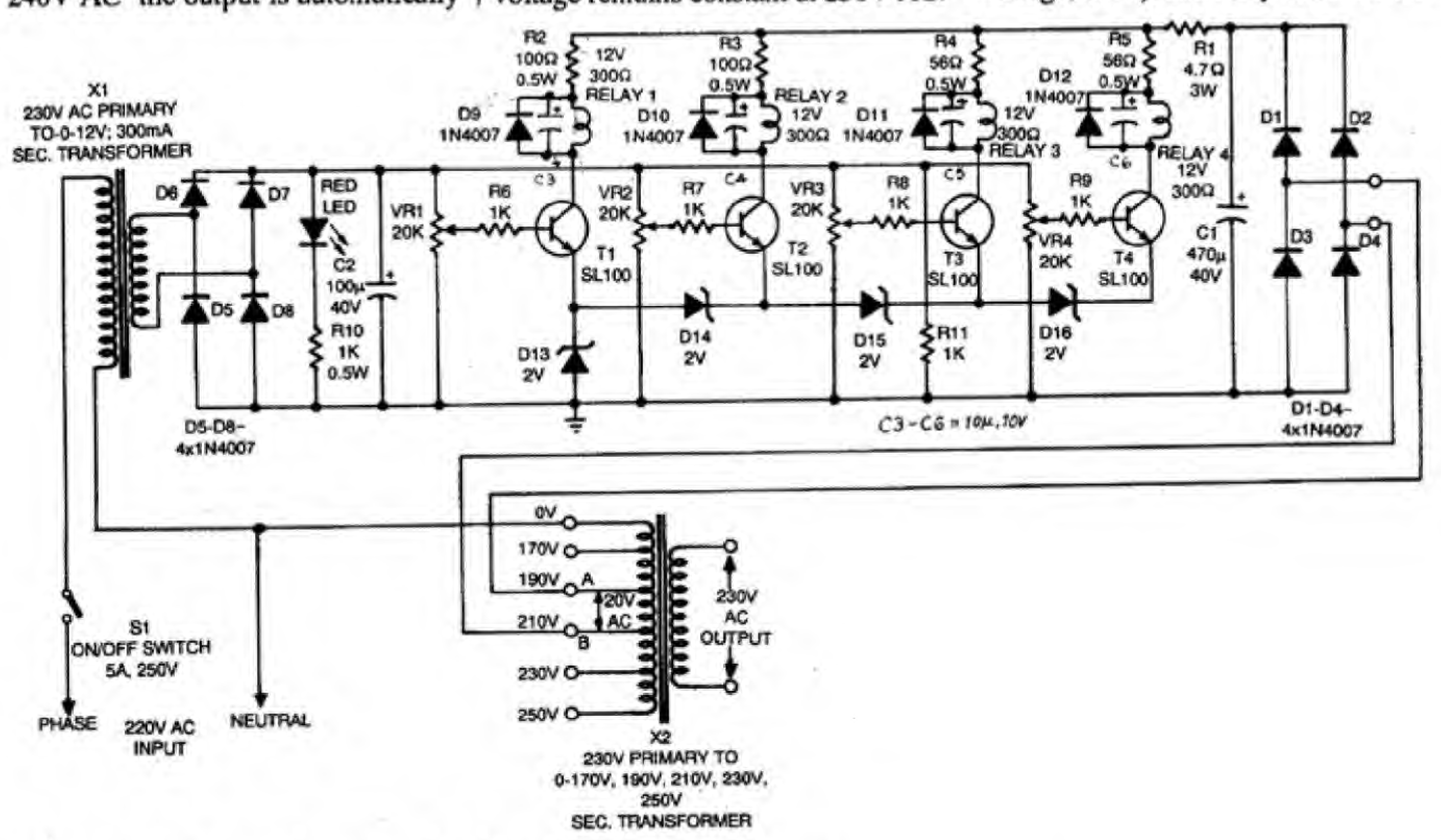
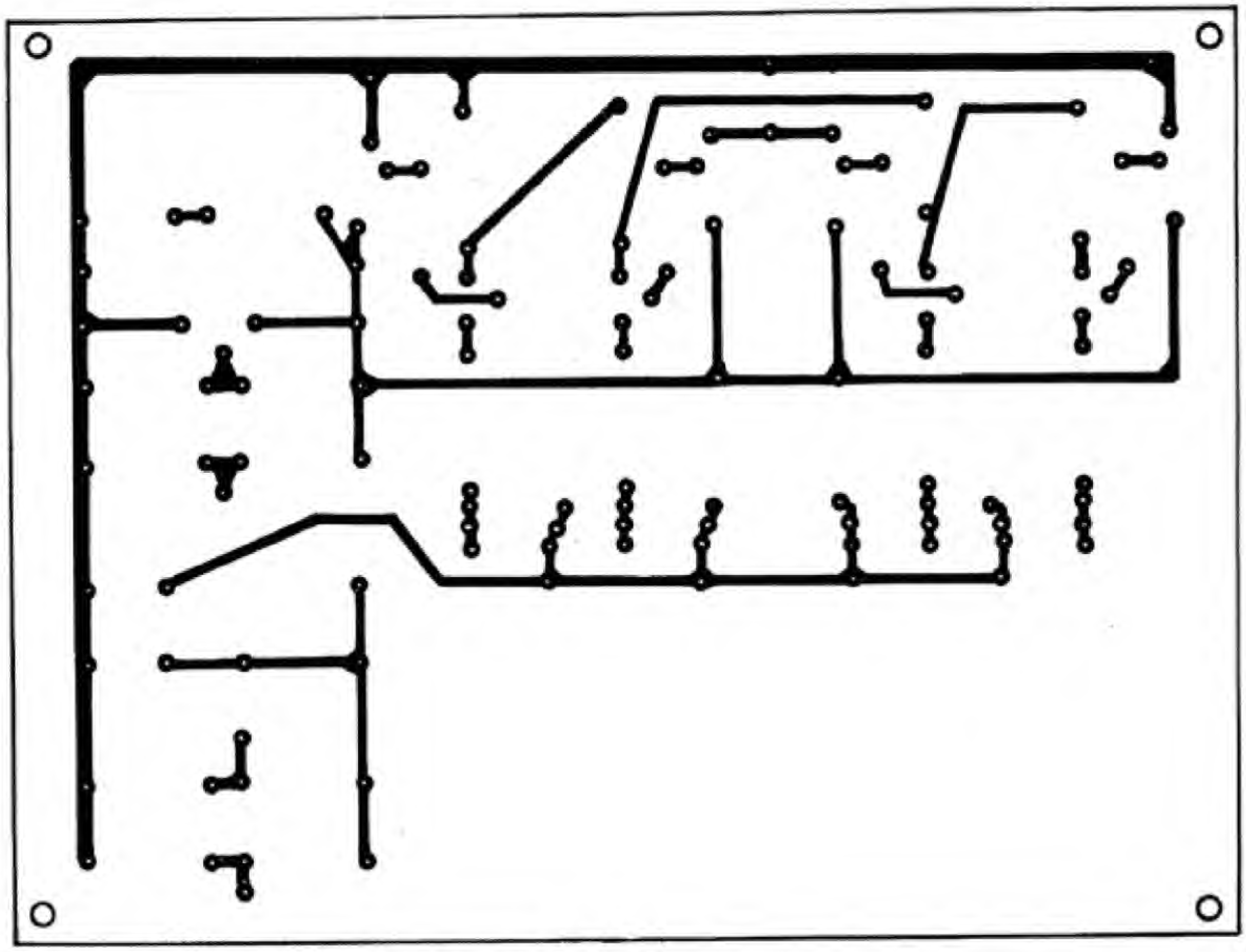


Fig. 1: Circuit diagram for automatic voltage stabiliser.



g. 2: Actual-size PCB layout for the circuit shown in Fig. 1.

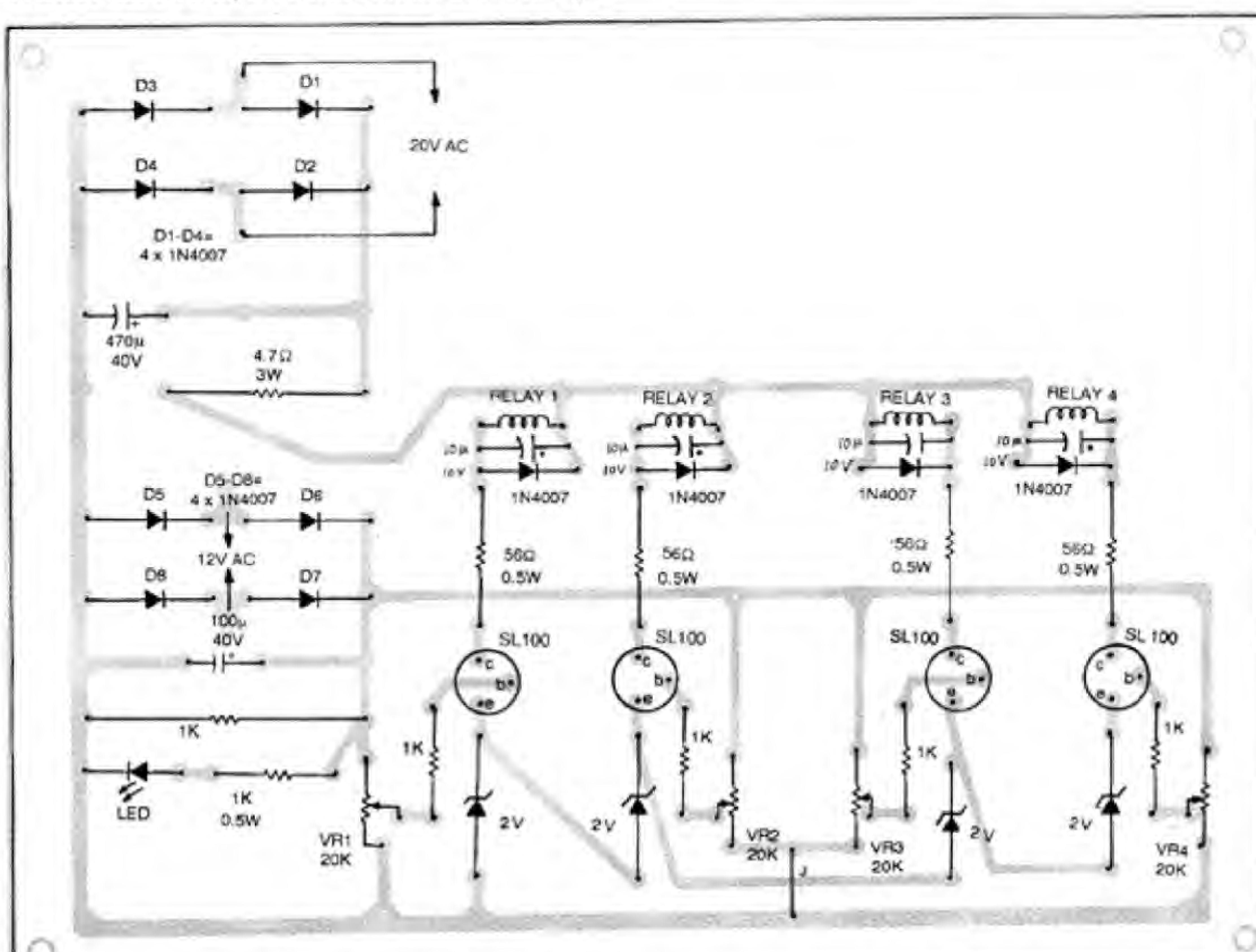


Fig. 3: Components layout for the PCB shown in Fig. 2.

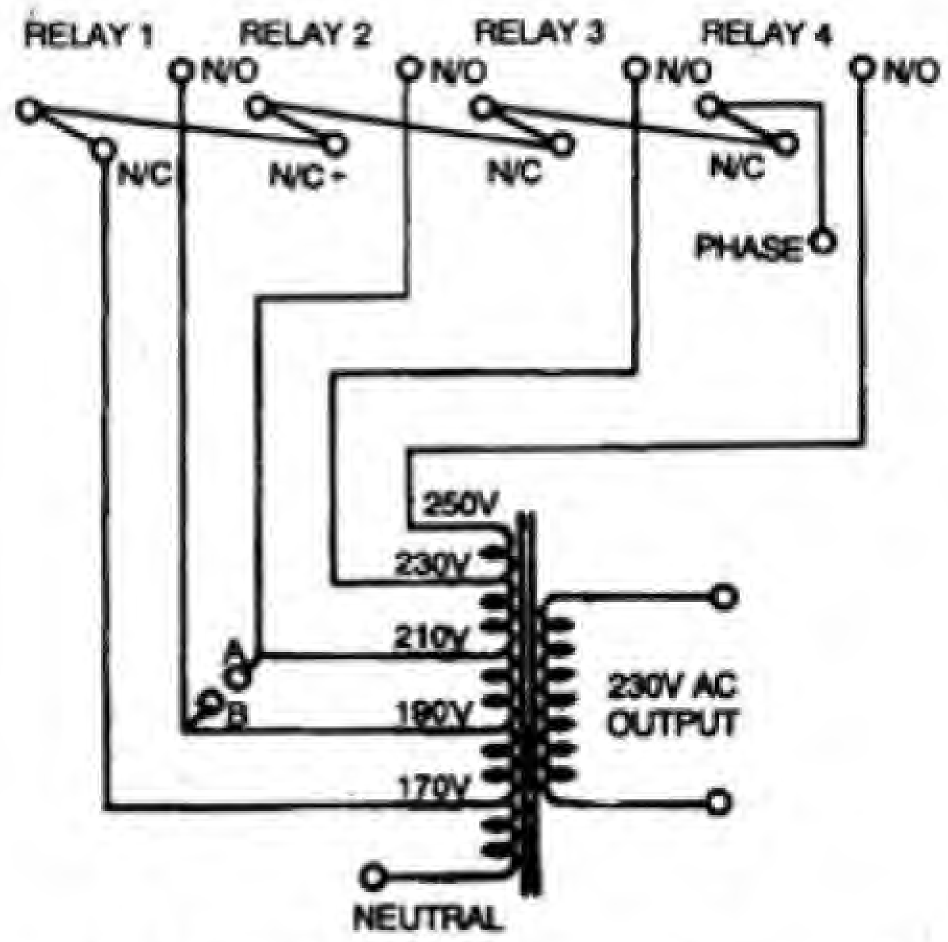


Fig. 4: Relays and transformer connection diagrams.

gised.

Similarly, transistor T2 will conduct only when the voltage exceeds 4.6V (i.e. zener voltages of diodes D13 and D14 + 0.6V).

Likewise, T3 will conduct when the voltage exceeds 6.6V, and T4 will conduct at voltage exceeding 8.6V. Corresponding relays RL2, RL3, and RL4 will energise when T2, T3 and T4 conduct.

The exact conduction of T1 through T4 can be controlled by pots VR1 to VR4.

Diode D1 to D4 are used for rectification while capacitor C1 is used for filtration. Similarly, diodes D5 to D8 have been used for rectification and capacitor C2 for filtration.

Diode D9 to D12 have been used to protect the transistor from failing due to reverse voltage at the time of dropping of relays.

The circuit can be assembled on a veroboard or a breadboard or a stripboard, but the best would be to use the PCB shown in Fig.2. The PCB lends a lot or reliability by avoiding most external connections and thus eliminates chances of failure due to snapping of wires.

PARTS LIST

Semiconductors:	
T1-T5	— SL100 npn transistor
D1-D12	— 1N4007 diode
D13-D16	— 2V, 1 amp. zener diode
Reistors (all 1/4W, ±5% carbon unless stated otherwise):	
R1	— 4.7-ohm, 3W
R2, R3	— 100-ohm, 0.5W
R4, R5	— 56-ohm, 0.5W
R6-R9	— 1-kilohm
R10	— 1-kilohm, 0.5W
VR1-VR4	— 20-kilohm linear
Capacitors:	
C1	— 470µF, 40V electrolytic
C2	— 100µF, 40V electrolytic
C3 to C6	— 10µF, 50V electrolytic
Miscellaneous:	
X1	— 230V AC primary to 0-12V, 300mA secondary transformer
X2	— 230V AC primary to 0-170V, 190V, 210V, 230V, 250V secondaries transformer
RL1-RL4	— 12V, 300-ohm double contact relay
	— LED

Q. Details of the transformer are not mentioned in the circuit. How much maximum load it can handle is also not mentioned.

—Many Readers

A. Considering 85 per cent efficiency for the transformer and a load power factor (P.F) of 0.8, the power handling capacity should be determined with the mains voltage at its lowest value i.e 170VAC. We can work out the primary and secondary current rating of the windings from the following formulae:

$$\text{(a) Pri. Current} = \frac{\text{output Power (watts)}}{0.8 \times 0.85 \times 170}$$

$$\text{(b) Sec. Current} = \frac{\text{output Power (watts)}}{0.8 \times 230V}$$

From the above parameters, design of the transformer can be carried out to meet the specific power output requirement.

(Note: The relay contact rating should be selected as per the primary current worked out form above formula).

Digital Car Lock with Alarm

Amrit Bir Tiwana

This car theft deterrent circuit locks the starting motor until an authorised code is recognised, and in case an attempt is made to 'break' the lock code an alarm is sounded.

The design ensures full protection of the car against theft by allowing the car to be started only when a correct code number is entered through the keypad mounted on the dashboard. If a wrong code is entered, the car horn is sounded as an alarm which can attract the attention of the passers by and probably the owner. In such a case, the circuit will simultaneously lock up the starting motor, to ensure that even if the last keyword is to be entered, or has been entered, the accidental pressing of any other (wrong) key will make all efforts futile.

The keypad is an ordinary 3x3 non-matrix keyboard, which has keys marked one to nine out of which five are used to enter the code and two are dummy keys which activate the alarm. The last one ceases the alarm in case the user accidentally triggers the alarm.

The circuit, as shown in Fig. 1 is based on a single CMOS hex non-inverting buffer, CD4050. Buffers 'a' through 'e' comprise the main locking circuit, while the last one works as the

PARTS LIST

Semiconductors:	
IC1	— CD4050, hex non-inverting buffer
T1	— BC148 npn transistor
T2	— BC558 npn transistor
D1-D7	— 1N4001
Resistors (all 1/4W, ±5% carbon, unless stated otherwise):	
R1-R6	— 10-kilohm
R7, R9, R11	— 1-kilohm
R8	— 2.2-kilohm
R10	— 100-kilohm
Miscellaneous:	
S1-S8	— Push-to-on switch
RL1, RL2	— 12V, 200-ohm relay

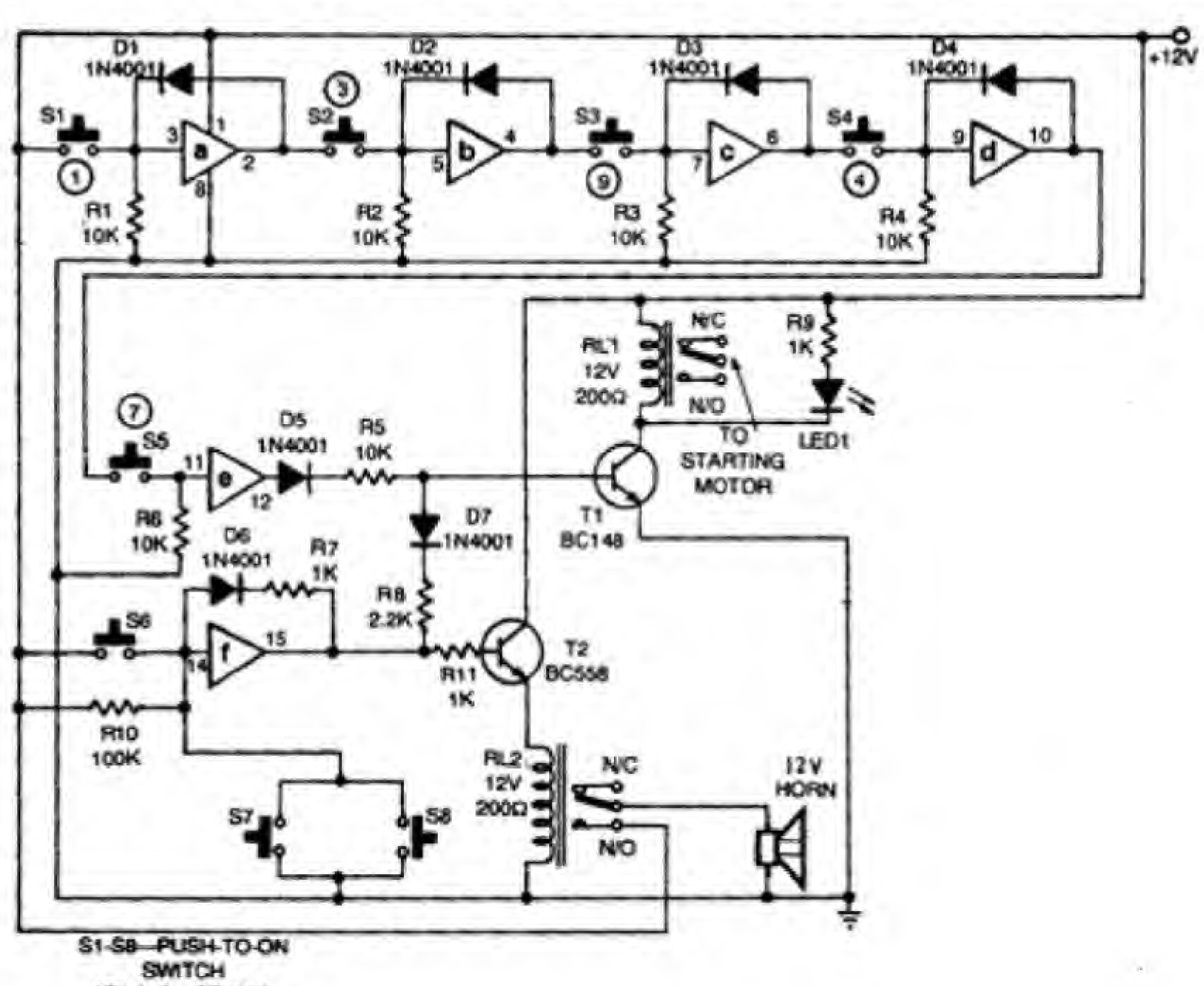


Fig. 1: Circuit diagram for digital car lock with alarm.

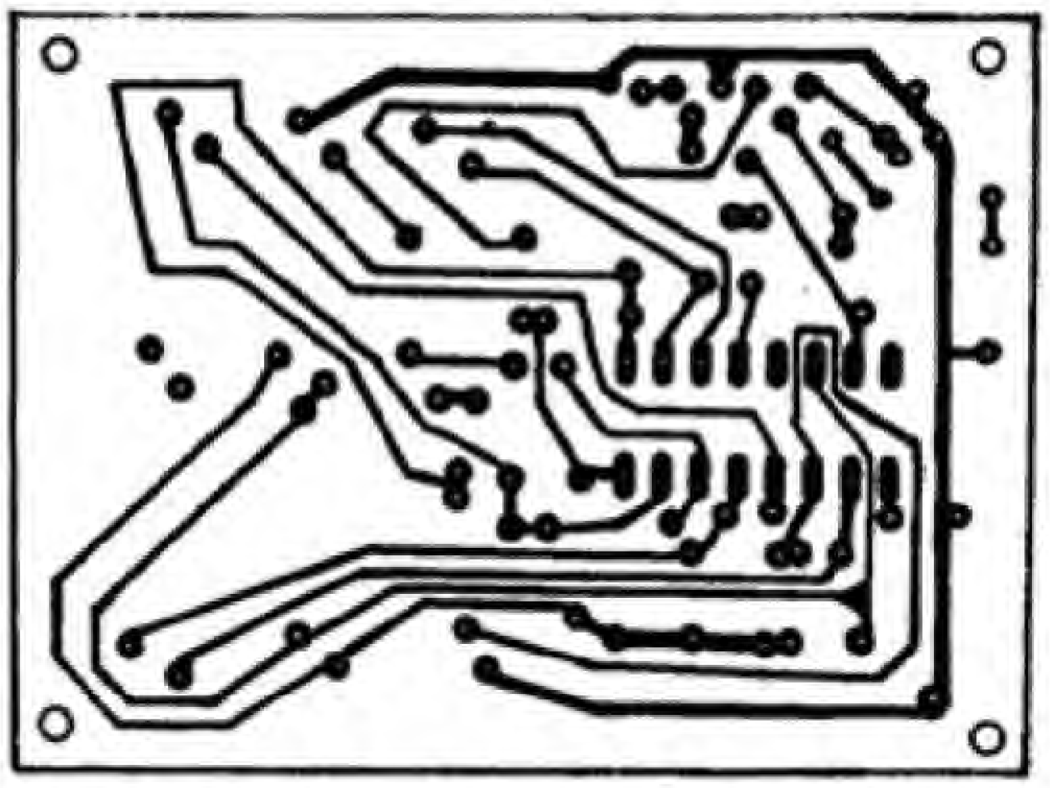


Fig. 2: Actual-size PCB layout for the circuit shown in Fig. 1.

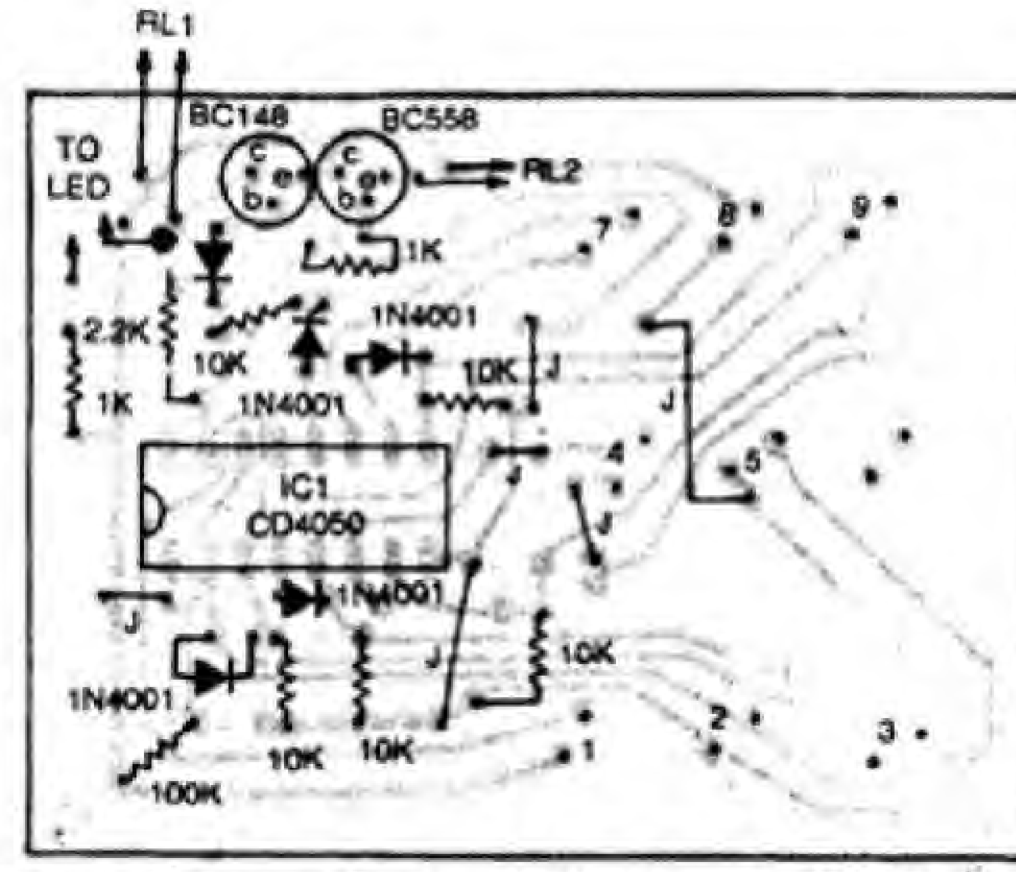


Fig. 3: Components layout for the PCB shown in Fig. 2.

alarm latch. Initially, all buffer outputs are low (except f), and when the keys marked 1,3,9,4,7 are pressed in sequence, the outputs are sequentially incremented to the upper logic. They are held in this state by the silicon diodes, which bias the input towards the output state. The starting code in this case is '13947', which can be easily altered by changing the wiring sequence. The circuit will fail to trigger in case the sequence is not followed, thus making the code even harder to 'crack'! In case the keys not associated with the code are pressed, the alarm is sounded, as relay RL2 will activate the main horn. This condition will prevent the car from being started by disabling the starting motor relay RL1. This state can be reset by pressing the '8' key.

The circuit may be assembled on a piece of veroboard or on the PCB designed for the purpose, as shown in Fig. 2. The relays can be mounted near the starting motor and the horn respectively, while the complete circuit board can be mounted under the car's dashboard. LED 1, which indicates the opening of the lock, may be fixed on the car's front panel. The keyboard can be affixed on the dashboard itself. ❑

AM/FM Radio Receiver using BEL7220

The BEL 7220 is an integrated AM/FM IC designed for economical and high quality receivers. The BEL 7220 IC can be used in battery or mains operated AM/FM receivers working from a nominal voltage of 1.6 to 6 volts. The functional block diagram is shown in Fig.1. With the exception of FM front end and audio output stage,

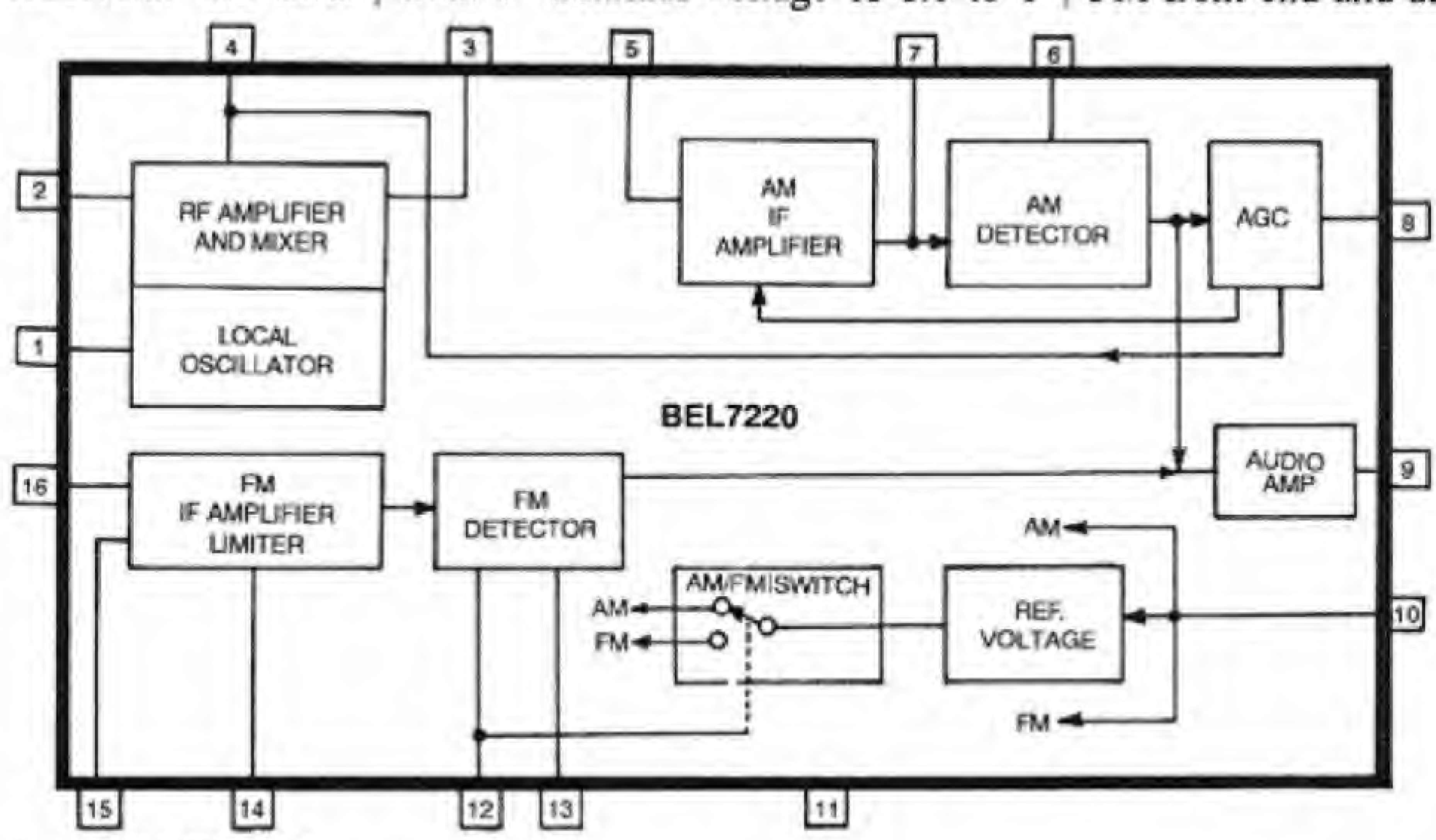


Fig. 1: Block diagram of IC BEL 7220.

DETAILS OF COILS

Description	Test Frequency	Lo µH	Co pF	Qo Pin 1-3	Turns Pin 1-2	Turns Pin 2-3	Turns Pin 1-3	Turns Pin 4-6	Swg	Remarks	Ckt. Ref.	Qty
FM BANDPASS FILTER	98 MHz				7				22	Air Core 5mmϕ	L9	1
FM ANTENNA	98 MHz				5				22	Air Core 4mmϕ	L10	1
FM IF TRAP	10.7 MHz				11.5				27	Air Core 5.5mm ϕ	L11	1
FM OSCILLATOR	98 MHz				3				22	Air Core 5mm ϕ	L13	1
FM IF INPUT	10.7MHz	2.7	82	90			12	2	45	10mm IFT	L12	1
MW ANTENNA	1.0 MHz			120			65	7	36	On Ferrite Rod	L1	1
SW ANTENNA	10 MHz	3.0		100	10	2		5	45	10mm IFT Open	L2	1
MW OSCILLATOR	1.0 MHz	140		100			75	10	45	10mm IFT	L3	1
SW OSCILLATOR	10.0 MHz	3		85			10	5	45	10mm IFT	L4	1
AM IF	455 kHz	640	200	115	81	63		8	45	10mm IFT	L5	1
AM DETECTOR	455 kHz	640	200	115	81	63		8	45	10mm IFT	L8	1
FM QUADRATURE	10.7 kHz	22		100			42		45	10mm IFT	L6	1
FM DETECTOR	10.7 MHz	2.7	82	90			12		45	10mm IFT	L7	1

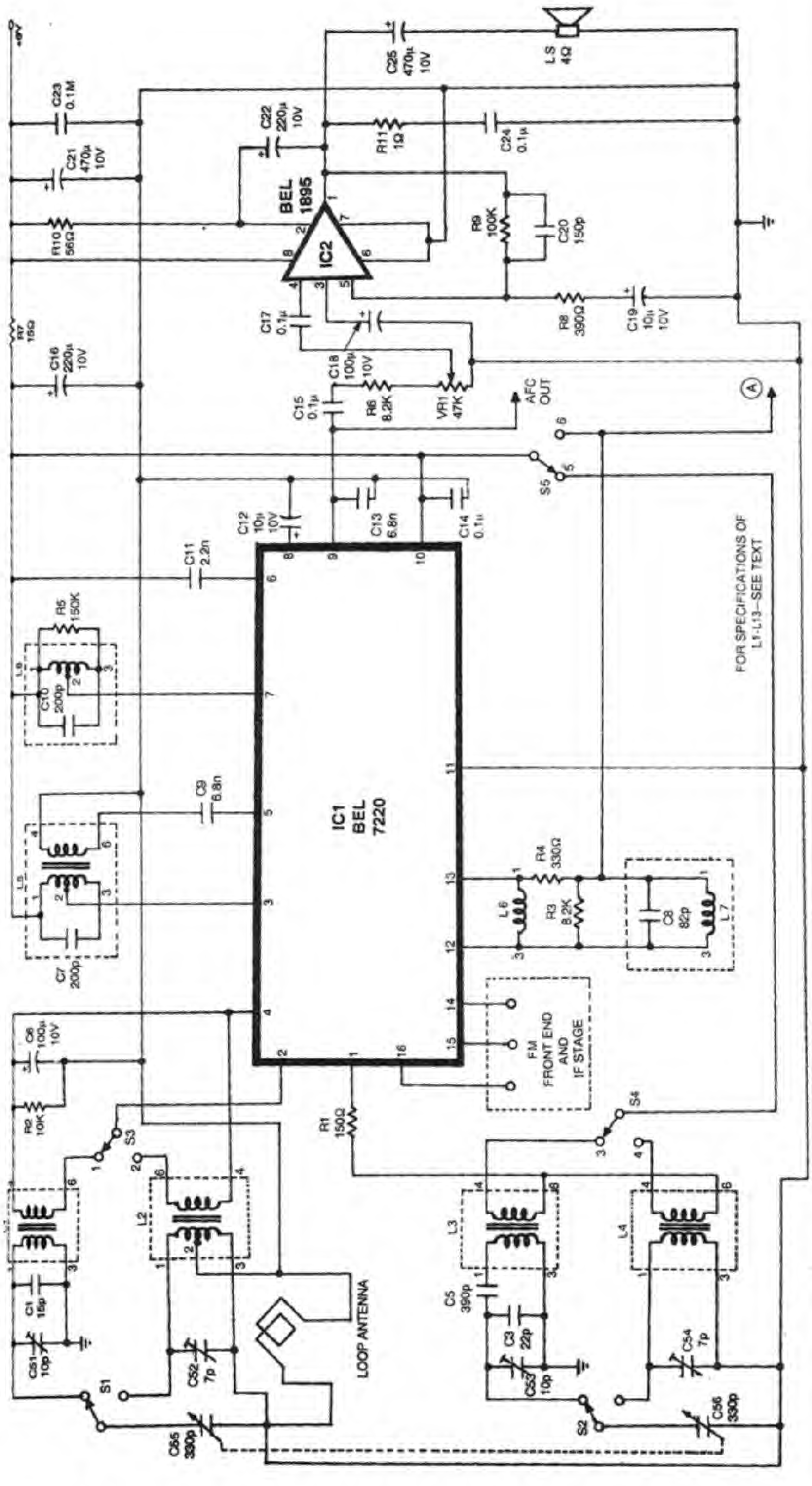


Fig. 2: Circuit diagram for AM/FM radio receiver using BEL7220.

PARTS LIST

Semiconductors:

IC1	—	BEL 7220
IC2	—	BEL 1895
T1, T2	—	BF 1393 transistor
T3	—	BF 494B transistor
D1, D2	—	SD 50F diode
D3	—	IN4936 diode
D4	—	BEL 106 diode

Resistors (all 1/4W, ±% carbon unless stated otherwise):

R1	—	150-ohm
R2	—	10-kilohm
R3, R6	—	8.2-kilohm
R4, R16, R24, R30	—	330-ohm
R5	—	150-kilohm
R7	—	15-ohm
R8	—	390-ohm
R9, R29	—	100-kilohm
R10	—	56-ohm
R11	—	1-ohm
R12	—	680-ohm
R13, R21	—	3.3-kilohm
R14, R28	—	100-ohm
R15	—	4.7-kilohm
R17, R18	—	2.2-kilohm
R19	—	22-ohm
R20	—	1.2-kilohm
R22, R26	—	1-kilohm
R23	—	820-kilohm
R25	—	470-ohm
R27	—	33-kilohm
VR1	—	47-kilohm log pot with on/off switch
VR2	—	10-kilohm linear pot

Capacitors:

C1	—	15pF ceramic
C2, C4	—	20PF+20PF (221580710028-Philips FM gang)
C3, C27	—	22pF ceramic
C5	—	390pF ceramic
C6, C18, C31, C38, C47	—	100μF, 10V electrolytic
C7, C10	—	200pF ceramic
C8, C40	—	82pF ceramic
C9, C13	—	6.8nF ceramic
C11	—	2.2nF ceramic
C12, C19	—	10μF, 10V electrolytic
C14, C15, C17, C23, C24, C30 C45, C46 C48	—	0.1μF ceramic
C12, C19	—	10mF, 10V electrolytic
C20	—	150pF ceramic
C21, C25	—	470μF, 10V electrolytic
C26	—	120pF ceramic
C28, C34	—	33pF ceramic
C29, C37, C42	—	4.7nF ceramic
C32, C39, C41	—	6.8pF ceramic
C33	—	4.7pF ceramic

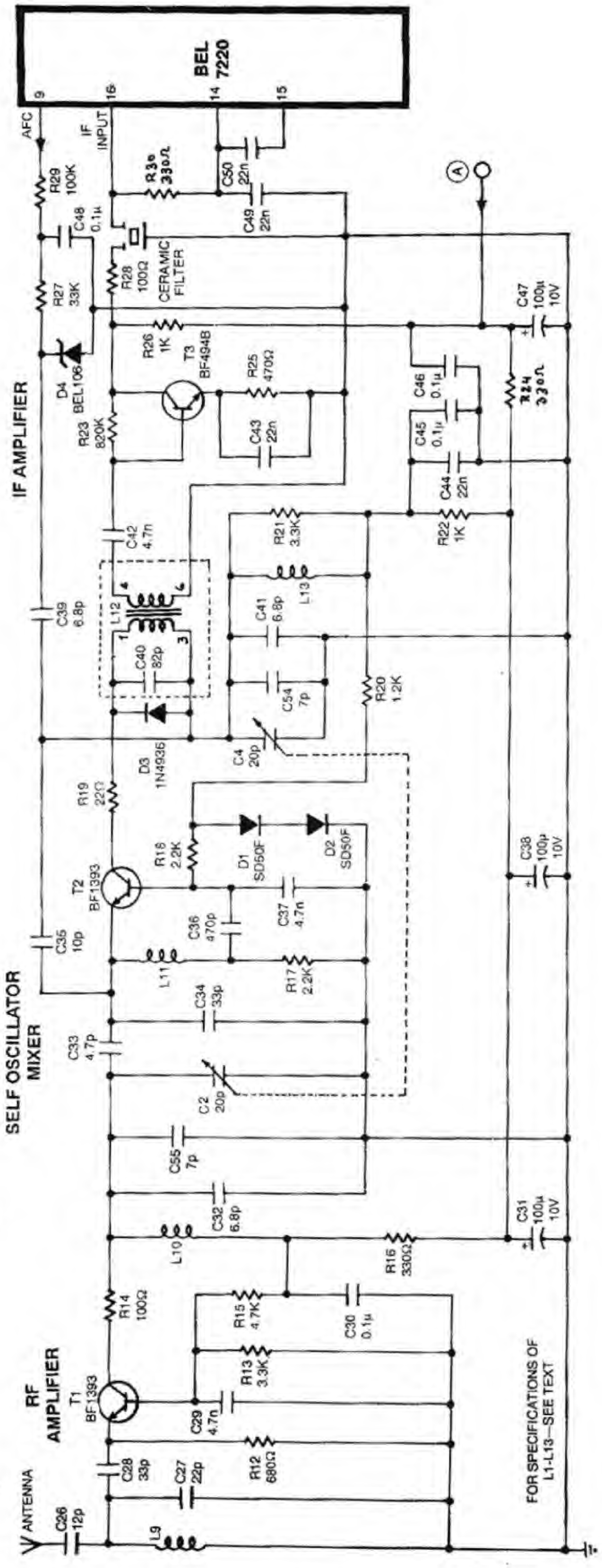


Fig. 3: Circuit diagram for FM front end and if stage.

C35	—	10pF ceramic
C36	—	470pF ceramic
C43, C44, C49, C50	—	22nF ceramic
C51, C53	—	10PF+10PF (221580710028 Philips) AM trimmer
C54, C52	—	7PF+7PF (221580710028 Philips) FM trimmer
C55, C56	—	330PF+330PF (221580710028 Philips) AM gang condensor

Miscellaneous:

S (S1..S6)	—	6-pole 3-way band switch
	—	24152724515 Philips 4-ohm loudspeaker
	—	Loop antenna
	—	FM telescopic antenna
	—	10 x 135mm (311510490300 Philips) ferrite rod
	—	SFE 10.7 MA (Murata) ceramic filter

the following functions are integrated.

(a) Pre-amplifier and double balanced mixer with AGC

(b) One pin local oscillator

(c) IF amplifier with internal AGC

(d) FM/IF amplifier and limiter

(e) Detector

(f) FM quadrature detector

(g) Audio pre-amplifier

The audio power amplifier stage makes use of IC BEL 1895. This is an audio power amplifier IC designed specially for radio application delivering 1W power into 4 ohms at 6V. The output exhibits low distortion and good noise characteristics. The schematic of AM/FM receiver is given in Fig.2.

FM section. The FM radio section consists of FM tuner, FM-IF amplifier, limiter and FM detector. All these sections except the FM tuner are integrated within the IC BEL 7220. The AM/FM selection is achieved by the selector switch. The FM selection is effected by applying DC voltage at pin 13 which switches the internal reference. The FM tuner covers the frequency from 87 to 108 MHz. The three-transistor FM front end schematic is shown in Fig. 3. It consists of a RF amplifier and a self-oscillating stage followed by a buffer amplifier. The front end transistors have been selected to give low noise figure and the design is stable under all conditions.

The tuned circuit at the IF input of IC provides high selectivity to the receiver. Ceramic filter can also be used in place of tuned coil, and in this case, pin 16 is biased from pin 14 by a low value resistor. The 10.7 MHz IF signal from the input coil is amplified and limited by the four stage differential IF amplifier. The gain of the IF stage is 81dB typical.

The FM IF output at pin 12 is applied to the discriminator network. The signal at pin 13 will be in quadrature (90 degree phase shift) with the input signal at centre frequency (10.7 MHz). The linearity can be improved by using a double tuned network, implying lower distortion comparatively. However, this leads to a reduction in the level of the recovered audio. A compromise between the two is achieved in the circuit. The audio output is available at pin 9. The capacitor at pin 9 filters the IF signal and also acts as de-emphasis network.

AM section. The AM section is designed to receive medium and short wave frequency ranges as given below:

MW 520 kHz to 1620 kHz

SW 4.5 MHz to 16.5 MHz.

The RF amplifier stage of the IC BEL 7220 receives the input from the secondary winding of the ferrite rod antenna coil, and SW antenna coil for the MW and SW operation respectively. The band selection is done by the bandswitch. The RF input of IC BEL 7220 is biased by pin 4 through antenna coil. Gain of the RF amplifier is about 30dB.

The local oscillator of IC BEL 7220 is a cross coupled differential amplifier which oscillates at the frequency determined by the resonant circuit formed by the oscillator coil with the gang condensor. Transformer coupling is used to improve the Q factor and to obtain better frequency stability of the oscillator circuit.

The mixer employed in IC BEL 7220 is a double balanced multiplier type. The IF output available at pin 3 is directly connected to the IF filter coil. The coil has been designed to have good selectivity. The tuned output is transformer coupled to IF input at pin 5.

For higher selectivity either an additional coil or ceramic filter can be used. The IF output available at pin 7 is detected. The capacitor at pin 6 acts as the peak envelope detector. This capacitor not only helps to recover the audio signal but also reduces the IF radiation and other spurious detector products. The audio output is available at pin 9.

The capacitor at pin 8 derives a mean DC signal to drive the AGC circuit. The IC has AGC range of about 90dB. The AGC action is obtained by the control of the transconductance of the RF amplifier, mixer and the IF amplifier stages. With weak signals, the AGC controls the IF stage gain maintaining the S/N (signal-to-noise ratio) maximum. With strong signal the gain of IF stages reduces first and then the RF stages. The detected output at pin 9 is coupled to audio amplifier stage through a capacitor.

The most popular BEL 1895 IC is used as the audio power amplifier.

Electronic Switch Starter

Nipun Kumar Chawda

This electronic switch starter provides some excellent facilities like overload and overvoltage protections, and auto-trip. Considering its small size and weight, as compared to that of conventional starters, it is far more attractive to use than the latter.

This starter has hardly any mechanical or moving part, except the relay, and is therefore very quick in sensing unfavourable conditions for the machinery to which it is connected. It trips the supply on sensing overload or overvoltage conditions.

Working

For switching on the starter switch S1 is pressed which energises the relay, thereby providing the supply to the circuitry as well as to the load connected to output terminals of the ciruitry. When S1 is released the relay remains activated until and unless there is a change in the supply which raises the voltage above the preset level adjusted through presets VR1 and VR2. The starter is switched off by pressing switch S2.

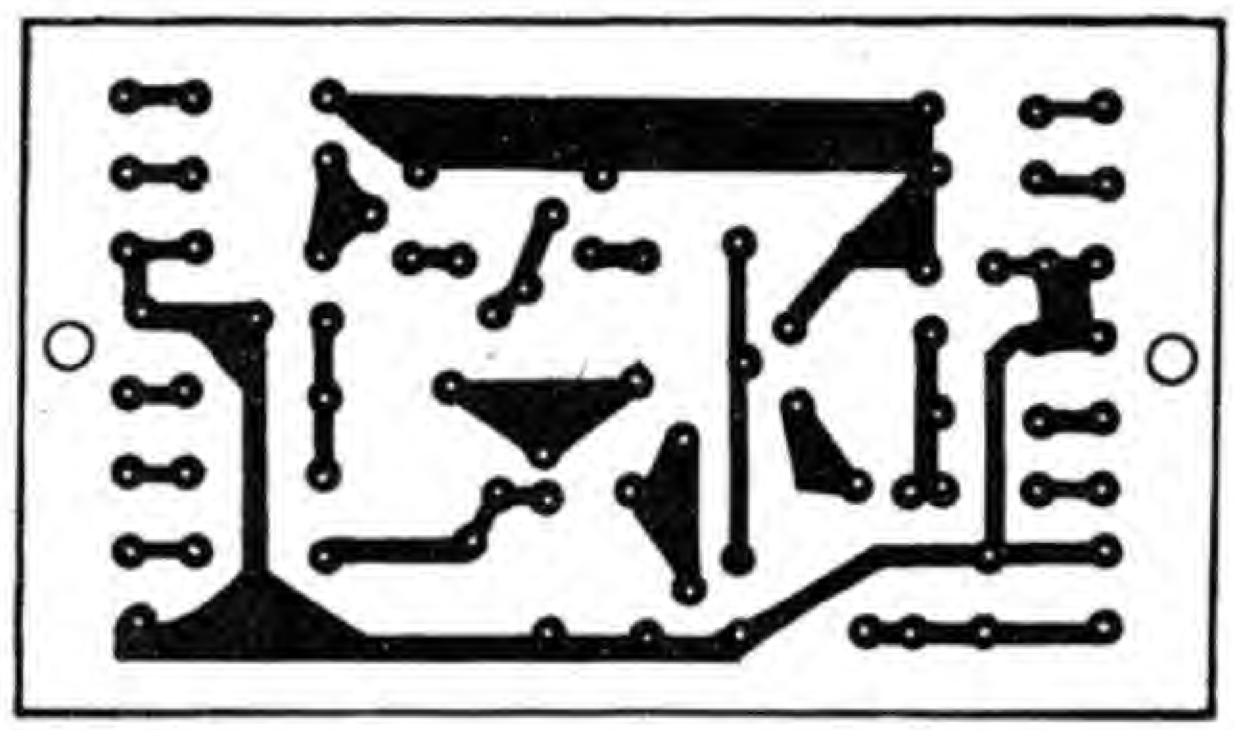


Fig. 2: Actual-size PCB layout for the circuit shown in Fig. 1.

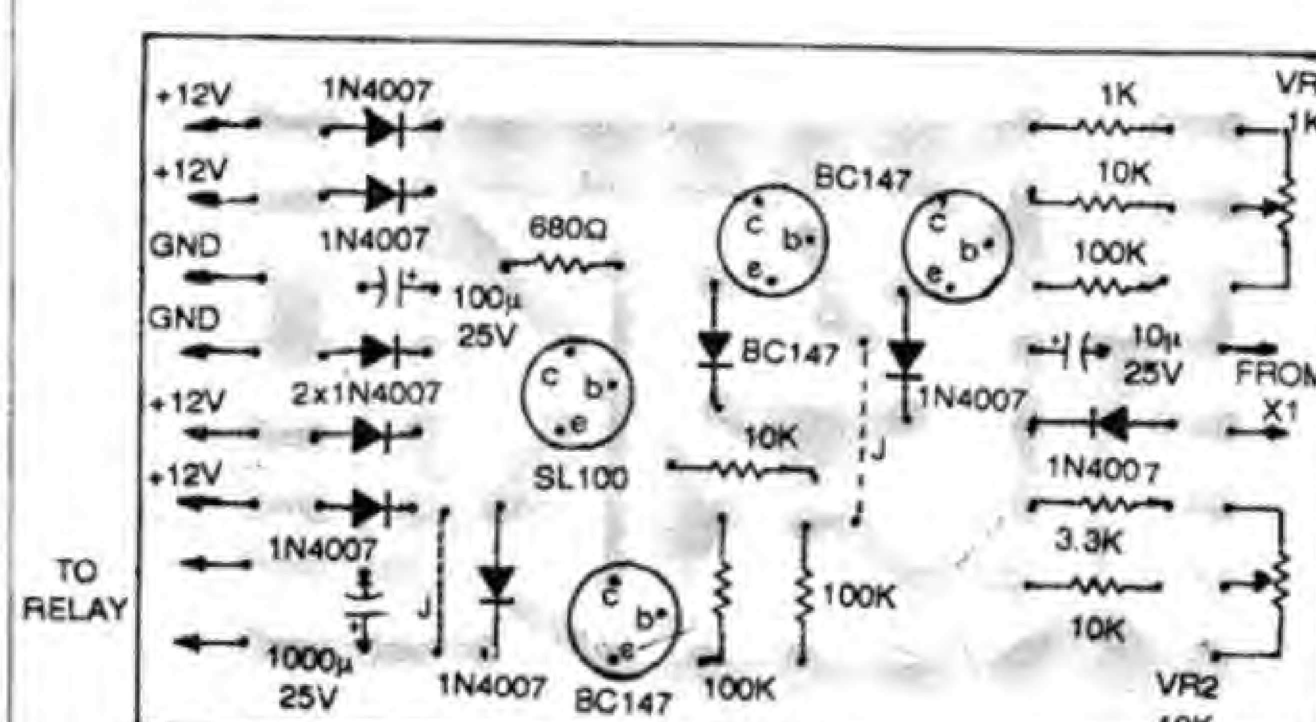


Fig. 3: Components layout for the PCB shown in Fig. 2.

As transformer X1 is required to act as an overload sensor for the device some modification has to be made in it. On the 0-6V side of the transformer, which acts as the secondary side, one turn of 14SWG copper wire is wound after removing the coil from the transformer. Its connection is made as per wiring diagram.

The circuit is simple and self-explanatory. It can be used for loads up to 750 watts. For higher loads, values of resistor R2, preset VR2 and the capacitors need to be changed, besides modifications required in transformer X1 and wiring, and an increase in the contact rating of the relay.

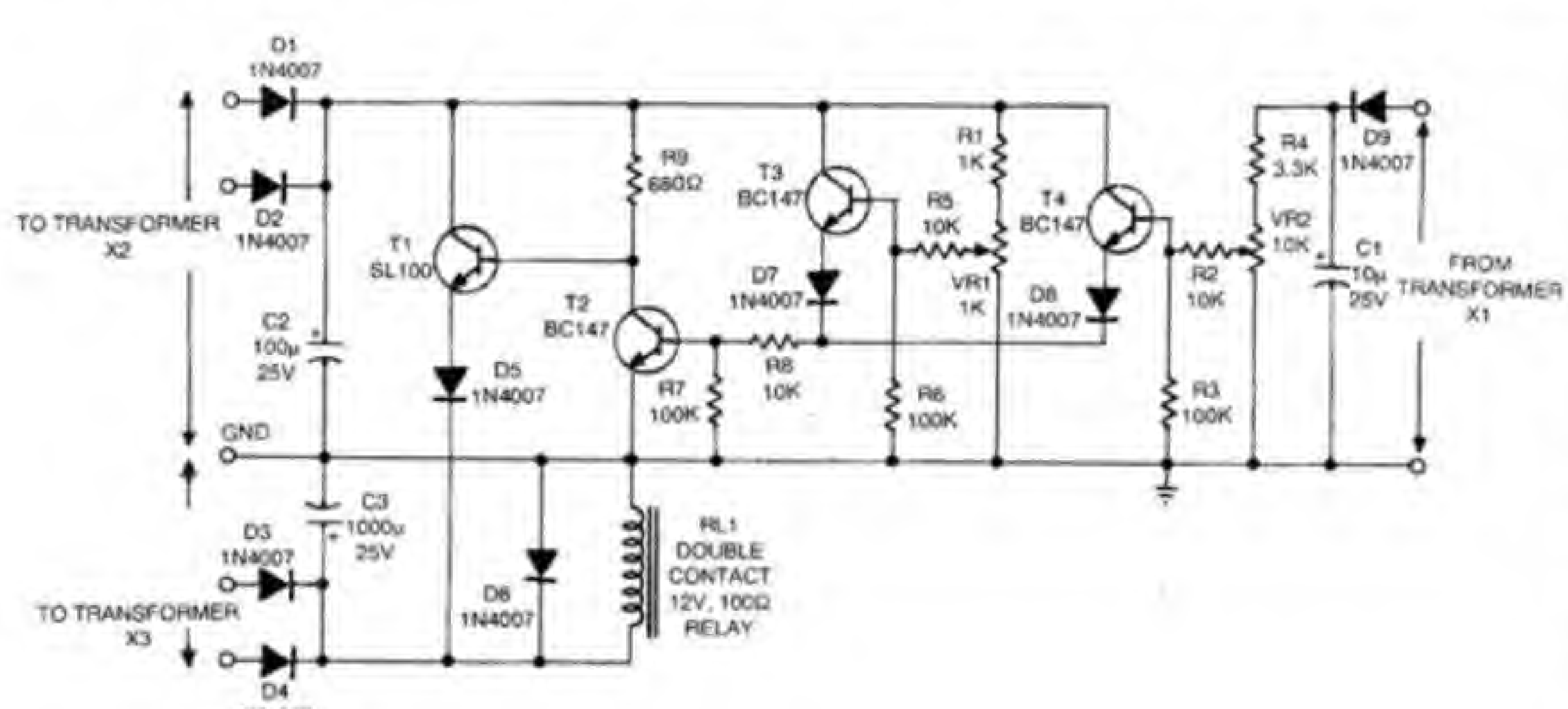


Fig. 1: Circuit diagram for the electronic switch starter.

Construction

The circuit may be wired on a PCB whose actual-size pattern and components layout are given here. It can also be wired on a general-purpose veroboard with almost equal ease as the ciruit is not so big.

For winding transformer X1, an old

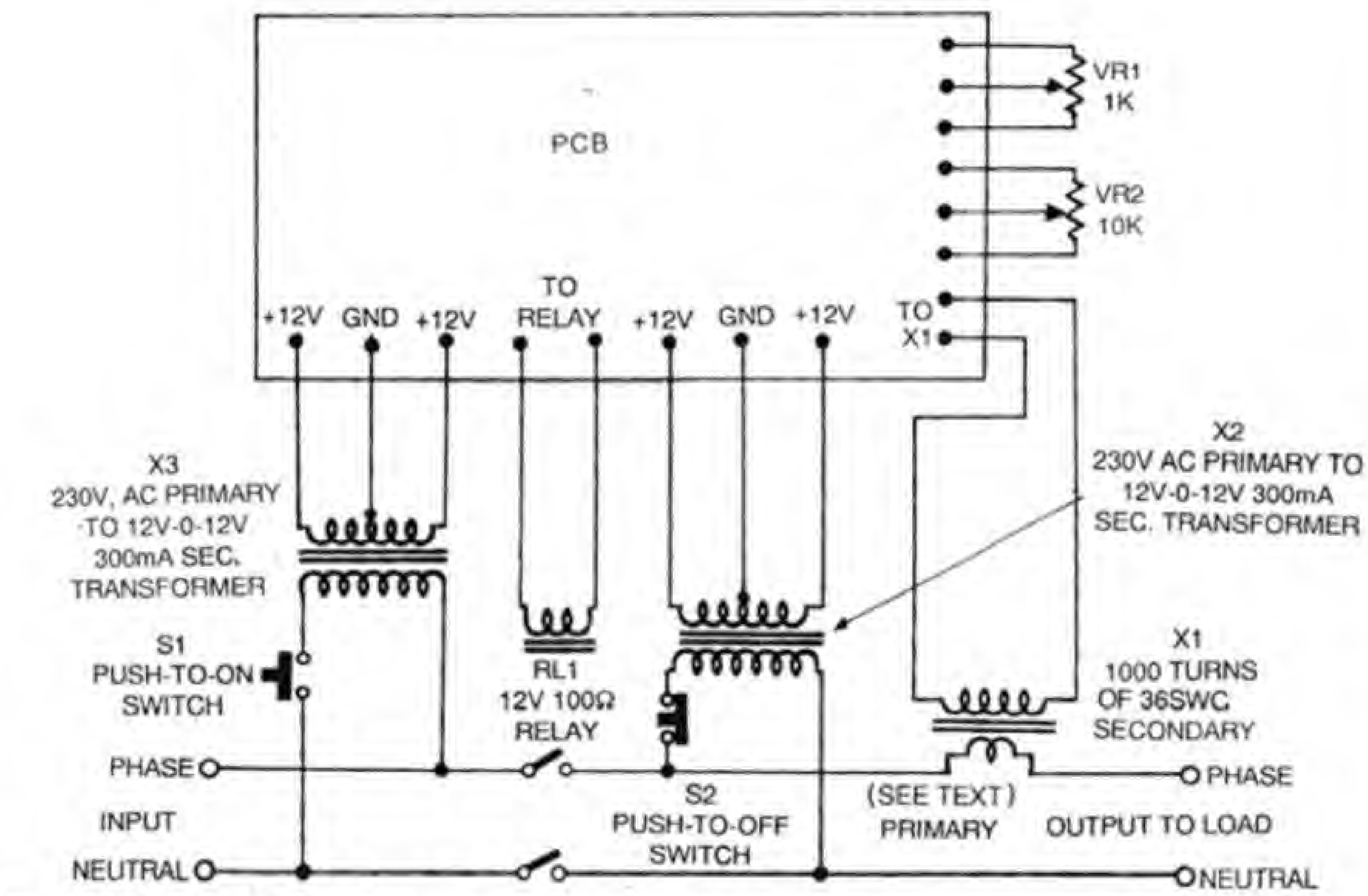


Fig. 4: Wiring diagram.

or 'burntout' transformer of 300mA rating may be procured and both its primary and secondary windings removed. Using 36SWG insulated copper wire 1000 turns may be wound uniformly on the bobbin. Insulating this layer properly, another layer of primary coil may be wound over it using a wire of appropriate thickness and giving it appropriate number of turns as per load requirement. The primary coil is connected in series with the load in the circuit. However, it should be ensured that the voltage developed across the secondary coil of 1000 turns does not exceed the voltage rating of capacitor C1.

As an example, keeping the secondary coil of 1000 turns, one can control loads of 200 watts to 5000 watts. Only the primary coil, which is in series with the load, has to change in accordance with the load connected at the output. For loads between 200 and 750 watts five turns of 18SWG wire are enough, while for a load of 5000 watts only one turn of 10SWG wire is required.

Setting

For setting, both the presets are kept close to the ground (zero potential) level and the normal 230V AC is supplied through a variac. Preset VR1 is turned slowly and left at the position where the relay just trips.

Next, disconnecting the variac, the AC mains are connected directly to the circuit's input terminals and the load is connected to its output terminals. Now preset VR2 is gradually turned slowly, starting from its initial ground-level position, till the relay just trips. VR2 is also left permanently at this position.

Testing of the circuit may be done by connecting a 100-watt light bulb in series with the load. Now as the current passing through transformer X1 would have increased, it is sensed by the circuit and the relay should trip, disconnecting the load from the mains supply.

It is noticed that the switch starter trips off sometimes just after switching on. This happens due to the heavy current that is induced in transformer X1 because of charging of a large capacitor in the inductive motors. If this happens frequently, replace capacitor C1 with that of a higher rating.

The switch may cost Rs 250 to 300 only to build.

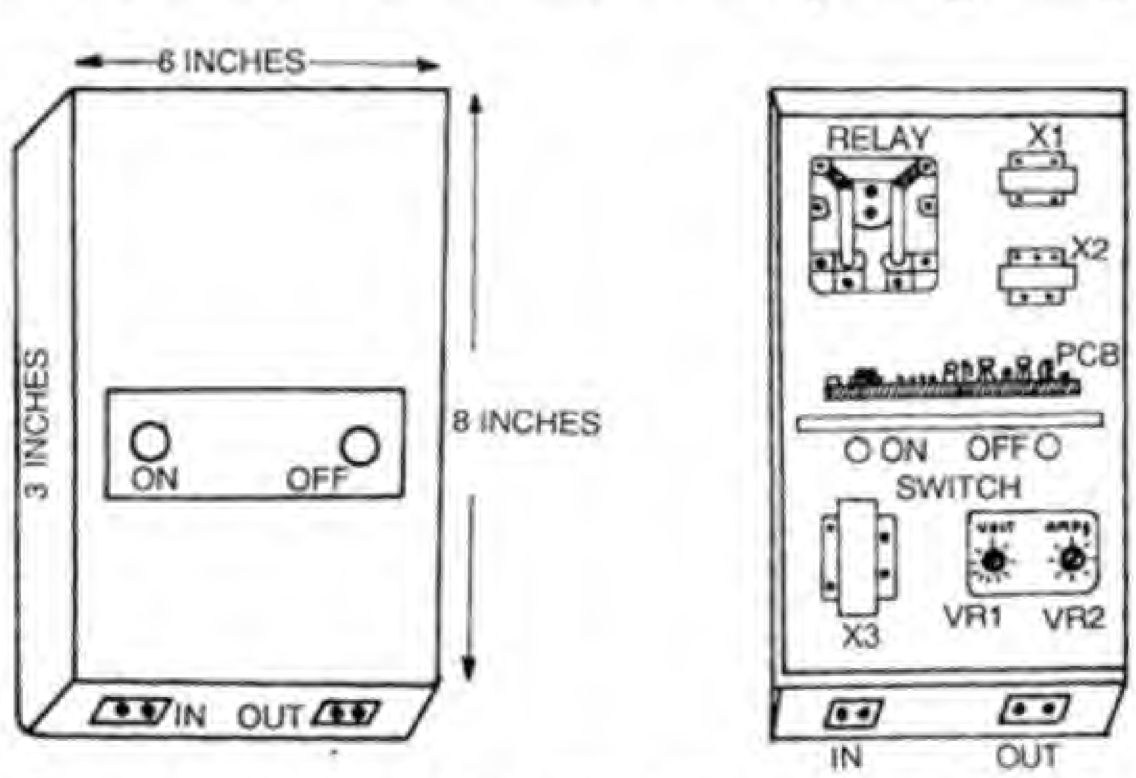


Fig. 5: A complete view of the electronic switch starter.

PARTS LIST

Semiconductors:

T1	— SL100 npn transistor
T2-T4	— BC147 npn transistor
D1-D9	— 1N4007 silicon diode

Resistors (all 1/4W, ±5% carbon unless stated otherwise):

R1	— 1-kilohm
R2, R5, R8	— 10-kilohm
R3, R6, R7	— 100-kilohm
R4	— 3.3-kilohm
R9	— 680-ohm
VR1	— 1-kilohm, wirewound type pot.
VR2	— 10 kilohm, wirewound type pot

Capacitors:

C1	— 10μF, 25V electrolytic
C2	— 100μF, 25V electrolytic
C3	— 1000μF, 25V electrolytic

Miscellaneous:

X1	— 1000 turns of 36SWG secondary, primary: (see text)
X2, X3	— 230V AC primary to 12V-0-12V, 300mA secondary transformer
RL1	— 100-ohm, 12V twin contact relay
S1	— Push-to-on switch
S2	— Push-to-off switch

Readers' Comments:

❑ Is it possible to use this circuit for overload protection only?

JYOTIRMOY DE
Hooghly

The author, Mr Nipun Chawda, replies:

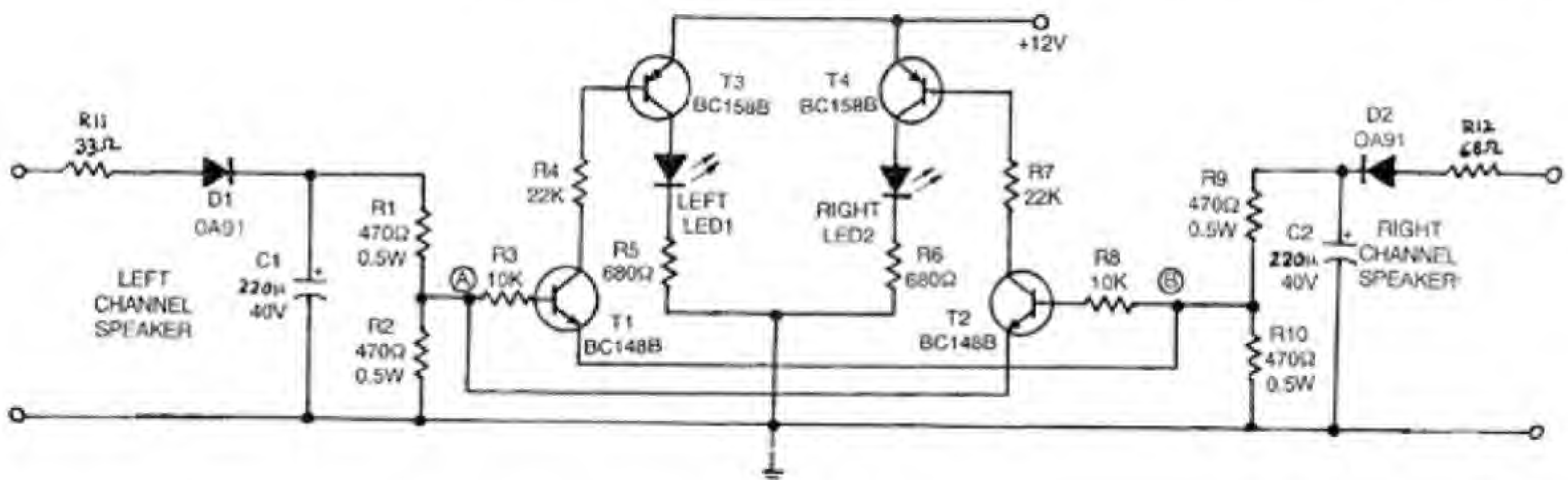
Regarding Mr Jyotirmoy's question, this circuit can be used for overload protection only by eliminating the overvoltage section or by keeping the preset of overvoltage VR1 to the ground level.

Section B: Circuit Ideas

Stereo Balance Indicator

Jayakar Wilson

This circuit can be used in stereo amplifiers to indicate the balance level of volume. As human ear is not so much sensitive to difference in sound level, the circuit indicates the difference in sound level in any channel by means of LED.



Input to the circuit is taken from output terminals of each channel. The output signals are rectified by diodes D1 and D2, and filtered by capacitors C1 and C2. A DC voltage is developed across the voltage dividers comprising R1, R2 and R9, R10.

When there is same volume in both channels, voltages at points A and B are equal and the voltage difference between points A and B is zero. So both transistors T1 and T2 remain cut-off. When volume in the left channel is increased, the voltage at point A also increases. When the voltage at point A increase by about 0.6 V more than the voltage at point B, transistor T1 starts conducting and switches on the LED, driving transistor T3. Transistor T2 remains cut-off.

When the voltage at point B increases by about 0.6 V more than that at point A, transistor T2 conducts lighting RIGHT LED. Left channel LED remains off. In this way the respective channel LED lights up to indicate the rise in volume level.

If one wants to get a very accurate stereo balance indication, you can replace T1 and T2 with AC187 without altering any components. As AC187 is a germinium transistor it requires only 0.2 volts to conduct while silicon transistor requires a minimum of .6 volts to conduct.

But it will be very difficult to adjust the balance as slight increase in any side will give an indication.

Unlike mono, in stereo the music will not be same in both the sides.

Readers' Comments:

The author has not mentioned the current rating of the 12V transformer for the Stereo Balance Indicator circuit in Jan.'92 issue!

N.G.
Calcutta

❑ Germanium diode OA91 is out of production since long, and so I would like the author to suggest a suitable substitute for it. I tried the circuit with OA70 and 1N34 diodes but the effect of 'balance indication' was not satisfactory.

SANDEEP S.
Bangalore

The author, Mr Jayakar Wilson, replies:
A small 100mA transformer is sufficient for stereo balance indicator as well as active bass and treble controls. For stereo balance indicator, power supply can be taken from the amplifier itself. Only the current limiting resistors R5 and R6 have to be changed to suit the voltage available. Any small signal diode having a minimum of 100mA forward current, and a reverse breakdown of 75 volts, can be used. For instance, 1N91, 1N457A, 1N485B, 1N486B, BA155, BAX16 etc. Even an 1N4001 can be used, but it has poor high frequency response.

Versatile Auto-cut Off Unit

V. Suresh

An auto cut-off facility is necessary for all the mains operated equipment and voltage stabilisers (automatic as well as manual) to switch them off when the voltage shoots above or falls below a certain safe level. The cut-off facility available in most commercial stabilisers is so abrupt that they switch off the moment the voltage goes beyond a predetermined window (normally, 180V to 250V) and switches on immediately the voltage falls within the calibrated range. Power interruptions are quite frequent, at times and the deviation of mains voltage from its normal safe value for a few seconds is also a common phenomenon. But it is undesirable to switch off and on equipment frequently, particularly motors and compressors which undergo greater stress during start-up period than during their run time. Hence, it is highly desirable to keep the switching on and off processes down to the minimum.

Introduction of on-time and off-time delays into the cut-off unit proves helpful under such circumstances. Such a cut-off circuit will switch-off the load only when the mains voltage deviates from the safe value and remains there for a few seconds. If the mains voltage returns to its safe value within this time limit, the load will not be switched off. Similar is the case when the load is switched on.

The circuit diagram shown here includes supply section (within dotted lines). IC1 (LM393, a dual comparator with open collector outputs) senses the voltage and IC2 (555 timer) introduces the delay during switch-on and switch-off. The outputs of both the comparators in LM393 are tied to the common pull-up resistor R3. Hence if the output of any comparator goes low then voltage at point X will also be low.

One input of each comparator is connected to reference voltage of 3.3 volts provided by R2-D5 combination. The other inputs are connected to presets VR1 and VR2. Preset VR1 sets the upper cut-off level while VR2 sets the lower cut-off level. If the mains voltage rises above the upper cut-off level or falls below the lower cut-off level, the output of the corresponding comparator and hence the voltage level at point X will go low.

Initially, when the unit is switched on, and assuming that the mains voltage is within the limits set by VR1 and VR2, the outputs of both the comparators will be high. So capacitor C4 will start charging through R3 and D6. Since during switch-on the capacitor starts charging from zero volt, the output of IC2 goes to high level and the relay remains in the deactuated state. Hence the load is not switched on. When the voltage across the capacitor crosses 2/3 Vcc, the output of IC2 goes to low level, the relay gets actuated and switches

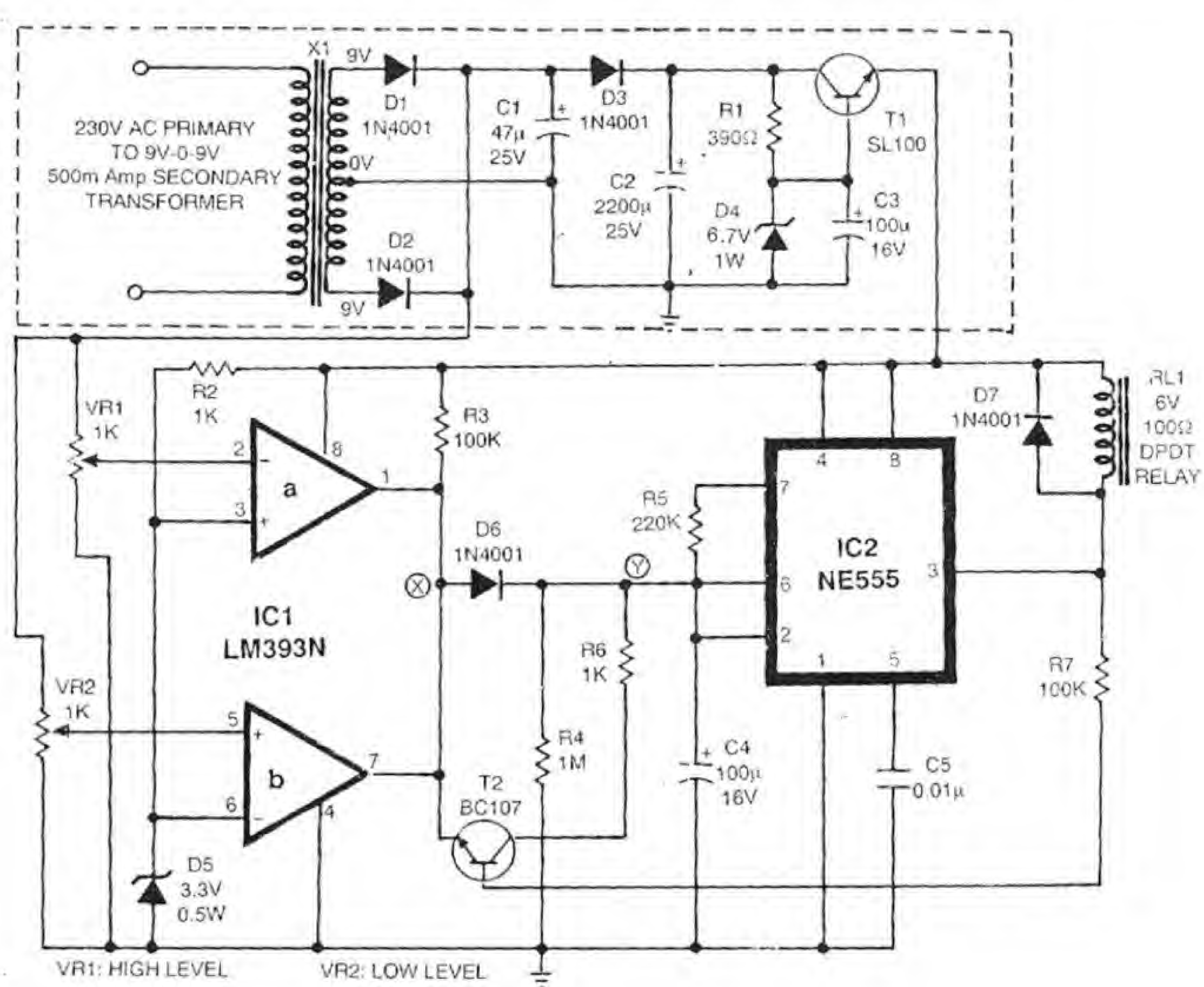


Fig. 1.

on the load. This constitutes the power-on delay and is about 10 seconds for the values shown.

At the same time pin 7 of IC2 is grounded by the internal transistor of IC2. Now capacitor C4 is discharged by the parallel combination of R4 and R5, but at the same time it is being charged by R3. The overall combination of R3, D6, R4 and R5 is selected (see Fig. 2) in such a way that the voltage across the capacitor is maintained above 1/2 Vcc (say V). This is the steady-state condition.

If the mains voltage shoots above the level set by VR1 or falls below the level set by VR2 the output of the corresponding comparator and hence the voltage level at point X will go low. Now diode D6 being reverse biased isolates points X and Y. Hence there is no charging path for C4 and it discharges through the parallel combination of R4 and R5. When voltage across the capacitor goes below 1/3 Vcc the output of IC2 will go high, switching off the load. At the same time the internal discharge transistor in IC2 is cut-off. (Now the only discharge path for C4 is the high valued R4.) The time taken by the voltage across C4 to fall from V (its steady-state value) to 1/3 Vcc is the delay introduced by the circuit to switch off the load after sensing an error in mains voltage.

If at any time before the load is switched off the mains voltage returns to its normal value, charging process of C4 through R3 and D6 is again started. And since the resistance in the charging path is lower than that in the discharge path, the voltage across C4 is taken to its steady-state value of V without much delay and the load is not unnecessarily switched off.

When mains voltage returns to its normal value after the load has been switched off, capacitor C4 starts charging through R3, and once the voltage across it reaches 2/3 Vcc, the output of IC3 goes low, actuating the relay, thereby switching on the load and returning the circuit to its steady state. Again, the time taken by the voltage across C4 to reach 2/3 Vcc is the delay introduced in

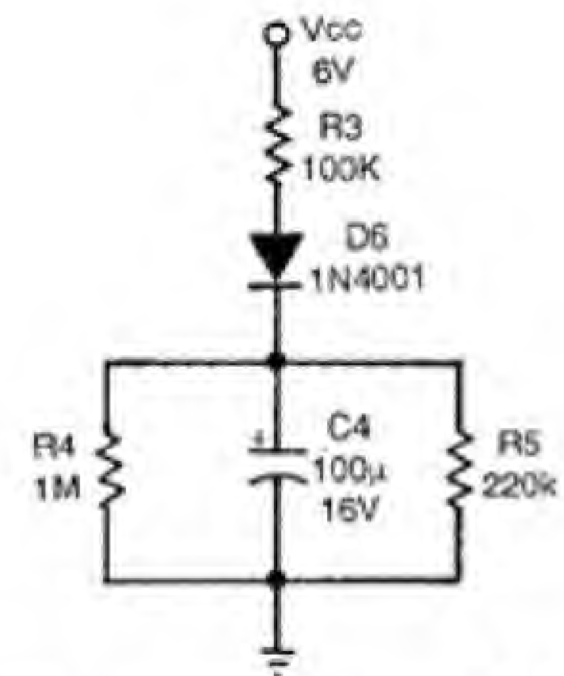


Fig. 2: Steady state condition of C4.

the circuit. But before the voltage across C4 reaches 2/3 Vcc, if the mains voltage goes out of the window, then charging of C4 is stopped and the load is not switched on. And C4 slowly discharges through R4.

Now consider a peculiar case. If mains voltage fluctuates in such a way that it is within the window defined by VR1 and VR2 for a few seconds and outside the window for a few seconds, both time durations being less than the delay introudced in the circuit, and such a fluctuation continues for a certain duration, say a few minutes. (Such a behaviour of course has a very low probability of occurence.) According to the standards set for this cut-out circuit, discussed so far, during such a behaviour of mains voltage the load should not be switched off if it is in on and vice versa.

After detecting a deviation in the mains voltage, to switch off the load, the circuit calculates the time by discharging C4, and by charging it to switch on the load when the mains voltage returns to its normal value. Always the resistance in the charging path is lower than that in the discharge path. Hence when the load is on and mains voltage fluctuates as seen above, since C4 is replenished at a faster rate, voltage across it will not go below 1/3 Vcc and the load will not be switched off—conforming to the standards set earlier. But if the load is off, and mains voltage fluctuates as seen above, because of the same reason that C4 is charged faster than it is discharged (now the resistance in the discharge path would be the high valued R4, since R5 is isolated because the internal discharge transistor in IC2 is cut-off) after few cycles of such fluctuation the voltage across C4 would reach 2/3 Vcc and the load will be switched on—deviating from the standards set!

Even though the probability of such a continued fluctuation is very low, still the circuit can be made fool-proof by adding one transistor and two resistors as shown in Fig. 3. Every time the load is off, base of T2 is held high.

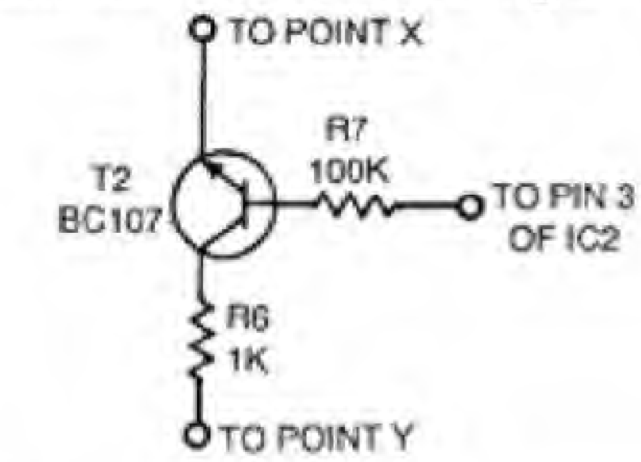


Fig. 3: Fool-proof circuit (see text).

Whenever the mains voltage goes out of the window, emitter of T2 (which is connected to point X) is also grounded, thereby discharging C4 fully. Hence mains voltage is to be within the limits set by VR1 and VR2 and should reamin there for atleast T seconds for the load to be switched on. Once the load is on, the base of T2 is held low and has no effect on the behaviour of the circuit. With the addition of T2, R6 and R7, of course R4 can be omitted and the value of R5 reduced to 180k.

To set the presets VR1 and VR2, apply mains voltage to the circuit through a variac. Set the mains voltage to the upper cut-off level. Adjust VR1 so that voltage at its variable pin is 3.3 volts. Now set the mains voltage to the lower cut-off level and adjust VR2 so that voltage at its variable pin is also 3.3 volts. The circuit is ready.

The circuit can be constructed easily on a general-purpose strip board. It can be used either independently as an auto cut-off unit or as an add-on to an existing voltage stabiliser. Ensure that the contact rating of the relay suits the particular load in operation. The delay time introduced by the circuit, both during switch-on and switch-off, can be varied by changing the value of C4. Reducing the value of C4 reduces the time delay and vice versa.

❑

Readers' Comments:

I found the 'Versatile Auto Cut-off Unit' in EFY Jan. '92 issue very interesting and useful. The author is requested to suggest the unit without the time-delay switch-on and switch-off circuit. What will be the connections of relay in that case? Can this circuit be used in a 3-phase system to cut-off over/under voltage and over voltage through a 3-phase contractor and controlling the operating coil through the relay?

Also clarify the IC LM393, a dual comparator with open collector output.

Is there any other method to set the VR1 and VR2?

G.D. RAJPALI
Ghaziabad

The author, Mr V. Suresh, replies:
The circuit diagram without time-delay is shown in Fig. 1. The load should be connected to the N/C contacts of the relay. It should be possible to control the operating coil of a 3-phase contactor through the relay.

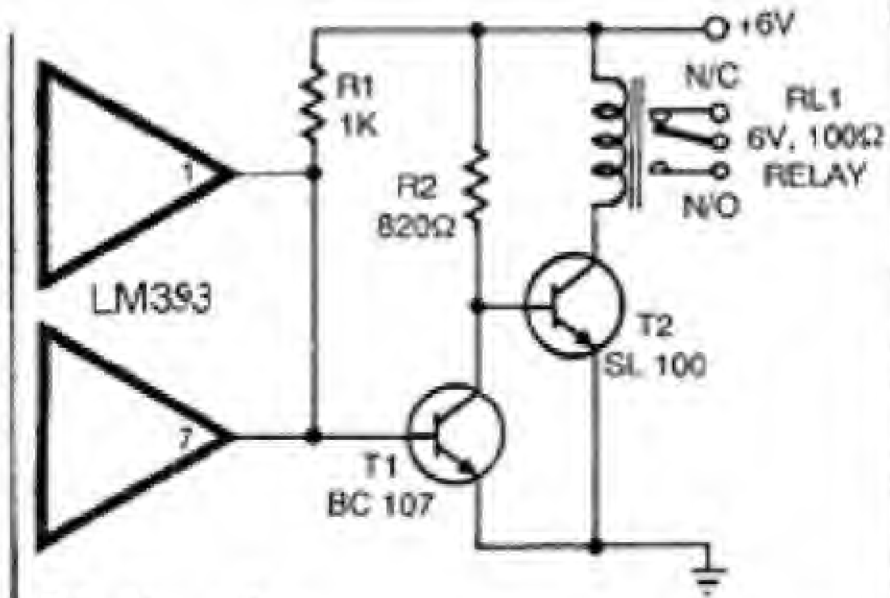


Fig. 1:

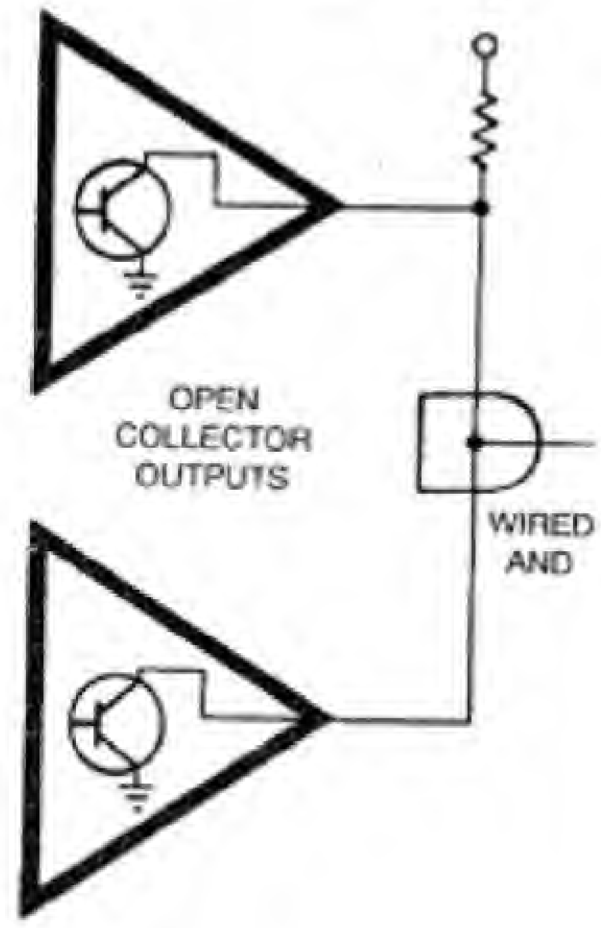


Fig. 2:

Whenever an IC is said to have an open collector output it means that the corresponding output comes from an internal transistor's collector that is uncommitted internally, i.e. no pull-up circuits are there internally for the output transistor's collector. This is shown in Fig.2. In such cases, a number of these outputs could be tied together and, by adding an external pull-up resistor, could be used for wired-OR (actually wired-AND) functions.

The method described to set VR1 and VR2 is the simplest and ideal.

Staircase Light Switch

K.M. Reddy

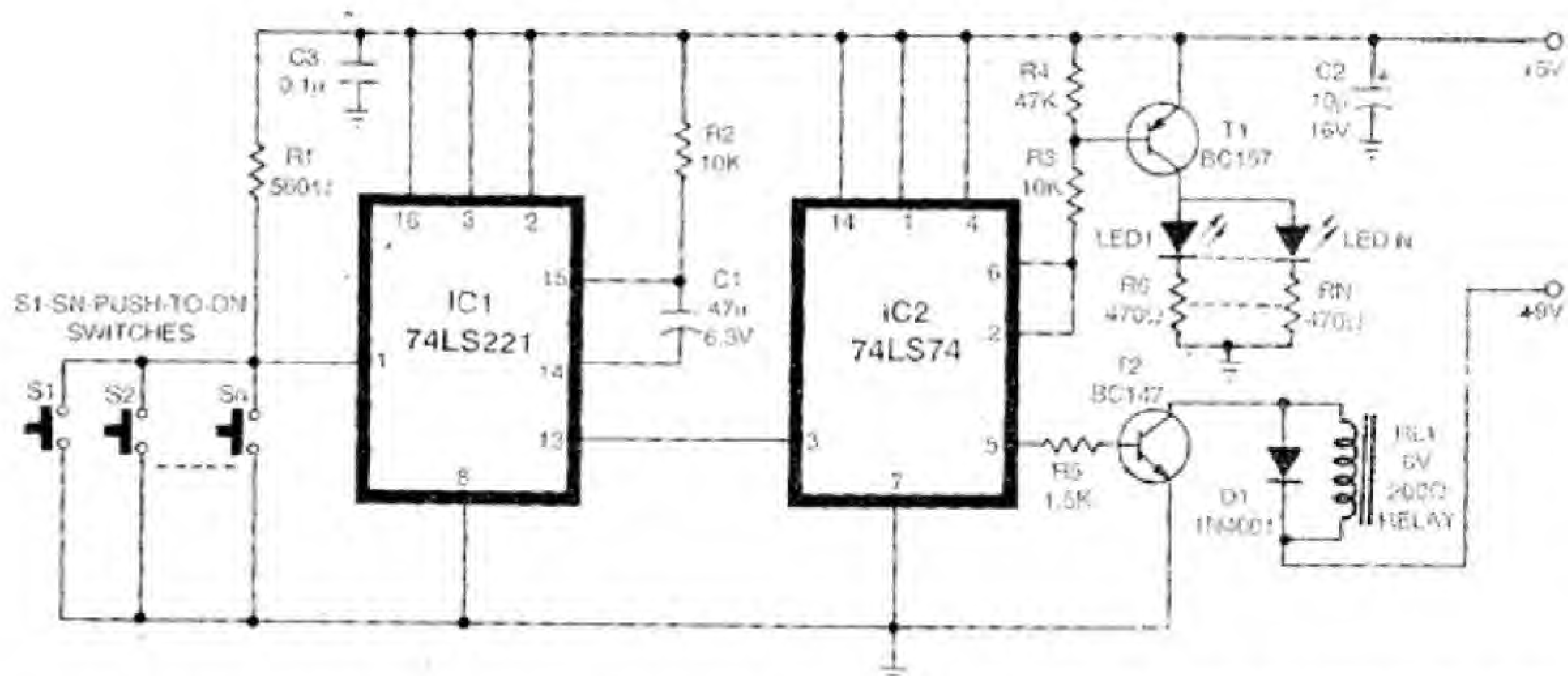
This circuit may be used where it is necessary to control a single light or device by switches that are situated at different places. The control of a staircase light is one of the applications of this circuit. This circuit can also be used to control an outdoor light using switches that are situated both inside and outside the house.

Any number of switches may be connected to this circuit. As the switches are wired in parallel, the wiring can be done using a 2-wire system. This circuit has simpler wiring as compared to the conventional electrical circuit.

An LED may also be added next to each switch to indicate whether the light is on or off. This feature can be useful when the light is far from the switch and cannot be seen easily. If LEDs are used for indication, however, another wire has to be used along with the two wires used for connecting the switches to the circuit.

The circuit is based on two low-power Schottky ICs. IC1 is a dual non-retriggerable monostable multivibrator while IC2 contains two D-type flip-flops. IC1a is wired as a monostable multivibrator which supplies a 0.5 second pulse whenever any of the pushbuttons are pressed. These pulses clock the D-type flip-flop which divides by two. The first pulse will make the output of the flip-flop high while the next time the pushbutton is pressed, the output will go low.

The output of the flip-flop is connected to a transistor which drives a relay. The relay controls the load which may be a light or any other electrical appliance. The realy contacts should



be rated higher than the load current.

A transistor controls the LEDs which are used for indication. If the LEDs are not required, they need not be included in the circuit.

The power supply for the circuit is of conventional design and consists of a transformer, bridge rectifier and capacitor. A regulator is used to derive a 5V supply which is needed for the ICs. Since IC1 and IC2 contain an unused monostable and flip-flop respectively, they may be used in a similar circuit to control a different load.

The circuit being simple can be made on a general-purpose PCB.

Readers' Comments:

The 'Staircase Light Switch' circuit in EFY Jan.'92 issue is complicated and costly too as it needs two ICs and separate power supplies. I have made such a bistable multivibrator using a CD4017 decade counter which is working very well. The circuit is very simple.

ABSHISHEK PANDEY
Indore

❑ Your above-mentioned circuit may be very useful but it involves excessive hardware and also requires a 5V regulated power supply.

RAMESHWAR
Itarsi (UP)

❑ In the above circuit idea LED1 to LEDN have been shown. I can't understand this.

All LEDs are connected in parallel and the input to LED driven transistor is taken from a single point of IC2. So the idea of separate LED indications on pressing of input switches is absolutely foolish!

PRADEEP G.
Allappey

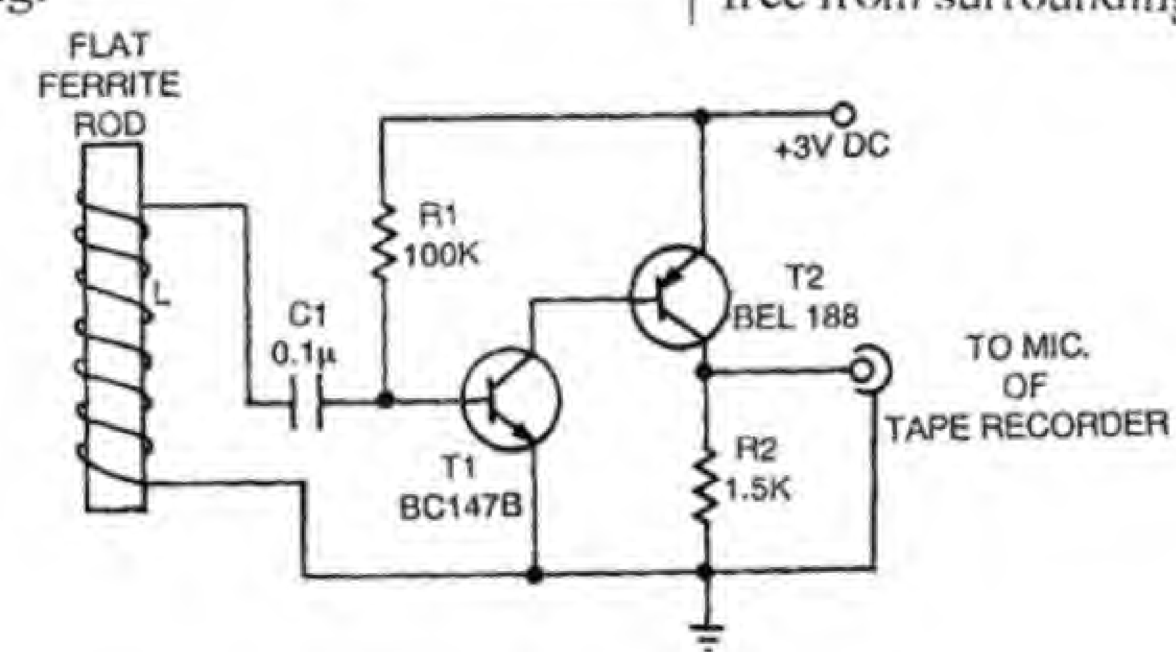
The author, Mr K.M. Reddy, replies:
I would like to thank Mr Rameshwar and Mr Pandey for their interest in my circuit. I fully agree with them that my circuit is more expensive. However, my circuit will prove to be more economical when two such switches are needed. In that case only some passive components and two transistors need to be added as the ICs 74LS74 and 74LS221 contain two flip-flops and two monostable multivibrators respectively. More importantly, in my circuit there is effective debouncing of the switches.

I would like to advise Mr Pradeep to read the article carefully and try to understand the circuit. This "foolish" LED is most suitable in remote switching where one cannot easily ascertain whether the load is 'on' or 'off'. Transistor BC147 can easily handle 5 to 7 LEDs, and the output of the IC can drive the transistor.

Wireless Recording

R.K. Gupta

Generally, recording from tape to tape is done with the help of a lead, which is often associated with electrical noises. To avoid this, inductive recording is done, which is superior as compared to direct electrical recording.



For such recording from any source of sound, the sensor is placed near the speaker and the earphone pin is inserted into the external mike jack of tape recorder, which is set into the recording mode. In this way, recording free from surrounding noises and electrical disturbances is done.

The circuit works with two pencil cells which last quite some time due to low consumption of power. The sensor is home-made by winding 24SWG enamelled copper wire on the whole length of a flat ferrite rod (used with antenna coil in a pocket radio set). The sensor is placed near the speaker and the jack is inserted into the tape recorder's socket in recording mode. The volume of voices being recorded is adjusted to give distortionless recording.

This circuit can also be used for tape recording 2-way coversation going on a telephone.

Readers' Comments:

The circuit of 'Wireless Recording' in EFY Jan. '92 issue does not serve the very purpose of its design! Its quality of recording can never be equal to that of 'with-cord' recording.

First, magnetic stray disturbances are more probable than electrical disturbances. Besides, there will be a high degree of non-linear distortion and frequency distortion, as the voltage induced in the sensor is proportional not only to the current in voice coil but also to the mutual inductance with the voice coil, which changes non-linearly with the movement of voice coil. The frequency distortion arises as a consequence of the frequency-dependent nature of the speaker.

T.S. SHANKAR
Hyderabad

The author, Mr R.K. Gupta, replies: I am thankful to Mr Shankar for pointing out the theoretical error in my circuit. I found the electrical recording associated with noise. To eliminate that I started using this device. By adjusting the volume of the recording material I have been getting good results for my personal tape recording.

The mutual inductance associated with sensor and voice coil is very negligible. So the second effect mentioned by Mr Shankar is negligible.

A Versatile Decibel Meter

T.S. Shankar

A decibel meter is an instrument to measure levels of input signal(s) in decibel units. The main areas of application of decibel meters are audio level indicators, record level indicators, spectrum analysers and the like.

The circuit shown here provides a resolution of 20 steps. Although the steps are linear, they are calibrated with cor-

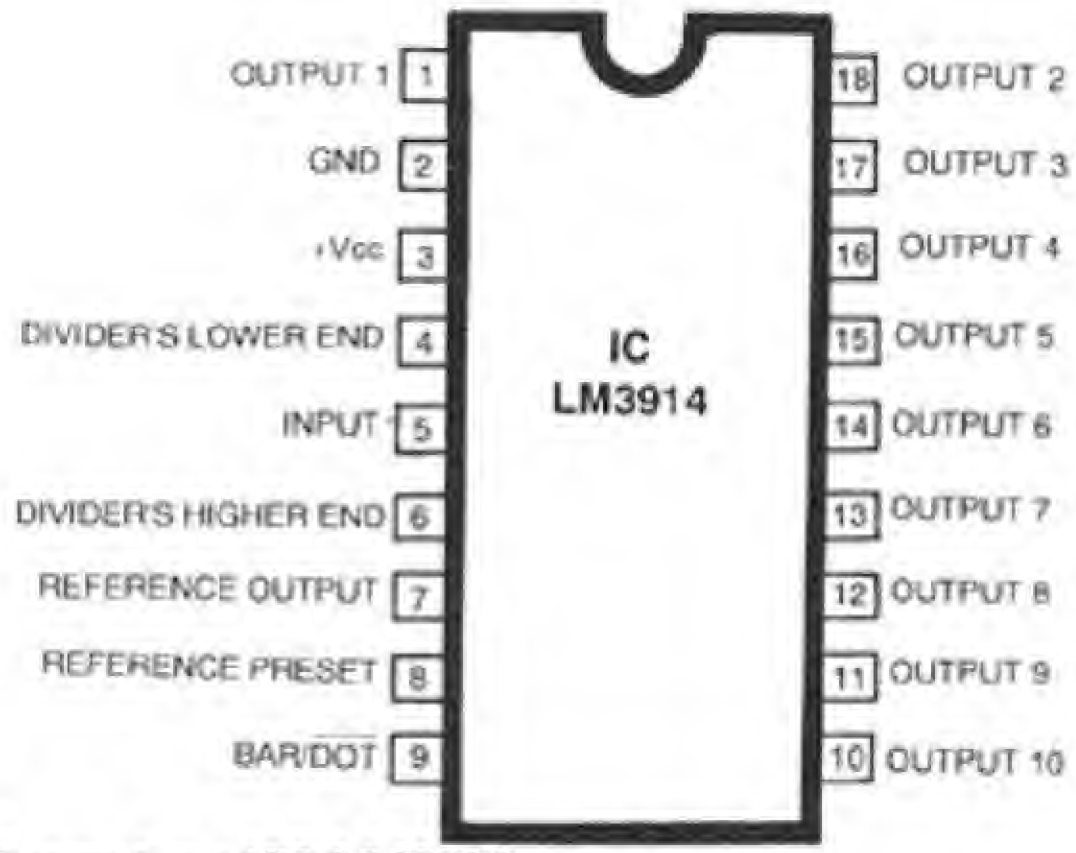


Fig. 1: Pin configuration of IC LM3914.

responding decibel value so that it suits most of the requirements.

The circuit is shown in Fig. 2. It is based on IC LM3914 integrated circuit intended for bar graph generator circuits. The IC has 11 op-amps, out of which one is used for buffering the input and the rest as comparators. The inverting inputs of all the comparators are tied together and linked to output of the buffer op-amp, inside the chip. The non-inverting inputs are each given a different reference voltage generated by a resistor ladder. Both the ends of these ladders are available externally at pins 4 and 6. The IC incorporates a stable reference voltage at pin 7. This reference output can be elevated by raising the voltage at pin 8, which is the reference preset input. The outputs are active low, and the current at the outputs can be determined by a load resistor connected to pin 7 and ground. IC LM3914 has two modes of operation—bar mode and dot mode—which can be selected by applying appropriate logic at its pin 9.

The circuit incorporates two LM3914 ICs for obtaining 20 steps. One more IC may be cascaded to obtain 30 steps. But 20 steps were found adequate for most of the practical purposes.

The divider's lower end of IC1 (pin 4) is grounded so that the lowest levels of input signals are detected linearly. The divider's higher end (pin 6) is given a reference voltage of 1.25V obtained from pin 7. So each comparator switches at steps of 0.125V of the input signal. The load resistors R2 and R3 each of 1.5k limit the current through each LED to 12 mA.

The reference voltage of IC2 is made 2.5V by raising pin 8 to 1.25V obtained from pin 7 of IC1. The divider's lower end is also raised to 1.25V so that signals above 1.25V are handled by IC2. The voltage at pin 7 of IC2 is now 2.5V and is given to pin 6 of IC2 to fix the divider's higher end of IC2 to 2.5V.

The circuit as a whole has 20 comparators, each with a reference voltage of 0.125V. The output can be selected to bar or dot mode by applying high or low logic respectively to pin 9.

The circuit can be used for any range. The range can be obtained by attenuating the input signal accordingly. Otherwise, a multi-way switch can be used to select the range which switches over to different potentiometers, that were preset for different ranges.

The unit Bel or Decibel is only a ratio of two quantities such as voltage or power and is not an absolute value. Whenever a quantity is expressed in decibels, it should also provide a reference level to which the quantity is referred to.

Decibel values related to some parameters are given by

Power in dB = 10 log (P2/P1)

where P2 is the power in question and P1 is the power to which P2 is referred toVoltage in dB = 20 log (V2/V1)

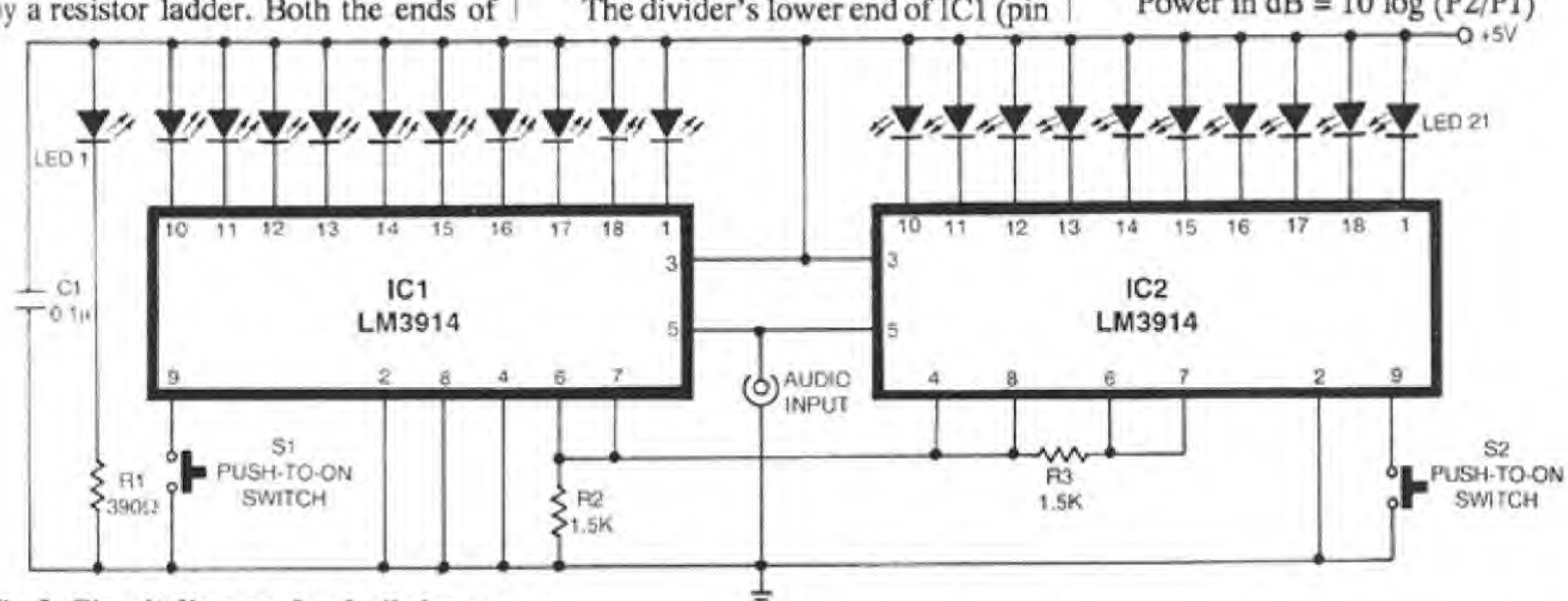


Fig. 2: Circuit diagram for decibel meter.

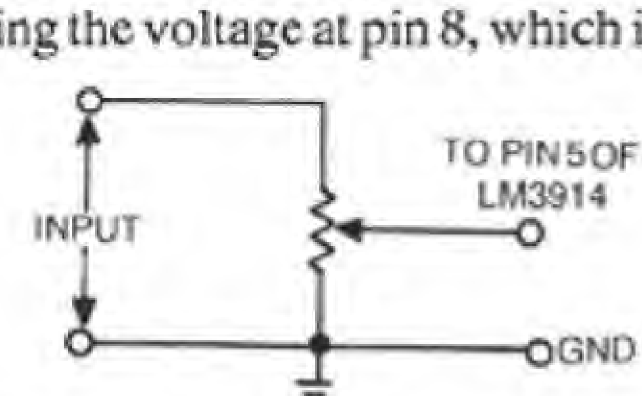


Fig. 3: Divider network

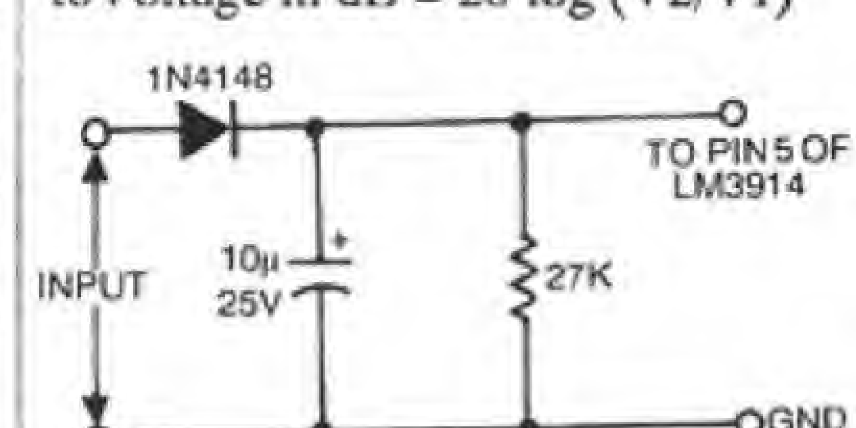


Fig. 4: Circuit for audio application.

where V2 is the voltage in question and V1 is the voltage to which V2 is referred to.

In most cases, a power of 1mW dissipated in 600 ohms resistor is taken as reference. That corresponds to a voltage level of 0.7745 volt. This means that 0.7745 volts is taken as 0 dB. As such, the sixth LED corresponds to 0 dB in this circuit. The decibel values for other LEDs can be calculated by the formula

dB = 20 log (n x 0.125/0.77459)

where n is the number of the particular LED.

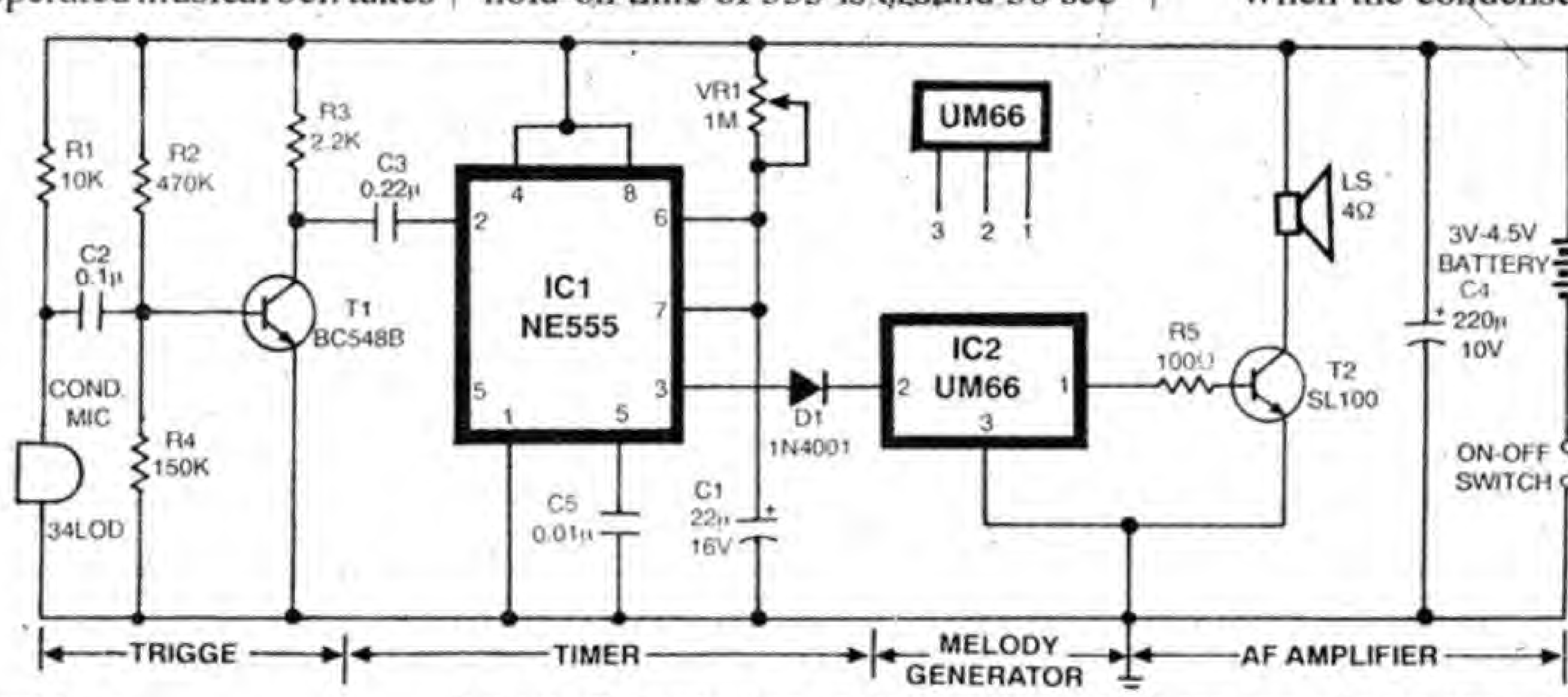
To change the above values to suit someone's requirement, divide the incoming voltage through a potentiometer as shown in Fig. 3. The choice of VR1 depends upon the input impedance required.

For using the circuit in tape decks, a well calibrated equipment should be available for precalibration of the circuit.

Sound Operated Musical Bell

Narpat Singh Rana

Sometimes ringing the bell manually becomes difficult, especially when you are holding something in your hands. This sound-operated musical bell takes care of the problem.



In this circuit, the use of an external relay has been eliminated. The circuit comprises a trigger stage (around BC548B), a timer stage (around NE555) and a melody stage (around UM66 and SL100).

Transistor BC548B is biased in class-C operation. Every sound causes triggering at pin 2 of 555 timer.

When VR1 is at maximum, the hold-on time of 555 is around 30 seconds. But this time period can be set to a lower value by VR1, as per requirement, using the relationship:

T = 1.1 x VR1 x C1

where VR1 is the actual resistance of the preset in circuit. UM66 IC has ROM memory of 64 notes which are produced one by one and then over with a gap of about half second and they start again. Transistor SL100 can be replaced by transistor BD115.

When the condenser mic. receives the sound of a clap, the timer is triggered and the output at pin 3 of IC 555 goes high which gets applied through diode 1N4001 to pin 2 of musical IC UM66. As UM66 gets the positive supply, it starts giving electrical fluctuations of the music to the base of SL100, and a charming music comes out at the 4 ohm speaker. The music stops after the completion, as per time setting of timer 555.

The value of resistance R2 is 270-kilohm for 3V supply and 470-kilohm for 4.5V to 6V supply.

The speaker should be kept away from the condenser mic. to prevent false triggering.

Readers' Comments:

In EFY Jan.'92 issue there is a circuit for 'Sound Operated Musical Bell' which, the author says, is very useful when we are holding something in our hands and cannot reach for the doorbell. But later he says that this bell can be activated by a clap. Now if the hands are free for clapping, we can as well reach for the doorbell.

Secondly, there is no novelty in this circuit to warrant its publication. Almost any sound, such as a log dropping, a coconut falling (or a dog barking) can trigger this circuit, causing undue annoyance to the user.

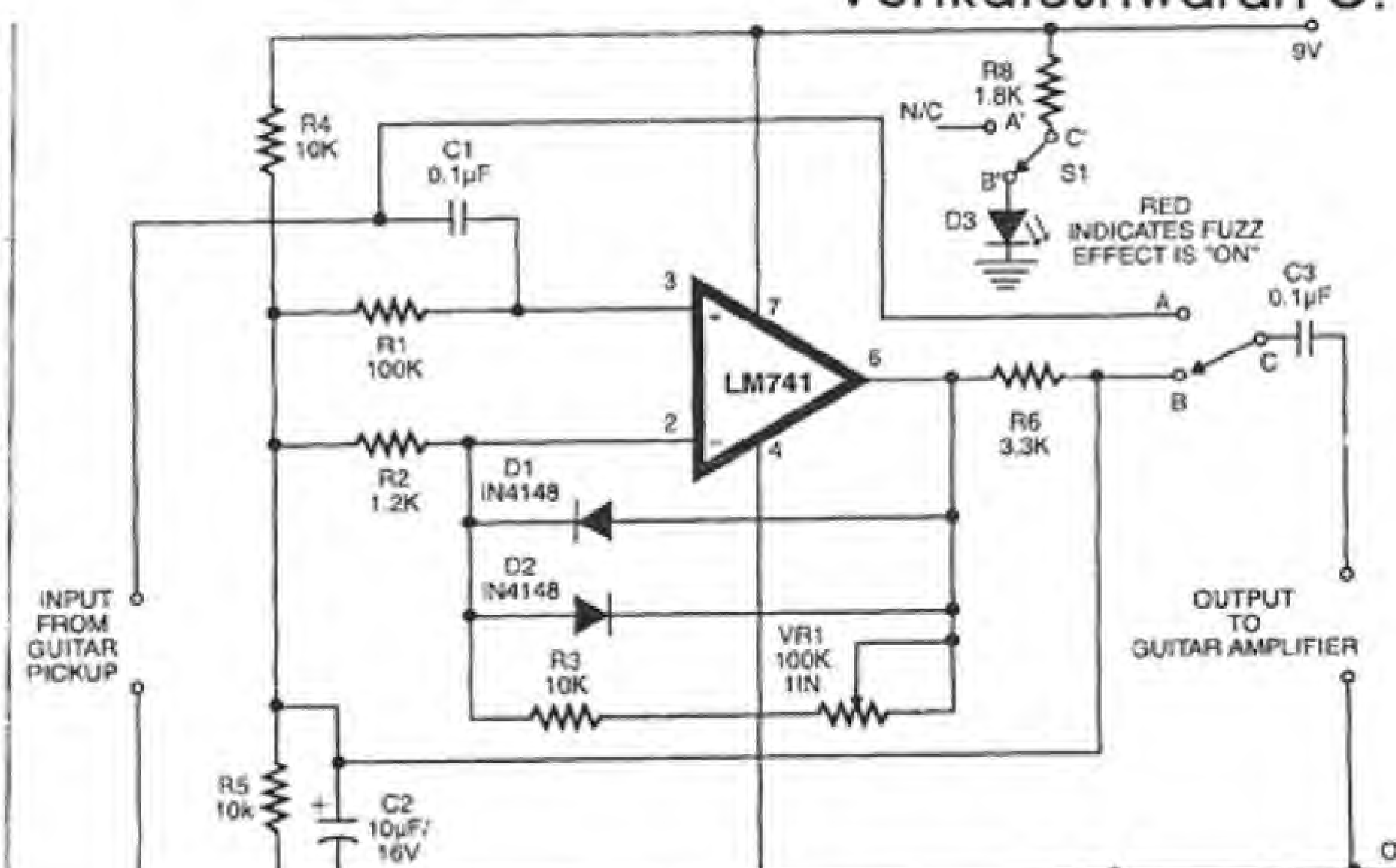
AMEET K. HINGORANI
Secunderabad

The author, Mr Narpat Singh Rana, replies:

If one is holding something in hands, sound produced by mouth would also activate the bell. It appears that the reader is laying too much stress on theory but if he tries the circuit he would be able to appreciate it better. The bell can even be installed in (or near) a safe as a burglar alarm, and perhaps lot more applications can be found.

Fuzz Effect Box For Guitarists

Venkateshwaran G.



The 'Fuzz' sound is derived by clipping the input waveform, thereby enriching the signal with odd harmonics which provide the harsh sound. This circuit produces a fuzz which gradually decays into a 'clean signal'.

The circuit uses the standard op-amp 741 in non-inverting configuration. The gain of this amplifier is controlled by the feedback network comprising VR1, R2 and R3.

Input signal from the guitar passes to the op-amp through DC blocking capacitor C1. Resistor R1 sets the input impedance at 100k, which suits most guitars. Resulting signals from the op-amp are reduced in amplitude by the potential divide action of R6 and R7, giving an attenuation factor of approximately four. Thus the maximum output signal via capacitor C3 available for inputting to an amplifier is about 150mV. This level is maintained during the period of clipping (fuzz) and then decays naturally to zero.

A foot-switch may be used to bypass the signal whenever required. The whole circuit can be assembled on a general-purpose PCB. A red LED can be used to indicate that the 'Fuzz Effect' is 'on' by coupling it to the bypass switch suitably.

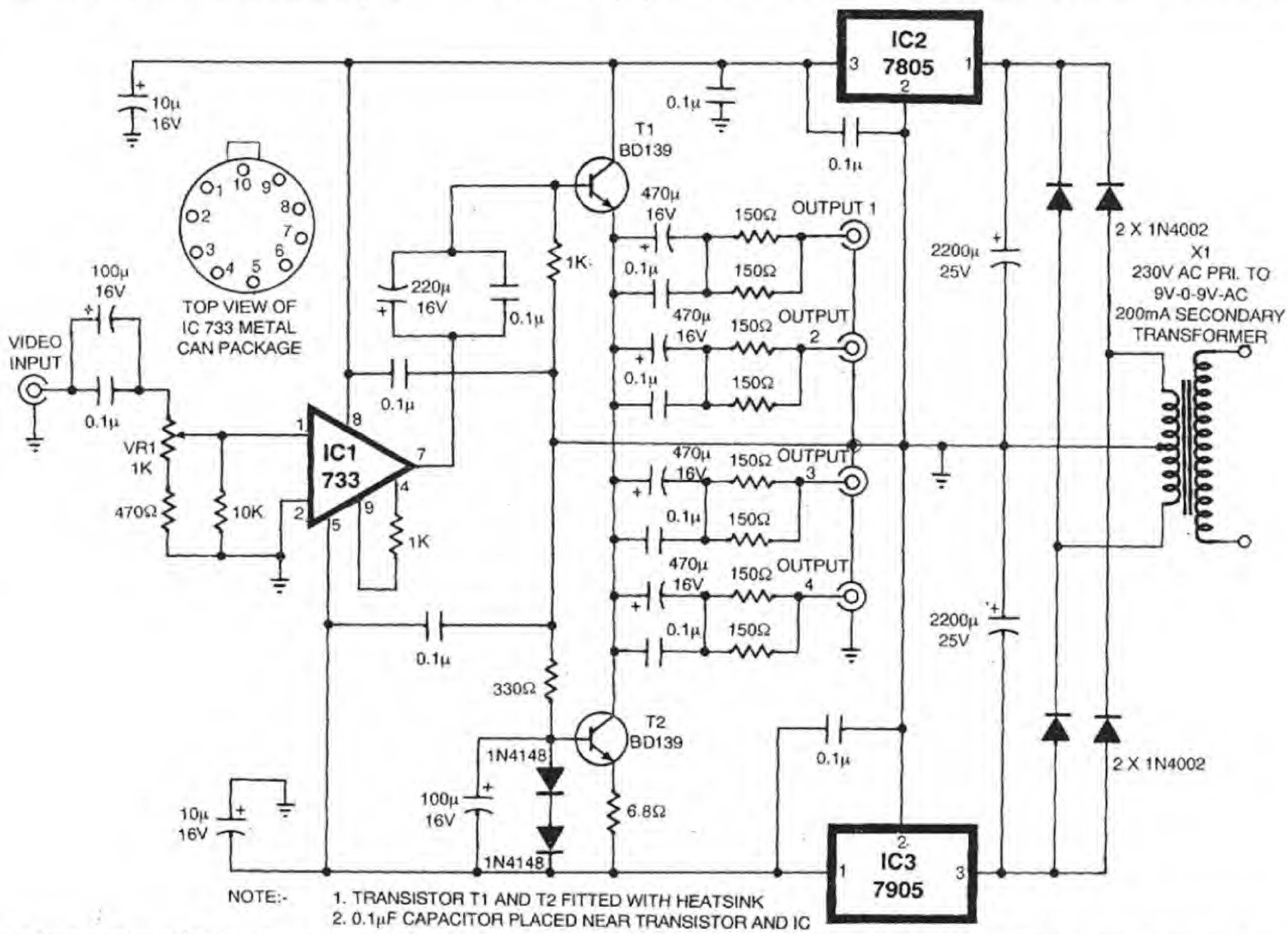
This unit is powered by 8V PP3 battery.

Video Distribution Amplifier

C. Sanjay

This video distribution amplifier enables four video recorders or four TVs to be connected to the output of one VCR or VCP. This situation is likely to arise when copies of video cassettes are required and several machines have to be used at the same time. This circuit can be used as a distribution amplifier not only for VCRs and VCPs but also for distributing any other signal with a bandwidth of about 10 MHz. The gain provided is about 5 times which should be more than sufficient to compensate for cable losses and loading losses.

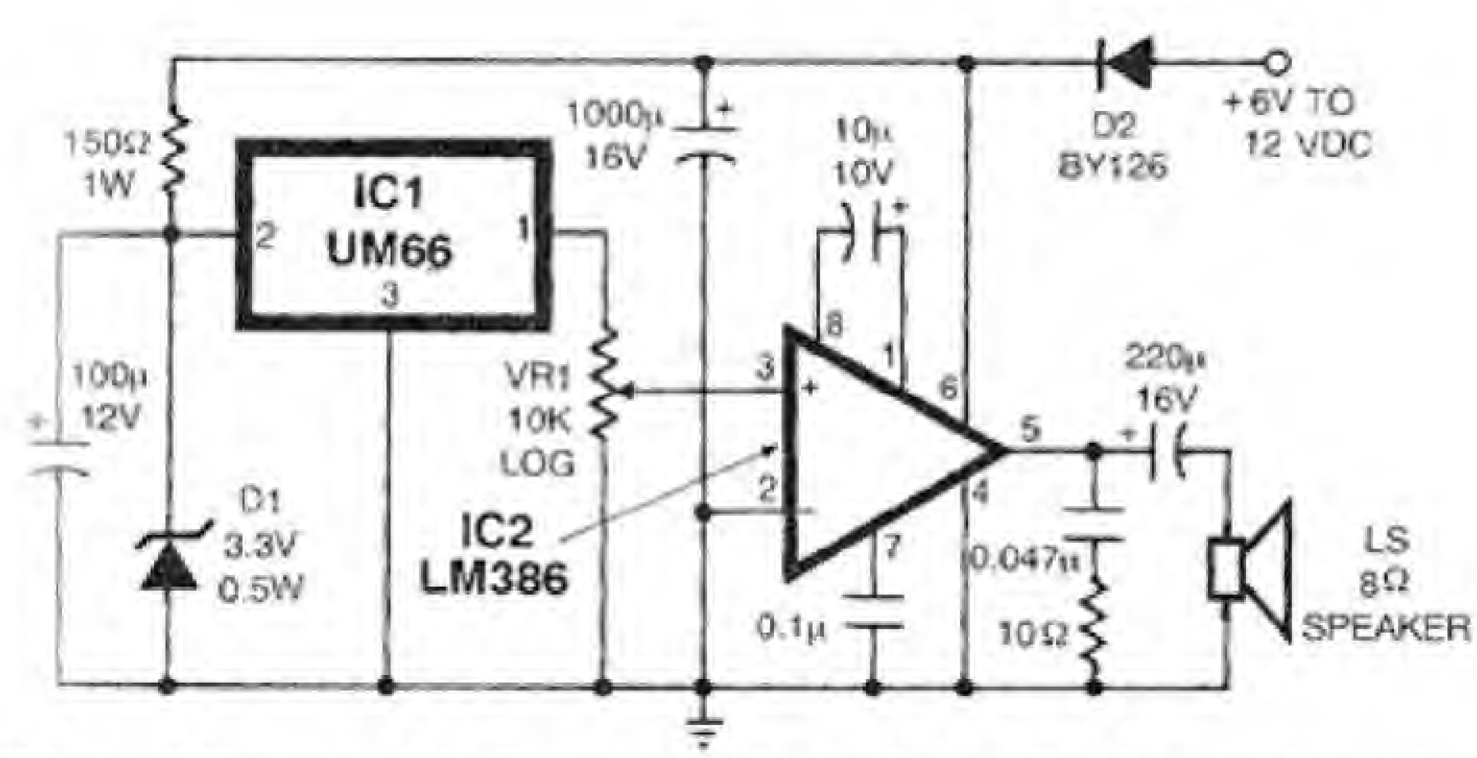
IC1 is the popular 733 which is a simple single-chip amplifier for up to 20 MHz. In the present circuit, however, it is used only for up to 10 MHz. (Video bandwidth is only about 5 MHz max.) VR1 at the input allows to set the amplification to some extent. The output of the amplifier is fed to the buffer consisting of transistor T1 and T2 where T2 serves as a current source for T1. As the working current of T1 and T2 is set to 100 mA, both the transistors need heatsinks. The resistor networks at the outputs serve as impedance matching networks if long coaxial cables are used. The power supply must be regulated at 5V. A simple means of achieving this would be to use two regulators as shown in the circuit diagram.



Low-Cost Musical Horn

Pradeep G.

The circuit described here for a musical horn is very simple. It needs very few components. It can be easily constructed on a small size PCB. Here the music generator is UM66 IC. It has the size and shape of a tiny silicon tran-



...sistor. The amplifier stage is built around LM386 IC. It is a small 8-pin DIL IC. It needs very few external components. It can give 1-watt power at 12V supply.

A simple regulated 3V supply is used for IC1. As power supply can be varied from 6 to 12 volts, this horn can be used with cars, scooters or even as a musical door-bell. Don't forget to use a bridge rectifier or four diodes when this circuit is used with scooters because it has an AC supply. The output can be changed with volume control VR1.

UM66 IC costs around Rs 8 while LM386 costs around Rs 13.

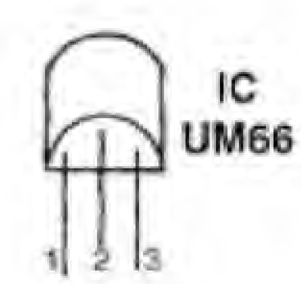
(Prototype has been successfully tested with a 6 to 12V variable battery eliminator.)

Readers' Comments:

The author of the circuit for 'Low Cost Musical Horn' may please explain how he has numbered the pins of IC UM66 which has just three legs like that of a transistor. Moreover, are there any substitutes for the LM386?

A.A.KHAN
Shillong

The author, Mr Pradeep G., replies: The pin configuration of IC UM66 is shown here. UM66-T01L generates popular jingle bell sound. But UM66-T19L has a different music programmed into it which I like more. There is no direct substitute for LM386. But the entire amplifier circuit can be replaced with a general-purpose power amplifier using LM380, BEL1895, TBA810 etc. If BEL1895 amplifier is used, the supply voltage should not exceed 9 volts. Though it can be

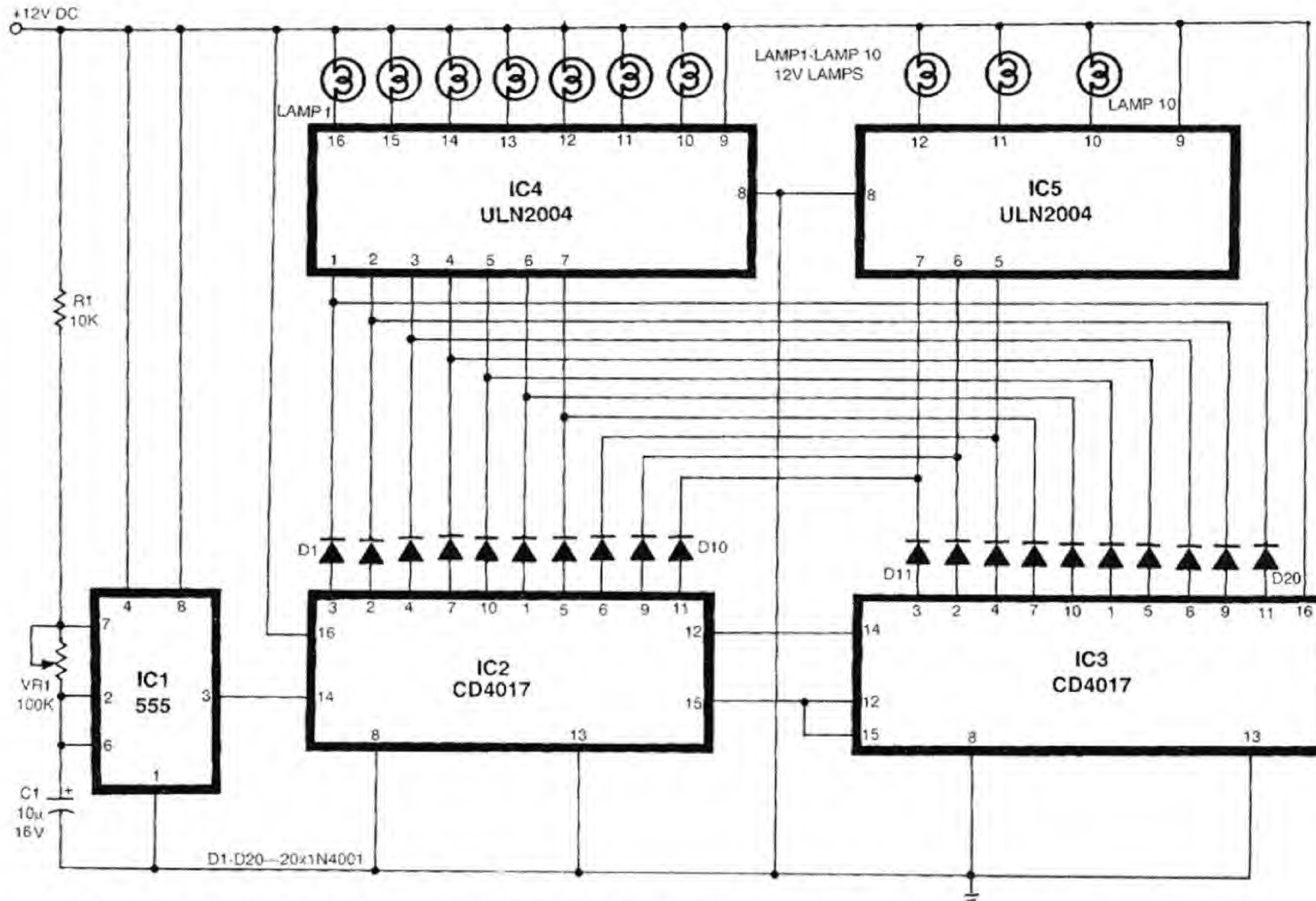


connected to a 12V battery using a 7809 regulator.

Ten Channel Sequential Lighting For Cars

B. Jaya Prakash

The circuit presented here gives a flashing light effect from left to right and then from right to left. IC1 (555) generates clock pulses for IC2. The outputs using rectifiers produce the effect of bulbs flashing from left to right.



As the carry output pin 12 of IC2 is connected to the clock input of IC3, the bulbs which are connected to IC5 also start flashing from right to left.

As these outputs are not capable of handling large currents, they have to be amplified to the proper level so that 12V lamps glow with sufficient brightness.

The amplifier is built around two ULN2004 ICs. The IC consists of seven darlington stages, each of which has an open collector output.

The whole unit can be easily assembled on a veroboard. The power supply for the gadget can be derived from the car battery itself.

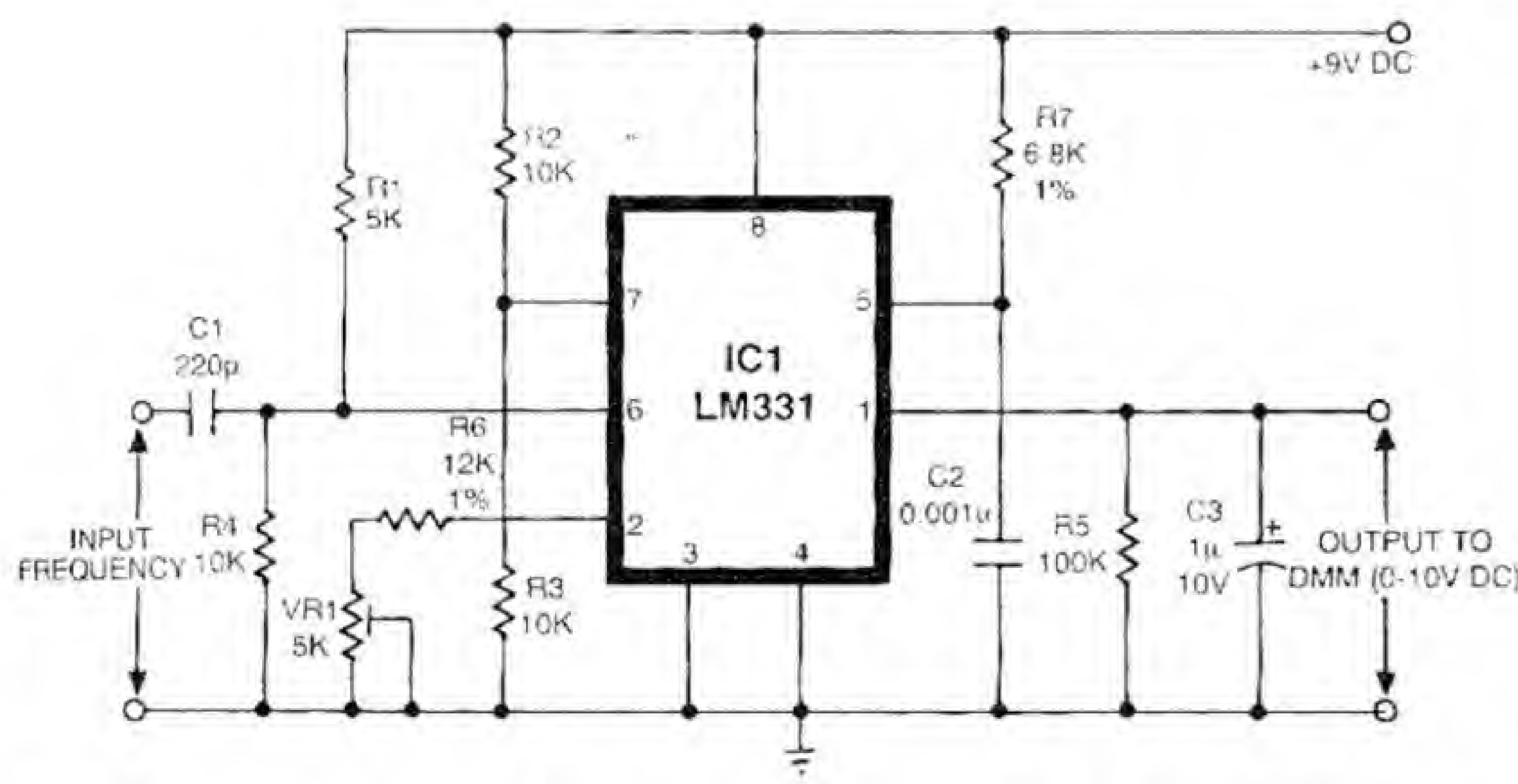
Convertion of DMM Into Frequency Counter

Bharat D. Mehta

To measure the frequency of circuits, one requires a frequency counter which is quite expensive. The circuit given here will serve as an alternative counter of low cost. By using a normal digital multimeter's DC voltage range we can measure frequency up to 100 kHz.

There are many more chips available, using those, one can measure even higher frequencies like AD650, ADVFC32 etc but it requires special care for their operation at higher frequencies.

The circuit shown in the figure con-



verts input frequency into DC voltage and measures it. The heart of the circuit is LM331 (voltage to frequency and frequency to voltage converter), and this chip includes comparator, monoshot and current source. The differenciated frequency at pin 6 triggers monoshot inside the IC. Monoshot will supply a charge into an integrator built externally with resistance R5 and capacitor C3.

The average current flowing out of pin No. 1 is

I (ave) = (i x (1.1 x C2) x freq.]

Thus the voltage developed at integrator becomes an average DC voltage corresponding to the applied frequency, i.e. 0-100 kHz which corresponds to 0-10V DC at output and will be measured on digital multimeter.

It can go upto 100 kHz with changing the values of resistors and capacitors.

Here the frequency of different waveshapes can be measured but the slewing edge of the wave should be fast and the input pulse must be large enough to trigger the input comparator. All resistors are of ±5%, 0.33W, unless otherwise specified, and R5 preset trims the tolerances of the components used. Initially calibration must be done.

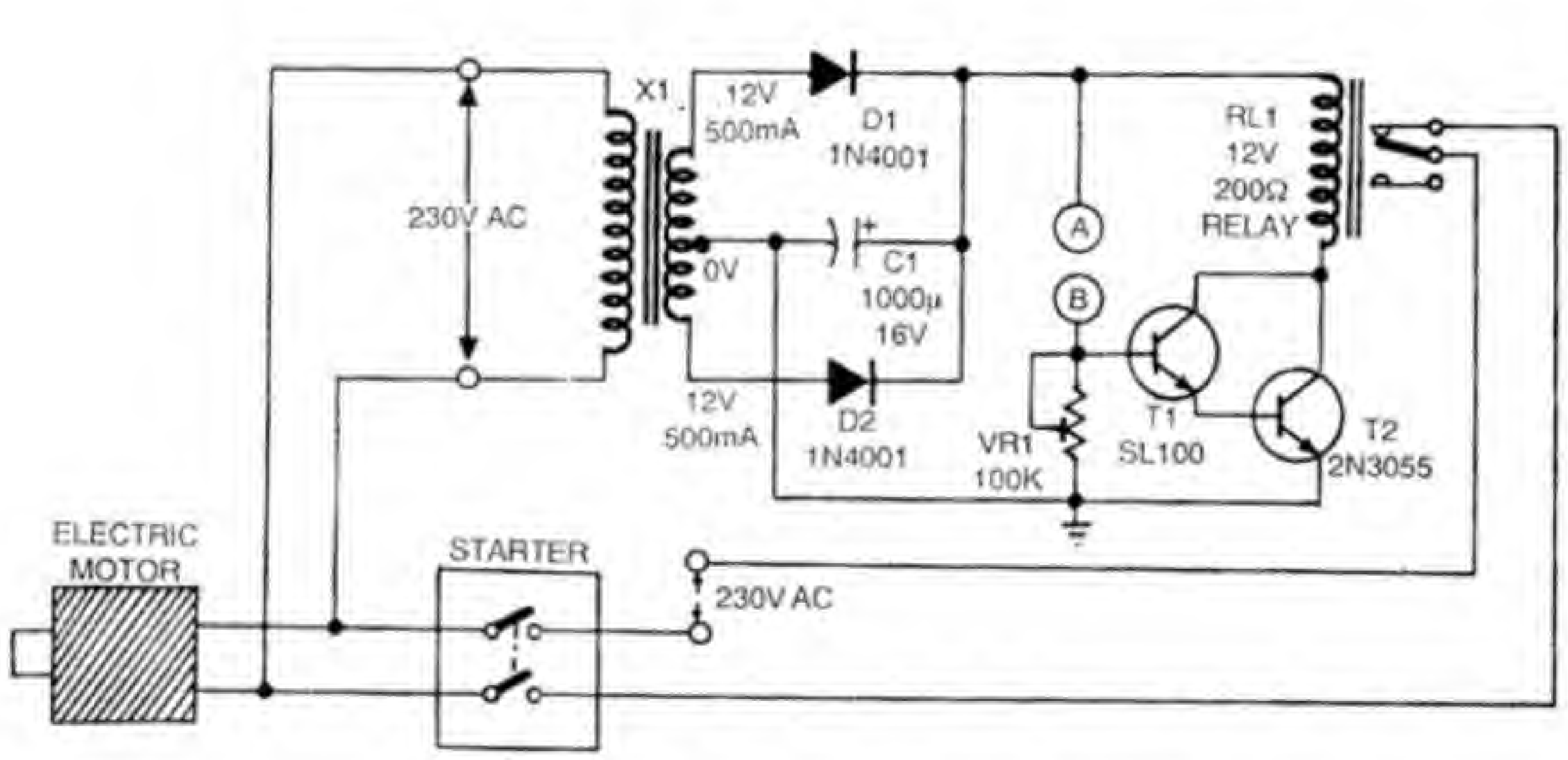
The components R7 and C2 should be used stable with low temperature coefficient and R5 preset trims out the tolerances of all the components Initially calibration must be done.

Auto Power Off for Motor Pumps

Sunish Issac

Many circuits of water level controllers have appeared in EFY. If such a controller is used in a low voltage area, it will be of no use because the motor won't be switched on automatically. Even if it gets switched on, the armature will not rotate, resulting in a burnt coil. In such a case, an auto power off may be better, as one gets the chance to check the mains voltage. This circuit is intended to be used with a motor fitted with D O L (direct-on-line) starter with thermal overload protection. (Starter used in prototype is of ESCOL make.)

This circuit is far more superior than the usual water level controller circuits. There is no problem as far as voltage is concerned and full protection



to the motor is ensured by the use of starter. Supply to the circuit takes place only when the motor is on, making it totally safe. Another advantage of using the auto power off circuit is that one can manually switch off the motor even if there is any problem in the circuit or the wiring to the tank. If there is a mains failure while the motor is on, and if the supply is restored later, the starter will be in the off state. This fact is utilised in designing this simple circuit.

When there is water between the points A and B, the relay gets activated with the darlington pair consisting of transistors SL100 and 2N3055. The 100-kilohm preset is to be set such that the relay gets activated when there is water in between. In the 'on' condition the circuit as well as the motor get supply through the normally-closed contacts of the relay, which is connected to the starter. The relay gets activated when water reaches the preset level, disconnecting the supply to the starter, and thus the motor is switched off.

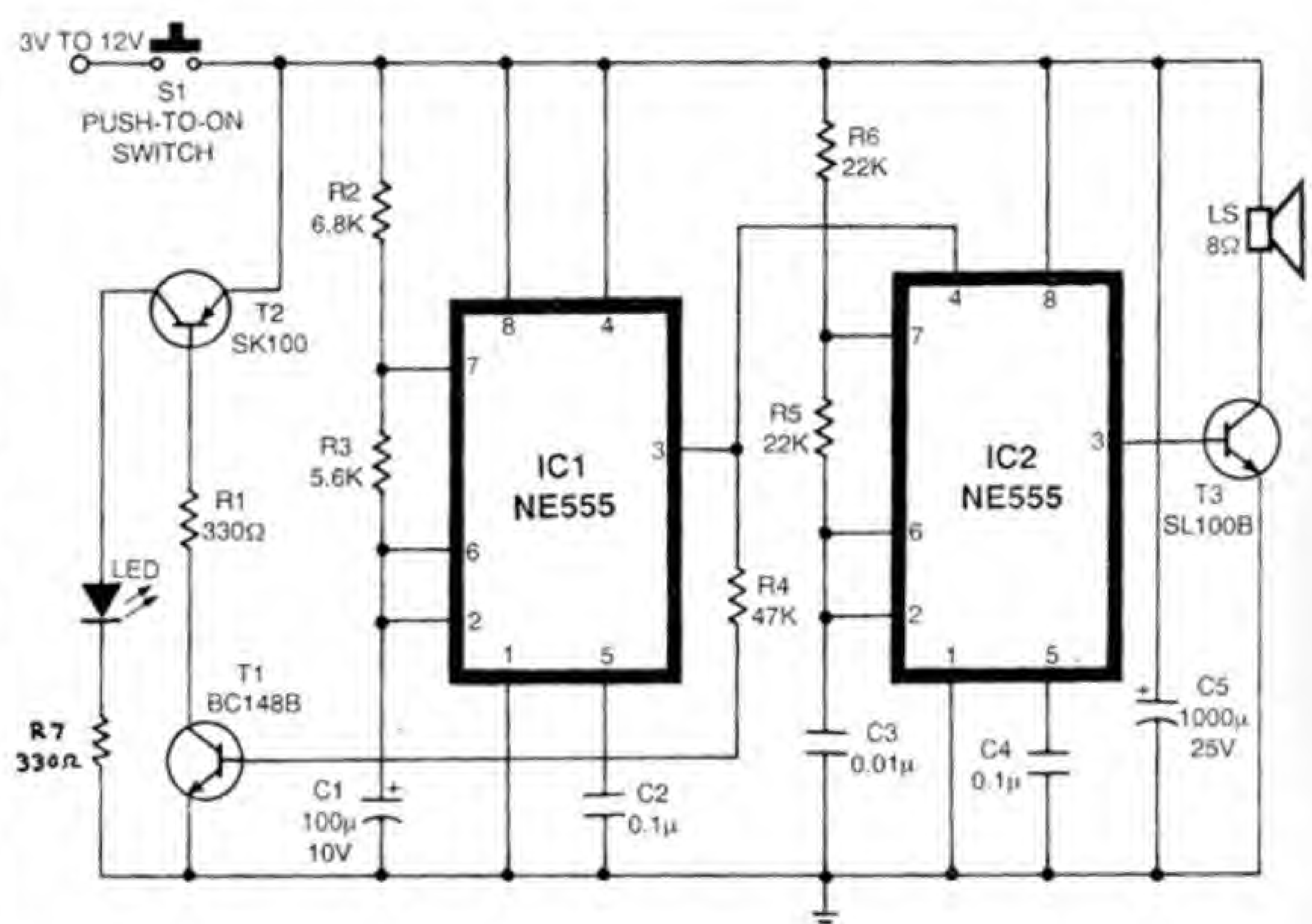
The circuit can be assembled on a general-purpose PCB. The relay, PCB and the transformer can be fitted in a suitable enclosure which may be mounted on the switchboard of the starter. The wires from the tank and the PCB must be well insulated for safety.

Beeper cum Visual Indicator

Nag Raj Kaul

Here is a simple circuit of Beeper Cum Visual Indicator. This circuit has tremendous potential for use in electronics, electrical and automobile industries. The circuit is wired around NE555 ICs. The two ICs are connected in an astable mode configuration.

When S1 (push-to-on switch) is pressed, a supply of (6V to 12V activates the circuit. Then frequency produced by IC1 is controlled by the fixed value capacitor C1. The output is obtained from pin 3 of IC1 and the input is fed to IC2 at pin 4. At the same time, input pulses are fed to transistor T1 (a voltage amplifier transistor) through resistor R4. The resistor R1 is connected to the base of T2 (SK100) which works as a switching transistor. An LED is connected to the collector of transistor T2 and grounded through a 330Ω resistor. The output from pin 3 of



IC2 is given to the base of SL100B which is used as a power amplifier transistor. An 8-ohm speaker is connected at the output as shown in the circuit. The beeping sound time interval and the time period of LED is set by capacitor C1.

When output obtained from pin 3 of

IC1 is fed to T1, the visual indicator lights up with each beep having the same time period. For better performance, the circuit should be operated with dry batteries or fully rectified DC supply. We can replace the LED with a 3V to 12V DC bulb after eliminating resistor R7. The entire circuit costs around Rs 50.

Electronic Washing Machine Control

T.S. Shankar

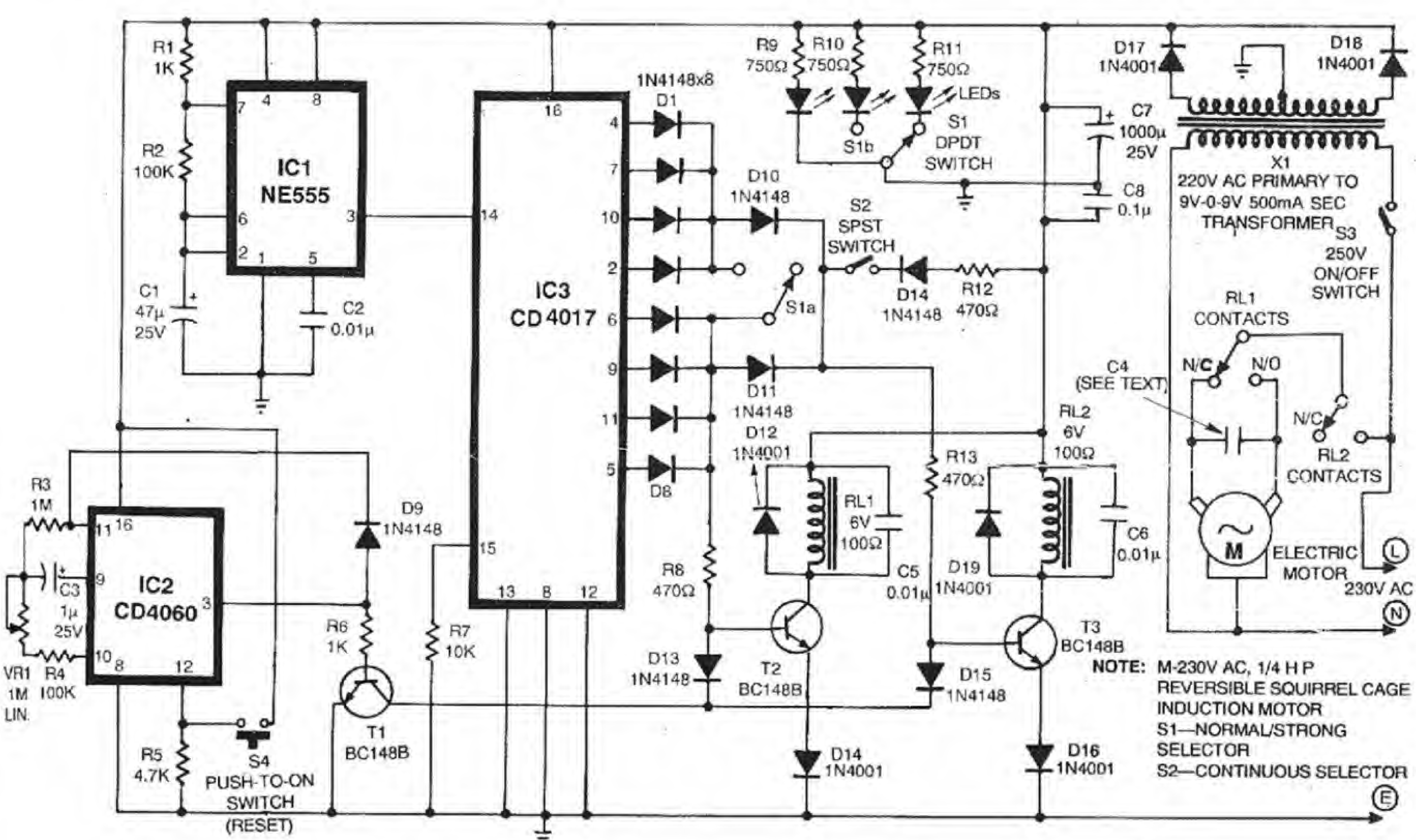
Nowadays, commercially available washing machines are provided with features like auto-off timer, reversible impeller etc. Most of them have mechanical timers, reversers etc. Some are equipped with electronic timers. But they are very expensive and out of reach of the average consumer.

Keeping this in view, I have designed an electronic washing machine control circuit. The circuit provides all the facilities provided by reputed companies and even more. The circuit has a timer circuit which can be set to any duration from 0 to 15 minutes and can be extended to any length of time by merely changing a capacitor. The circuit has switching circuits which run the impeller in one direction for 25 seconds, stop the motor for five seconds, run the impeller in reverse direction for 25 seconds and stop the motor for five seconds. This cycle repeats until the time set in the timer has elapsed.

An optional switch is provided to select normal/strong washes. During 'normal' washing, the impeller rotates in both directions alternatively with five seconds gap between reversals. This type of wash is suitable for delicate clothes. During 'strong' washing, the impeller rotates in one direction only with five seconds pause after every 25 seconds.

Another switch is provided to select the 'continuous' facility. In this mode, the impeller rotates in one direction only continuously. This mode is suitable for blankets, rugs etc.

Before coming to the working of the circuit I would like to explain the principle of operation of motors. Washing machines are driven by universal or induction motors. Induction motors are more suitable for washing machines



than universal motors, and hence are used by most of the reputed companies.

The induction motor runs on the principle of electromagnetic induction. Primarily induction motors are 3-phase type. They consist of a stator with 3-phase winding. The stator produces rotating magnetic field and induces strong currents in rotor windings which are short circuited. The rotor opposes the rotation of magnetic flux (Lenz's law) and hence tries to catch up with the stator rotating flux. As a result, the motor starts rotating, thus producing rotor torque. An induction motor has constant speed, variable torque characteristics, which makes it suitable for washing machines.

As washing machine is a household appliance, using a 3-phase motor would be cumbersome. A single-phase induction motor is used in place of 3-phase induction motor. Single-phase induction motors are not self-starting due to their single-phase nature. As such they are made self-starting by making them 2-phase motors virtually. Single-phase induction motors are provided with two windings, one of which is connected to the supply directly and the other to the supply through a capacitor. The capacitor draws large leading current which is 90° out of phase with the voltage. Due to this a rotating flux is produced and the motor starts up. By interchanging the winding, we have achieved reversal of motor, as interchanging the winding causes reversal of flux rotation. Note that ordinary induction motors have unidentical windings for main and auxiliary windings. Such motors cannot be reversed by this method. Only reversible motors can be reversed this way.

The heart of the circuit is IC3 which is a CMOS decade counter cum decoder. The IC provides ten outputs which go high one at a time for every clock pulse applied at pin 14. The clock pulses are obtained by IC1 NE555 wired in astable multivibrator mode. The second, third, fourth and fifth outputs are OR'ed by four 1N4148 diodes. Similarly, the 7th, 8th and 9th to 10th outputs are OR'ed by four 1N4148 diodes. The first and sixth outputs are left unused.

When IC 4017 starts counting, the first pulse is not received by any diode, and during that period transistors T3 and T2 are off and the relays are also off, disabling the motor. During counts from second to fifth pulses T3 is on and T2 is off. The motor runs in one direction for four clock pulses. During sixth pulse, once again T3 and T2 are off and the motor stops. During seventh to tenth pulses, T3 and T2 are on and the motor runs in opposite direction due to switching of winding by relay RL1 contacts.

The timer is based on IC2 CD4060 which is a divide by 16384 counter. The timer can be set by 1M potentiometer. After the set-time T1 switches T2 and T3 off, thus disabling the motor. The 4060 can be reset by the push-to-on switch provided.

Capacitor C4 is a starting capacitor already fixed to the motor. Relays RL1 and RL2 are 6V, 100-ohm, 6A rated relays.

The circuit can be assembled on general-purpose PCB. Mains wiring should be made with high current stranded copper wire. The circuit being fairly simple does not pose any problem.

Readers' Comments:

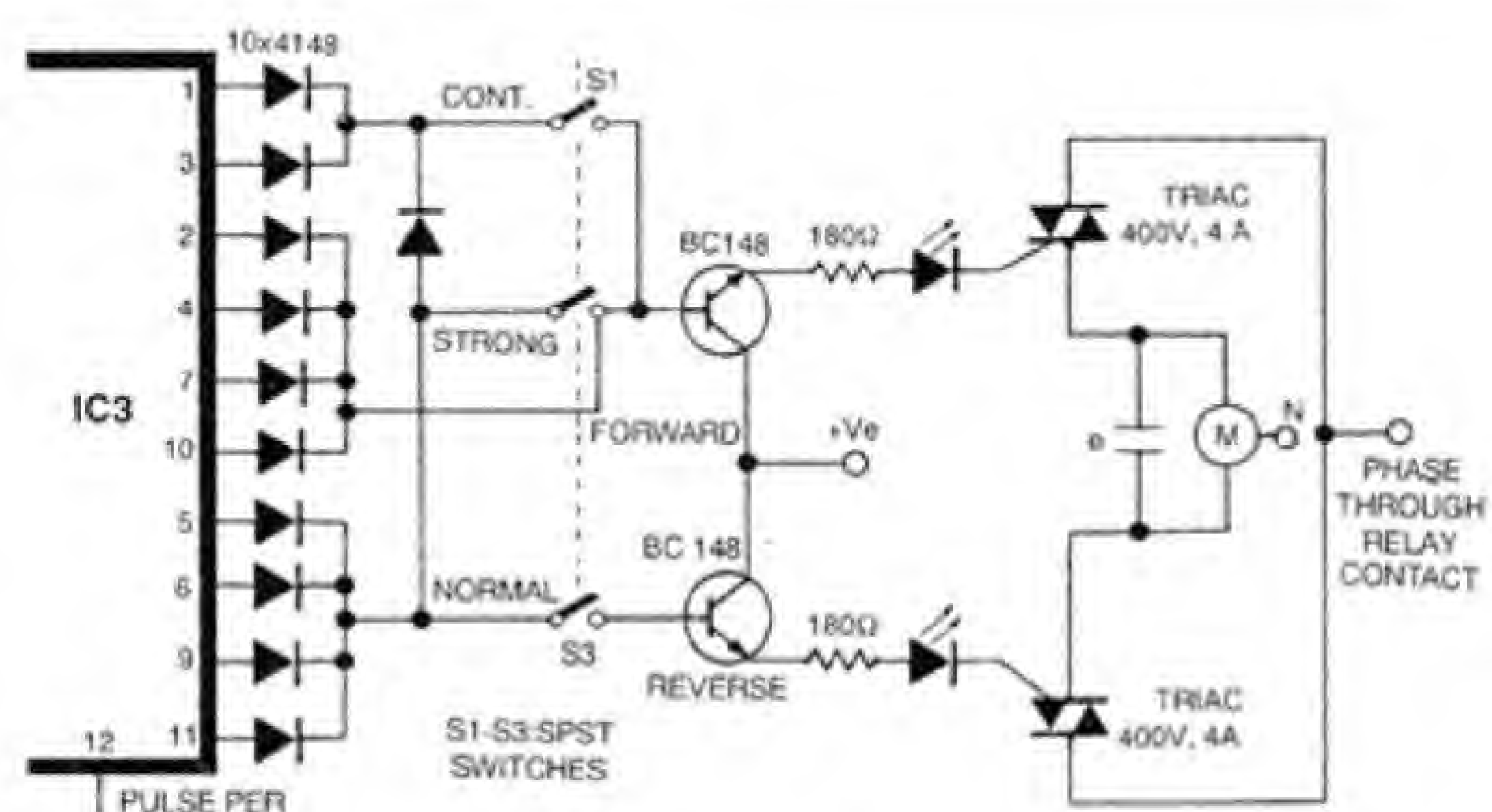
'Electronic Washing Machine Control' circuit in EFY March '92 issue was fantastic! I had been waiting for such a circuit.

When we close switch S2 for a continuous wash, relay RL2 gets activated and remains in that state. If switch S1a is open, whenever pins 4, 7, 10 and 2 of IC3 go 'high', relay RL1 is activated and changes the direction of rotation. But even when S1a is closed, whenever the outputs of pins 3 and 1 (not shown connected) of IC3 go 'high', relay RL1 is deactivated, while it remains activated at the other output state. So the motor changes its direction of rotation without any intermediate off state. Thus the motor would get damaged faster in such a continuous wash mode.

I have modified the circuit, using triacs, to make a timer without any moving parts. Pin 12 of IC3 can be connected to another timer for controlling the entire circuit.

Anodes of the triacs are connected to contacts of the relay which is to be controlled by IC2 or any other timer.

DINESH KUMAR D.
Kasaragod



Modified part of the timer for washing machine.

❑ The circuit needs a little correction. Switch S1's right hand side pole is connected correctly but its left hand pole should not have been shown connected to the cathodes of diodes D10 and D11. This pole should in fact be connected to the anode of D11. Otherwise, the motor would rotate improperly.

JAGDISH MAHENDRA KOTHARI
Bombay

The author, Mr T.S.Shanker, replies: I'm thankful to the readers for pointing out the error. Mr Dinesh Kumar's TRIAC circuit is appreciated.

Triangular Waveform Generator

M.S. Nagaraj

Most triangular waveform generators of op-amp integrator-comparator type have the disadvantage that when the peak values of the generated waves are changed, the frequencies also change. Here is a circuit of a triangular waveform generator (Fig. 1) with maximum peak level (Vmax) and minimum peak level (Vmin). The frequency of oscillations can be independently varied by controls VR1, VR2 and VR3. The circuit is built around quad op-amp IC TL084 and analogue multiplexer IC CD4053.

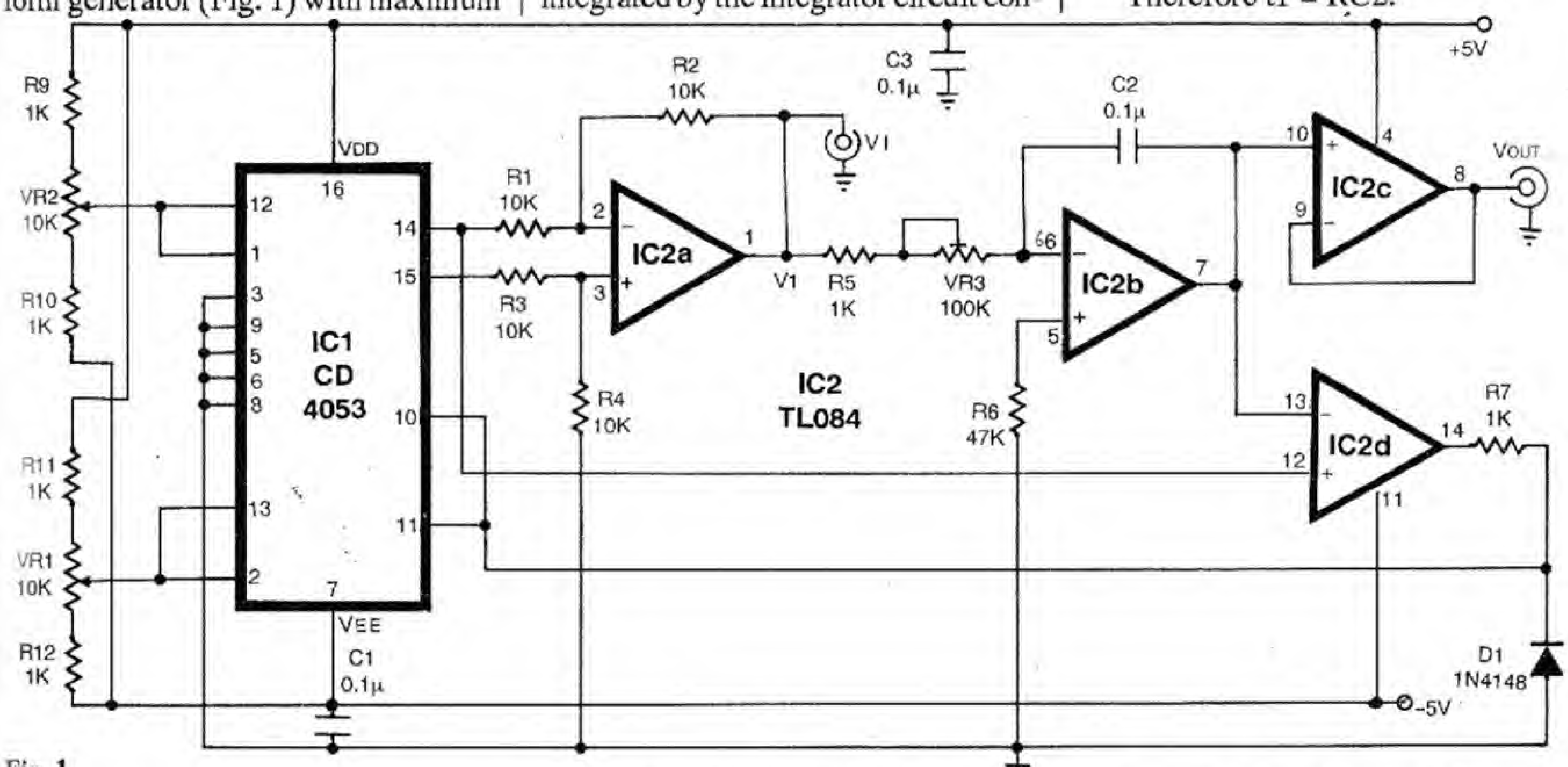


Fig. 1

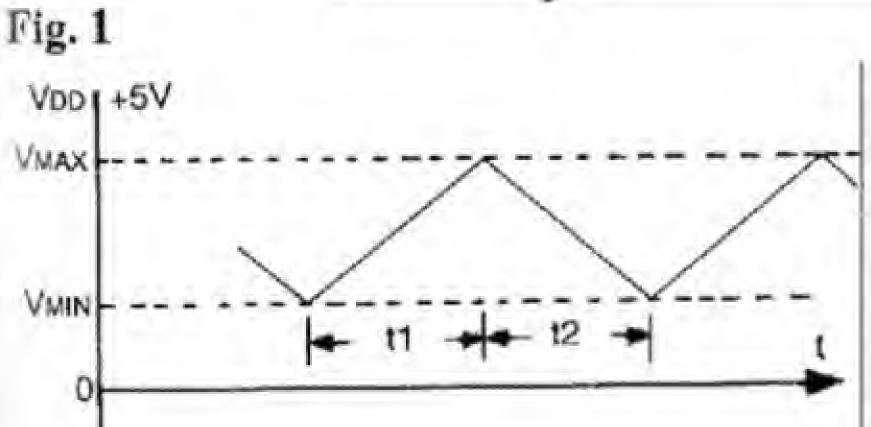


Fig. 2

When the output of op-amp IC2d functioning as a comparator is high, the analogue multiplexer routes the two reference voltages to the inputs of the op-amp IC2a functioning as a differential amplifier whose output is V1 = -(Vmax-Vmin). This voltage is integrated by the integrator circuit consisting of VR3, R5, C2 and op-amp IC 2b. When the ramp having a positive slope at the integrator output exceeds the level Vmax, the comparator output goes negative. Now the analogue multiplexer routes the reference voltages such that V1 = (Vmax-Vmin). The integrator generates a ramp with negative slope. When the integrator output goes below Vmin, the comparator output goes positive and the entire cycle repeats. Op-amp IC 2c buffers the integrator output.

During the time period t1, the integrator output changes from the initial value Vmin to the final value VMax.

Vmax = Vmin + (V1/RC2) .t1

where R = VR3+R5

Therefore

t1 = Vmax -Vmin . RC2/V1

But the output of differential amplifier is V1 = (Vmax - Vmin)

Therefore t1 = RC2.

During the time period t2, the integrator output changes from the initial value Vmax to the final value Vmin.

Therefore

Vmin = Vmax - (V1/RC2) .t2

Therefore

t2 = (Vmax - Vmin) .RC2/2

Again V1 = (Vmax - Vmin)

Therefore t2 = RC2

Thus the period of oscillation T = t1+t2 = 2RC2 and is independent of the peak values set. For the component values shown in the circuit, the frequency can be varied between 50 Hz and 5kHz.

Auto Changeover from Genset to Mains Supply

Neelotpal Sarma

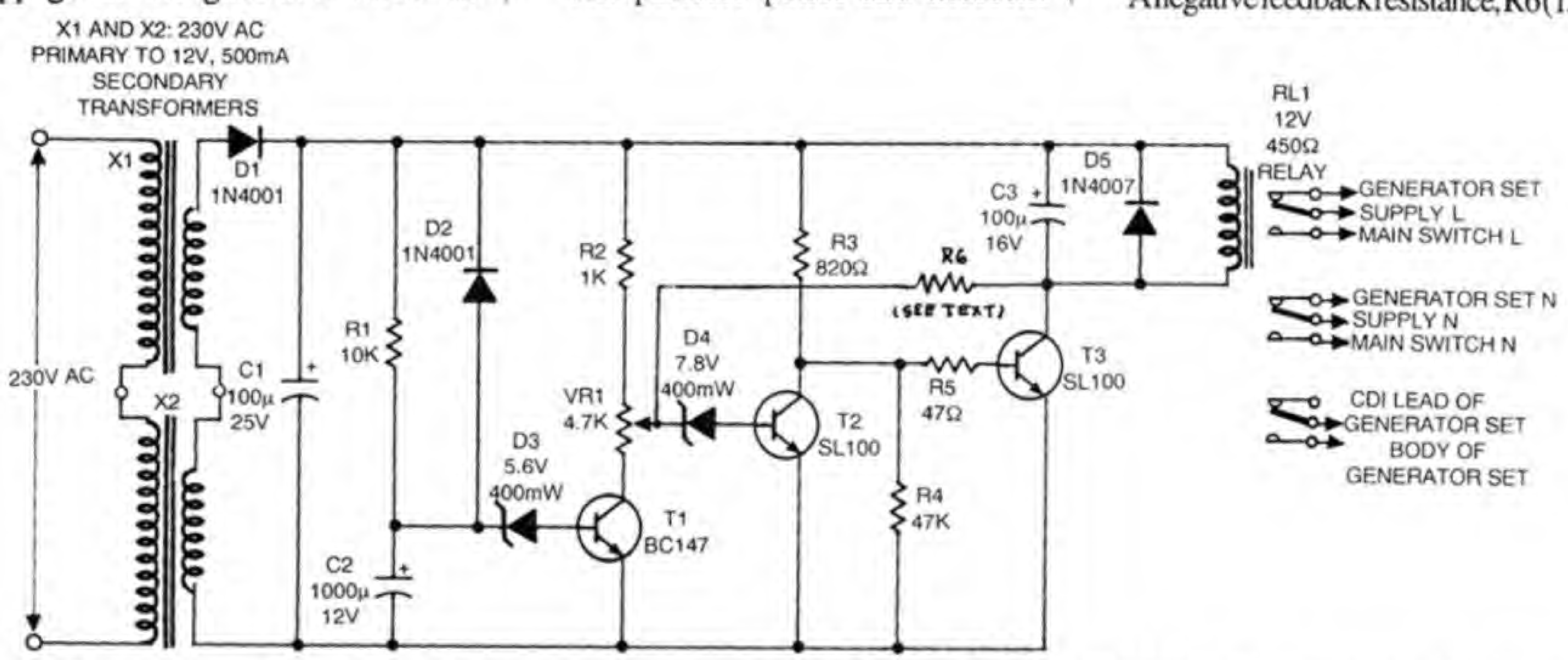
Load shedding is a common feature these days. Sudden power fluctuations, surges and high voltages may spoil sophisticated household appliances like TV, VCR, VCP and music system. This circuit provides protection against the said problems and helps automatic stoppage of the generator when the supply of electricity resumes. The total cost of the circuit is Rs 60 to 80.

This circuit is self-explanatory. When line supply voltage crosses the preset level, zener D4 breaks down and thus transistor T2 conducts, T3 does not conduct, causing the relay to de-energise. Voltage surge at the time of power resumption is protected by the delay circuit around transistor T1.

All portable petrol and kerosene generators have a connection from CDI. To stop the engine of the generator-set, this connection is to be grounded momentarily (through a switch). This lead is to be connected with the ground through the N/C point of the relay.

Instead of one transformer, two transformers are used in series to ensure better life of the unit. Value of capacitor C2 can be increased or decreased for the variation of delay time.

A negative feedback resistance, R6 (15K to 100K) can be incorporated between transistors T3 and T4 to overcome the damage that could be caused by voltage fluctuations.



Transformer Test Circuit to Overcome Line Voltage Variation

M.S. Nagaraj

One of the initial production tests carried out on power transformers used in electronic equipments is the measurement of no-load voltages across their secondary windings. During this test, the basic requirement is that the voltage across the primary winding be maintained at the rated line voltage. But in practice, there will be variations

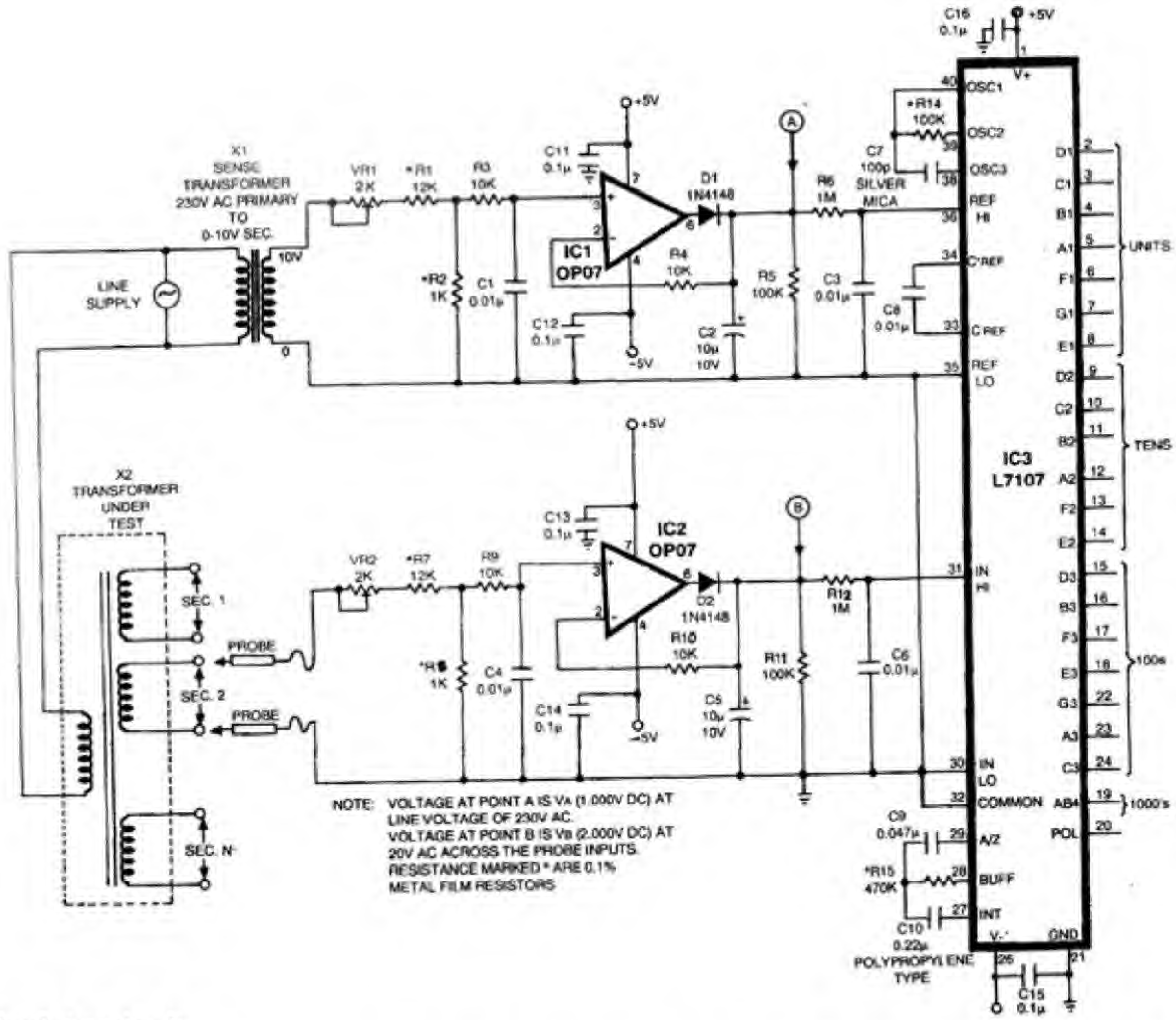


Fig. 1: Simple test circuit.

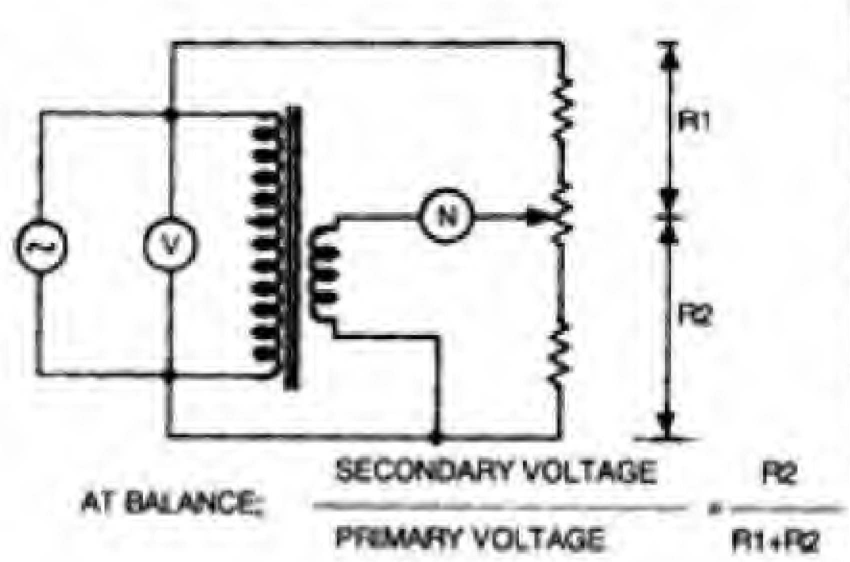


Fig. 2: Conventional method.

in the line voltage and its effect will be reflected in the secondary side. Hence the test carried out will have this inherent error.

The conventional method (Fig.2) to solve this problem is to use a ratio meter which consists of a bridge circuit in which the voltages of the windings of the transformer under test are balanced against the voltages developed across the fixed and variable resistors of the bridge. This method has the disadvantage that the calibrated variable resistor is to be adjusted until a zero deflection is obtained in the galvanometer.

Here is a simple test circuit (Fig. 1) which offsets the effects of variations in the line voltage and reads the voltages across the windings corresponding to the rated line voltage applied to the primary winding. For example, a transformer having a secondary voltage of 12 volts for a primary voltage of 230 volts, will produce a secondary voltage of 12.5 volts when the line voltage has varied to 240 volts. But this test circuit applies corrections and reads 12 volts. This is made possible by deriving a reference voltage in the circuit proportional to the line voltage.

Intersil IC 7107, high-performance 31/2-digit analog-to-digital converter is used to measure and display the rectified output of the secondary windings. The reference voltage, which establishes the full scale value of the ADC, is made proportional to the line voltage. Transformer X1 senses the line voltage. Op-amps IC1 and IC2 are configured as precision peak-detector circuits. Preset VR1 is adjusted to get a reference voltage of 1.000V DC at peak-detector 1 output corresponding to a line voltage of 230V. Preset VR2 is adjusted to get a voltage of 2.000V at peak-detector 2 output for a voltage of 20 volts rms across the input probes.

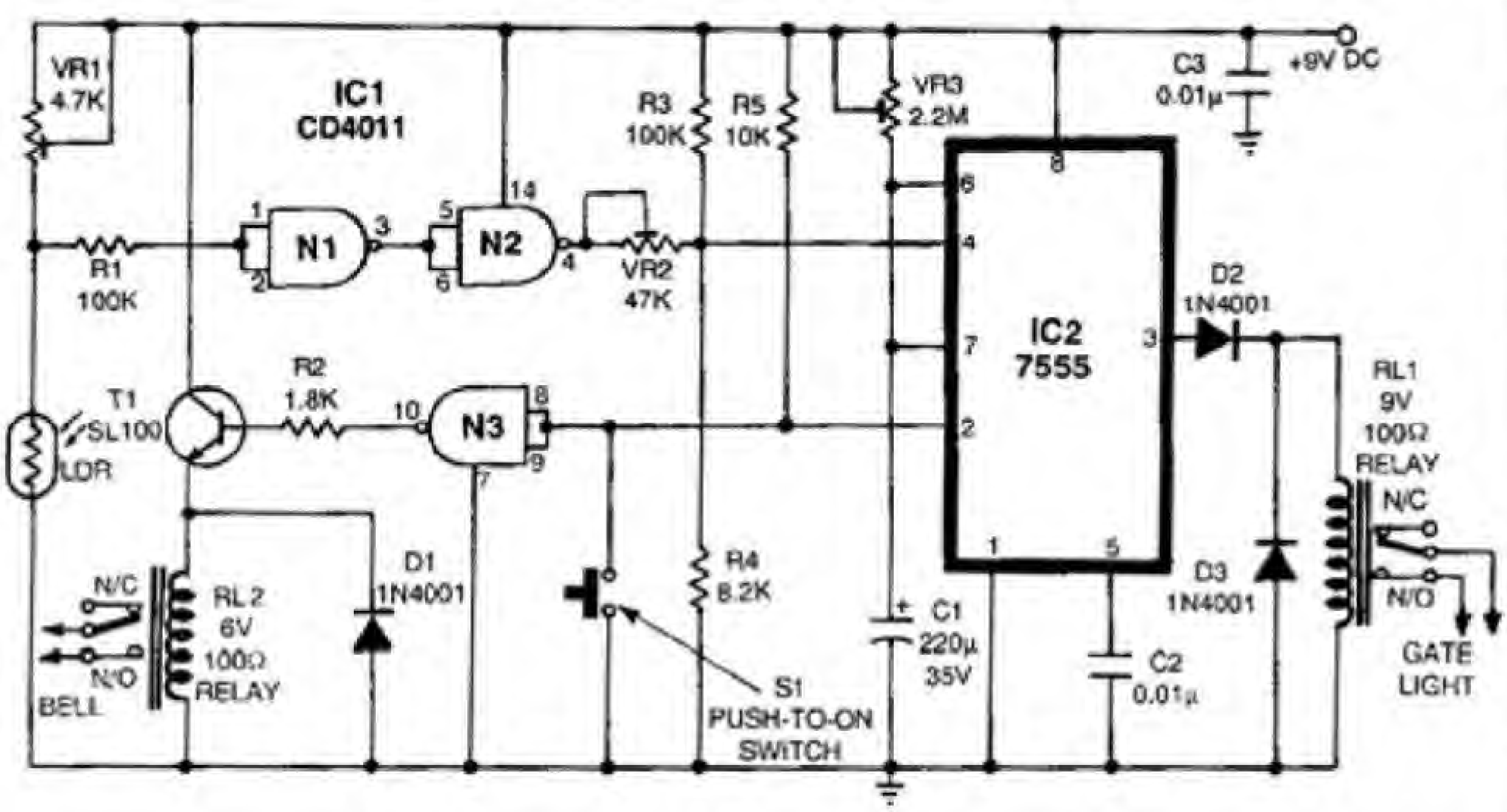
A number of transformers having different secondary voltages were tested using this tester. The supply voltage was varied from 180V to 250V AC and the display readings were found to be accurate to 0.5 per cent.

Although the voltage divider consisting of VR2, R7 and R8 is designed for a measurement range of 20V AC, it can be suitably modified to measure higher voltages.

Automatic Gate Light

Harinder Singh

While returning home on a cold winter night it can be really frustrating if one is unable to unlock the gate due to insufficient light. A simple, economic yet reliable solution to the problem is provided by this circuit. When it is quite dark, a slight pressure on the bell switch switches the gate lights on for a preset interval of time. The circuit is also a valuable addition to domestic security arrangements as it deters unwelcome callers.



N1 and N2 of IC1 (CD4011) are wired as inverter gates. When light falls on the LDR, its resistance becomes low, so the output level of N1 at pin 3 becomes high whereas output level of gate N2 at pin 4 becomes low.

VR1 is set so as to switch on the gate light. Switch S1 is pressed when the light falling on the LDR is very low (at night). VR2 is set for about 0.25V at pin 4 of IC2 when light falls on the LDR and about 0.45V when no light falls on the LDR. Gate light is switched on as soon as switch S1 is pressed, provided no light falls on the LDR. And it remains on for a preset interval of time, which is set with VR3. Gate N3 is also wired as an inverter gate. Its output is high for the time in which S1 is pressed. Transistor T1 operates relay RL1 which in turn operates the bell. Operation of bell is independent of the light falling on the LDR, i.e. it can be operated both in day and at night whereas the gat light operates only at night.

In stand-by state, i.e. when both the relays are inactive, the current consumption is as low as 6 mA. The maximum current rating of the relays should not exceed 200 mA. The gate light can be latched from inside the house by simply switching on the existing gate-light switch if it is connected in parallel with the relay contacts (relay RL2). Capacitor C3 should be soldered on the PCB as close as possible to the supply pins of IC1. The LDR should face downwards so as to prevent all other night lights falling on it.

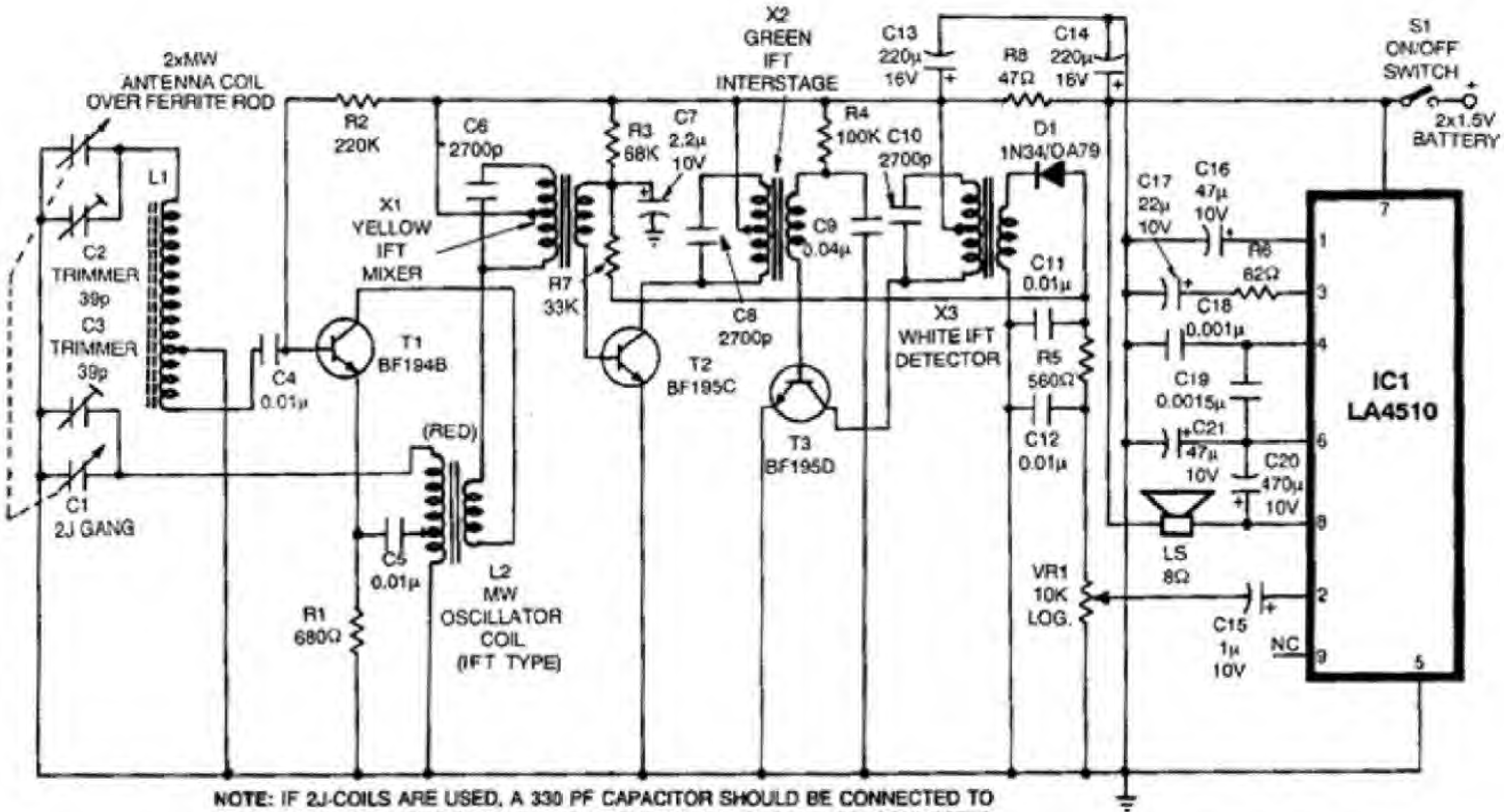
Pocket Radio Using LA4510

Pradeep G.

Here is a circuit for a pocket radio using one IC LA4510 and three transistors. Actually, this circuit differs from ordinary circuits at the audio stage only. Here a small 9-pin IC LA4510 is used. It replaces three transistors, driver transformer and many other passive components. This amplifier circuit needs only one resistor! At zero signal level, this circuit draws 8-10 mA current only. At With 3-volt supply this circuit can give 200 mW output power.

For making this radio you may buy an ordinary pocket radio PCB and assemble IF and RF sections. LA4510-amp circuit may be assembled on a small separate veroboard which may be fixed on the PCB using adhesive. Otherwise, you may make a new single PCB for this circuit.

Alignment of this radio can be done



NOTE: IF 2J-COILS ARE USED, A 330 PF CAPACITOR SHOULD BE CONNECTED TO OSCILLATOR COIL FROM GANG AND THE TRIMMER SHOULD BE CONNECTED BETWEEN OSCILLATOR COIL'S TOP AND GROUND.

exactly as described in the article 'Handheld MW Receiver' published in Electronic Projects, Vol. 4 (pages 72-76).

The entire circuit costs Rs 60 including the cabinet. LA4510 would cost around Rs 13. Two 1.5-volt pen torch cells can be used to power the circuit.

Telephone Melody Ringer

K. Sundararajan

This melody ringer gives a pleasant tune each time the telephone rings. The tunes are soothing as compared to those of old telephone instruments and the piezo buzzer in the current electronic telephone instruments.

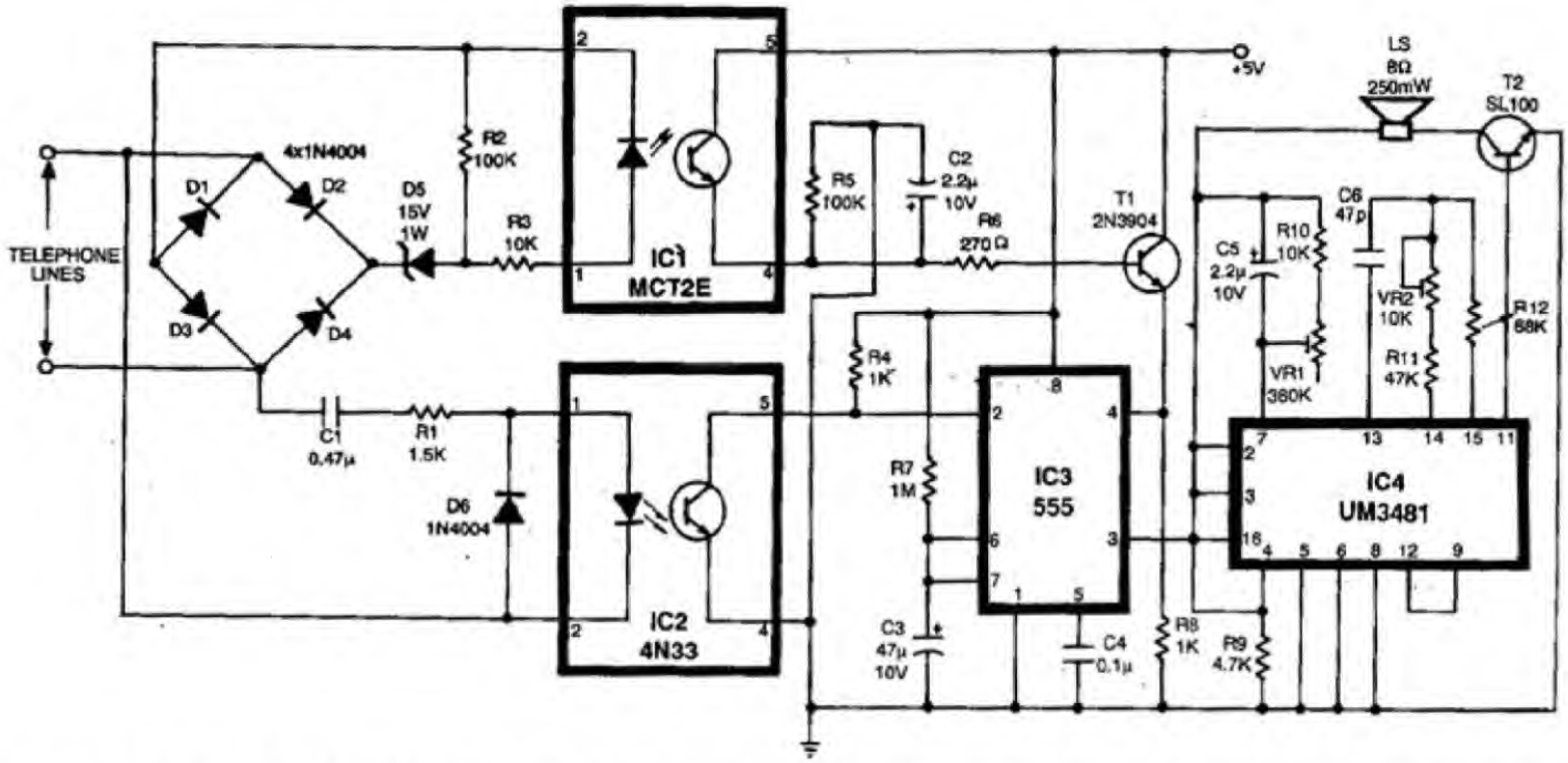
This circuit is based on the musical IC UM3481/3482/3483/3484. When the telephone senses an incoming call signal, all the tunes stored in the ROM of the IC are played in sequence. The bell stops ringing when the handset is picked up.

The complete circuit is shown in the figure. The telephone line is connected across the bridge rectifier comprising diodes D1-D4. This bridge circuit provides correct polarity to the LED inside the opto-coupler of IC1, even if the telephone line is connected in wrong polarity by accident. When the telephone is in idle condition, i.e. 'on-hook' condition, there is about -48 volts DC across the telephone line. This DC voltage is divided by the divider network comprising 15-volt zener diode D5 and resistor R2. The voltage across R2 is again reduced by R3 and is used to light the LED inside IC1. When the LED glows, the transistor inside IC1 conducts and aids transistor T1 to conduct. Hence the supply voltage is extended to the reset pin 4 of IC3. As pin 2 of IC3 is in 'high' condition, the output of IC3 is low.

Condenser C1 across the telephone line blocks the DC voltage of about -48 volts and prevents it from reaching the telephone ring sensing circuit built around IC2. Resistance R1 reduces the AC ringing voltage to a sufficient value so as to light the LED inside opto-coupler IC2. Diode D6 protects this LED during the arrival of the ringing signal.

When ringing signal is present on the telephone line, the LED of IC2 glows and causes the internal transistor to conduct, thereby extending 'low' to pin 2 of IC3, which is wired as a monostable multivibrator. Now IC3 operates and extends a 'high' into its output pin 3, which is the power supply of the music circuit based on IC4. The output of IC3 is high for a period determined by the values of R7 and C3. During this period, IC4 generates pleasant tunes.

As IC3 is wired as a monostable, it responds to the first ring and ignores subsequent rings during its timing cycle, thus allowing IC4 to produce tunes for the entire time period. When the telephone is answered or is 'off-hook', the telephone line potential drops to 5-6 volts due to the impedance of the telephone instrument. This prevents D5 to



conduct and hence the LED inside IC1 turns off. This, in turn, switches off transistor T1. When T1 is turned off, the reset voltage on pin 4 of IC2 is removed and it turns off. Hence power to the music circuit is withdrawn and the melody is stopped.

The positive voltage available at pin 3 of IC3 is used to supply IC4. Output pin 3 of 555 IC is capable of sinking or sourcing current up to 200 mA. Hence the musical IC4 can safely work with this power.

Let us cover the working details of IC4. When the power is extended, pin 4 of IC4 triggers it into operation. The output from pin 11 is amplified by transistor T2 in order to drive the speaker.

Resistor R10, preset VR1 and capacitor C5 change the internal modulation of the music IC to sound like different musical instruments such as piano and organ.

Resistors R11, R12, preset VR2 and capacitor C6 change the speed or the tempo of the tune. The frequency of the internal oscillator is based on these components. Preset VR2 determines the speed at which the tune is played. Large value of C6 slows the beat, and low value increases the speed of the beat.

As this circuit is not able to distinguish between incoming ring pulses and outgoing dial pulses, sometimes during dialling a melodeous tone may be heard. Though this is a disadvantage, many people will prefer this drawback because it gives an audible indication that the exchange is responding to the digits being dialled.

The operating voltage of IC4 should not exceed 4.5 volts.

Dynamic Display

Rajeev Kapoor

This circuit is based on serial input and parallel output shift register 74164. With the help of this circuit we can build a display board, where LEDs blink to give a running light effect.

This circuit may be used for advertising or display of name plates etc. It is made versatile by using the 555 and 74 series of ICs, which are readily available in the market.

In this circuit we have given four inputs to IC 74164 and Vcc supply of 5V is given at pin 14. The output here is taken from pins 3, 4, 5, 6, 10, 11, 12 and 13. The input to the pins 1, 8 and 9 are

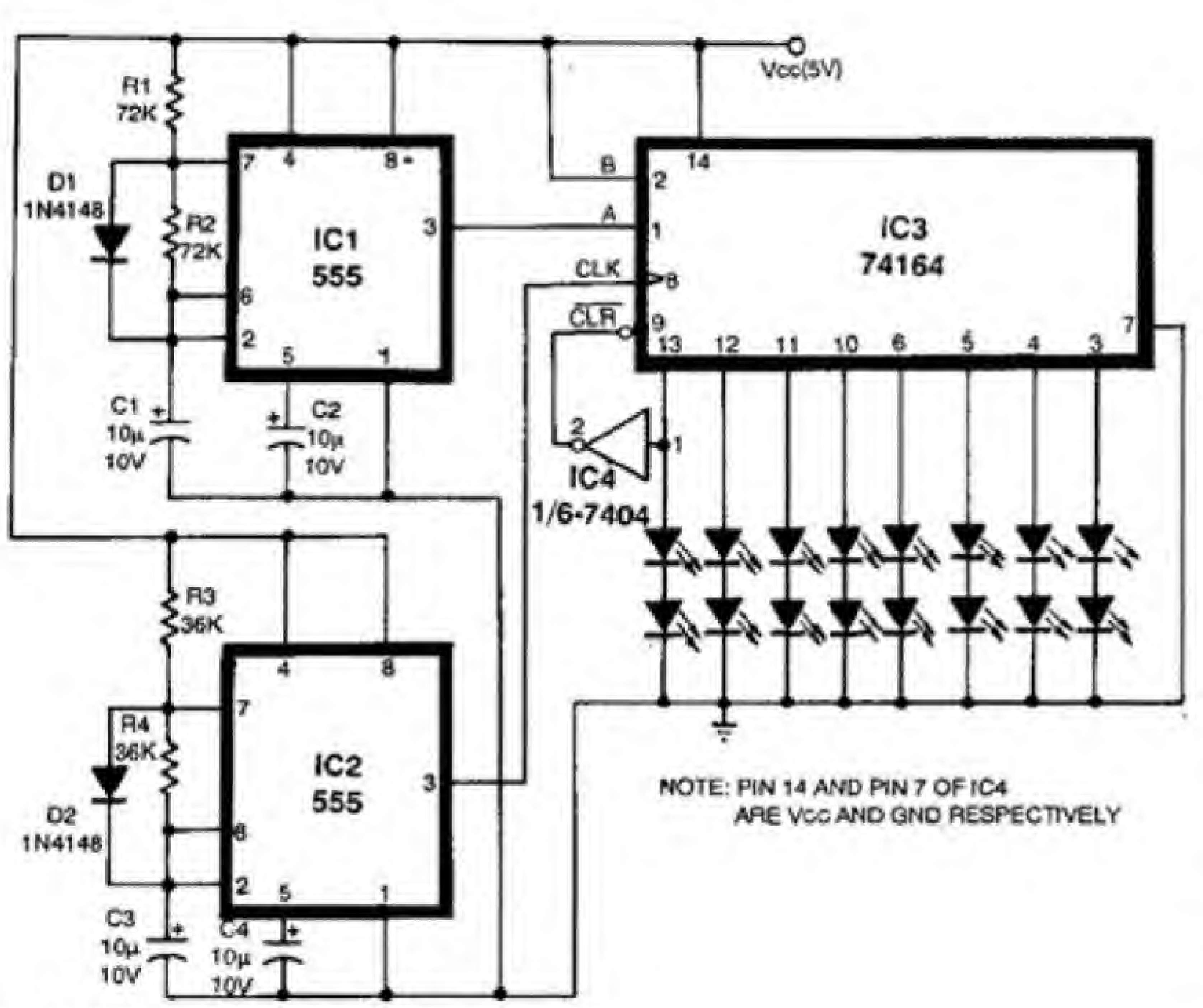


Fig. 1: Circuit diagram of dynamic display.

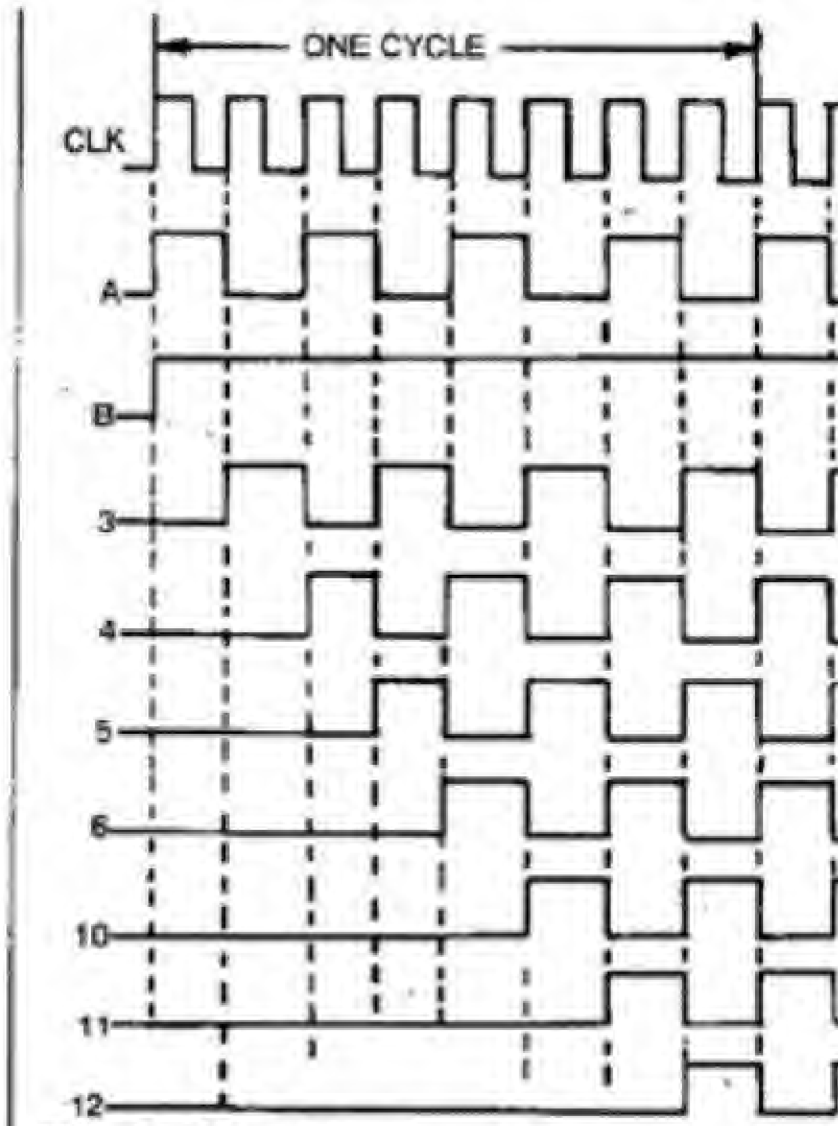


Fig. 2: Waveforms.

given with adjusted frequency. The input given by IC 555 is designed for 50 per cent duty cycle, with T = 2x7.92 ms. Pin 2 in IC 74164 is made 'high' continuously to enable the input. Pin 8 of IC3 takes clock pulses from timer IC2 having 50 per cent duty cycle with time period of 0.555 sec. The output from pin 13 of IC3 is inverted by IC4 and given to pin 9 of IC3. This terminal is used for resetting purposes. In IC 74164 the data of pin 3 shifts to pins 4, 5, 6, 10, 11, 12 and 13 successively. We have used LEDs at output terminals of IC3 which act as load. The LEDs are arranged in such a way that they form a display. As the LEDs connected to pin 13 glow the whole display will reset and the cycle will start again.

Here we have the display of LEDs arranged in a way to make 'ELECTRON' with the output pins 3, 4, 5, 6, 10, 11, 12 and 13 respectively. In the first cycle the letter E will glow, in the second cycle L will glow, in the third cycle the first and the third letter will glow. In the fourth cycle C and L will glow, in the fifth cycle E,E and T will glow, in 6th cycle L,C and R will glow, in 7th cycle E,E,T and O will glow and in 8th cycle L, C, R and N will glow and then circuit will be reset switching off the whole display. After receiving the reset pulse, the first cycle will start again and will display in the same manner. The above operation will be so fast it will give a running light effect. This is limited up to 7 characters only.

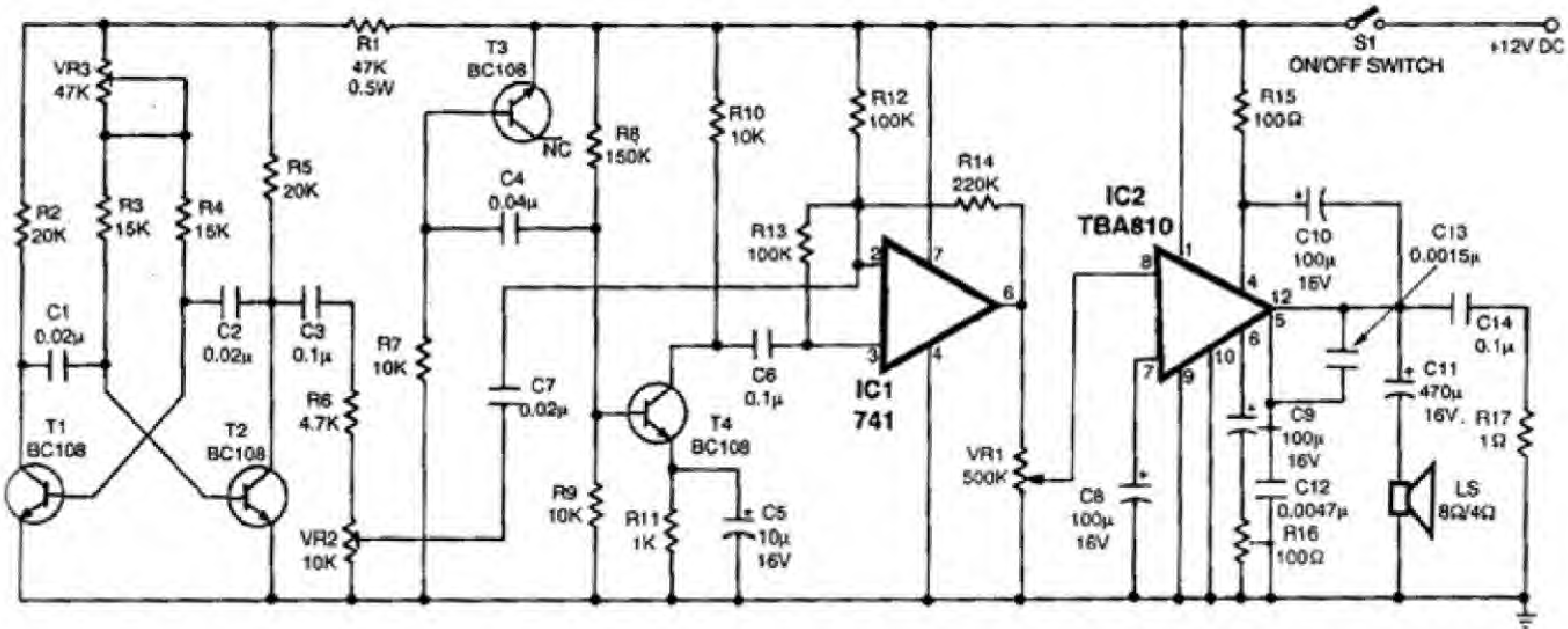
We can increase the display by 7 characters by cascading one more IC 74164. If we are cascading four ICs, we can get 7+4x8=39 characters. Here we can cascade as many ICs as we require. For cascading purpose, the output of pin 13 of first IC 74164 should be given to the input of second IC 74164 at pin 1. And the reset input pin 1 should be connected to the same as corresponding pins of first IC 74164. In place of LEDs we can also use display of AC bulbs. For this purpose we have to use relays at output terminals and this relay should be of high switching speed.

Editor's Note: Time period of IC1 applied at A input of IC3 is double the CLK period applied at CLK input pin 8, i.e. A input period = 1.10 sec. approximately and not as stated by the author.

Steam Whistle

N.J. Chandran

The circuit produces a sound similar to that of a steam locomotive whistle. Transistors T1 and T2 form a multivibrator, the frequency of which is set by preset VR3. This is the 'toot' part of the whistle. Transistor T4 amplifies white noise generated across the reverse biased transistor T3. White noise and toot are mixed by IC1. The ratio of these is



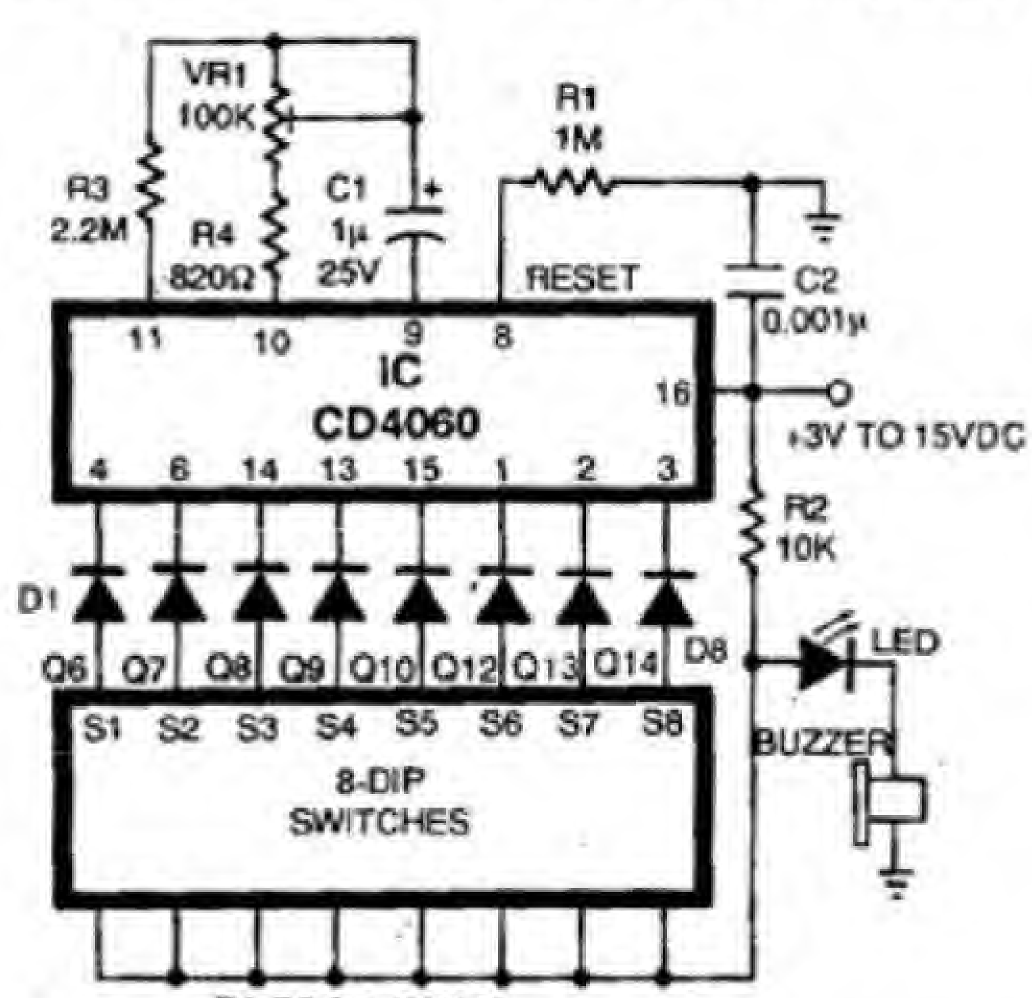
set by preset VR2. The output from IC1 is fed to a simple amplifier based around TBA810 device.

The positive 12V could be fed to the circuit by a push switch near the controller or by the model train itself by means of reed or microswitch devices.

Programmable Timer

Prasanna D. Upasani

Many timer circuits have been published so far but this one happens to be the most versatile, inexpensive and extremely compact timer with alarm. This timer can be programmed for more than 250 different time intervals.



The heart of the circuit is a 14-stage binary counter, CD4060. As shown in the figure, clock pulses are generated by connecting C1, R4 and R3 to terminals 9, 10 and 11 respectively of CD4060. Preset VR1 (100-kilohm) is connected in series with resistance R4 to adjust the frequency of the clock pulses.

Power-on-reset is provided to reset the counter by giving a pulse from the supply line via C2 (0.001 µF), after which it starts counting the pulses generated by the oscillator.

Diodes D1 through D8 along with the resistor R2 (10-kilohm) are used to form an 8-input AND gate. The truth table of the same is shown in Table I.

The timer has eight programmable switches, each with a fixed time interval. For example, with approximately 1.06 Hz frequency adjusted with the help of preset VR1, the output Q6 (pin 4) will go high after receiving $2^6 = 64$ pulses, that is after about 60 seconds. In the same way, Q14 (pin 3) will go high after $2^{14} = 16384$ pulses, that is after about four-and-a-half-hours.

But if Q6 and Q14 are switched on simultaneously, their time intervals get added because of the AND gate arrangement made by using the diodes and the resistor. That is why 256 different time intervals can be programmed. The circuit can be powered by a 9V battery, and can be enclosed in a compact plastic box.

TABLE I

A	B	Y
0	0	0
0	1	0
1	0	0
1	1	1

LED Stop Watch

Pramod Kumar

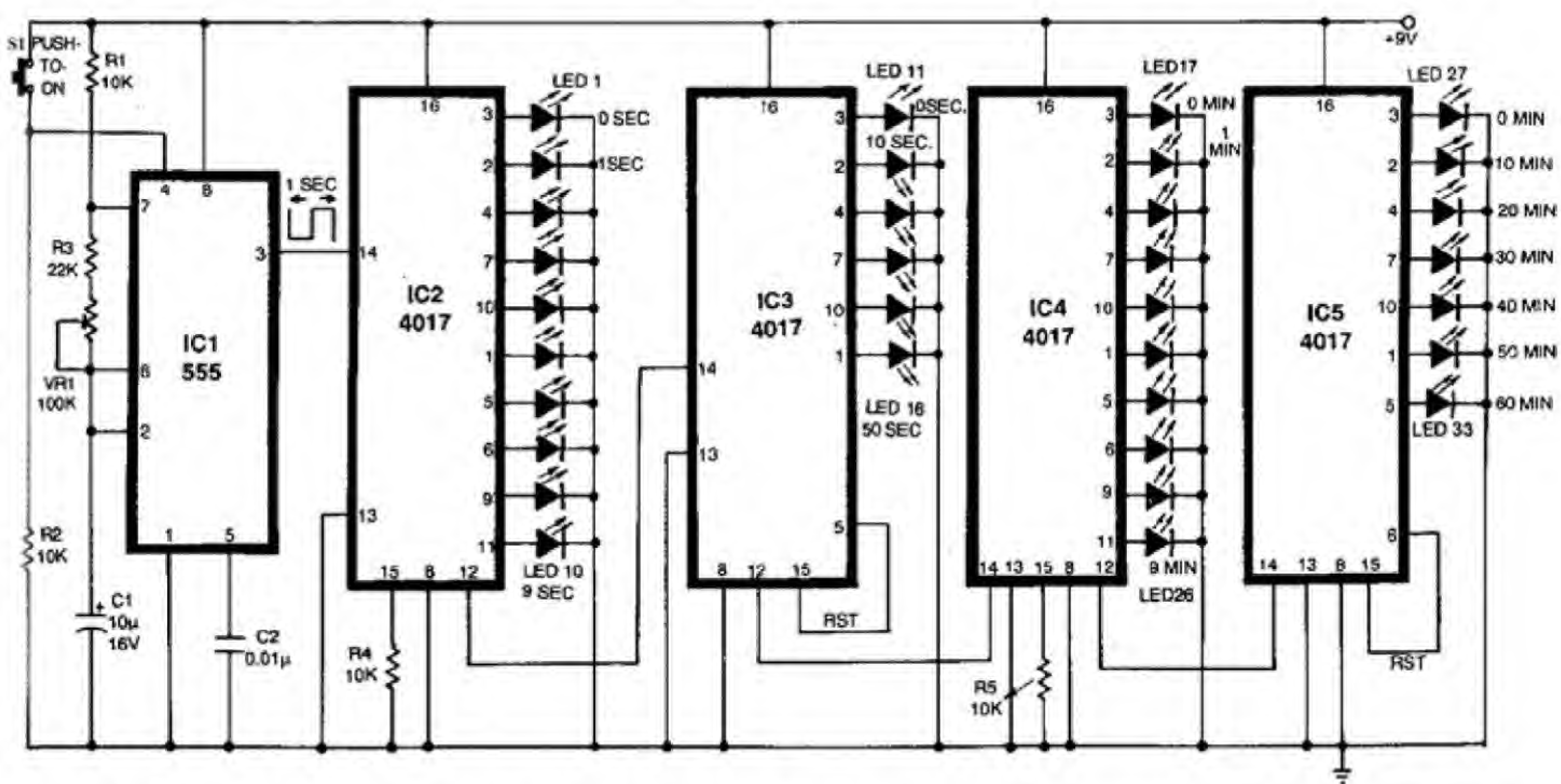
ICs 555 and 4017 are well-known to electronics hobbyists. Presented here is a very interesting circuit of an LED stop watch using timer 555 and decade counter 4017 ICs. This stop watch is able to monitor time from one second to 60 minutes. It can be used in sports, laboratories etc.

normally but as soon as pin 4 gets low level logic, it stops to generate clock pulse and the output stays at *low* level.

In this circuit, pin 4 of IC 555 is wired to ground through a 10-kilohm resistor, and push-to-on switch S1 is provided across the positive supply and pin 4. As soon as switch S1 is pressed,

S1 is released, IC1 stops generating clock pulses and all counter ICs stop counting. The positions of all glowing LEDs will show how much time (pushing time of S1) has elapsed.

IC1 counts for 1 to 10 seconds, IC2 counts for 10 to 60 seconds, IC3 counts for 1 to 10 minutes and IC4 counts for



IC 555 is the heart of the circuit. It is used in astable multivibrator mode. The special feature of this mode is that if pin 4 of IC 555 is kept at high level logic, it produces clock pulse

IC1 starts generating clock pulses and the whole circuit gets activated.

At each clock pulse, IC2, IC3, IC4 and IC5 start counting which is indicated by glowing LEDs. When switch

10 to 60 minutes. Preset VR1 should be adjusted so that IC1 produces one full clock cycle in one second.

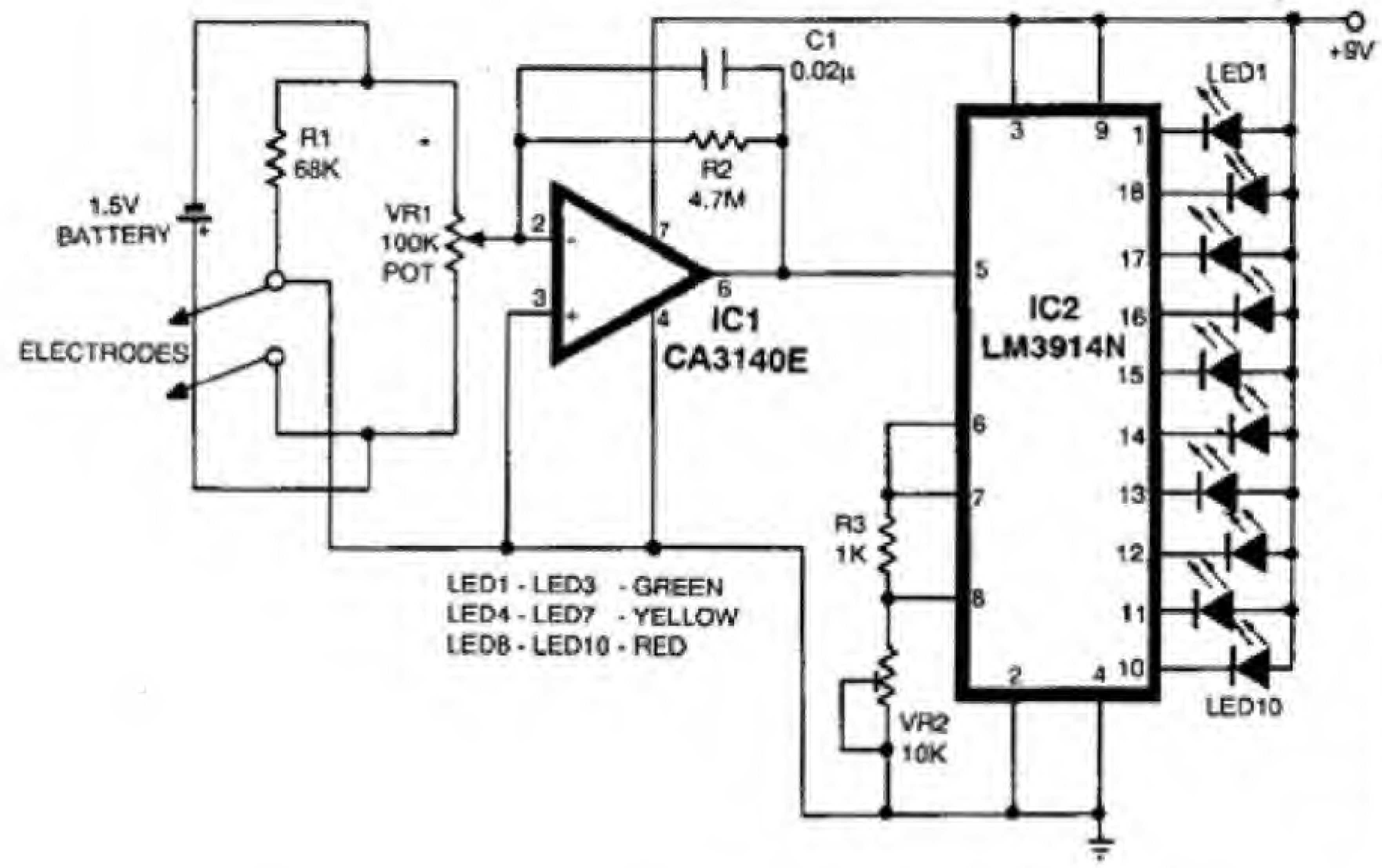
Lie Detector

K. Sundararajan

The instrument to find whether a person is speaking the truth or not is called a lie detector or polygraph. It records the heart beats, blood pressure, body temperature and tension level of the person undergoing the detector test.

General questions along with other relevant questions are asked to the subject. When the person tries to tell lies, his body physiology changes. These changes are recorded and compared with the results that are obtained for

normal questions. Such sophisticated instruments can however give wrong results. Hence the results obtained through lie detectors are not taken as evidence in court cases.



Our electronic lie detector is for entertainment purposes only. Emotional stress is not only reflected by heart beats or trembling hands, but also by an increase in skin moisture.

When the skin becomes moist, its resistance decreases. Thus the skin resistance is a good indicator of the stress level of the subject. The lie detector presented here has been designed to detect skin resistance of the subject and to give visual indication through bar arrangement of different colour LEDs.

The circuit for the lie detector is shown here. It is very simple to construct and use.

The circuit consists of a bridge, an amplifier built around IC1 and a display stage around IC2. The electrodes, fixed resistor R1 and balance control VR1 make up a bridge circuit. The bridge network is connected to operational amplifier IC1. In this circuit, popular CA3140 op-amp is used as it is readily available and inexpensive. Much better op-amps are available in the market and these can be used for precision results. As this lie detector circuit is only for entertainment purposes, engaging such costly op-amps is not necessary.

The output of IC1 drives IC2. This display driver is the popular IC LM3914, which measures the voltage from IC1 and converts it into digital signals that light appropriate LEDs.

The output of IC1 is extended to pin 5 of IC2. This is the input voltage of IC2, according to which it acts. The IC has an internal stable 1.25V reference voltage source. The reference voltage is available at pin 7 and may be varied by preset VR2. This IC is wired to give a bargraph mode which lights all LEDs successively and keeps them 'on' to display a bar of light. The length of the bar will vary in accordance with the value of input signal available at pin 5 of IC2.

1.5V cell is provided to supply power to the bridge.

Place the palm of your hand on the electrodes. The skin resistance across the palm becomes part of the bridge. Since the skin resistance and fixed resistance R1 are not normally equal, there will always be some error in the positive or the negative direction in its output voltage. This condition is corrected by the use of balance potentiometer VR1, which allows the output of the bridge circuit to be corrected for variation. Also, the general emotional condition of a person can only be ascertained by measuring the average resistance of the skin over a period of time. Hence, it is necessary to adjust VR1 a few times for balance until a relaxed state is reached. Once this is done at the start of the session, there is no need to adjust VR1 thereafter.

Also, as the skin resistance varies from person to person, it may be necessary to adjust VR1 for each participant. Once the bridge is balanced, the lie detector reading will vary in accordance with the changes in body resistances. The circuit amplifies any minor changes in the subject's resistance and causes LEDs to light. Any LED that lights up thereafter indicates that the skin resistance is changing under stress.

For calibration, connect a resistor with the same value of R1 in the place of electrodes. Bring potentiometer VR1's wiper to the centre of its rotation. Now the differential voltage at the input ports of the op-amp IC1 is near zero. Thus the output of the IC1 assumes its midrange value of 4.5V.

Now slowly adjust preset VR2 so as to light fewer LEDs.

Remove the fixed test resistor and connect the electrodes. Touch the electrode with your palm. Adjust the setting of balance control VR1 such that the bargraph lights up to approximately midway. Note down the number of the glowing LEDs. Hold the electrodes very tightly with the forefinger and the thumb. Now the electrodes will get heated up and consequently their resistance will reduce, and this will cause more LEDs to turn on. Once you get the above mentioned indications from the initial test, your circuit is ready. Preset VR2 need not be adjusted further.

Now ask the participant to touch the electrodes with his palm and set the balance control so that some LEDs light up. Stress causes a decrease in body resistance which results in more LEDs lighting up in the display.

Two bare flexible wires can be used as electrodes. If regulated power supply is available, the LEDs will give a stable output.

The lie detector circuit can be used as a relaxation monitor for monitoring relaxation and reduction of tension. Set the balance control to light more number of LEDs. As you relax or reduce tension, your body's resistance increases. This will cause more LEDs to extinguish.

Readers' Comments:

In the Lie Detector circuit published in April'92 issue can I use μA741 for IC1 and LM3915 IC for IC2?

MADHUSUDAN AGASTY
Tharsoguda (Dt Sambalpur)

The author, Mr K. Sundararajan, replies:

ICs LM3915 and μA741 are not equivalent to LM3914 and CA3140E respectively. IC LM3915 is the logarithimic version of the popular LM3914, and it is used only in audio circuits. uA741 does not give as satisfactory a performance as a CA3140E for such a sensitive measurement. Hence the reader is advised to follow the published circuit only.

Temperature Controlled Soldering Iron Station

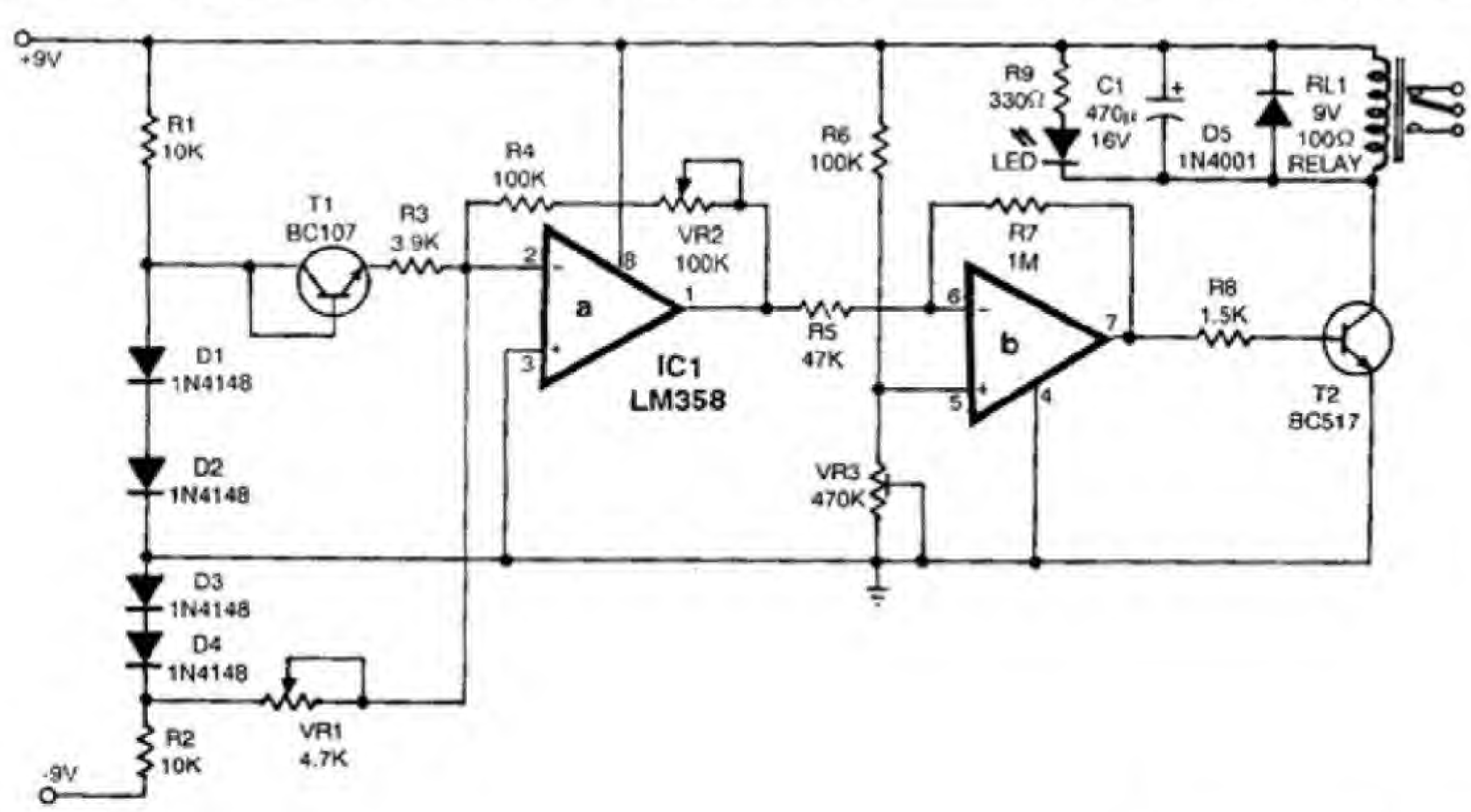
Kalpesh T. Dalwadi

Temperature controlled soldering iron stations are now readily available in the market. Such instruments use thermocouples or thermistors as temperature sensors. Generally, thermocouples are preferred. These units are available for Rs 300 to Rs 600. Temperature sensors such as PT 100, PT 500, PT1000 etc are very precise but their cost is around Rs 800. Here is a project to construct such a unit at almost half the cost, while it is almost as reliable as the commercial one.

An electronics hobbyist would surely like to build this unit to enhance the working life of his soldering iron bit and to save power against a nominal investment of around Rs 150.

With basic knowledge of comparators, this circuit is very easy to understand.

Temperature sensor BC107 is an inexpensive silicon transistor. The fact that the emitter to base turn-on voltage of a silicon transistor is linear with temperature, is utilised to sense temperature. If the operating current of sensing



transistor is made proportional to absolute temperature, the small non-linearity which is prevailing can be eliminated.

Diodes D1 and D2 provide voltage source of 1.2V, which is applied through resistor R3 to set operating current of transistor T1. Here VR1 biases the input of amplifier for zero output at zero degree centigrade, while VR2 can be calibrated for 100 mV/°C at pin 1 of IC1.

IC1(b) acts as a simple comparator. R7 provides some hysterisis. Preset VR3 can be varied to control the temperature of soldering iron from about 250°C to 450°C.

T2 drives the relay. If the temperature of soldering iron increases above the set value, output at pin 7 of IC1 goes high and T2 gets base drive. Relay operates and the solder iron is cut off from the supply. When the temperature of iron comes within the range of the set limit, the output at pin 7 goes low, thus tripping the relay. And then the soldering iron is again connected to the supply. Capacitor C1 eliminates the relay flutter at the time of changing of the logic levels at pin 7 of IC1.

The sensor can be mounted half centimetre away from the soldering iron bit with a single-core copper wire. Use mounting sockets for IC.

For calibration of the system adjust VR1 and VR2 at positions slightly greater than their mid-positions. In this case, voltage at pin 1 will be around 4.8V.

Connections of VR3 are to be made such that rotating VR3 from its minimum position in clockwise direction will decrease the voltage at pin 5 of IC1. When VR3 is in minimum position the voltage at pin 5 of IC1 is around 4.2 volts. When VR3 is at maximum (when rotating in clockwise direction VR3 will decrease due to reverse connection of preset) the voltage at pin 5 will be zero volts.

For calibration of VR3, take a thermometer which can measure temperature up to 500°C. Set VR3 at minimum position switch on the unit. When the relay is energised and LED glows, measure the temperature of the soldering iron with the thermometer. It will be around 260°C.

Now rotating VR3 in clockwise direction in fixed steps, go on measuring the temperature of the soldering iron till the LED glows. Mark that position for the measured temperature.

When VR3 is in maximum position in clockwise direction, the maximum bit temperature measured will be around 430°C.

Completing the above, your soldering iron station is ready for use. The whole unit would cost around Rs 150.

Mini Emergency Light

B.S. Malik

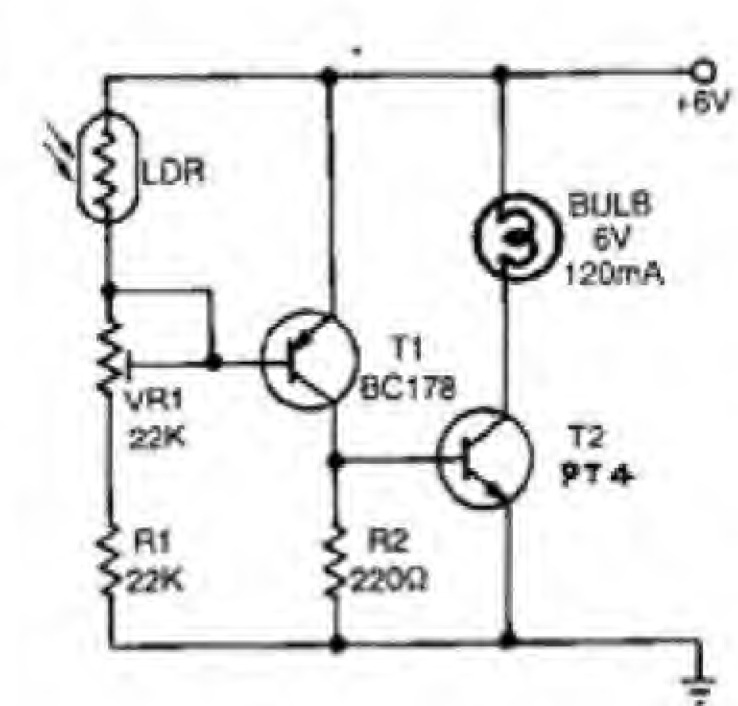
There are various types of emergency light circuits. Every circuit has its own importance and utility. But size, cost and efficiency of the circuit are some of the main features of interest. A very simple circuit is given here.

In normal daylight or electric light, the LDR offers very low resistance. So a positive voltage is applied to the base of transistor T1, making it reverse biased. Therefore, T1 does not conduct in presence of light. As transistor T2 also is reverse biased it does not conduct either. So the bulb does not glow.

In darkness, to make the bulb glow at a desired intensity of light, the LDR offers high resistance due to which a negative voltage forward biases T1. Hence T1 conducts and voltage drop across resistor R2 is applied to base of T2, causing it to conduct. In this way the bulb now glows.

Preset VR1 can be adjusted to make the bulb glow at a desired intensity of light.

In presence of light, the circuit is off but draws about 125 μA from 6V supply. The total consumption of circuit depends on the bulb's rating. If a bulb of 6V, 120mA rating is used then the circuit consumes about 300 mA current.



Automatic Time Indicator for Telephone

Mangesh M. Kasbekar

The circuit presented here provides an audible warning 2.5 minutes after dialling the telephone. The circuit does not make use of telephone lines for its operation.

The circuit consists of three 555 ICs. It can be divided into three parts—touch switch using IC1, timer using IC2, oscillator using IC3.

The on touch plate is in the form of a wire, the insulation of which is attached to the stopper on the telephone dial.

The off touch plate is in the form of a conducting silver paper strip which is stuck on the body of the telephone such that a similar strip stuck on the handset touches it when the handset is kept in position.

While dialling a number, the finger touches the stopper and the switch becomes 'on'. Pin 3 of IC1 goes high, thus giving supply to IC2 which is triggered as a timer without a trigger.

The timer triggers falsely when the supply is given and pin 3 of IC2 goes high. After preset time interval, the voltage drops to ground level and the oscillator becomes operative.

The circuit will not work on battery since the grounding of touch plates is involved. Use a 9-volt regulated supply. The line and neutral terminals should be connected properly. Otherwise, the touch switch action will be momentary. The wire connecting the on touch plate to the PCB can be long but that for the off plate should not be longer than 4-5 cms.

The siren can be stopped by keeping the handset in position or by touching the off plate first and then the on plate for issuing a warning after the lapse of 2.5 minutes.

The circuit draws 3-5 mA in off state. It remains off for incoming calls. It is automatic in the sense that it switches itself on and off within the normal procedure of making a phone call.

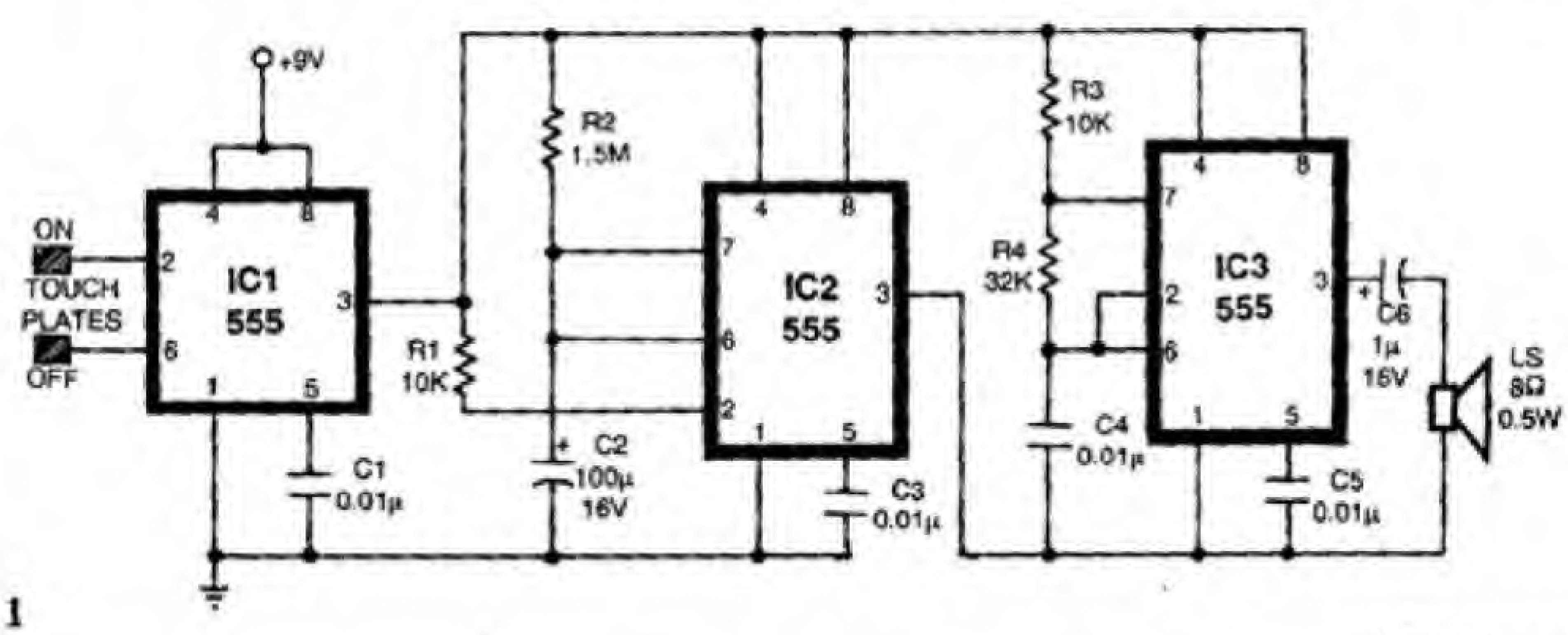


Fig. 1

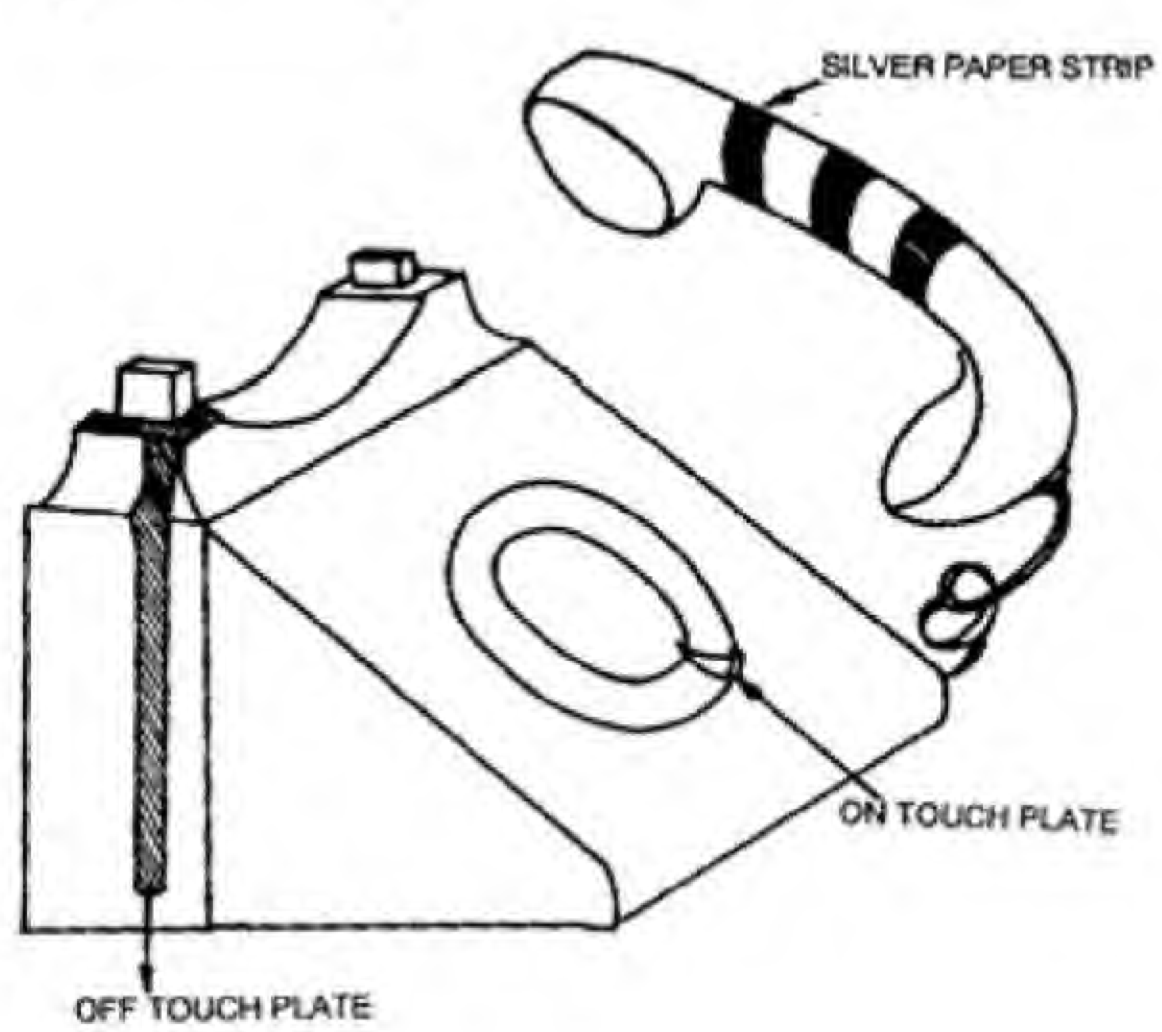
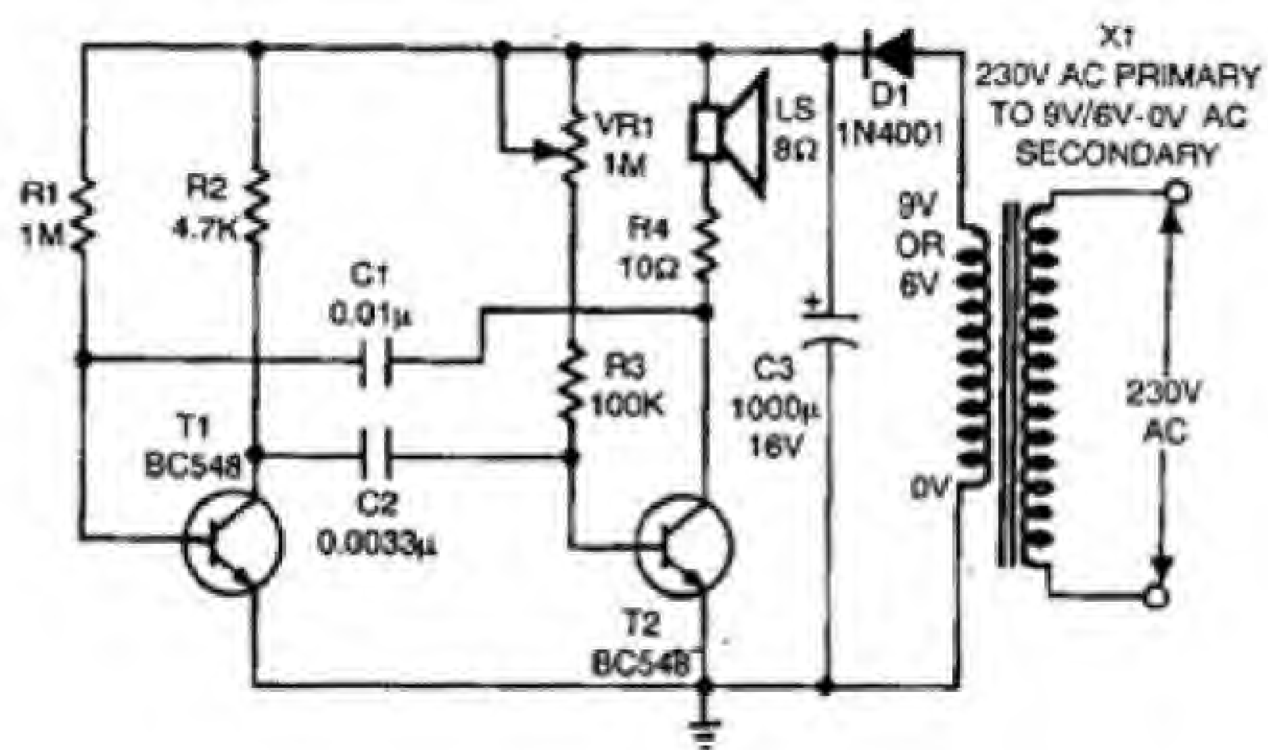


Fig. 2

Wind Sound Generator

Pradeep G.

Using this simple circuit, one can generate the sound of wind. The circuit is basically an astable multivibrator built around two npn transistors. Here two BC548 transistors are used but they can be replaced with any general-purpose silicon transistors.



By adjusting the 1M potentiometer, the sound can be changed from that of wind to storm, sound of sea, hiss of escaping gas from a container through a small hole etc. A 9-volt or 6-volt unregulated power supply is enough. However, a battery may be used instead. The output sound will be slightly changed. The prototype has been successfully tested with the given power supply. Also an 8-ohm, 5cm, low wattage speaker is recommended. The circuit can be easily assembled on a small veroboard. Values of feedback capacitors may be changed slightly, if necessary.

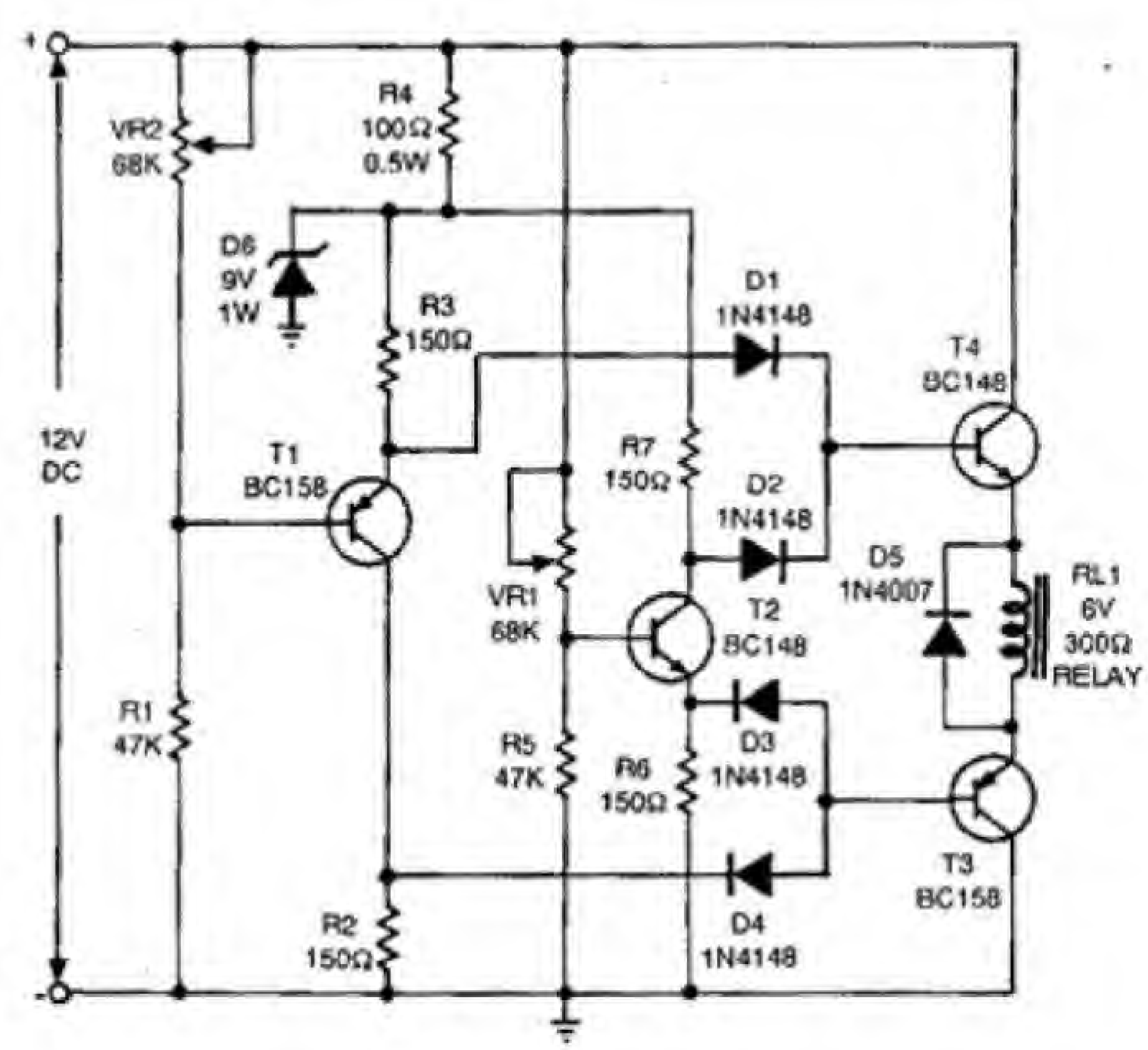
Automatic Cut-Off Power Supply

Biswadeb Kumar Nath

We are aware that when the line voltage becomes more than 250 volts and less than 160 volts, it can damage our TV sets, refrigerators etc. Hence, we use voltage stabilisers which are costly. The circuit described here is low-cost. The assembling cost comes to around Rs 50 only. If the voltage exceeds the mentioned range it automatically cuts-off the supply so that the life of the TV set and other devices can be extended.

The common point of the relay is connected to the phase line and from the normal point it is connected to the device. The nuetral will have a direct line from the mains supply.

To adjust VR1 and VR2, you have to take the help of a manual voltage stabiliser. First adjust the manual voltage



stabiliser so that its output gives 160 volts. Then adjust VR1 so that the relay goes to the excited position. Now adjust the manual voltage stabiliser to give an output of 250 volts. Then adjust VR2 so that the relay just goes to the excited position.

This circuit requires nearly 75mA current at 12 volts. You may not get a transformer of this range in the market. Therefore, take a 6-volt, 300 mA centre-tapped transformer which is easily available in the market. Now obtain 12 volts from the transformer using bridge rectifier from the two end points of the secondary winding, leaving the centre tap open.

Battery Charger with Overcharge and Deep-discharge Protection

Dr D. Kumbhakar

Lead-acid storage cells are often used as stand-by source of electrical energy during the periods of supply line failure. The electrical energy stored in the cell is extracted during mains failure; when the mains supply sets on, the energy can be replenished from the mains source through a device known as charger. Both the discharging and charging of the cell are chemical processes, one in the forward direction and the other in the reverse direction. But what may happen when the charger remains 'on' even after the electrical energy of the cell has been fully recovered?

Another important question to a battery user is how long a battery can be discharged after it is fully charged? This is mentioned by the ampere-hour capacity of the battery specified by the manufacturer. As an example, a battery of 90 ampere-hour will deliver current at an average of 9 amperes for 10 hours. What will happen if the discharging is continued beyond that time limit?

The battery will be damaged beyond repair if it is driven beyond the limit. The plates will be coated with insoluble molecules of lead sulphate which cannot be removed. This state is known as deep-discharge of the battery. This state is also manifested in the battery voltage. For 12-volt batteries, which is our concern here, this is 10.8 volts. So the battery voltage should not be allowed to fall below 11 volts.

Presented here is a reliable and efficient method to cut-off the charging of a 12-volt battery at full charge and also the discharging at a safe limit. So let us first take a look at the charger itself.

The heart of the charger is a transformer in a metallic box. The primary of the transformer is connected to the AC mains (Fig. 1). The secondary of the transformer usually has a centre terminal and the two terminals at its sides are 12 volts AC with respect to it.

The centre-tapped terminal is di-

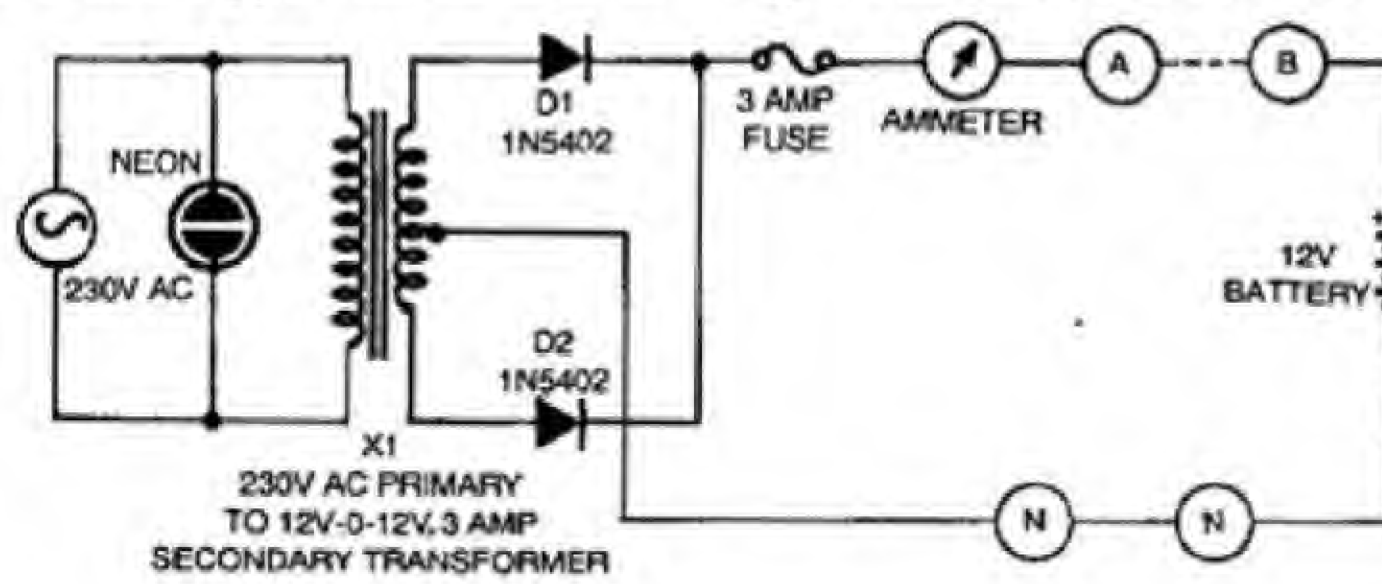


Fig. 1

rectly connected to the negative terminal of the battery. The other two terminals are connected to the anode ends of two diodes. The other ends, i.e. the cathode ends of the diodes, are joined together and are led to the positive terminal of the battery through an ammeter and a safety fuse.

To cut off the charging, as the battery reaches full charge, i.e. 13.2 volts, a circuit board with a relay can be used. The circuit board has a zener which gives a reference voltage of 5.1 volts (Fig.2). The current through the zener is maintained at about 5mA through a resistance of 1.8k from the supply voltage which is around 12-15 volts. This reference voltage is put at the emitter of transistor T1 whose base senses the battery voltage through a potential divider formed by 4.7k and 3.3k resistors, and a preset of 2.2k. When the base voltage is not above 0.6 volt than the emitter voltage, transistor T1 does not conduct; the collector voltage of T1 remains at Vs. Transistor T2 also does not conduct since the voltages at its emitter and base are the same and equal to Vs. As the base of T1 rises above 5.7 volts, T1 starts conducting and the collector voltage falls below Vs. The base voltage of T2, a pnp transistor, becomes lower than that of its emitter—eventually T2 also conducts and the relay is energised.

There is another potential divider formed by two 4.7k resistors and the 2.2k preset. Transistor T3 senses the same zener voltage of 5.1 volts at its emitter and the battery voltage at the base. If the battery voltage is about 11 volts, the transistor conducts fully, the collector voltage remains around 5.2 volts. The collector of T3 is linked to the base of T1 through diode D3. If the

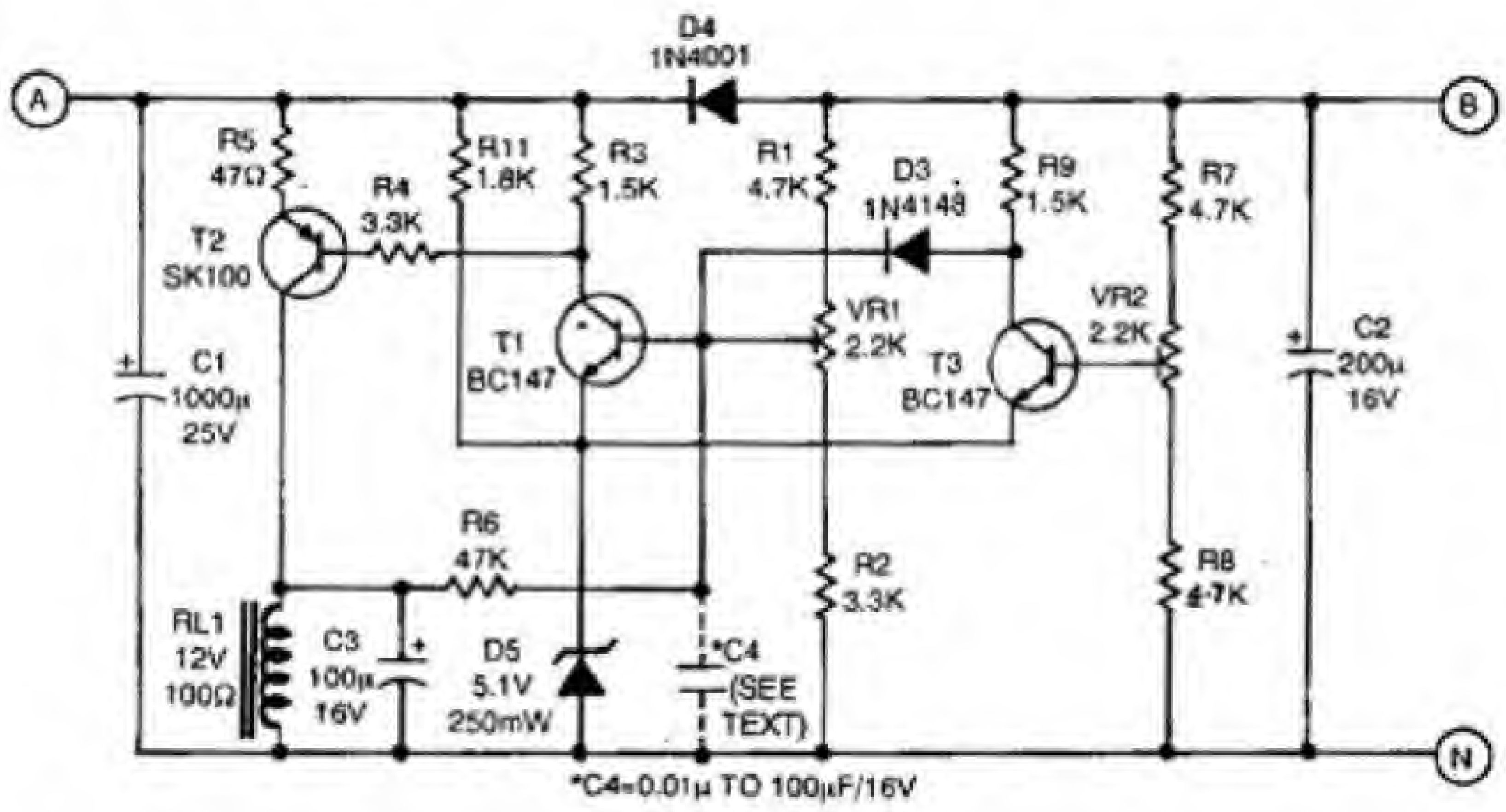


Fig. 2.

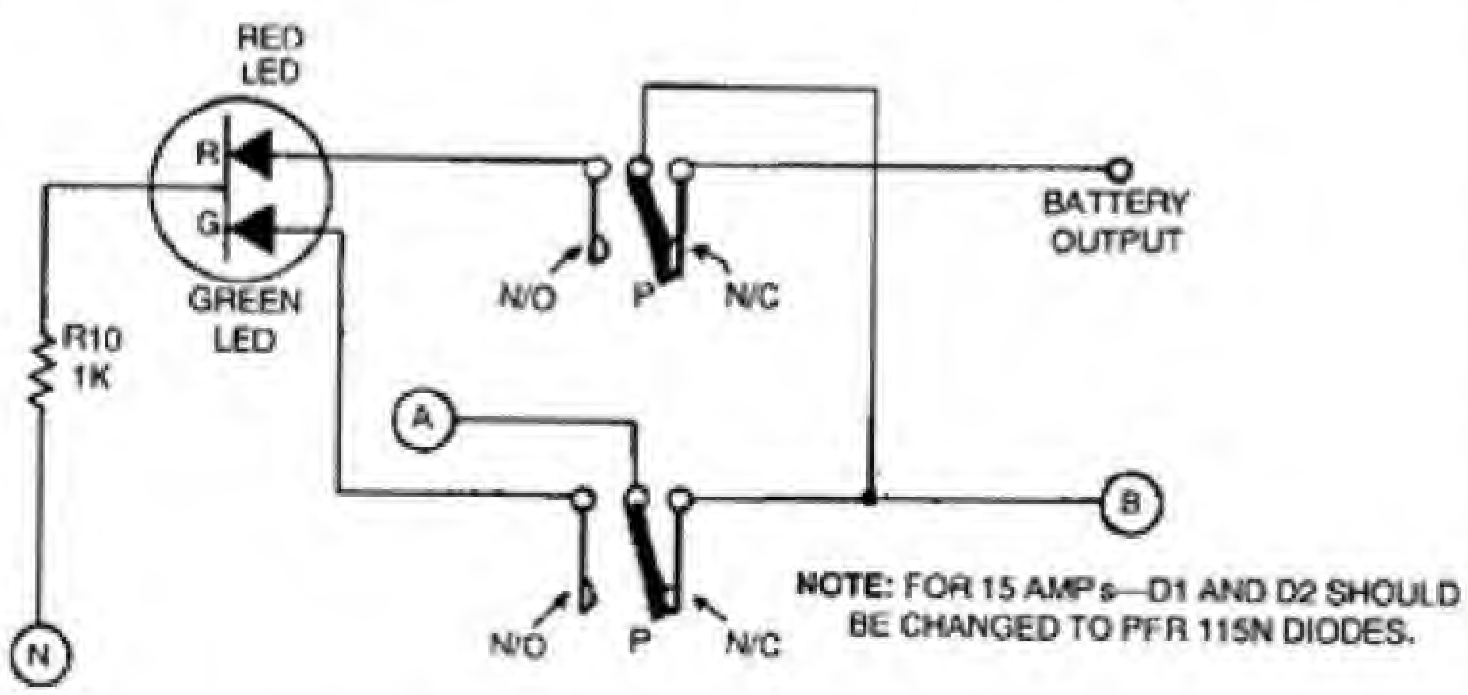


Fig. 3.

battery voltage falls below 11 volts, conduction of T3 decreases and the collector voltage rises. D3 then conducts to raise the base voltage of T1. Transistors T1 and T2 conduct sequentially and the relay is energised.

To avoid flickering in the relay contacts during overcharge or deep-discharge cut-off, a feedback resistance of 47k is placed between the collector of T2 and the base of T1. A condenser of 100µF across the relay also reduces the flickering. If further damping is needed, a condenser should be set at the base of T1.

Both the overcharge and deep-discharge cut-offs are provided by a single relay. Hence, it has to be a double-contact relay. Normally, the DC output of the charger at point A charges the battery through one normal contact (Fig.3). The battery is also connected to the pole of the other contact and the battery output is taken from its normal contact. A double LED serves as both the overcharge and deep-discharge cut-off indicator. When the relay is energised due to overcharge, the voltage at A lights up green part of the LED, at the same time reverse-biasing the red part. During discharge, if the relay is activated, the red part will glow since the voltage at A is absent.

For setting, first set the preset VR2 at the lowest towards ground. Then let the battery voltage rise to 13.2 volts by charging. Set the preset VR1 to cut the charging at a voltage slightly above 13.2 volts.

A satisfactory check for the setting will be as follows. First discharge the battery through an ammeter for a certain time. For example, let the current be 5 amperes and time 8 minutes. Then let the battery be charged. If the charging current is 4 amperes, then the minimum charging time required is given by 4t = 5x8.

Here is a problem. The charging current is not a steady one. So you have to find the average current. By repeating the above procedure several times you have to fix the preset, keeping in mind that the power supplied during charging should be somewhat greater than the power delivered by the battery during discharge.

While the battery voltage is at 13.2 volts, shift the battery clip from the positive terminal to the positive of the preceeding unit (6 units in 12-volt batteries). Then the voltage reaching the circuit board is 13.2x5/6 = 11 volts. Use this voltage to set preset VR2 for discharge cut-off.

Readers' comments:

The circuit for 'Battery Charger with Overcharge and Deep-Discharger Protection' in EFY Apr. '92 issue does not work. I assembled this particular circuit on a veroboard and checked the connections thoroughly!

S.DUTTA GUPTA
Babupara South (Dt Darjeeling)

The author, Dr D. Kumbhakar, replies.

I have checked the circuit on a general-purpose PCB once more. My observations are:

1. Before setting VR1, preset VR2 should be set highest towards supply and not lowest towards ground.

2. Resistor R5 should be changed to 1-ohm for less sensitive relays.

3. Condenser C4 is usually unnecessary.

4. The circuit can also be used for 6-volt batteries if the 5.1-volt zener is replaced by four 1N4001 diodes in series (forward biased)

I deeply regret for the mistakes 1 and 2.

I may further add that the circuit is working smoothly for years in my 12-volt DC-to-250V AC inverters with some modifications in the relay and supply connections. Thanks to the reader whose efforts have led me to detect the errors.

Electronic Ballast for Tubelights

K. Sridhar

The fluorescent tubelight requires additional gear such as the copper ballast and starter for normal operation. These two are required to provide the initial high voltage for ionisation and thereafter to limit the current through the tube to safe values.

It has been observed that the illumination efficiency of the tubelight when excited by high frequency power source is higher than that when excited at the 50Hz line frequency. Moreover, the power factor and the efficiency of the bulky copper ballasts are poor. Hence, electronic ballasts were developed to overcome these deficiencies.

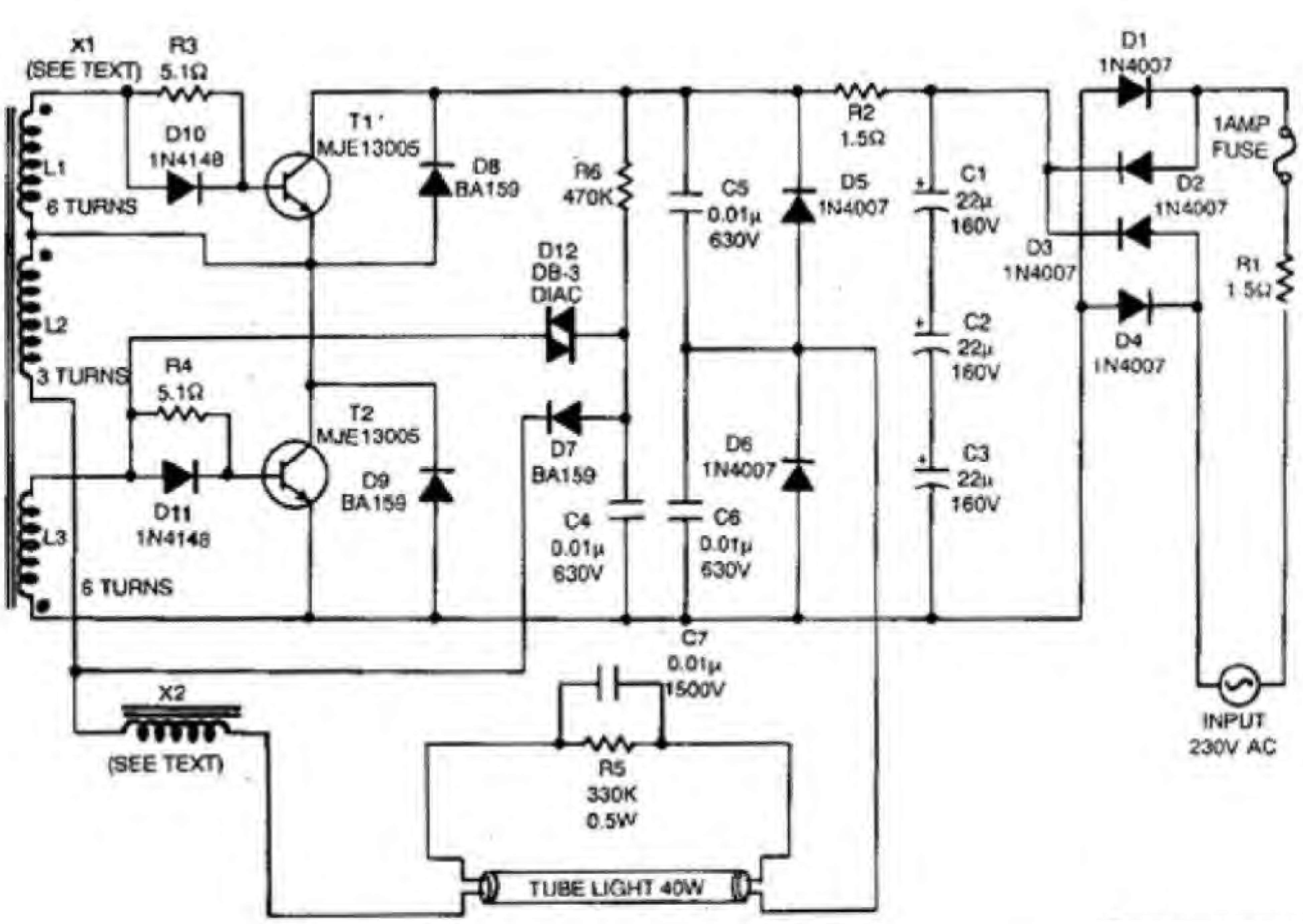
The electronic ballast is light in weight, compact and has a high power factor. It starts up even at low voltage, and above all has a very high efficiency.

The typical electronic ballast is a current fed oscillator in the half bridge configuration. Transistors T1, T2 and capacitors C5, C6 form the half bridge in the circuit shown. Diodes D8, D9, D5, D6 clamp the output voltage to values within the supply rails. Diodes D1 to D4 and capacitors C1 to C3 provide the required DC voltage for the circuit. Transformer X2 regulates the current through the tube and also determines the frequency of operation of the ballast. For the values shown, the operating frequency is typically 25 to 30kHz. R6, C4 and diac DB-3 form the start-up circuit.

As capacitor C4 charges up to approximately 35V, diac DB-3 provides a current pulse to the base of transistor T2, setting the circuit into oscillation. The specifications of transformer X1 and X2 are given below:

X1 (T-10) — Coil wound on ferrite T-10 or T-12 core. 6 turns, 3 turns and 6 turns wound by thin plastic coated copper wire. The different windings should show insulation in excess of 100 megohms at a test voltage of 500V.

X2 (E-25) — 160 turns of 29SWG enamelled copper wire with a sheet of thin insulating paper between layers. The E-25 ferrite core is fixed with a small air gap of about 0.2mm produced by paper kept between the faces of the ferrite core.



The transistors may be sorted by their current gain. The transistors with similar current gain can be used. Use a digital multimeter with transistor check facility for this.

Warning: All components of the ballast are live. They carry high voltage. Direct contact with the circuit may prove lethal.

Disconnect the mains whenever possible and discharge capacitors C1, C2, C3 before testing the components. Use a 100-ohm resistor connected in between two probes to discharge. Do not discharge by shorting the capacitors.

Listed below are some of the major faults diagnosed in electronic ballasts along with the probable causes.

1. Tube does not start up or flickers:

—Improper diac D12

—Wrong sequence of connection for coil X1

2. Tube flickers but does not start-up.

—Wrong connection of coil X1

—Faulty diodes D6, D5

3. Tube operates, transistors overheat:

—Poor insulation in X1 or incorrect no. of turns

4. Tube operates, coil X2 overheats:

—Too high an air-gap

5. Hissing sound or crackling sound:

—Improper insulation in coil X2

6. Flickering tube:

—Faulty capacitors C1, C2, C3

7. Does not start-up at low voltage:

—Very low air-gap in X2

For further experimentation capacitors C1, C2 and C3 can be replaced by a single 8μF polyester capacitor. This increases size and cost. This model will withstand high temperatures (outdoor application) and will have a long life.

Twin L-section filters consisting of inductors and capacitors can be used on the AC input side of the choke. This would suppress radio frequency interference (RFI). The coils may be of 15 turns on T-20 ferrite core. The capacitors may be 0.01μF, 1000 volts. ❑

Compressor/Expander Unit (Compander)

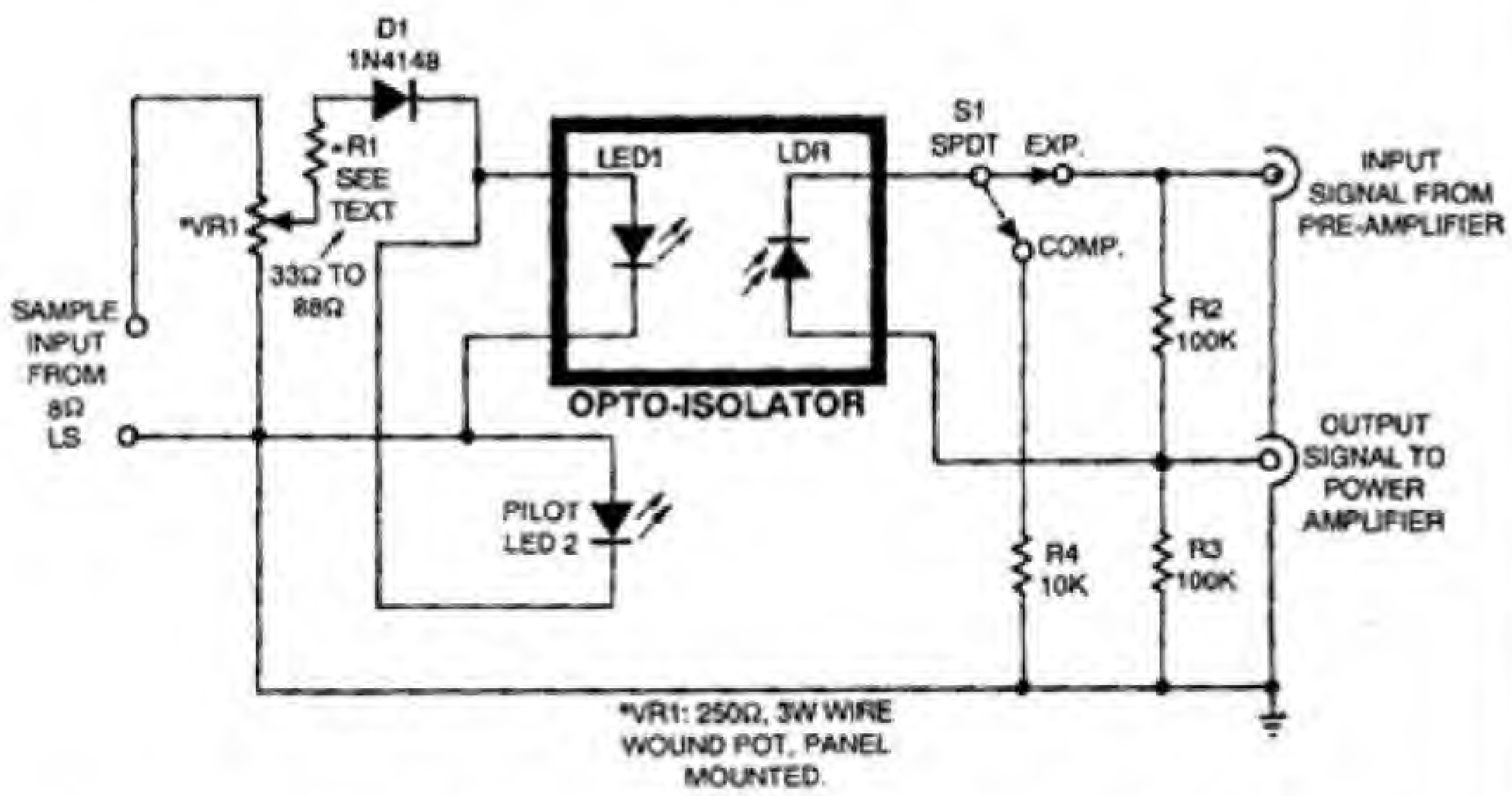
N.J. Chandran

The compression and expansion are two important techniques used by audio engineers during recording and reproduction of programme material.

The compression of dynamic range of programme material (records, speech or music broadcasting) permits maintaining constantly high modulation level while the expansion, when used with the reproduction of compressed material, restores the dynamic range and creates a 'live' music.

Creating these effects is costly and complex, and beyond the scope of amateur audiophiles. But the simple circuit shown here provides a low-cost solution. Constructed with a few passive components, it can give surprisingly good results. The circuit furnishes both the functions—compression and expansion (often expressed by the term compander)—easily.

The compander uses an opto-isolator. The LED from the opto-isolator is connected to the speaker terminals via a current limiting resistor in conjunction with potentiometer VR1 to sample



the programme material from the output of power amplifier.

Diode D1 and resistor R1 provide protection to the LED from excessive current, while potentiometer VR1 is used to vary sensitivity of the circuit. The value of R1 needs adjustment; with high power audio amplifiers its value should be increased. This should be decided experimentally.

The audio modulated light falls on the LDR which is light sensitive. So LDR's resistance varies with the modulated light. The LDR should have a 'dark resistance' of about 5 megohms, and when brightly illuminated it should offer a resistance of about 6 to 20 kilohms. It is therefore possible to vary its resistance by feeding the current to the LED from the audio output terminal of an amplifier. The LED and LDR should be enclosed in a light-proof box or a small plastic tubing.

When S1 is switched to 'EXP', the LDR gets connected across the high end of R2 and R3. When audio-modulated light from the LED strikes the LDR, which is now connected in parallel with R2, the combined resistance becomes lower and thus increases the output level.

When the S1 is switched to 'COMP', the LDR and resistor R4 come in parallel with R3. And when the LDR is illuminated by the LED, the composite resistance lowers and it compresses the signal. The amount of compression depends upon the values of R2 and R3. A high value of R2 means a greater expansion range is possible.

Compression depends upon the value of R4 (10k used here). As this value is decreased, the compression effect is increased. Thus it is possible to obtain practically the desired range of compression and expansion. The LDR's dark resistance value is also a participant and affects the performance of the unit. Its dark resistance should be between 5 and 10 megohms.

The compander can be used efficiently only if the preamplifier and power amplifier units are separate.

The programme source should be connected to the preamplifier and output from the preamplifier should act as the input to the compander. Expanded or compressed signal from the compander is fed to power amplifier. The output from the speaker terminals is connected to the input of opto-isolator (LED/LDR).

Audio compressor is much used in disk or tape recording, and can be interposed between the output of a mixer and the input of a tape recorder in order to ensure that the maximum recording level is not greatly exceeded.

The unit can be used as the volume control between the preamp and the power amplifier in an audio system. It can also be used in a musical instrument's amplifier, to extend the signal-to-noise ratio on expansion, or to prevent speaker blowout on compression.

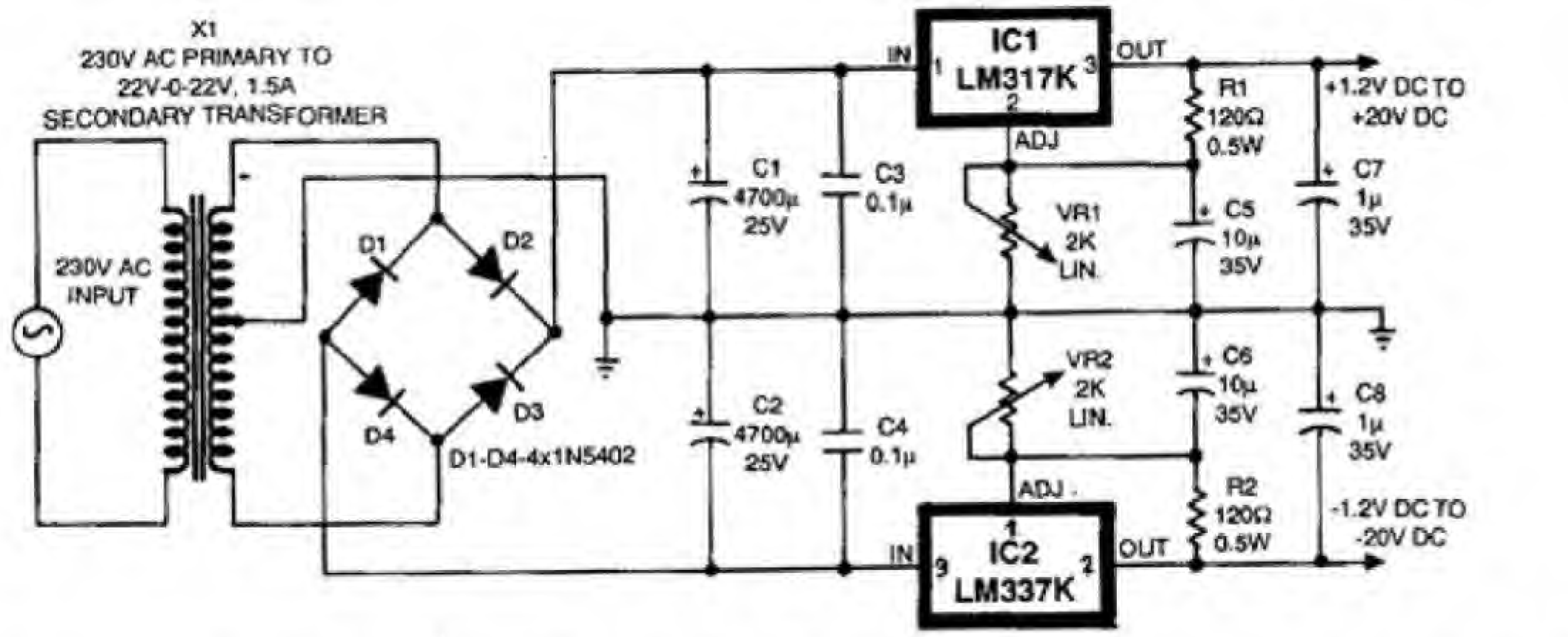
Adjustable Bipolar Voltage Regulator

Kamal Wason

For op-amp circuits the power supply must provide positive and negative voltages. Here is a simple circuit which gives regulated ±1.2V to ±20V supply. ICs LM317K and LM337K are used here as positive and negative regulators respectively.

The LM317K regulator has internal feedback regulating and current passing elements. It incorporates various protection circuits such as current limit (which limits package power dissipation to 15 watts for the TO-220 package and 20 watts for the TO-3 package) and thermal shutdown. Thus these two ICs form an independently adjustable bipolar power supply.

The steel K packages will easily furnish one ampere each if the heatsinks are properly mounted. Variable resistors VR1 and VR2 are adjusted for



each regulator to give a regulated output approximately between ±1.2V to ±20 volts. Capacitors C5 and C6 are used to improve AC ripple voltage rejection. However, if a short-circuit occurs across the regulator output, C5 will adjust the current in the terminal. The output can be calculated by the formula

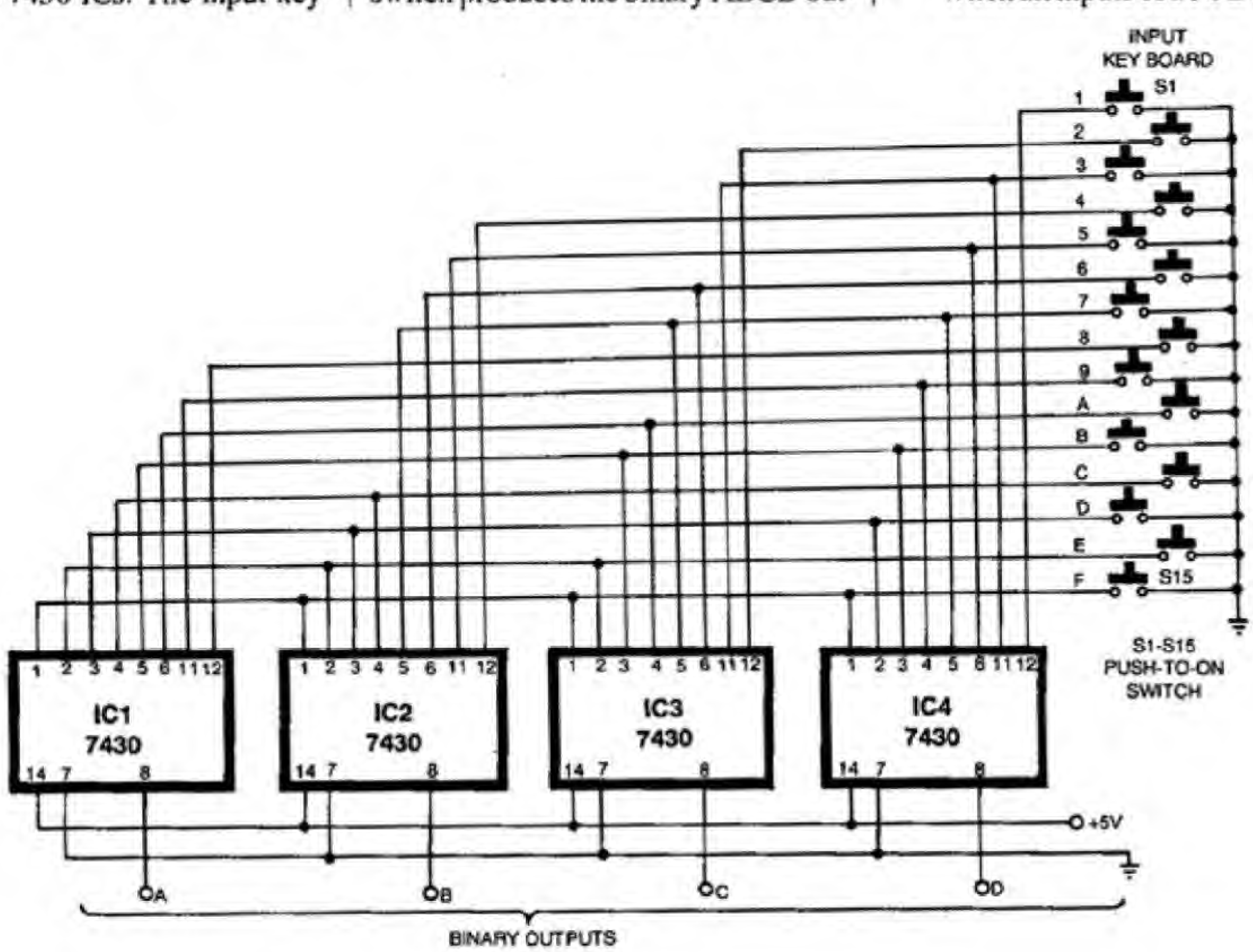
$$Vo = 1.25V \left(1 + \frac{VR1}{R1}\right)$$

Hex to Binary Encoder

Biju Kumar J.

The circuit described here is a hex to binary encoder using four, 8-input NAND gate 7430 ICs. The input keyboard switches S1 to S15 are connected in such a manner that pressing of any switch produces the binary ABCD outputs of corresponding decoded number.

When all inputs of a NAND gate are



high, it produces a low output. But when any of its inputs goes low, its output becomes high. Normally, all switches being open, the binary output is 0000. Pressing of a switch gives a 'low input' to the corresponding NAND gate, and hence the output code becomes a correct binary equivalent of the input hex number.

Electronic Siren

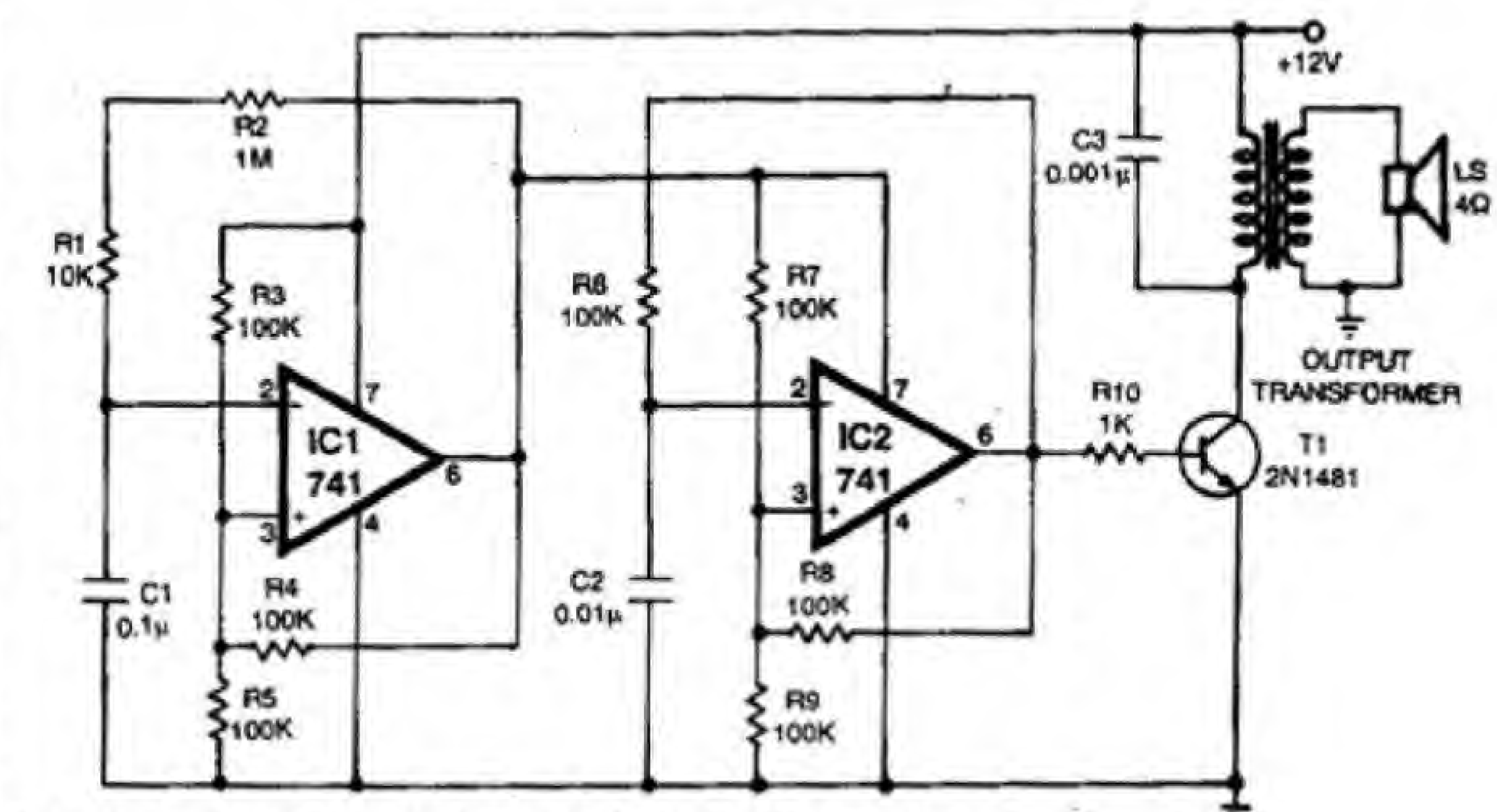
Kiran A.R.

Here is an inexpensive siren circuit built around the most popular and low-cost IC 741. It costs within Rs 50, excluding the power supply.

The circuit is basically a square wave generator which is used here to produce the tone of a siren.

The first 741 IC is used as a low-frequency multivibrator, the output of which modulates the high-frequency tone produced by the second 741 multivibrator. The final output is amplified and converted into a loud siren by transistor T1 and the speaker.

Several interesting tones can be obtained by changing the values of capacitors C1 and C2 and resistors R2 and R6. If the value of C1 is increased, the siren will produce sound like that of a fire engine.



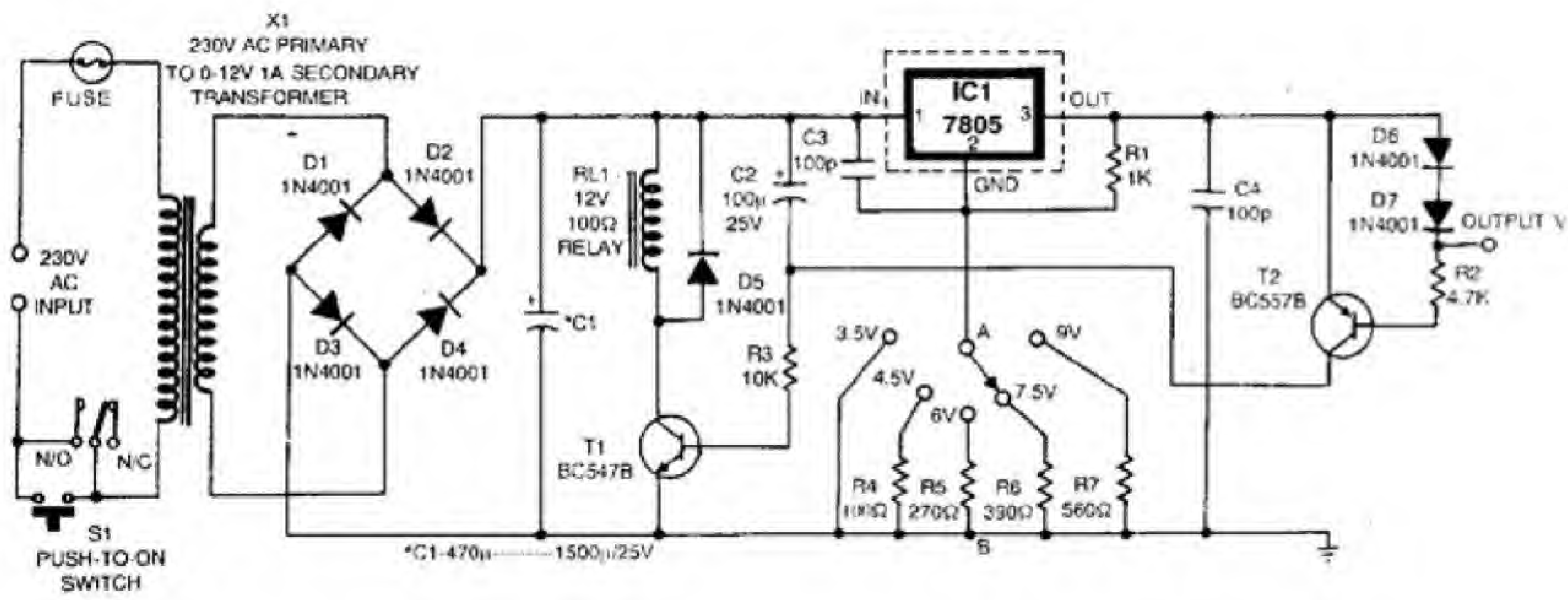
Self Switching-off Power Supply

N.J. Chandran

This power supply switches itself off when no current is drawn by the load.

When a load current flows, the potential difference across diode D6 is sufficient to cause diode D7 and transistor T2 to conduct. Transistor T1 is then switched on and the relay is energised. When the load current ceases, T2 switches off. The base current of T1 then charges capacitor C2 so that after a few seconds the relay is de-energised. The relay contacts switch to N/C and thus switch off AC mains supply at the primary side of the transformer. The supply is switched on again by reconnecting the load and pressing switch S1 momentarily.

The output voltage of the power supply depends on the resistance between points A and B in the circuit. A wire link there results in an output voltage of about 3.5V. For each 100 ohms increase, the output voltage will rise by about 1V. (The current from the regulators to ground is nearly constant at 10mA.) This facilitates variable out-



Note: Use 7805 in TO3 aluminium package rated for 1A.

put voltage with some resistors and a rotary switch.

The AC rating of the secondary of transformer X1 must be about 1.5 times as high as the desired DC output current. The output current should not exceed 1-amp; if that magnitude of current is drawn regularly, it is recommended to increase capacitor C1 to 1500 µF.

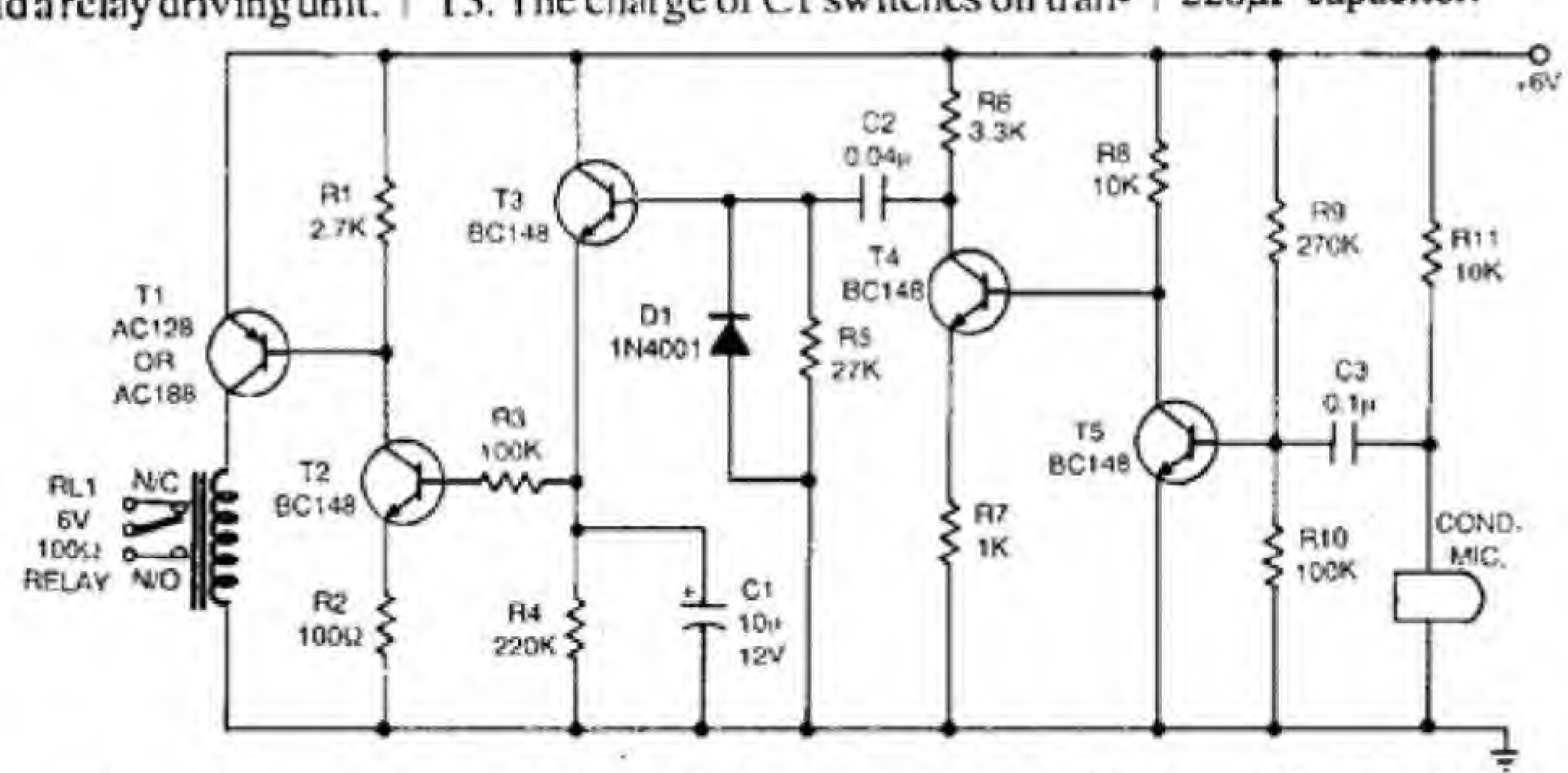
The delay in switch-off may be extended by increasing the value of capacitor C2. The heatsink of IC1 should be in accordance with the output current.

Sound Operated Timer

Pradip Kumar Bose

Several timer circuits have been published in EFY, but this one is unique as no timer IC has been used here. It is transistorised timer having a 2-stage audio amplifier and a relay driving unit. T4 and T5 amplifies the tiny signal. The amplified signal is rectified by diode D1 and is fed to the base of T3. Capacitor C1 starts charging through T3. The charge of C1 switches on tran-

C1, whose value can be in between 10µF to 220µF. It is found that the delay time is about one second with 10µF capacitor and it is about 20 seconds with 220µF capacitor.



The incoming sound waves are transformed into a low audio signal by the condenser (mic). The direct coupled audio amplifier built around transistors sistors T2 and T1 simultaneously. T1 energises the relay and the load gets power through it.

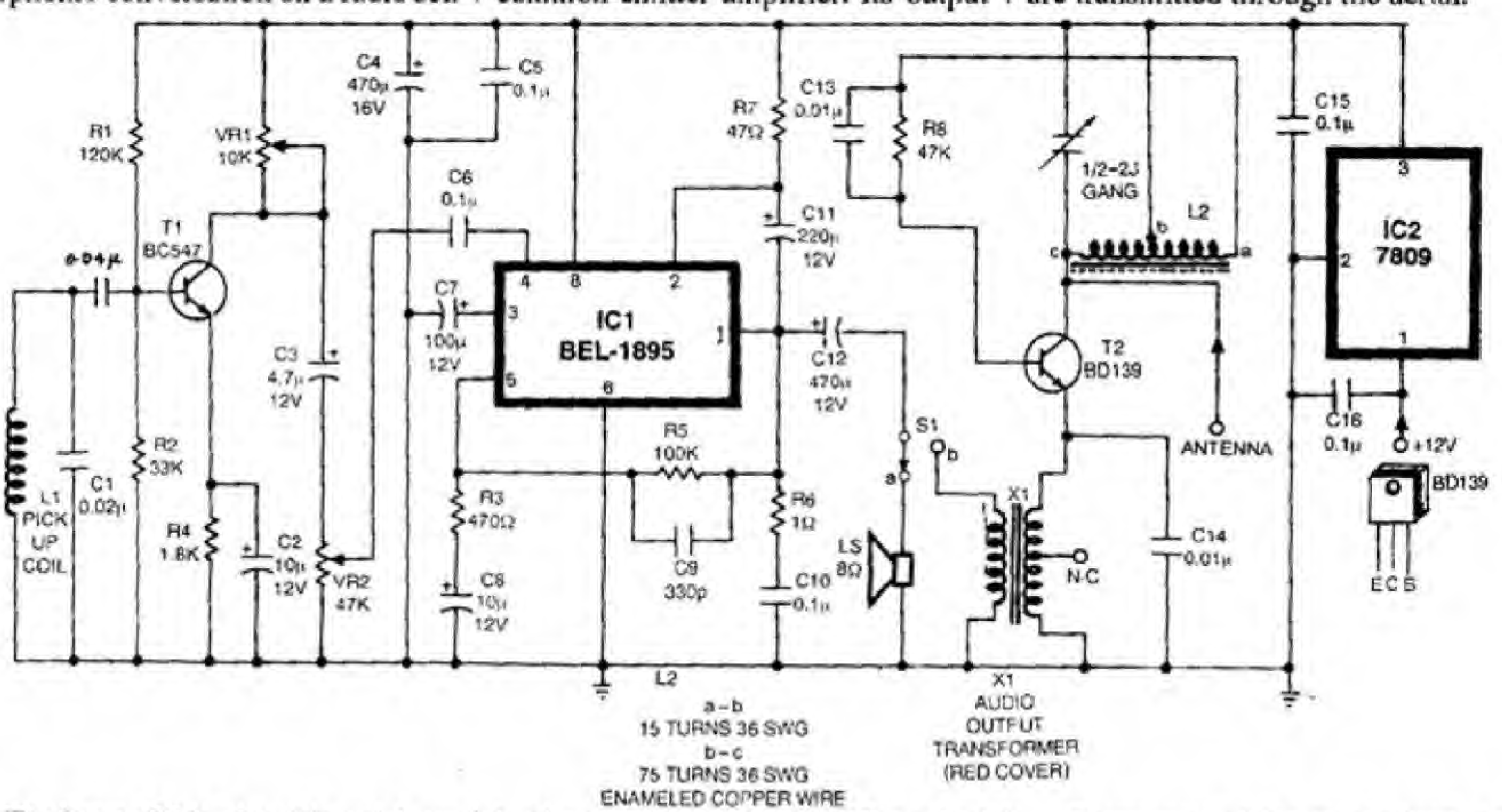
The time period is maintained by

The circuit can easily be mounted on a small veroboard. You can control radio, TV, taperecorder or any other electronic equipment with this timer.

Telephone Amplifier Cum Broadcaster

Pradeep G.

With this low-cost circuit for a telephone-amplifier-cum-broadcaster one can hear telephone conversation loudly. It also transmits speech signals in MW range so that one can listen to a telephonic conversation on a radio set.



The heart of this circuit is a pick-up coil which is made of 3000 turns of 42SWG enamelled copper wire wound over 3.8cm dia PVC pipe used as the former. After winding, remove the former carefully and wind self-adhesive (insulation tape) over the coil.

This coil is placed over the telephone set. A good shielded wire should be used to connect this coil to the circuit. Length of this wire should be as short as possible. Readers can determine the best position of the coil over the telephone set by trial and error to obtain the optimum results.

The audio signals picked up by coil L1 in the circuit are first amplified by transistor T1 which is wired as a simple common-emitter amplifier. Its output is given to the power amplifier wired around IC 1895.

When switch S1 is in position 'a', the speaker generates sound. Adjust VR1 and VR2 for a clear and loud sound. Don't place the speaker close to telephone mouthpiece as this would produce unwanted feedback noises.

When switch S1 is in position 'b', the speaker gets disconnected from the circuit, and the speech signals are carried to an RF oscillator circuit wired around transistor BD139. Here X1 is a 6-volt audio output transformer (red cover), normally used with a radio receiver (not driver transformer). X1 modulates AF signals with MW RF carrier waves. The modulated signals are transmitted through the aerial.

Frequency of the transmitted signals can be varied within the MW range through the gang condenser. (A fixed capacitor can also be used.) The change in position of L2 over the ferrite rod will also change the output frequency. Coil L2 should be wound exactly as described in the diagram. However, a 2X type MW antenna coil (not 2J) can also be used.

If a high-gain AC mains operated receiver is used, signals can be received even from a distance of 150 metres. The range will actually depend upon the length (height) of the antenna.

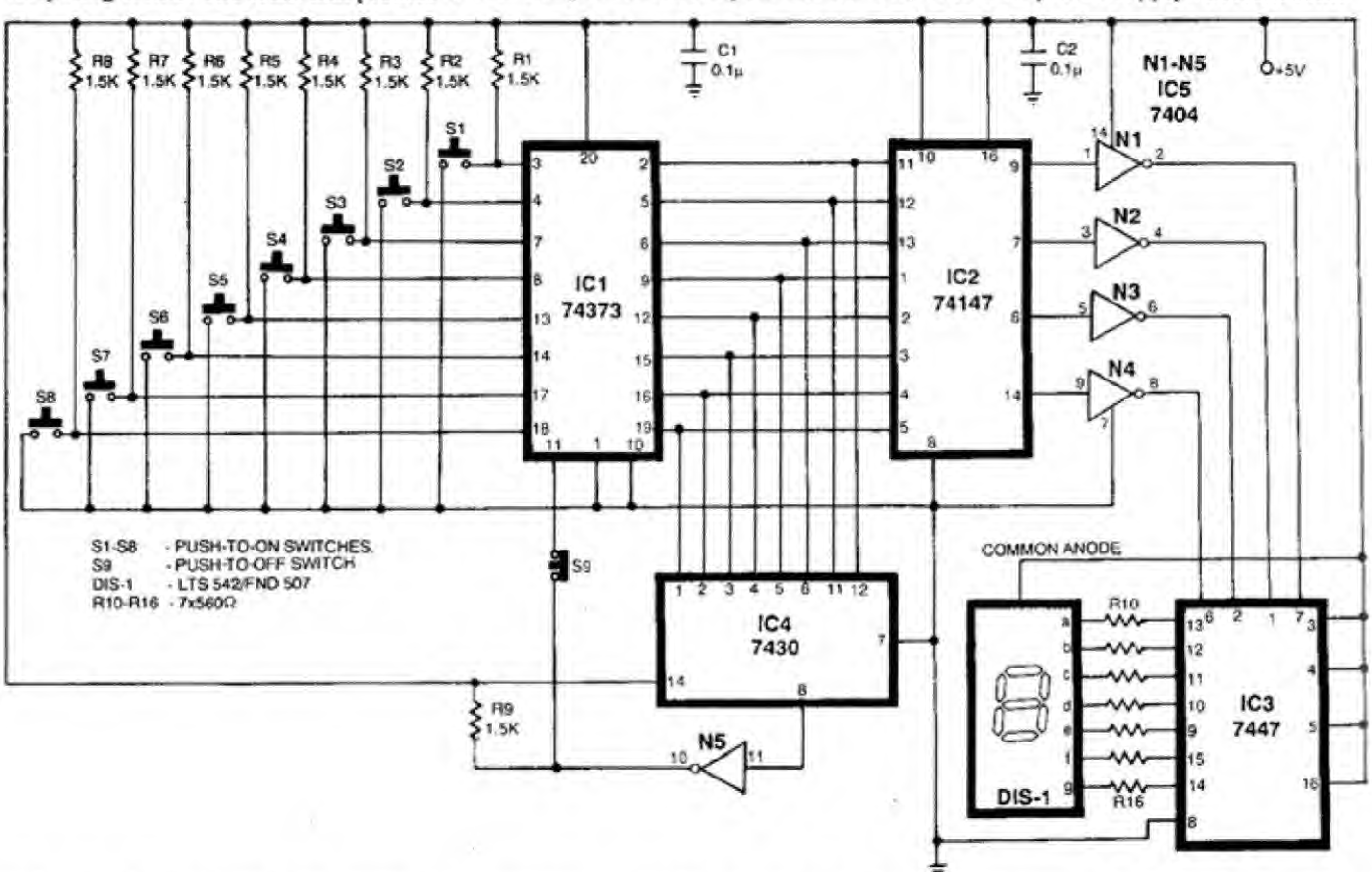
A regulated 9-volt supply using IC 7809 should be used. Otherwise, a little hum will be generated. Pin configuration of transistor BD139, being different from that of ordinary transistors, is shown in the diagram.

Quiz Display with Seven-Segment Indication

K.M. Reddy

Quiz contests are becoming increasingly popular and the so-called 'buzzer' rounds are now an integral part of such contests. In such rounds each team is provided with a pushbutton switch and questions are addressed to all the participating teams. The team that presses the buzzer first is allowed to answer the question. A circuit that can be used for this purpose is shown in the figure. It can accommodate up to eight teams. It makes use of a 7-segment display to indicate the team that pressed the switch first.

The circuit is based on TTL ICs,. IC1 is an 8-bit latch whose inputs are connected to the push-to-on switches and outputs to the inputs of IC2 which is a priority encoder. IC2 is used in this circuit to convert the data latched on IC1 to BCD. The outputs of IC2 are inverted by N1-N4 which are inverters. The complemented outputs are fed to the inputs of IC3 which is a BCD to 7-segment display decoder. This device's outputs drive a common-anode, 7-segment display. Current limiting resistors R10 to R17 limit the current available to the display. IC4 is used to prevent the latches from registering more than one team's input, i.e. only the first team's input is registred. This happens because whenever any one of the switches is pressed, the output of IC4 goes high. The complement of this input is fed to the enable input of IC1, disabling the latches until the reset switch is pressed.



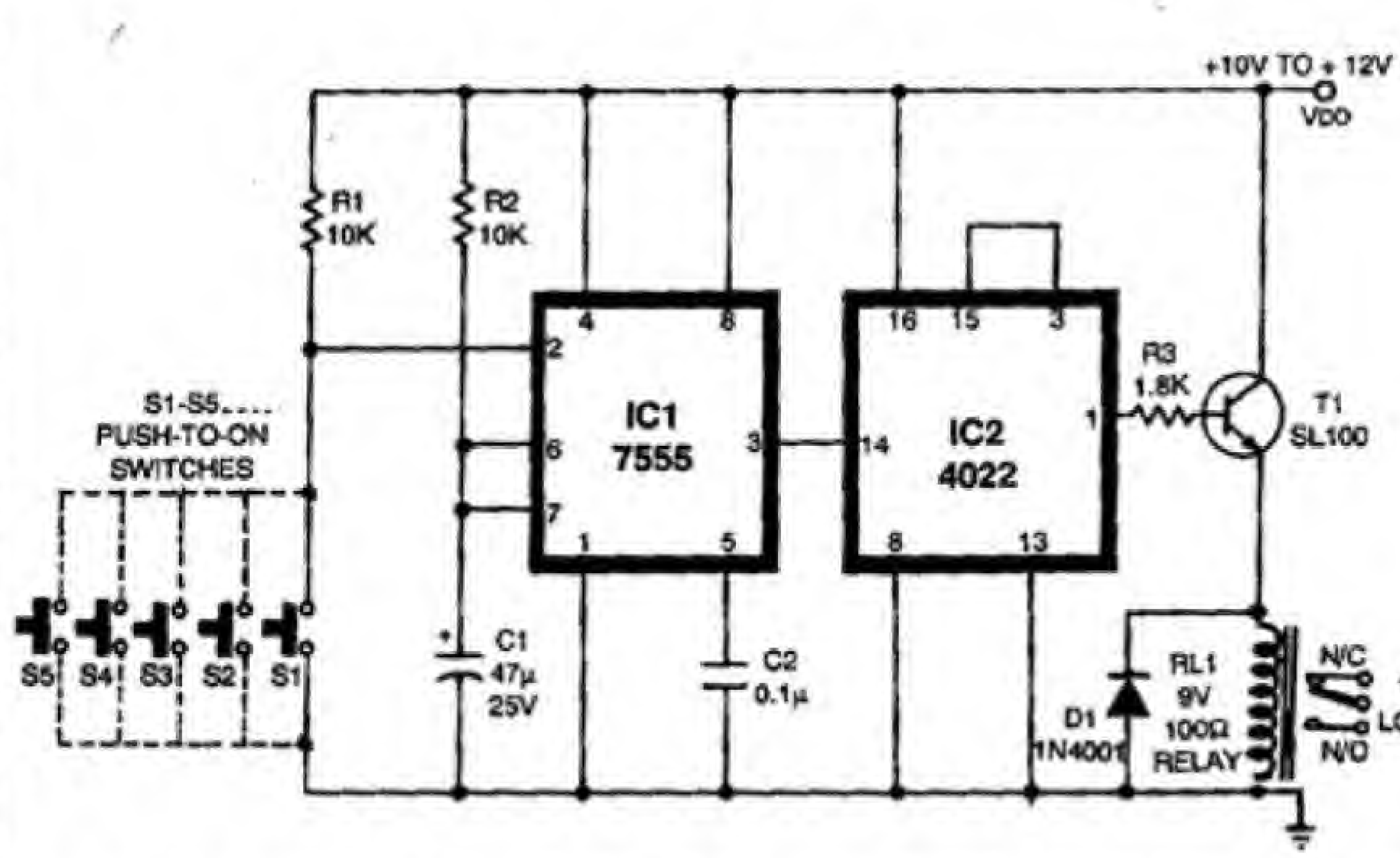
The circuit must be powered by a 5-volt ±5% power supply. Current limiting resistors (R10-R16) values may be increased to decrease brightness of the display and vice-versa. The whole circuit may be built on a veroboard. Until the switches are pressed, the dispay will show zero. When a zero is displayed, it means that the circuit has been reset and that it is ready to accept data from the switches.

Electronic Staircase Switch

Harinder Singh

If you want to control an electrical appliance from two places then you use a 2-way switch. But to control it from more than two locations (like operating a hotel's staircase light from individual floors from various locations), this circuit comes to your help. Due to the small size of the circuit it can be installed within a junction box.

IC1 is configured as a timer with a timing of 0.7 seconds. When switch S1 is pressed momentarily, output at pin 3 of IC1 goes high for 0.7 seconds. This clock pulse output is fed to the input of IC2 which is actually a decade counter (4022) but is used here for division by two.



When the circuit is switched on, Q0 of IC2 goes high. But when switch S1 is pressed, Q0 goes low and Q1 goes high, thus energising the relay due to conduction of transistor T1.

Q2 of IC2 is connected to pin 15 of the same IC which resets IC2 when this pin is at a logically high state. When S1 is pressed while the relay is energised Q1 goes low and Q2 goes high, which resets IC2, turning Q0 to a logically high state and all other outputs (Q1 to Q9) to a logically low state. This cycle is repeated sequentially as pushbutton S1 is pressed repeatedly.

Diode D1 has been used here to take care of the back emf generated by the relay during switching. IC1 also takes care of contact debounce as the output of IC1 remains high for 0.7 seconds after switch has been pressed once. So the bounce of a mechanical switch which lasts for about 20ms has no effect on the working of the circuit.

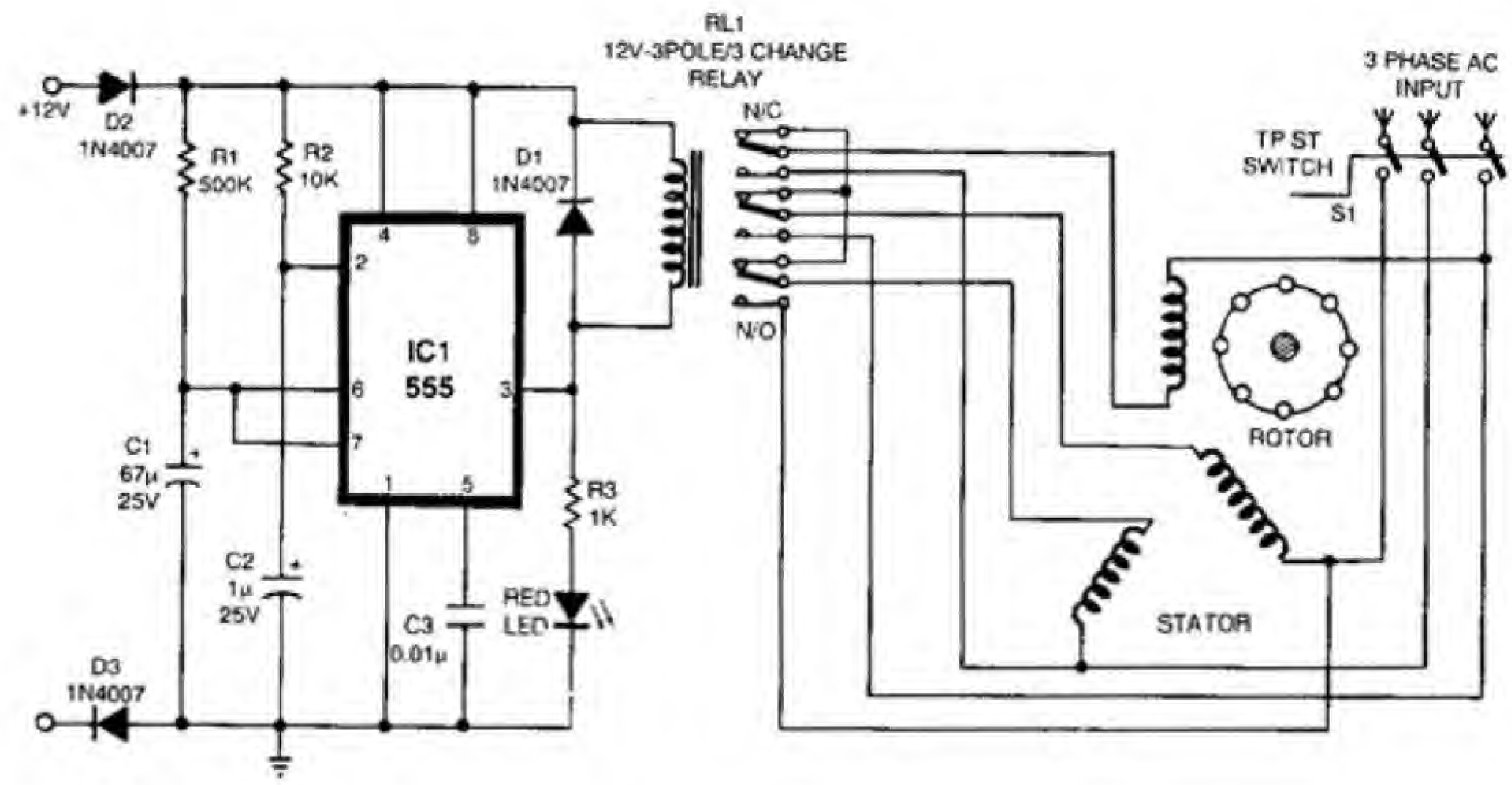
Current consumption of the circuit, when the relay is unactivated, is about 10mA. This, however, will finally depend upon the rating of the relay used.

Fully Automatic Induction Motor Starter

R. Sharath Kumar

Of all AC motors available, a polyphase induction motor is the one which is most widely used for several kinds of industrial drives. This is because it is very simple, extremely rugged, low-cost, reliable, highly efficient and requires little maintenance.

Among the induction motors available, a squirrel cage machine is the best. However, such motors can never be started by direct switching, as the motor would take 7 to 10 times their full-load current and would develop only 1 to 2 times their full-load torque. This initial excessive current is highly objectionable because it produces large line voltage drop, which affects the operation of other electrical equipment



connected to the same lines. So to prevent this, starter is used.

This circuit is one such starter. It is a very low-cost but highly reliable gadget, besides being fool-proof.

The circuit basically consists of a 555 timer chip (IC1). This timer switches on the 3-pole/3-change relay (connected in star mode for starting and delta mode for running) after a delay of about 60 seconds approximately, hence switching on the motor safely and also preventing line voltage drop. Here capacitor C1 starts charging as soon as the power is switched on.

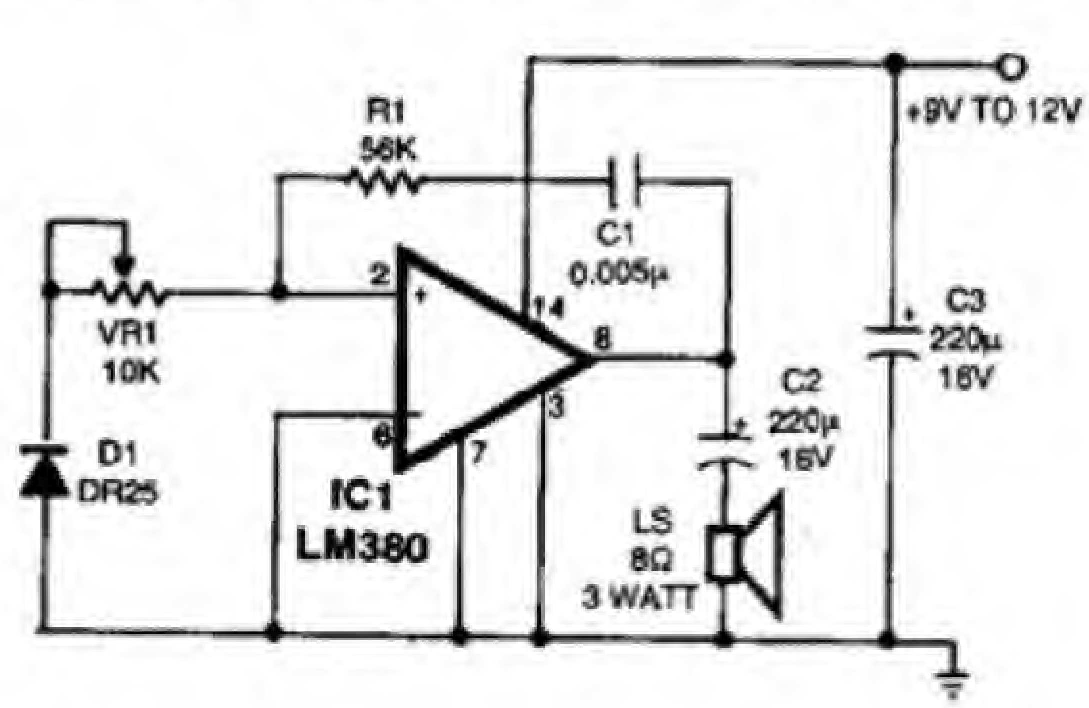
When C1 is charged to 2/3 Vcc the output goes low and energises the relay which changes contacts and hence the motor connections. The LED is on during the charging period of C1 and acts as a delay indicator. Diodes D2 and D3 protect the circuit against reverse polarities.

Another advantage of the circuit is that even in the case of power interruption, the motor would re-start in its usual manner. The circuit is very simple and can be assembled in less than an hour. Care has to be taken about the high voltage power lines.

Temperature Controlled Oscillator

Pradeep G.

Output tone of this circuit varies with the temperature at which the input germanium diode is held. Reverse resistance of DR25 diode varies from 500 ohms to 10-kilohm, when temperature varies between 20°C and 80°C. (At higher temperature germanium devices show very low resistance.)



This variation of resistance changes the tone of the output sound of the oscillator which is built around the AF amplifier IC LM380. Instead of germanium diode, base-emitter junction of an ordinary medium-power transistor such as AC128, AC188, 2N360 or 2N610 can be used. This circuit will not work with silicon diodes.

The circuit can be made light-controlled by just replacing the diode with an LDR or a reverse biased photodiode. (Tested with LDR only.)

A 9V to 12V ordinary unregulated power supply can be used for this circuit.

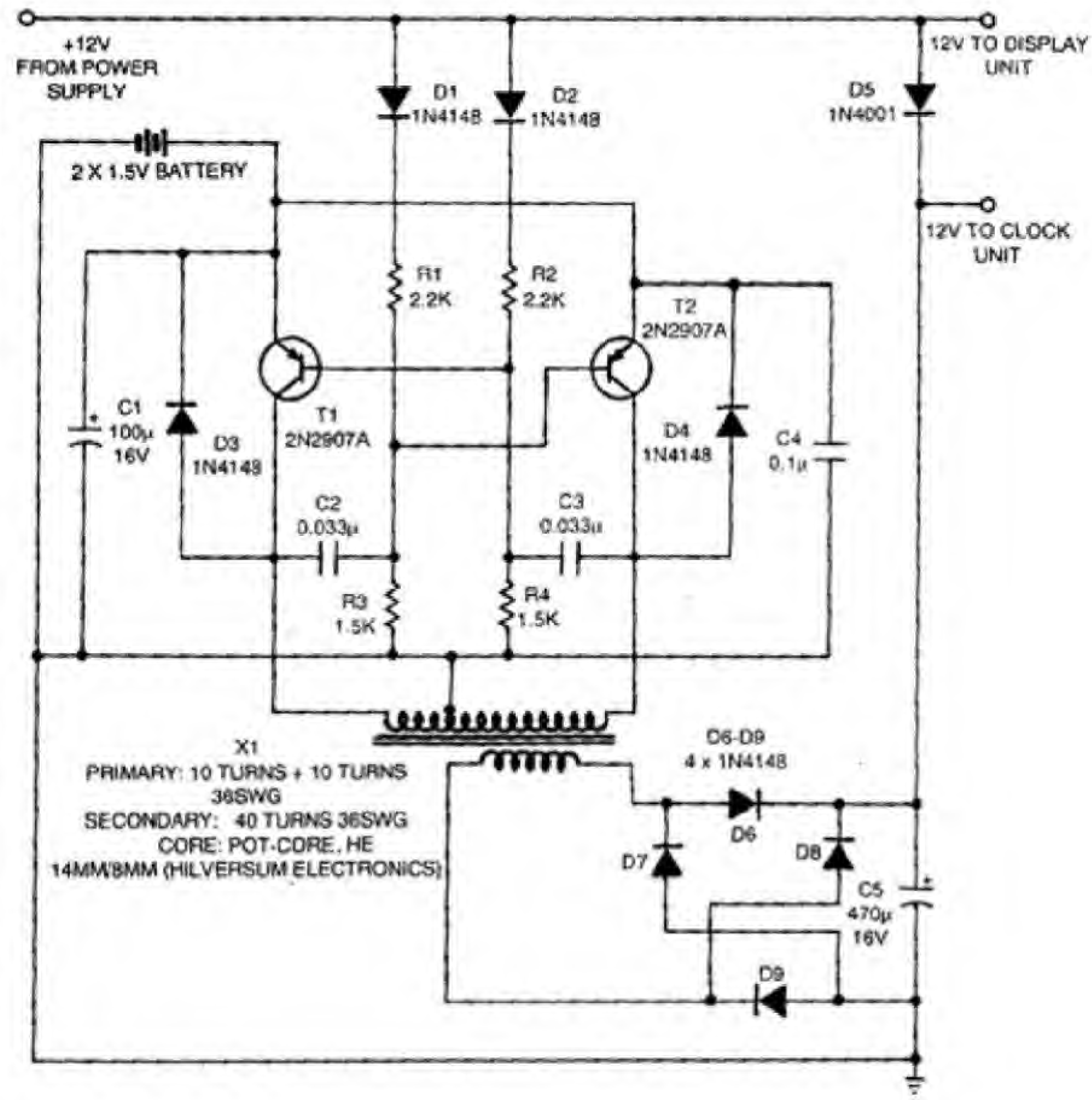
Power Back-up For Digital Clocks

C. Sanjay

he usual method of using a 9V battery for back-up in digital clocks, though common, is not very desirable for many reasons. The cost of the battery and the very short life are some of them.

The circuit described here enables us to get the required 9V from just two penlight cells. Though initially one has to invest in this circuit, in the long run, the lower cost of the cells and their longer life more than compensate for the cost of the circuit.

The circuit is a simple DC to DC converter formed by the astable multivibrator (transistor T1 and T2) and the step-up transformer X1. When the supply due to the mains is present, T1 and T2 remain off because of reverse bias due to the positive supply. During conditions of power failure T1 and T2 together function as an astable multivibrator for 15 kHz. The stepped up voltage is rectified by high-speed diodes D6....D9. Diodes D1 and D2 serve to isolate the base circuits of T1 and T2 while D3 and D4 protect T1 and T2 against reverse voltages and at the same time help to get a better wave shape.



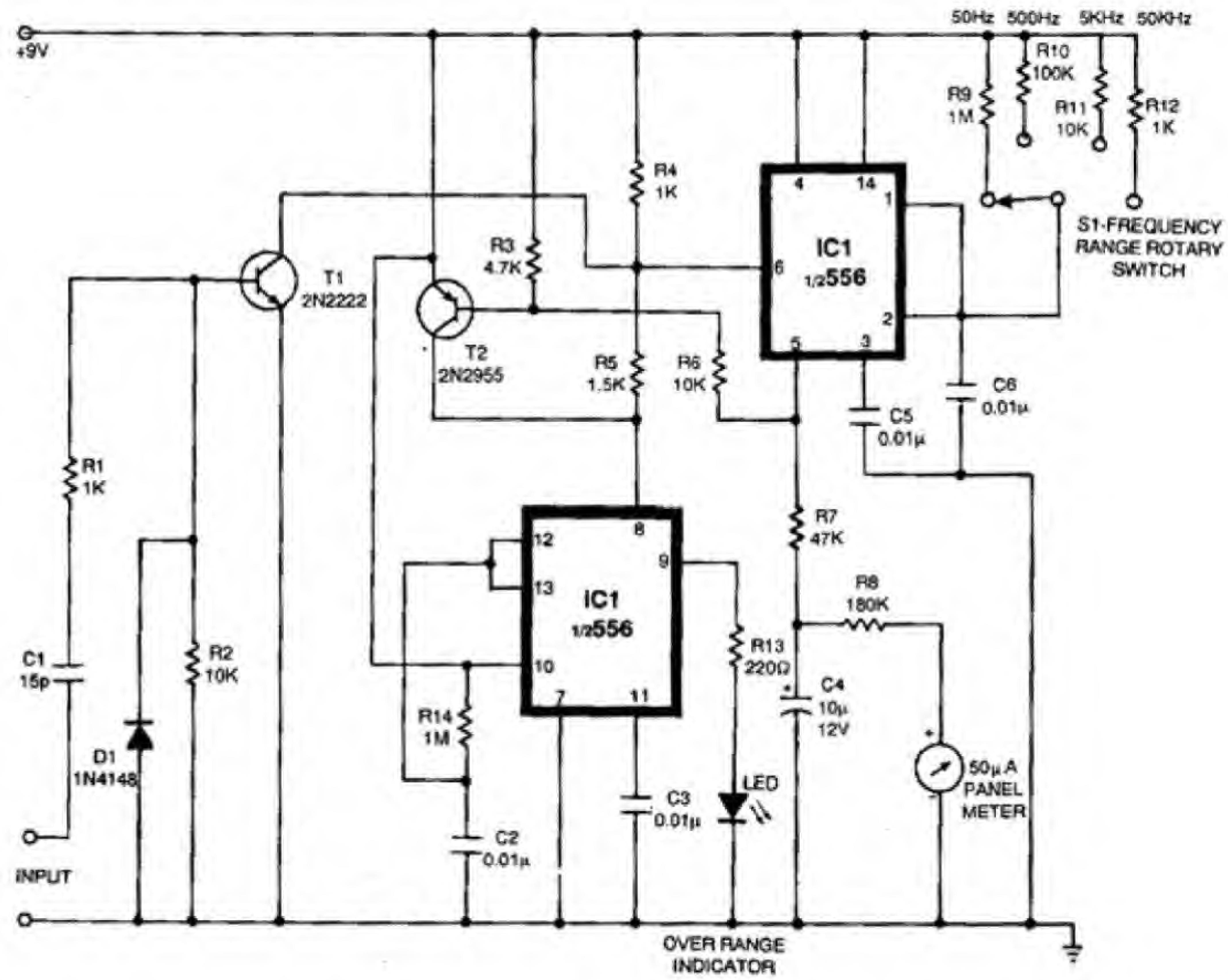
The whole circuit can be made into a compact unit and placed inside the clock cabinet. The 9V battery holder can be removed and a 2-cell holder used in its place.

Analogue Frequency Meter With Over-range Indicator

Saravanan M. Mallesan

The versatile IC timer 555 has yet another application as an analogue frequency meter. By making use of a 556 integrated circuit, which has two 555 timers in a single package, an over-range indicator can be economically added to the meter.

When this meter is switched to the 50Hz range, any input frequency from near DC to 50 Hz produces a correct panel meter reading, i.e. a frequency of 42 Hz produces a meter reading of 42 microamperes. However, the meter reading is incorrect when the input frequency exceeds 50 Hz, and there-



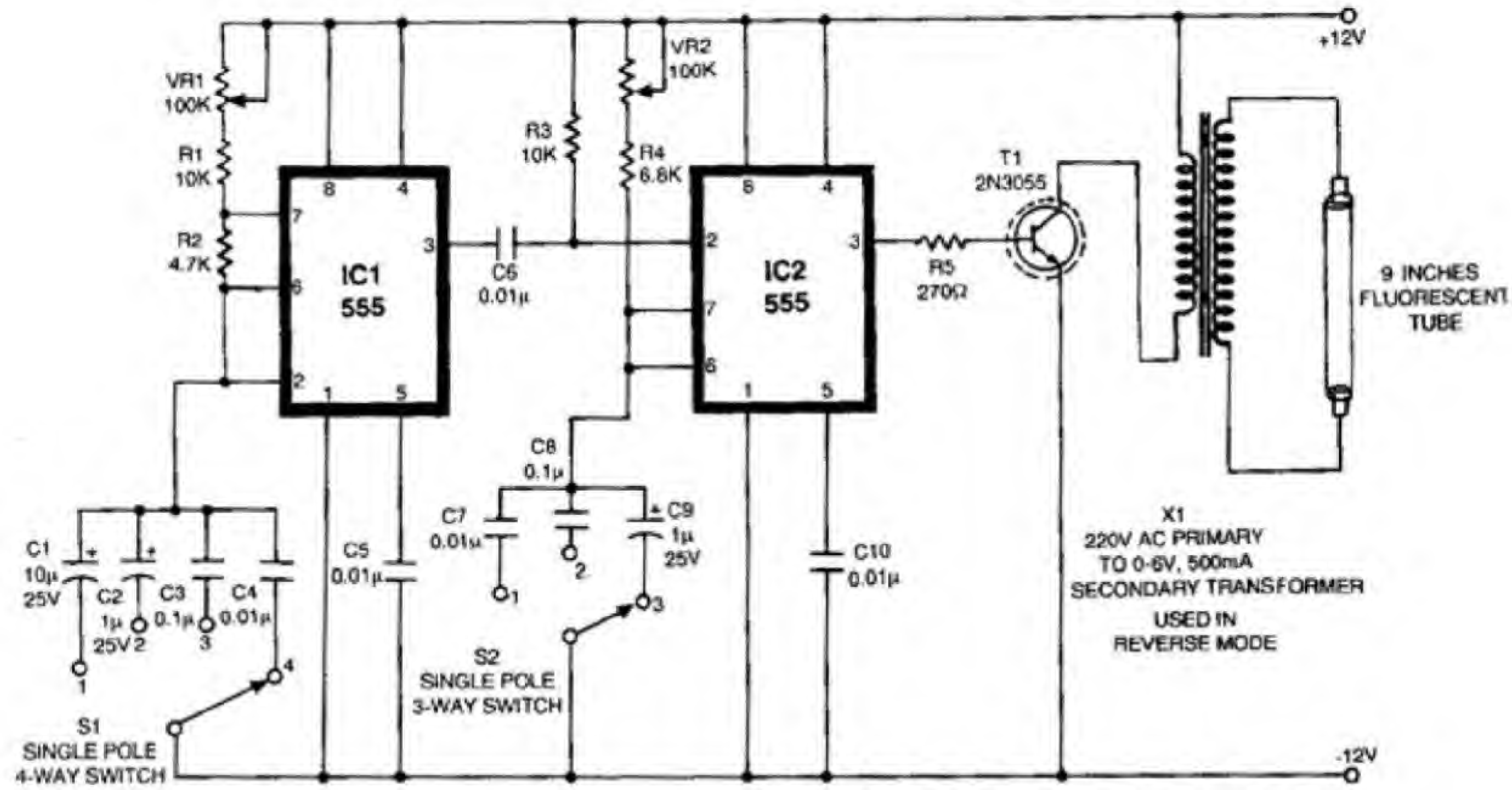
fore an LED over-range indicator flashes. If the range switch is then moved to a setting higher than the frequency, the LED stops flashing and the meter again indicates correctly. For example, a 300 Hz signal could be measured on the 500Hz range, where the meter would show 30 microamperes.

Here the input signal is a rectangular pulse train; the pulses are differentiated to produce the negative spikes that are needed to trigger the timer. For a sine wave, or sawtooth input signal, a schmitt trigger might be used to generate the negative impulses.

Versatile Stroboscope

Murty Master

A stroboscope is an instrument in mechanics. With the help of it one can see objects which are moving rapidly with a periodic motion as if they are at rest. For example, we can not see the tiny crack of a fan blade when it is in rest. But at a revolving state due to centrifugal force the crack widens, and the fault can be observed. The stroboscope



light flashes at a frequency that synchronises with the revolutions of a wheel which seems to be at a still position.

Presently, neon lamps are used in stroboscopes. Their light is dim to detect the fault. This stroboscope is a low-cost device with adjustable frequency and variable light on-off period (pulse width). A nine inch tubelight is used for good illumination. The circuit uses easily available 555 timers.

The IC1 555 timer is used as an astable multivibrator whose frequency can be varied over 1:10 range through 100k linear potentiometer. Range selection is done by switch S1. The frequency output is taken from pin 3 and connected to pin 2 of IC2 through 0.01μF disk capacitor. This circuit can generate 1.2 Hz to 12 kHz with proper adjustments.

The IC2 555 timer is used in monostable mode whose output pulse width can be varied from 100 microseconds to 100 milliseconds with the help of 100k linear potentiometer and switch S2.

The required pulse is taken from pin 3 of IC2 and connected to the base of transistor 2N3055 through limiting resistor of 270 ohms. 0V-6V, 500mA transformer is used in reverse mode (step up). One 6V terminal is connected to 12V DC supply and the other terminal to the transistor collector. The emitter is grounded.

Oscillating currents are generated in 6 volts winding as per our adjustments and stepped up to light the tubelight. The tubelight is focussed on rotating table fan blades and the frequency and pulse width is adjusted so that both are synchronised. This happens when the fan blades seem to be standstill.

All resistors are of 1/2W. All capacitors are disk type. A small heatsink for transistor is necessary.

Suggested modifications: If anybody wants to use bigger tubelight, a suitable driver stage and inverter transformer are essential.

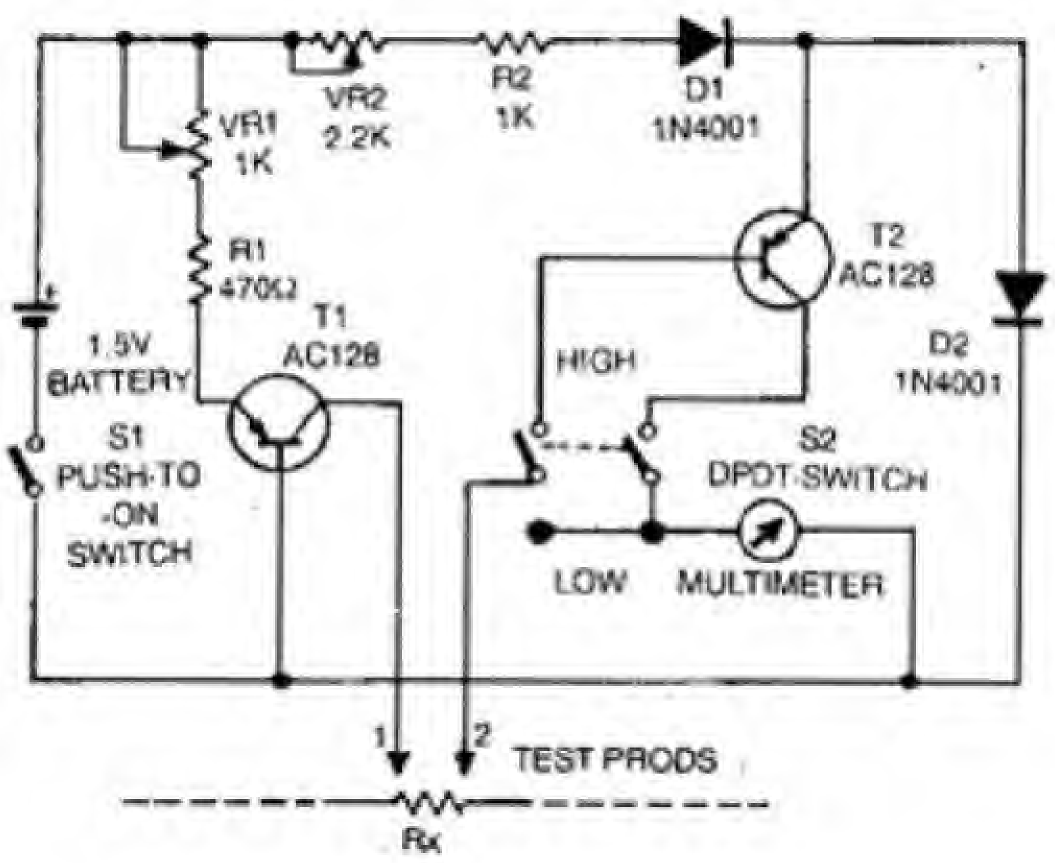
In-Circuit Ohmmeter (Ohmmeter for Electronic Circuits)

Kulwant Singh

While servicing gadgets, chances often occur when you feel the necessity of checking a defective resistor, shorted diode, transistor or a capacitor in a circuit. Didn't you desire that all could have been done without switching on the gadget and without desoldering and extracting the components? Here is a simple and effective remedy. All you need is two transistors and a few resistors.

When an emf of about 1.5 volts is applied across the emitter-base junction of a germanium transistor, an emf of about 0.25 volts develops across the collector-base junction, and this is the basic 'drug'.

The basic problem in checking the value of a resistor in a circuit is that our multimeter supplies about three volts across the test prods. This 3V is suffi-



cient to forward bias the diode or transistor junctions in the circuit, providing a stray current path between the check points. Thus the reading of the multimeter is that of effective resistance and not of the actual resistor value.

But if we apply around 0.25V to the test prods, the silicon junction is not conductive, since it needs a minimum of 0.6V to conduct. Most of our modern circuit boards tend to have silicon devices as active elements. Therefore, it will ignore most of the common junctions such as those in bipolar transistors, signal diodes, rectifier diodes, zeners, varactor diodes, FET gates etc, of course, with the exception of germanium devices which are becoming a rare entity.

In the circuit, transistor T2 has its emitter biased by 0.6V with the help of potential divider. 1N4001 or any general-purpose silicon diode may be used for this purpose. The collector of T1 being at about 0.25V, the test prods now develop 0.35V potential difference across them, which is insufficient for the silicon junctions to conduct. Pot VR1 (1k) and VR2 (2.2k) are meant for zero setting in the low resistance and high resistance mode respectively. The DPDT switch converts the circuit to multimode—high resistance/low resistance modes.

For zero setting put your multimeter in the 0.25V range and connect it to the meter. Now short the test prods 1, 2 and adjust VR1 in low resistance mode to get an exact full scale deflection on the meter; and your improved ohmmeter is ready. Surprisingly, you will find that you need not worry about the scale at all! I use general SANWA P3 multitester (175μA, 500-ohm movement) and its ohmmeter scale is marked 10k/100-ohm in the middle, and in this mode it reads 1k at this place, that is, a mid way scale, 1/10th of the high resistance range and 10 times the low range. The ohmmeter now runs from 10 ohms to 100k maximum measurements, which is by far the most prevalent range of resistances in general circuits.

In the high resistance mode, however, the characteristics of transistor T2 play the key role. It is not possible to provide any guidelines about the calibration of the scale, since it depends upon the type of the transistor used as amplifier. Moreover, the scale is not linear since the transistor is working in the lowest part of its characteristics. The germanium transistor has a small emitter-collector current flowing even with open base (infinite resistance). To avoid the problem considerably, a small-signal transistor is advised for this stage (transistor T2), since a very low current of the order of 0.25 μA max. is the requirement.

So if you wish to build this double-mode ohmmeter, an exclusive meter movement is recommended, whereon you can make your own scales for the two modes. Or if you use your own multimeter, don't mess-up the already burdened scale; rather prepare a conversion table for the high resistance mode.

Note: The transistor used, especially T2, should have low leakage current. AC128 has overdue emitter collector leakage current so fresh AC128 should be used.

Priority Lamp System

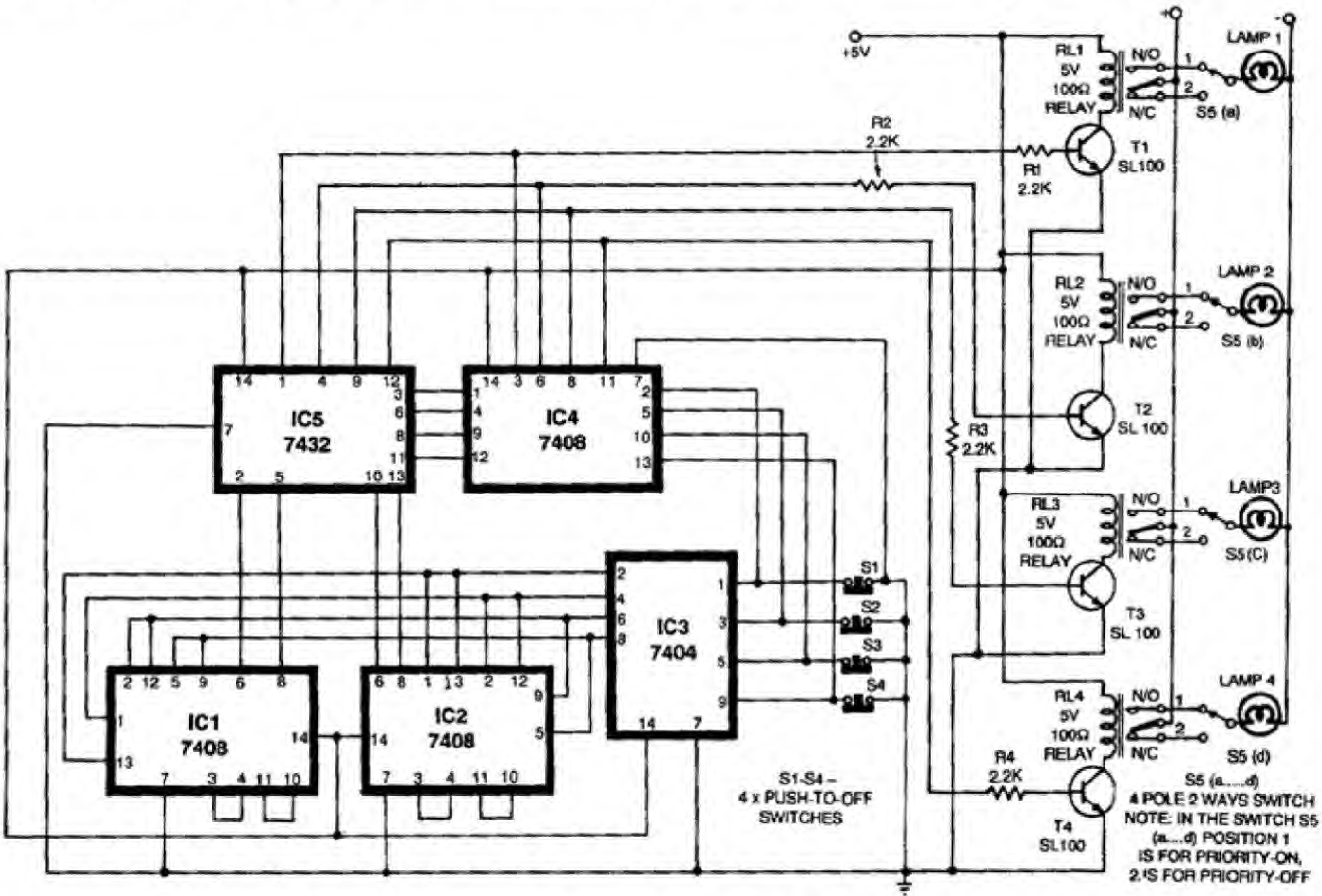
Biju Kumar J.

The circuit described here is a priority lamp system which gives priority in switching. Switches S1 to S4 are push-to-off type or pushbutton type, as desired. Normally, pushing of any switch will turn 'on' the corresponding relay, i.e. pushing of S1 enables the npn transistor T1 and hence relay RL1 operates. The logic section is designed to get a controlled high output. The pressing of one switch disables the operation of all switches and results in priority in switching. In normal cases, all switches are closed and all relays are in 'off' state. When two switches are pressed in one step, it checks priority and one relay turns 'on'.

The circuit comprises five ICs. IC1, IC2 and IC4 (7408) are quad 2-input AND gates. IC3 (7432) is a quad 2-input OR gate. IC5 (7404) is a hex inverter which can be replaced by IC 7400 with some modifications. The feedback loop between output and input lines of IC4 and IC5 gives controlled high output for one relay.

Select SPDT relay for dual mode operation for priority in 'on' and 'off' for the connected lamps as shown in the circuit diagram.

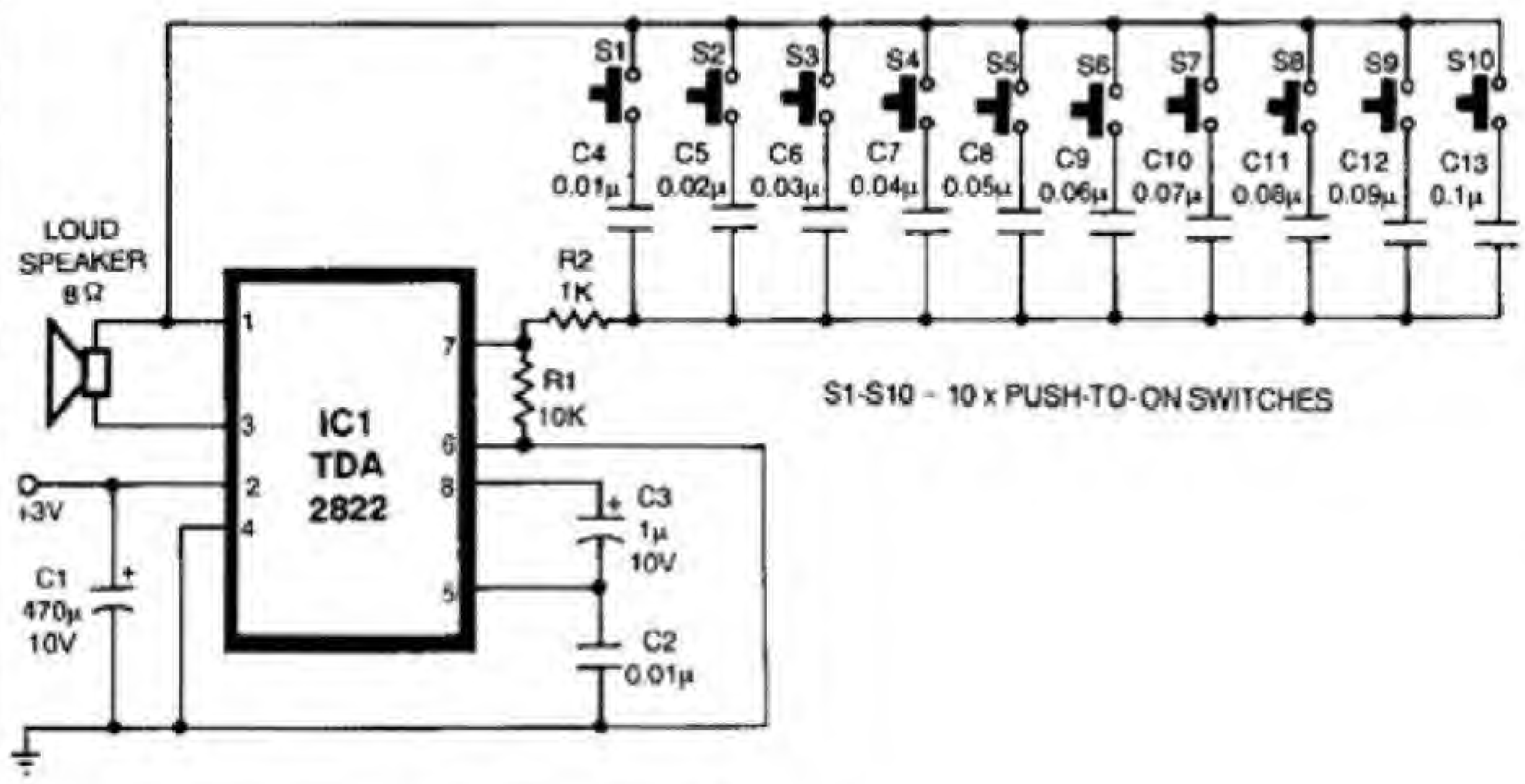
The input and output lines of the digital section of this circuit can be connected to other digital circuits to detect the input line from which the first high occurs. It is also used to make non-interrupted multichannel system. When any one channel is in working state the other channels are automatically disabled.



Miniature IC Organ

Pradeep G.

Here is a circuit for an IC organ using 3-volt AF amplifier IC TDA2822. Frequency of the AF sound generated depends on the capacitor between pin 1 and pin 7 of IC. When switches S1 to S10 are pressed, different audio tones are heard from the speaker. S1 to S10 are small push-to-on switches. Pin 2 of IC is connected to positive terminal of 3-volt battery. Two pen cells connected in series can be used to power this circuit. Satisfactorily loud sound will be obtained at 3-volt supply. 8-pin TDA2822 costs around Rs 25 (16-pin TDA2822 IC is also available in the market. Don't use that one!).



Note: Capacitors C6,C8,C9,C10, C11,C12 are parallel combinations of two or three capacitors to obtain the odd values.

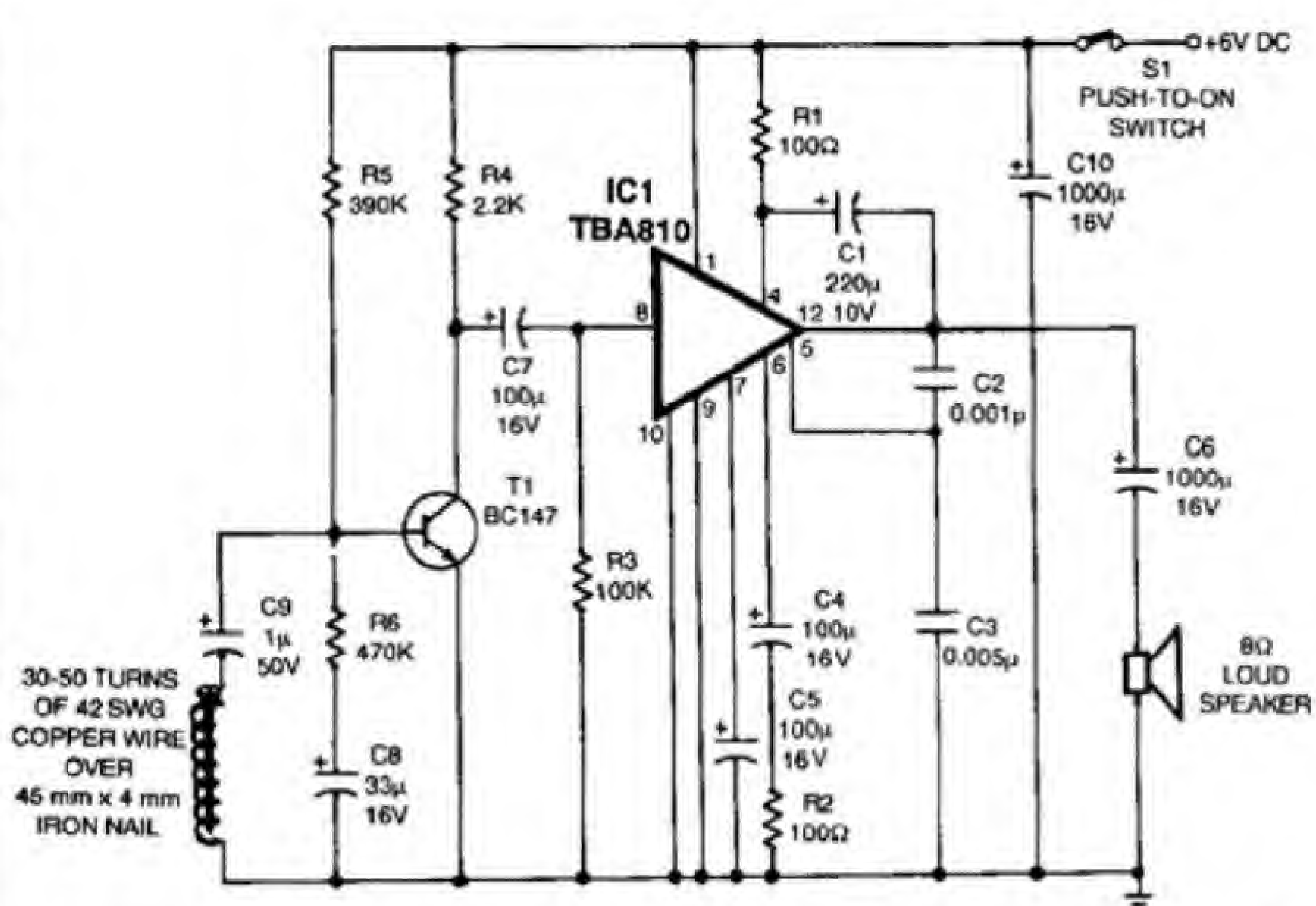
Quartz Watch Tester

Manoj and Dinesh Badgujar

Any mechanical watch can be easily checked, whether it is working or not, by listening to the sound of the movement of wheels and springs inside the watch. But in case of quartz electronic watches (especially without the seconds arm) it is very difficult to say as these do not produce any mechanical movement sound. In such case, a quartz tester provides the solution.

The circuit uses audio amplifier IC TBA810 and its biasing components. But the main thing here is to make a coil, which can pick up the pulses (signal) produced by quartz.

In working condition, the quartz crystal gives out pulses to drive the watch, i.e. to drive the 'hands' of the watch. Since these pulses are out of audio range, we cannot hear them.



But here, the coil made by winding a copper wire having 38-42 SWG on an iron nail can pick up these pulses. These pulses are fed to the preamplifier built around transistor T1. It is then fed to pin 8 of IC through coupling capacitor C7. Further, it is amplified by TBA810, which gives a good clicking sound.

For testing, just keep your quartz watch on the coil and you will hear the 'click-click' sound. For optimum performance, adjust the position of the watch on the coil. The circuit also checks the battery condition of the watch. It draws very little current (10-15 mA).

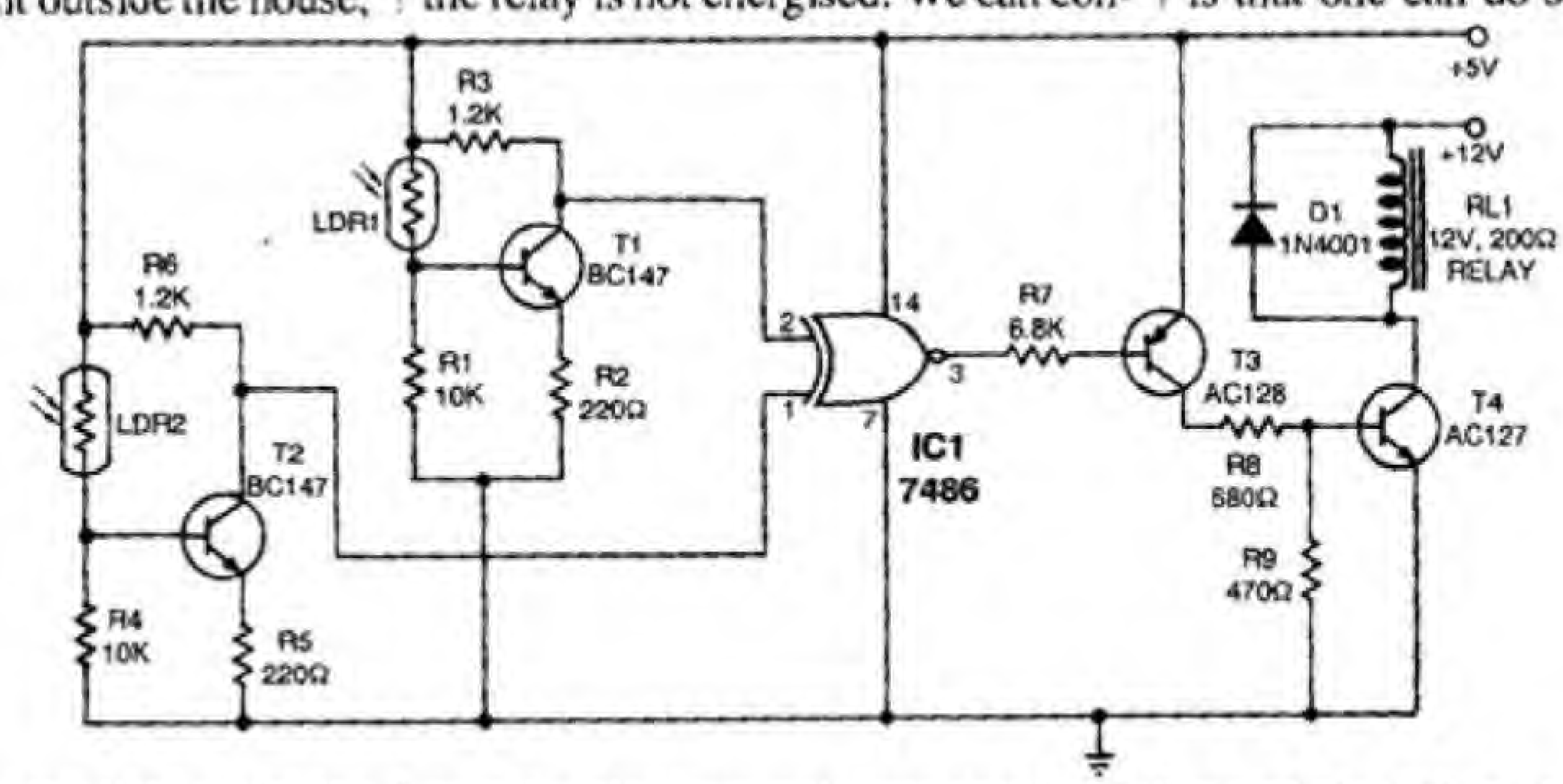
Note that, one cannot replace the coil by any type of mic. Care should be taken while winding the coil so that the turns do not overlap. The insulation of the copper wire should be of good quality. We used the copper wire used in transformer windings.

Automatic Control for Sitout Lights

Swayajith S.

This circuit is for controlling the light in the sitout of our house. The light is switched 'ON' when it is dark and is switched 'OFF' when everybody in the house goes to sleep.

The circuit consists of two LDR controlled switches and a gate interfaced relay circuit. LDR1 senses the presence of sunlight outside the house, while LDR2 senses the light inside the house. Transistors T1 and T2 conduct only when both the LDRs are in light. At this time, the voltage at the collector is 0 or low state. When both the LDRs are in the dark, T1 and T2 are in cut-off state and the collectors are at high state. These two collectors are the input of XOR gate. When one of the transistor is cut off and the other is at 'ON' state, there is a 1, 0 input to the XOR gate or vice-versa. In both the cases the output is at high state and the transistor T3 is cut off, hence there is no current flow through the transistor T4. At this state, the relay is not energised. We can connect the relay (two-pole, two-way) such as to 'ON' the sit out light.



When both the LDRs are in light or in the dark, the output of the XOR gate will be low. As a result transistors T3 and T4 conducts and the relay is energised. Now the sitout lamp will be switched 'OFF'.

LDRs should be placed in a convenient place free from damage. LDR1 should be kept outside the room in a dark place. At night, LDR2 should be kept inside the room. It should be placed outside during day time.

The main advantage of this circuit is that one can do some saving in his electricity bill as the light will remain off during day time.

The resistance R1 can be replaced with potentiometer with a series resistance of 4.7k to control the light conditions.

Readers' Comments:

'Automatic Control for Sitout Lights' circuit idea in July'92 issue has some shortcomings:

1. In the circuit, the gate shown is XNOR while IC mentioned in the write-up is 7486, which is an XOR gate!

2. With XOR gate (7486) the relay remains 'on' most of the day, resulting in unwanted loss of power.

3. The circuit does not take into consideration the case when the owner goes out early in the evening for a party or a film show. When he returns late in the night, he requires light in the sitout. As per the circuit, he will have to enter the house in dark to put on the sitout light.

4. As per the write-up, LDR1 should be kept in a dark place and LDR2 moved accordingly to sense light. It is

tedious and senseless.

In view of the above shortcomings, we propose certain modifications:

Instead of the XNOR gate, two XOR gates (7486) can be coupled to remedy the loss of power in the relay. The relay will be energised when the output of the gate is low and the bulb should be connected in such a way that it glows only when the relay is energised. The point to be noted is that a TTL gate can source only 400 μA while it can sink 16 mA.

To rectify the defects 3 and 4 mentioned above, a low-value resistance in series with a switch should be connected across LDR2 (which is placed inside the room). When the owner goes out to return only late in the night, he should close the switch before going out. When day light fades, LDR1 is in dark and hence transistor T1 is off, but due to the switching-on of the low-value resistance, transistor T2 is 'on' and the gate senses (1,0) state, driving the relay circuit.

Here the point to be noted is that the LDRs can be permanently positioned—LDR2 inside the house to sense light condition inside the house and LDR1 outside the house at a place where it can sense daylight.

ARUN KUMAR R., JAYS C.
Changanacherry

The author, Mr Swayajith S., replies: The gate shown in my circuit was XOR while the gate in the published circuit was an XNOR (74266).

The second point is a fact. I'm sorry it didn't attract my attention. The remedy lies in replacing the pnp (T2) transistor with an npn transistor with a biasing resistor.

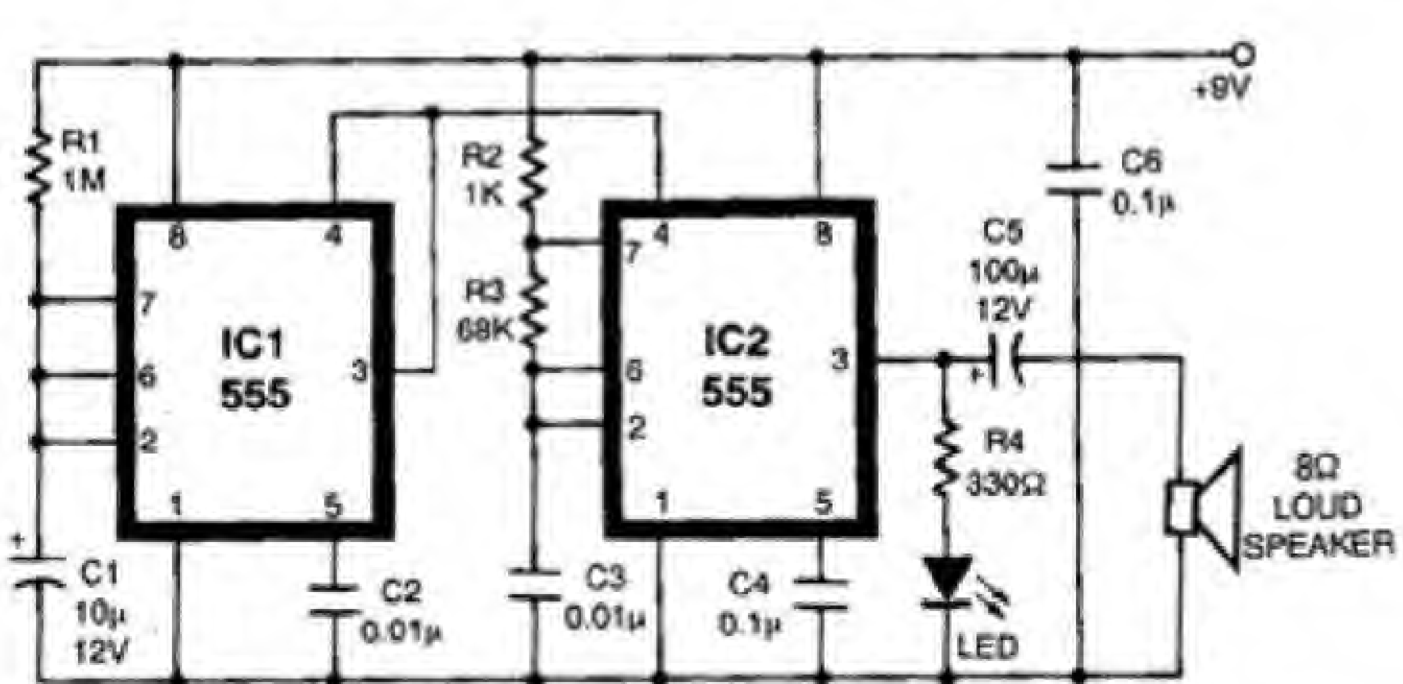
The third point is indeed valuable. It can be incorporated in my original circuit using an npn transistor instead of pnp.

The LDRs need not be moved as mentioned in the write-up. The LDRs should be kept in fixed positions exposed to day/room light.

Simple Power Supply Resumption Alarm

D. S. Vidyasagar

Once again the most popular timer chip IC 555 has proved that its applications are limited only to the ingenuity of the user.



The circuit shown here is very simple. IC1 is wired in a special kind of mode. When power supply resumes, pin 2 of IC1 is grounded through C1 and pin 3 goes high. This makes reset pin 4 to go high for about 10 seconds. When the capacitor C1 charges to two-third of the supply voltage, output of IC1 goes low, grounding the reset pin 4 and thus disabling the entire circuit.

The alarm circuit is wired around a second timer, IC2. Here it is used as an astable multivibrator, the frequency of which is about 1 kHz. This IC is enabled when the output of IC1 goes high. Thus, the speaker produces an alarm for about 10 seconds.

After 10 seconds, IC1 restores its stable state (i.e. output goes low). Capacitor C1 discharges quickly through pin 7, and the circuit becomes ready for the next detection, since pin 2 of IC1 is low. Thus, when the power interrupts again an alarm is produced.

The circuit can be constructed on a general-purpose veroboard. A regulated +9V DC power supply is required for the circuit.

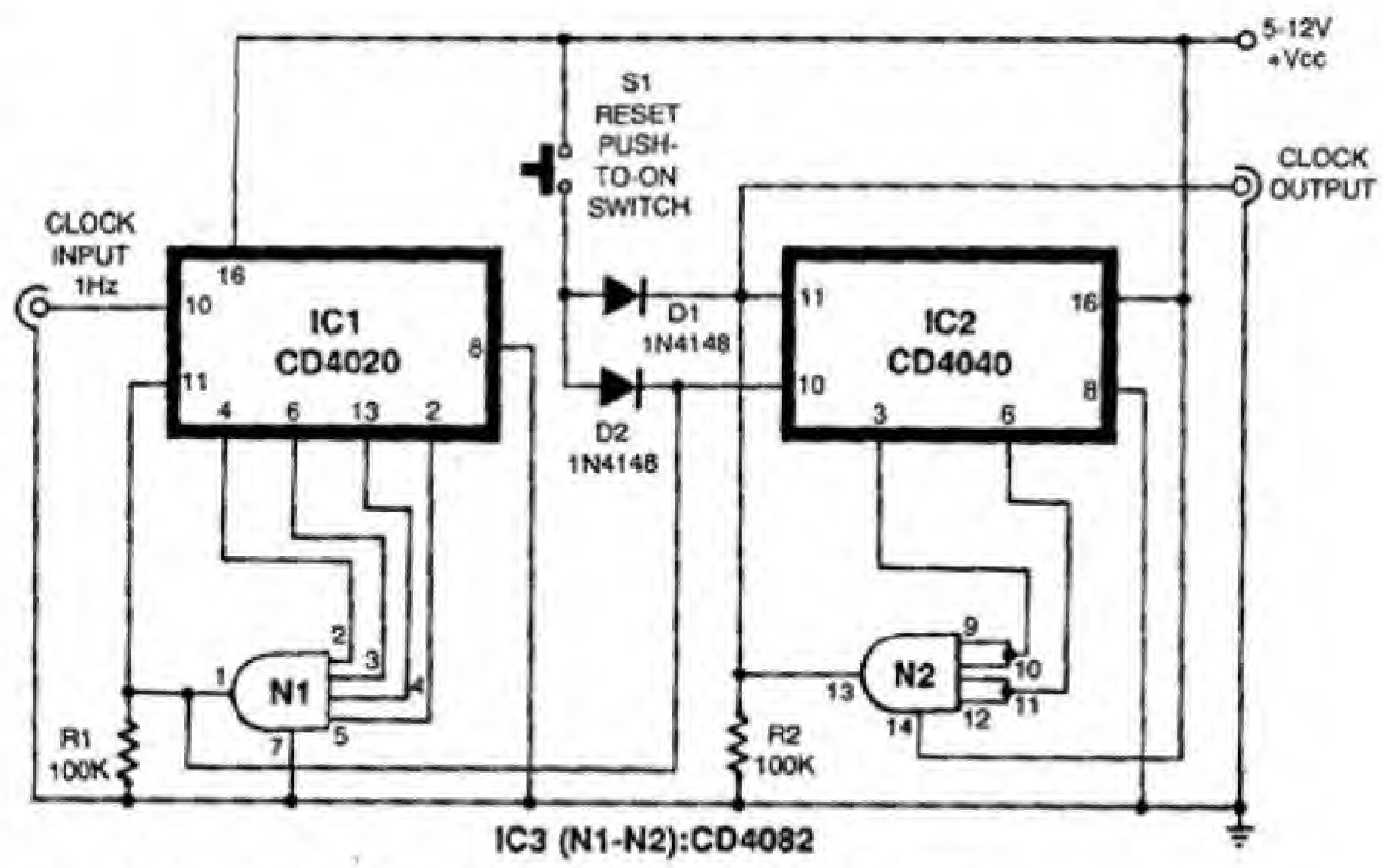
The LED serves as an indicator.

1/86400 Hz Generator

Harinder Singh

This circuit provides one pulse every 24 hours from a source of 1Hz input clock pulse, which is commonly available through a digital clock. It can be used to provide am/pm indication in those digital clocks which do not have this facility, or it may be utilised to advance the date of an electronic calendar every day. It can also be used to trigger an alarm at a determined time without fail.

The present circuit divides the number of incoming clock pulses by a preset value using a binary counter. There are some clocks which do not involve the use of 50Hz or 60Hz pulse. In such a case the circuit has to be made to work on battery and not on mains supply. The input pulses to IC1 is given by 'seconds' display of digital clock, thus providing a 1Hz pulse to the input of IC1. The output of IC1 is connected to the input of IC2 for a net division of 86400, i.e. providing a single pulse a day (every 24 hours) at the output of IC2.



AND gates are used to reset binary counters after a preset number of clock pulses which have been counted by them. IC CD4040 is a 12-stage binary counter and IC CD4020 is a 14-stage binary counter. IC 4082 is a dual, four-input AND gate.

Due to low power consumption and wide operating voltage (5V-12V) of CMOS ICs used, the circuit can be operated off the supply of most clocks. This compact circuit can be fitted in a table-top or a digital wall clock.

Programmable Frequency Multiplier Using PLL 565

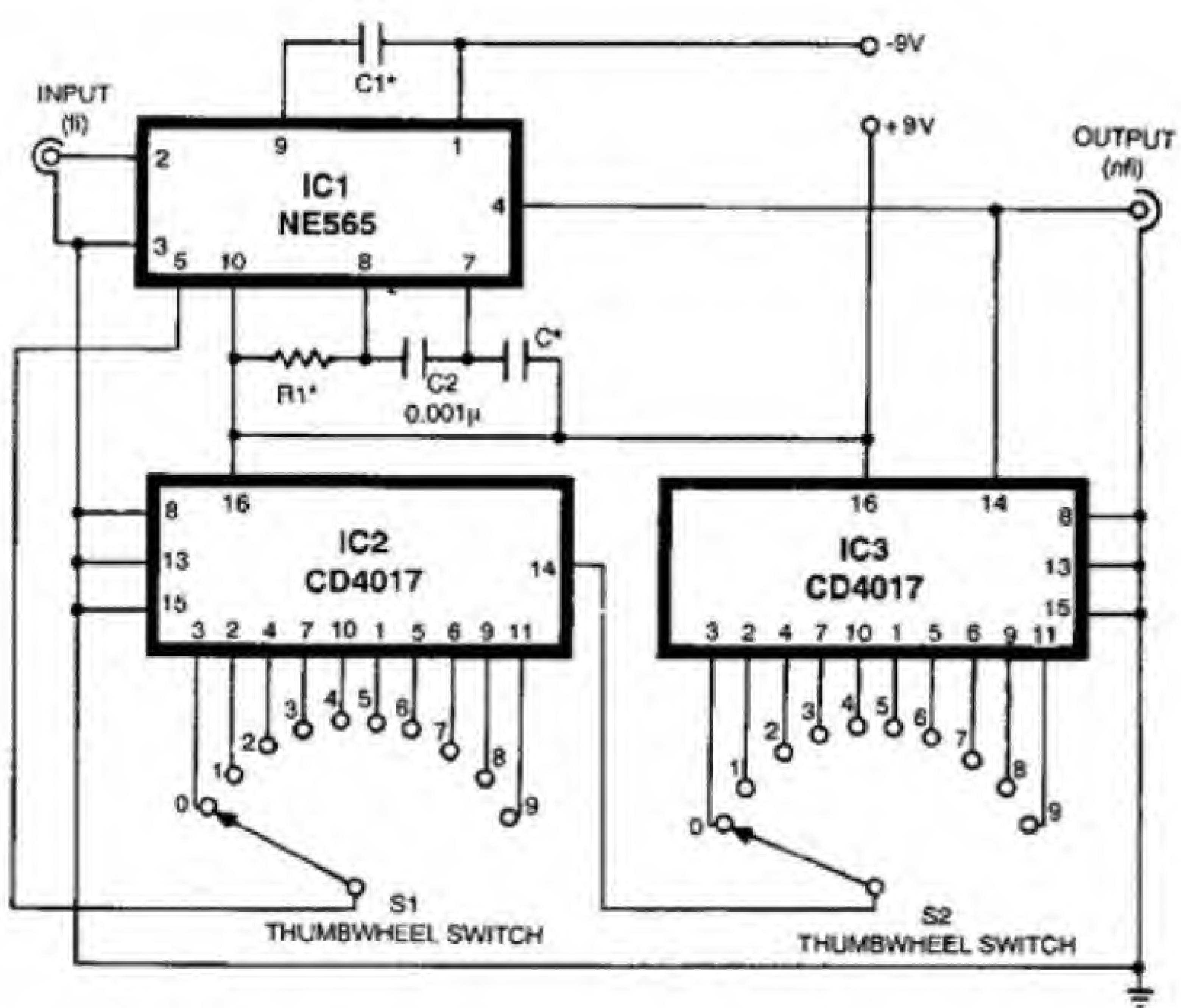
Lancy Silveira

Among its many diverse applications, the phase locked loop (PLL) exhibits tremendous flexibility in frequency multiplication. The 565 IC can be used over the frequency range of 0.001 Hz to 500 kHz, and an operating voltage range of 6V to 12V. It has a highly stable centre frequency, selected by an external resistor (R1) and capacitor (C1), which is given by

$$f = \frac{1.2}{4\,R1C1}\ \text{Hz}$$

It is selected at the centre of the anticipated input signal frequency range.

The capture range of this feedback control system is decided by the low-pass filter made up of capacitor C* and internal resistor R. C* must be selected



such that the cut-off frequency of the low-pass filter is above the maximum anticipated frequency difference between the input signal frequency and VCO (voltage controlled oscillator) free running frequency.

Please note, the value of R1 generally lies between 2k and 20k.

While testing in EFY lab the following values of variable were used:

R1=10k,

C1= 0.002µF

C*= 0.001µF

Using these values we can check the input frequencies up to 15 kHz and multiplying factor up to 33.

Frequency multiplication is achieved by breaking the feedback loop of the PLL at the VCO output and inserting a frequency divider mechanism made up of a CD4017 decade counter with one of the ten outputs selected by means of a thumbwheel switch. The divided VCO output is then fed to the phase comparator. This is locked to the input frequency. Thus the VCO now runs at a multiple of the input frequency. The multiplying factor is decided by the frequency divider and hence determined by the thumbwheel switches.

Allowing a maximum multiplying factor of 99 (which can be tailored to suit one's requirements), the maximum input frequency must be limited to 5kHz so that the maximum VCO frequency is 495 kHz, which is below the operational limit of 500 kHz for PLL 565.

Author's comments

There is a minor correction required in my circuit 'Programmable Frequency Multiplier Using PLL565' in EFY Sept.'92 issue.

Pin number 15 of both IC2 and IC3 should not be connected to ground. These should together be connected to the pole of thumbwheel switch S1 which is also connected to pin 5 of IC1. This resets IC2 and IC3 every time the selected count has been reached. Else, after the first cycle, a constant division factor of 100 will prevail.

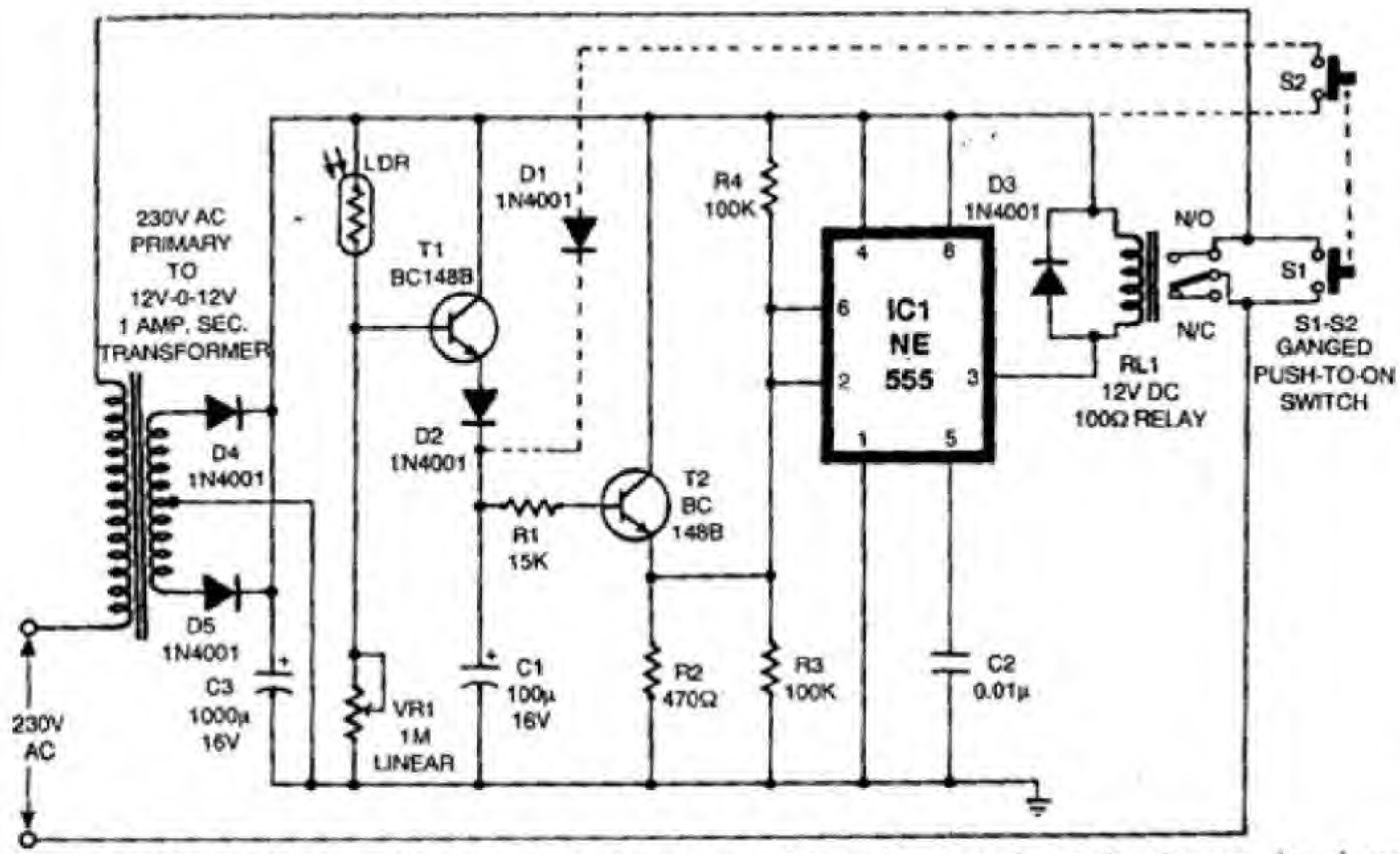
The circuit is also found to perform satisfactorily with CMOS PLL4046. Initial attempts to obtain a stable circuit may be carried out using a single divider.

LANCY SILVEIRA
Bombay

Auto-off for Cassette Players

Sukhpal

Most common stereo cassette players have an auto-stop deck mechanism but do not have the auto power-off function. This circuit is meant for cassette players having an operational voltage of 12V DC with the facility of



LED type VU meter. When the sound signal stops, the power is automatically switched off after a delay of approximately 30 seconds.

With sound present, the LEDs of VU meter emit light. The LDR on receiving light from LEDs gives a high pulse to transistor T1 which charges capacitor C1. The slow discharging of the capacitor provides a delay. Hence different values of C1 give delays of different durations. Charging and discharging of the capacitor results in an exponential signal which is passed through IC 555 (working as schmitt trigger) to convert it into a digital signal for proper functioning of the relay.

For setting and construction of the circuit:

1. Take connections of only first LED of the VU meter. For arrangement of mounting of LDR and LED together, place them face to face and wrap with 3-4 folds of black paper.

2. In some cassette players, the circuit shown in dotted lines is not required. So first try without this circuit.

3. For setting 1-megohm pot, turn it to zero resistance and connect the LED to emit light. Then connect the main circuit to 12V. Now start increasing the resistance of pot until the relay clicks 'on'. In this circuit the approximate value of VR1 is 100k.

4. A good realy should be used with a covered mechanism placed far away from the main circuit.

Electronic Changer

Dhirendra Prasad

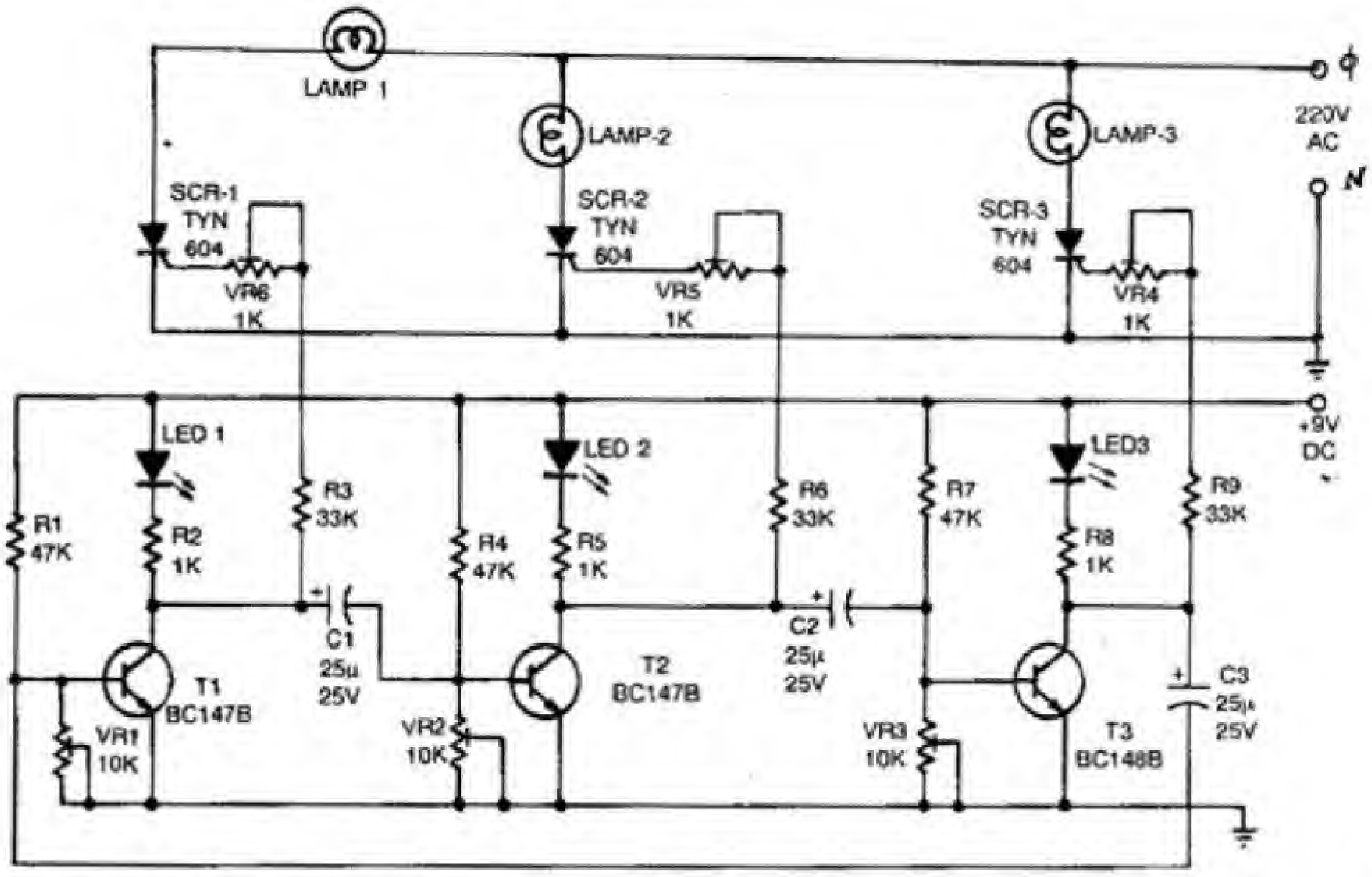
In many situations, whenever a running light effect is required, a wooden wheel switch is needed. The wheel is driven by a motor which normally connects three switches, one by one producing a running light effect. Such a switching system is very bulky and troublesome.

Here is a simple circuit with a very few components but which is equally effective.

In this circuit all transistors remain on except one which is off. This off sequence 'travels' through each transistor. Let us assume that T1 is off and T2, T3 are on. As T3 is on its collector voltage is low, so the base voltage of T1 is low as long as capacitor C3 is discharged. Now capacitor C3 charges slowly through R1, as a result of which base voltage of T1 rises. As soon as it crosses the cut-in voltage, T1 turns on and its collector voltage drops. This lower voltage applies a negative bias through capacitor C1 to the base of T2 to turn it off. Now the next sequence is T3 off and T1, T2 on.

The transistor that is off has an increased collector voltage which is used to trigger the SCRs. The triggering voltage is adjusted to the minimum to avoid false triggering. The SCRs get off by natural commutation. One end of each lamp is directly connected to the 230V AC supply while the other ends of the bulbs are connected to SCRs.

The SCR switching option is for low-power lamps (less than 100 watts) or else we can use relay switches.



Sometimes when we switch-on the circuit all three transistors remain on, as a result of which running off sequence is held up. In this case, any one transistor is required to be turned off momentarily by shorting its base to the ground. A pushbutton switch can be connected between base and ground of first transistor for this purpose.

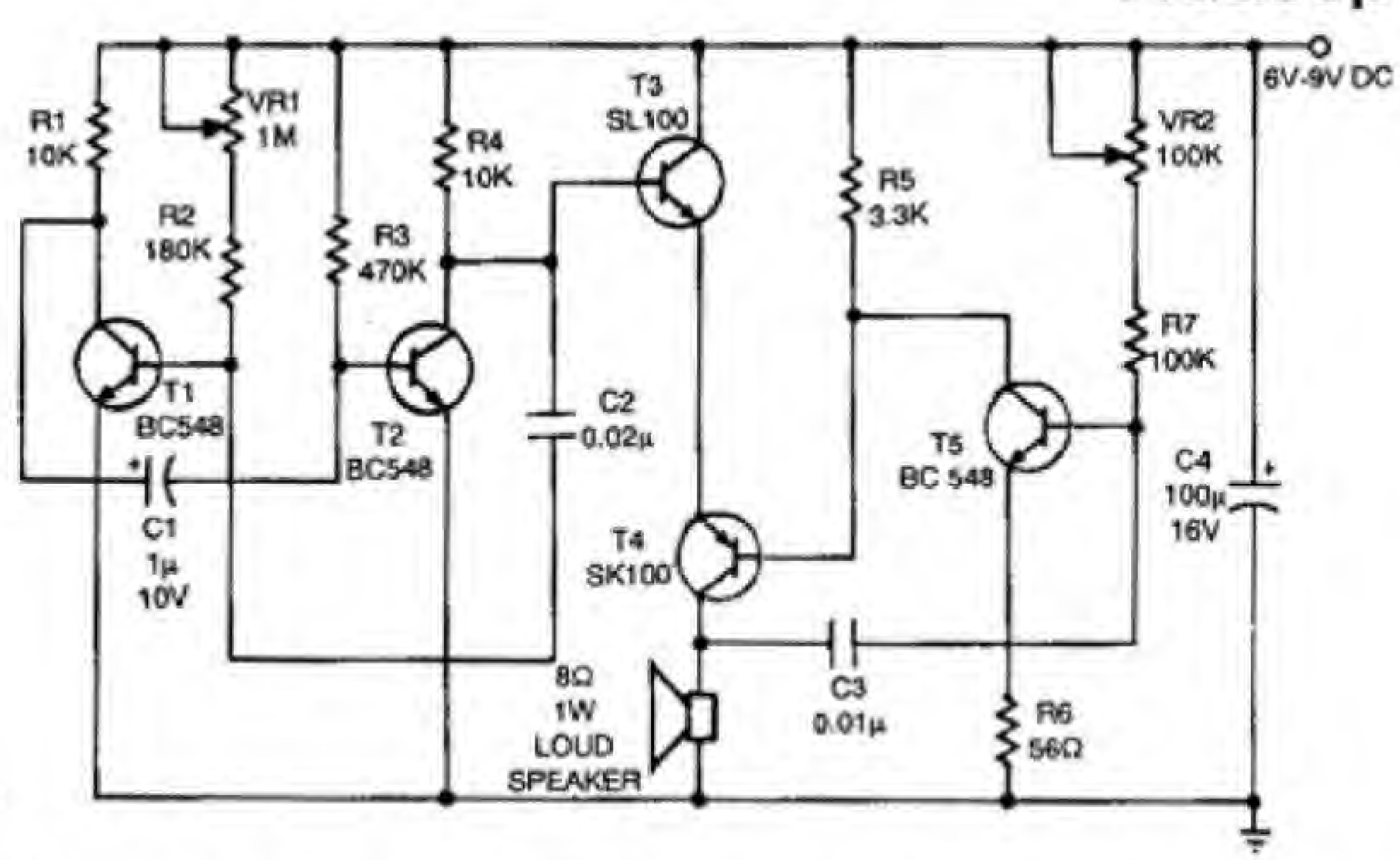
Transistorised Warning Alarm

Pradeep G.

The transistorised warning alarm described here can be used with burglar alarms, fire alarms or with any other security device to give an audible indication.

The circuit employs five ordinary transistors. Transistors T1 and T2 form a low-frequency astable multivibrator. Its frequency can be varied from 1 Hz to 10 Hz by adjusting VR1.

Transistors T4 and T5 form a complimentary pair AF oscillator. Collector supply to transistor T4 is given through T3. T3 switches off the oscillator according to the multivibrator frequency.

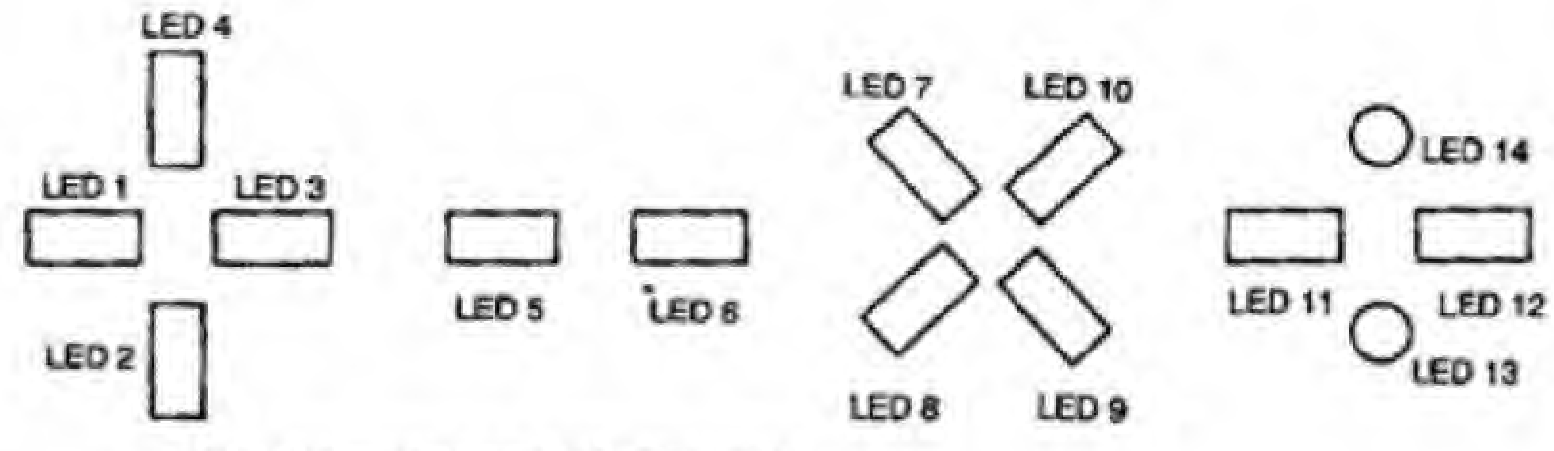


The tone of the sound can be varied by VR2 and the 'speed' of beeping by VR1. The circuit can be easily assembled on a general-purpose veroboard. An ordinary 6V to 12V battery or regulated power supply can be used.

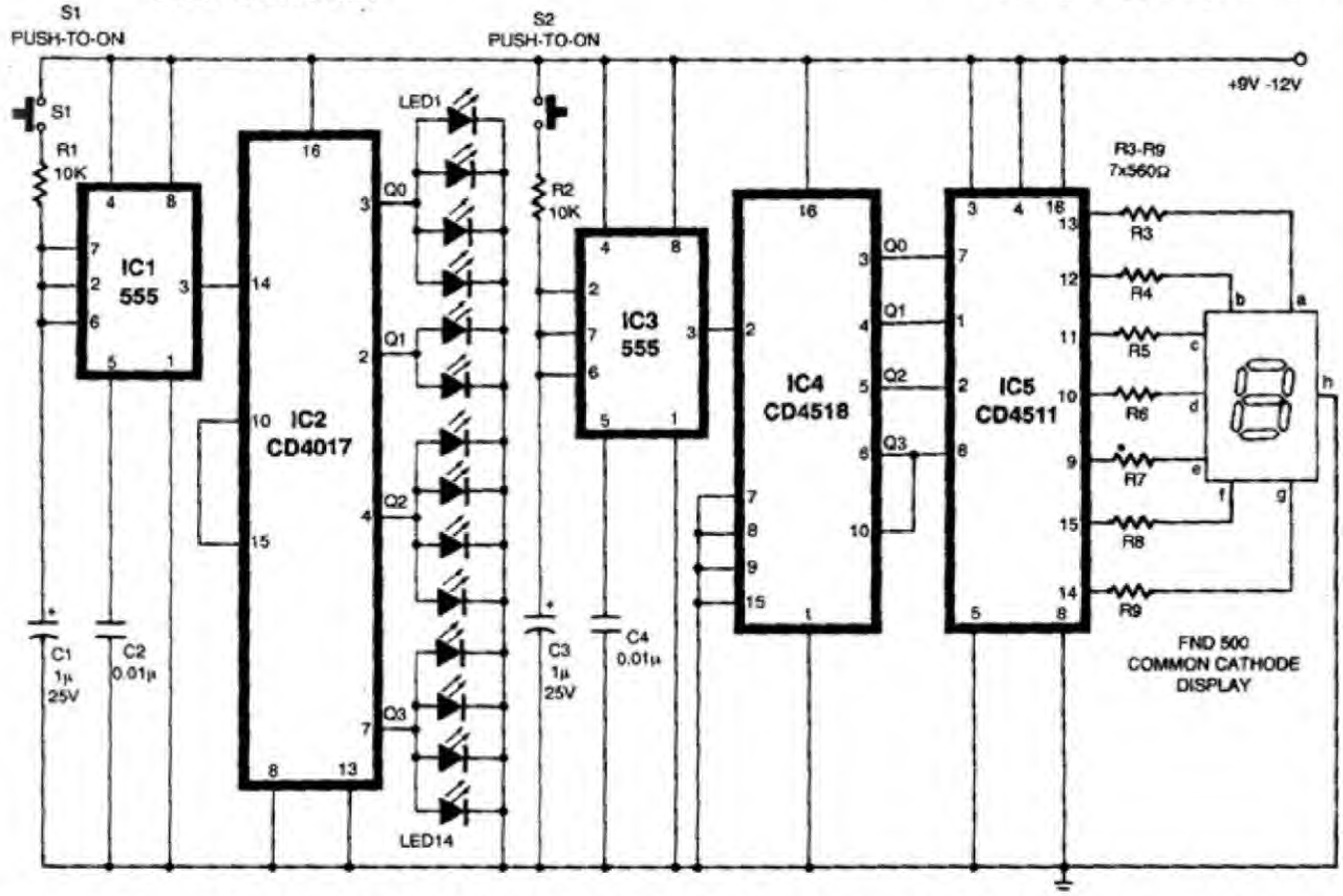
Electronic Number Scoring Game

Prodip Banerjee

Here is an interesting electronic number scoring game which can give you hours of fun. You can play this game alone or with some friends. The circuit uses two 555 ICs to generate clock pulse and a decade counter to



NOTE:- LED1-LED12-5MM SQUARE LEDS
D13-D14-CIRCULAR LEDS



generate mathematical signs. A BCD counter followed by a seven-segment LED display driver is used to generate numbers.

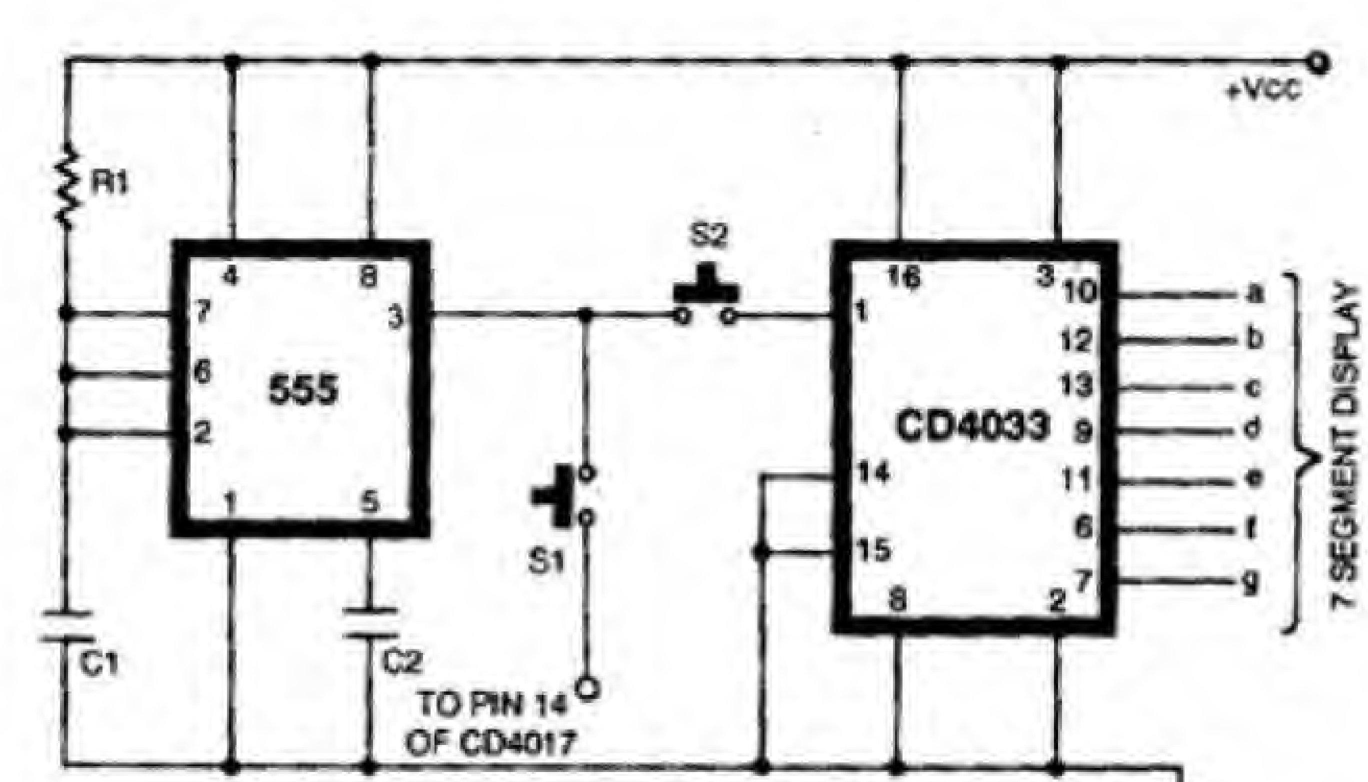
IC2 is a decade counter having ten outputs but here only four outputs are utilised. It is driven by clock pulse from IC1. When switch S1 is on the set of LEDs 'run' so fast that all LEDs appear to glow at the same time. But when S1 is off only one set of LEDs glows showing a particular sign. Similarly, in FND500 display numbers 0 to 9 appear so rapidly that the display always shows 8 but when S2 is off it shows a particular number from 0 to 9. The arrangement of LEDs to show the signs +, -, x and ÷ is very important. It should be done according to the figure.

Several players can participate, each having one chance to operate S1 and S2 alternately.

Scoring: Suppose you have +5, -2 and x7 in three consecutive chances. Your score is (+5-2)x7 = 21. In this way your score is continuously updated with every chance. But suppose you get ÷ 4. In this case the pattern of scoring is entirely left to the players' choice. They can approximate the scores like 21÷4 in their own way.

Readers' Comments:

I was surprised to see the circuit of 'Electronic Number Scoring Game' published in EFY Aug.'92 issue. Though the idea behind the game was excellent, the component count was quite high.



The decade counter-cum-7-segment display driver CD4033 alone can replace ICs 4518 and 4511. Also there is no need of two 555 ICs as is clear in the above circuit.

Specifications of R1, C1, C2, S1, S2 and all other connections of CD4017 will remain the same as published already.

HEMANT SHARMA
Guwahati

The author, Mr Pradip Banerjee, replies:

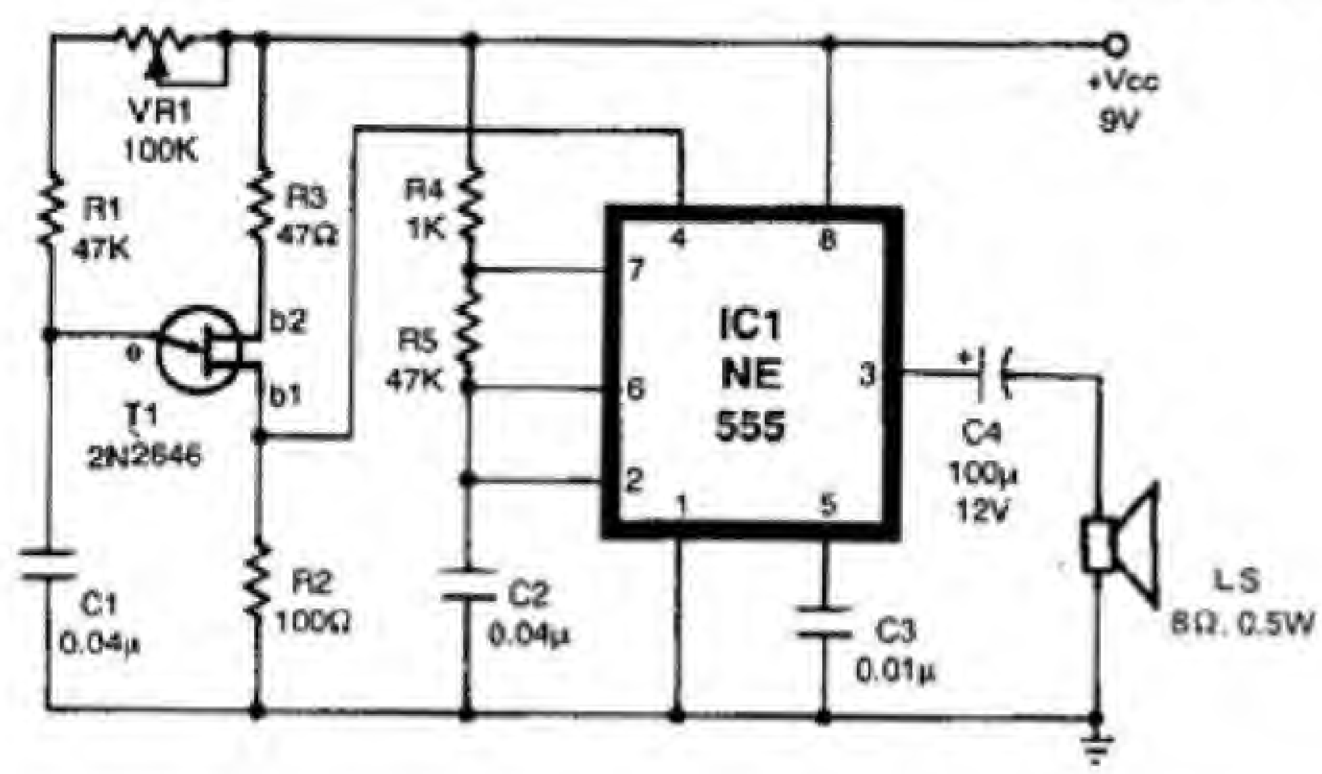
Modifications suggested by Mr Sharma are absolutely correct. I am thankful to him for the same.

Rain Sound Generator

Pradeep G.

The circuit described here is simple and uses ordinary components. It comprises two oscillators. One is a variable low-frequency oscillator using UJT 2N2646. A single UJT can be oscillated without using a tank coil. Electrical characteristics of UJT are quite different from ordinary bipolar transistors'. If ordinary bipolar transistors are used at least two transistors are necessary for oscillations, otherwise tank circuit has to be used (except in phase-shift oscillators, but in this case very weak oscillation is obtained).

The second oscillator uses IC555 in astable mode. But if UJT does not conduct, pin 4 of IC1 become inactive. So the operation of 555 depends on the conduction of UJT.



In this way a new type of sound, i.e. the sound of rain, is generated from the speaker.

A simple 9V DC unregulated power supply can be used. This circuit was successfully tested with a power supply unit using 0-9V, 500mA step-down transformer, four 1N4001 diodes and a 1000µF, 16V filter capacitor.

An 8-ohm, 5cm 0.5-watt speaker was used with the prototype.

Readers' Comments:

I assembled the circuit of 'Rain Sound Generator' published in EFY Sep.'92 issue. I have checked all the connections carefully, but the circuit is not producing any kind of sound.

ALISHA TISON
Chadrapore

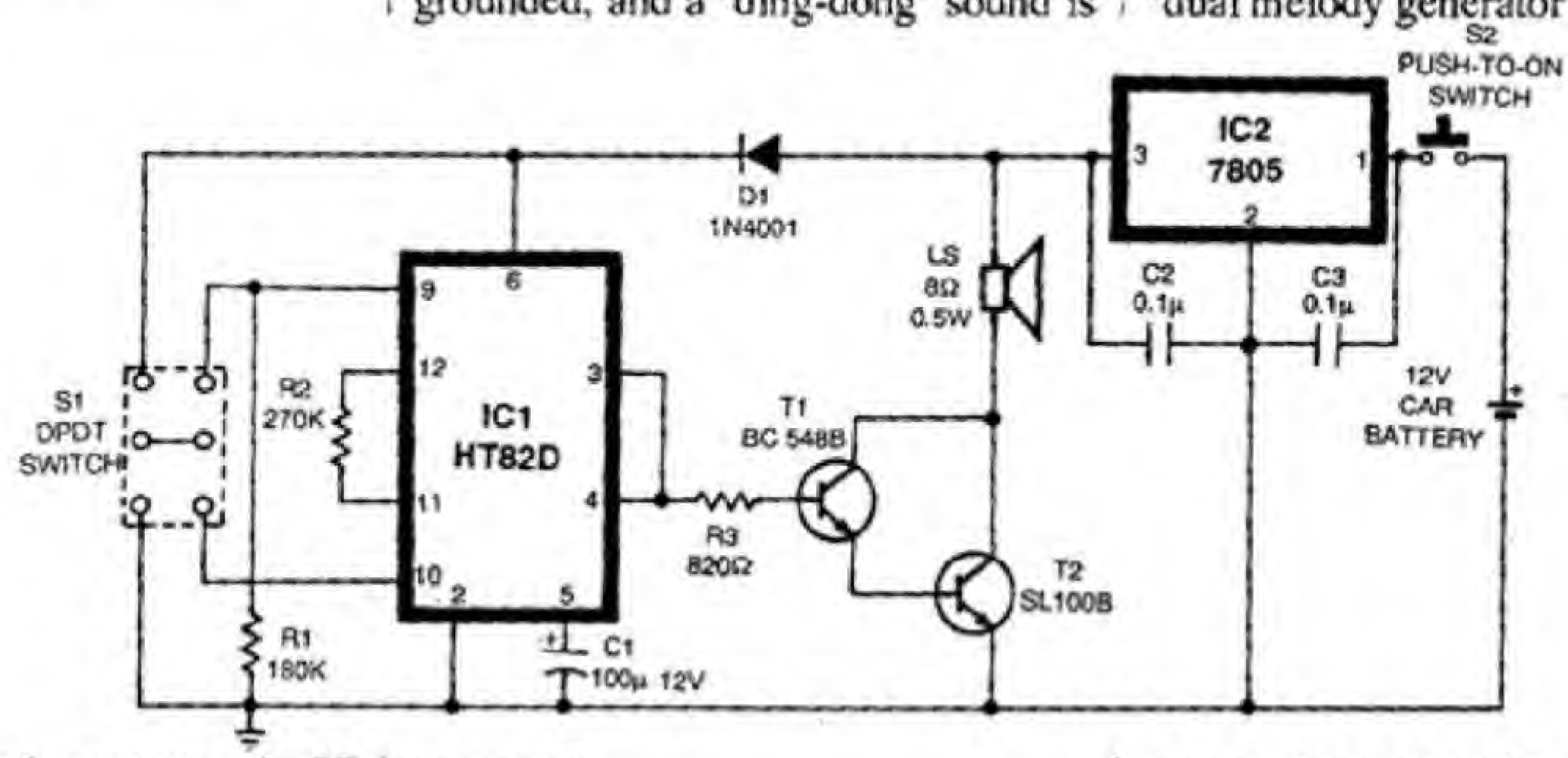
The author, Mr Pradeep G, replies:

The circuit has been tested with all the specified values for the components and it is working well. So I advise Miss Tison to test the circuit with a new IC555, check UJT 2N2646 for its pin connections. DC resistance between b1 and b2 is about 5-kilohm when emitter is open. Also check emitter-base junction for forward and reverse biasing.

Double-Tune Car Reverse Horn

Pradeep G.

Several circuits for musical car horns have been published in EFY but this circuit can generate two types of sounds—one a pleasant 'ding-dong' bell sound and the other a sweet chirping sound of a bird.



Here the sound generator is IC HT82D whose operating voltage range is 2 to 5 volts. DPDT switch S1 in the circuit selects the sound. When it is in top position, pin 9 of IC is connected to positive supply (common poles of the switch are connected to each other), and a bird's sound is generated. When S1 is in bottom position, pin 10 is grounded, and a 'ding-dong' sound is generated.

After moving selector switch S1, the push-to-on switch S2 has to be operated. When S2 is released the circuit switches off. Any low-wattage, 8-ohm speaker can be used. By using a 9-volt or 12-volt battery eliminator, the circuit can be used as a door-bell.

Readers are advised to ask for the 'dual melody generator IC' from component shops to make this circuit because some dealers may not recognise it from its number HT82D.

Traffic-Lights Controller

R. Shankar

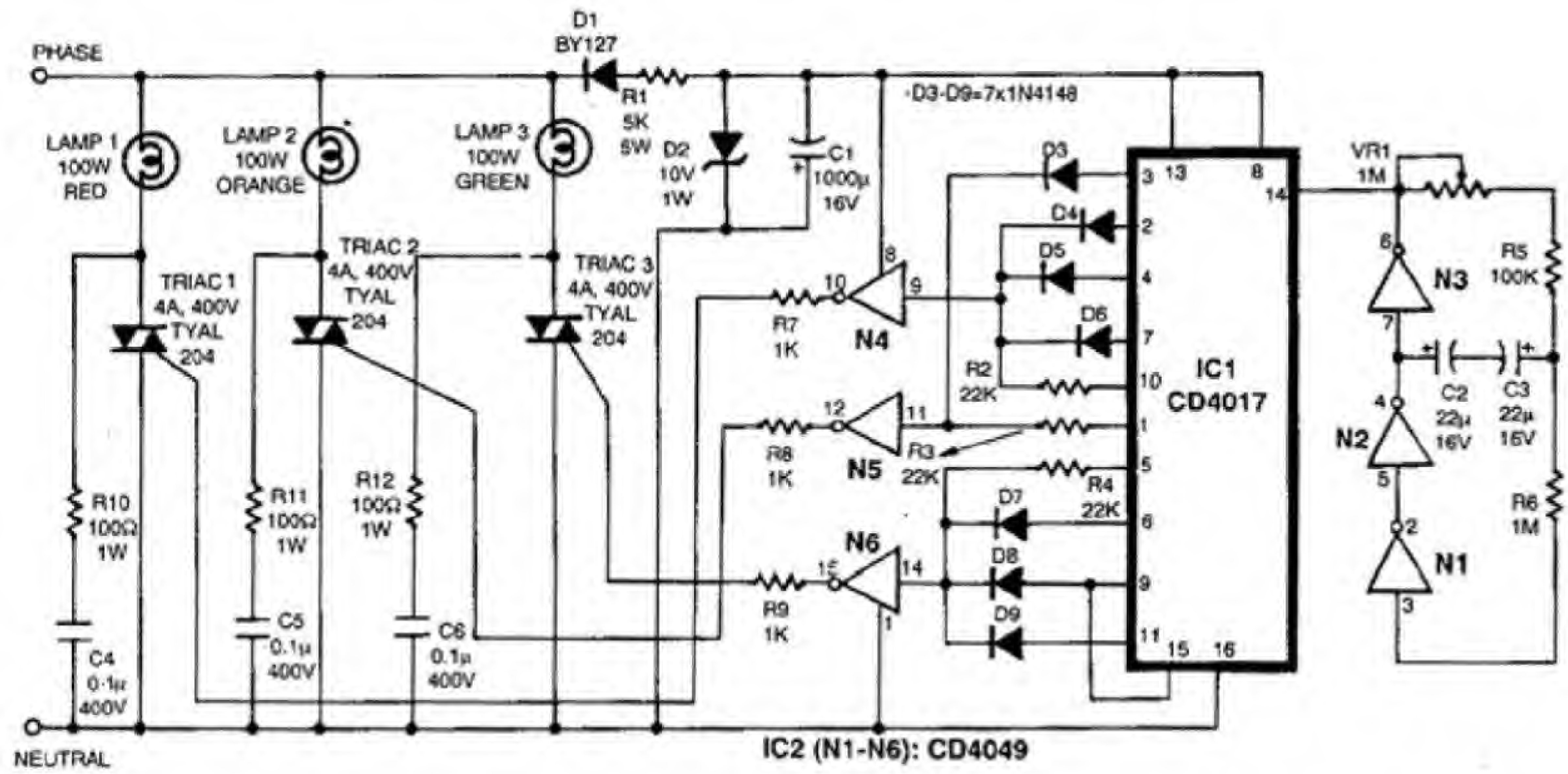
The circuit given here is a substitute of old mechanical traffic-lights controllers which are not very reliable. The circuit's timing and sequential operations are done by two CMOS ICs while the actual power switching is done by triacs.

A 10V negative power supply is obtained directly from the mains by means of D1, R1, D2 and C1. Gates N1 to N6 constitute IC2 (CD4049) while IC1 (CD4017) is a Johnson counter. N1-N3 are wired as an astable multivibrator whose time period can be adjusted between 1 second and 10 seconds with VR1. The decade outputs of IC1 are wired such that when Q0 or Q5 is high, the output of N5 goes low. Similarly, the outputs of N4 and N6 become low when Q1 to Q4 and Q6 to Q9 become low respectively. Since we have a negative supply, a low output of any of the gates N4 to N6 causes the respective triac to fire.

Thus, the ratios of the time periods for the lamps in the sequence O:G:O:R are 1:4:1:4.

Resistors R10 to R12 and capacitors C4 to C6 are absolutely necessary, these avoid spurious triggerings of the triacs which may hamper traffic flow.

Though only one lamp for each colour



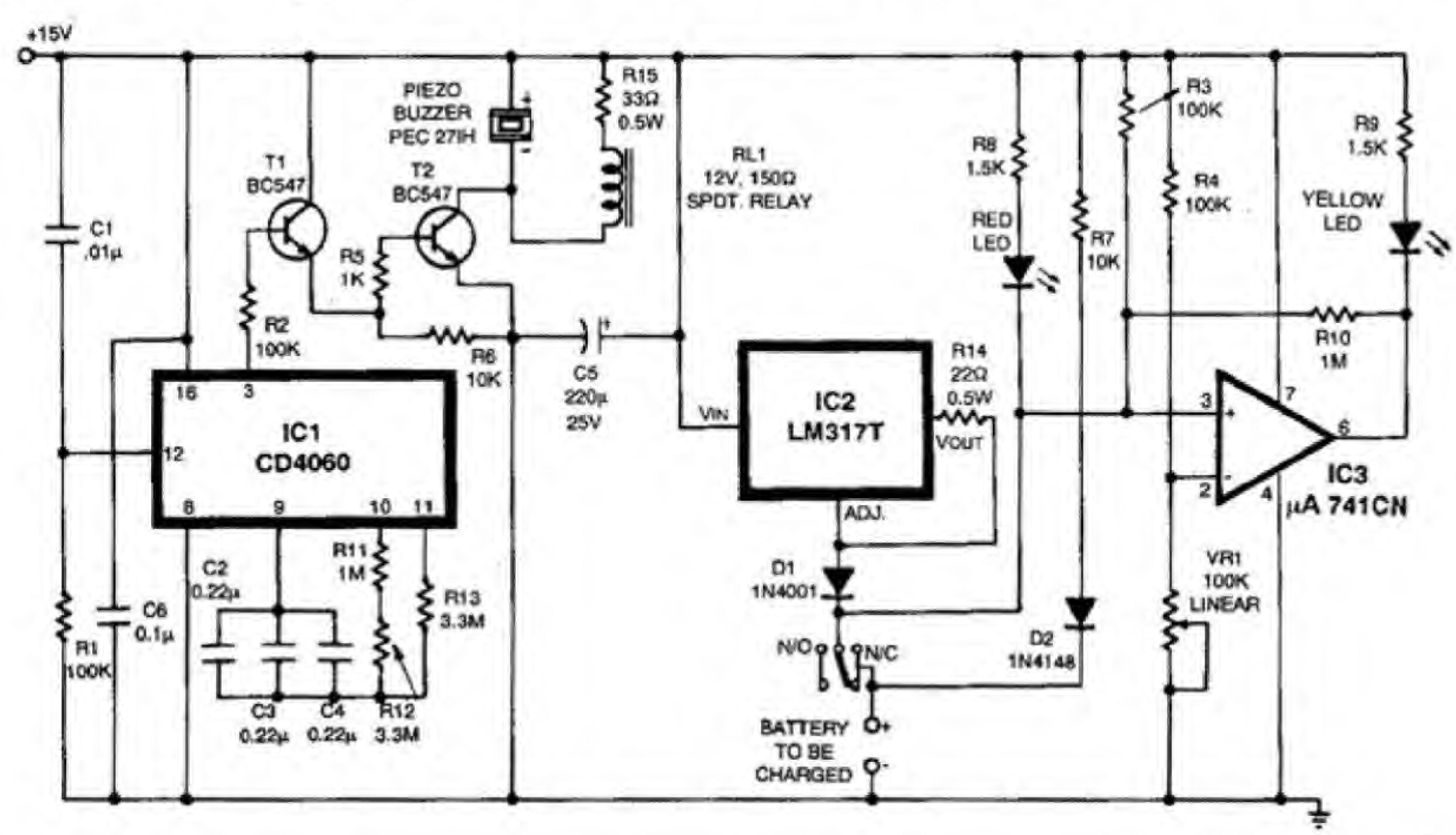
is given in the circuit, many more could be paralleled, as long as the total current does not exceed 4 Amps for each colour. For a 400V, 4A triac, the maximum number of 100W lamps that could be paralleled is eight. However, proper heatsinking of the triacs should be carried out at this heavy load.

Since the whole circuit works on AC mains, special care should be taken during construction and handling.

Sophisticated Ni-Cd Charger

Kalpesh T. Dalwadi

Nowadays, Ni-Cd cells are commonly used in household goods. Depending on their use (and misuse), these need to be charged quite often. Hence a good Ni-Cd charger has become a necessity.



The commonly used Ni-Cd batteries, which are rated at 500mA/hour, need to be charged at 50mA constant current. The circuit presented here will charge at a time seven Ni-Cd pencil cells connected in series or a 9V Ni-Cd battery. It will indicate faults such as reverse polarity, a shorted battery, a high resistance battery, or a low voltage battery through just two LEDs. After the normal charging time of 14 hours, it will disconnect the battery but shall start trickle charging it, thus ensuring that the battery does not lose its charge. Also, after the battery has been charged fully, it will give aural indication.

In spite of performing all these functions the circuit is very simple. It comprises a constant current source of 50mA, a 14-hour timer and a comparator.

LM317 (IC2) provides a very stable current source. Output current at terminal Vout of IC2 is given by I = 1.2V/R14. For the given value of resistor R14, output current is 50mA, irrespective of the battery voltage. Diodes D1 and D2 prevent the battery discharge during mains failure. Resistor R7 along with D2 provides trickle charging, in case the battery remains unattended after a lapse of 14 hours.

Timer CD4060 (IC1) is a 14-stage counter with an on-chip oscillator. The oscillator frequency is given as F=1/2.2RC, where R=R11+R12 and C=C2+C3+C4. With the values of R and C shown in the circuit, the oscillator oscillates at about 1/6 Hz, and the output at pin 3 goes high after 14 hours.

The darlington drive built around transistors T1 and T2 switches on relay RL1 which disconnects the batteries from the current source. At the same time the buzzer starts ringing, indicating that the battery is fully charged. The C1-R1 combination automatically resets IC1 at power-on.

IC3 forms a simple comparator. Voltage at its pin 2 is set to 0.4V with VR1. Its pin 3 is connected across battery, but in normal condition, it remains tied to +Vcc through resistor R3. R10 provides some hysterisis.

The table shows the conditions when different faults are detected.

Condition	RED LED	YELLOW LED	Indication
1.	ON	OFF	Normal battery charging
2.	ON	ON	There may be reverse connection of the battery. Check whether the battery is connected correctly. If it is connected properly then battery is short and is not usable.
3.	ON	Remains 'ON' for sometime and then goes 'OFF'.	Low voltage battery. Charging may be continued.
4.	Remains 'ON' for sometime and then goes 'OFF'	OFF	High resistance battery. Indicates that battery is not usable.

If you wish to charge a 6V lead-acid battery (for Bike) reduce R14 to 2.2 ohms, 2 watts and mount IC2 on a heatsink. No other changes are required.

To test the circuit, connect Ni-Cd battery across the positive and negative marked terminals and proceed as follows:

1. Connect a multimeter in series with the battery. Keeping it on 500mA range, switch the power supply on. The multimeter should show a flow of around 57mA. This value may slightly differ depending on the tolerance of R14.

2. Connect the battery by reversing the polarity. This must satisfy condition 2 of the Table.

3. Now discharge this battery by shorting it and then again connect it in the circuit. This must satisfy condition 3 of the Table.

4. Taking a shorted battery and connecting it in the circuit will satisfy condition 2 of the Table. In case of a high-resistance battery, condition 4 of the Table must be satisfied.

If your constructed circuit passes all the above tests, it is ready for use.

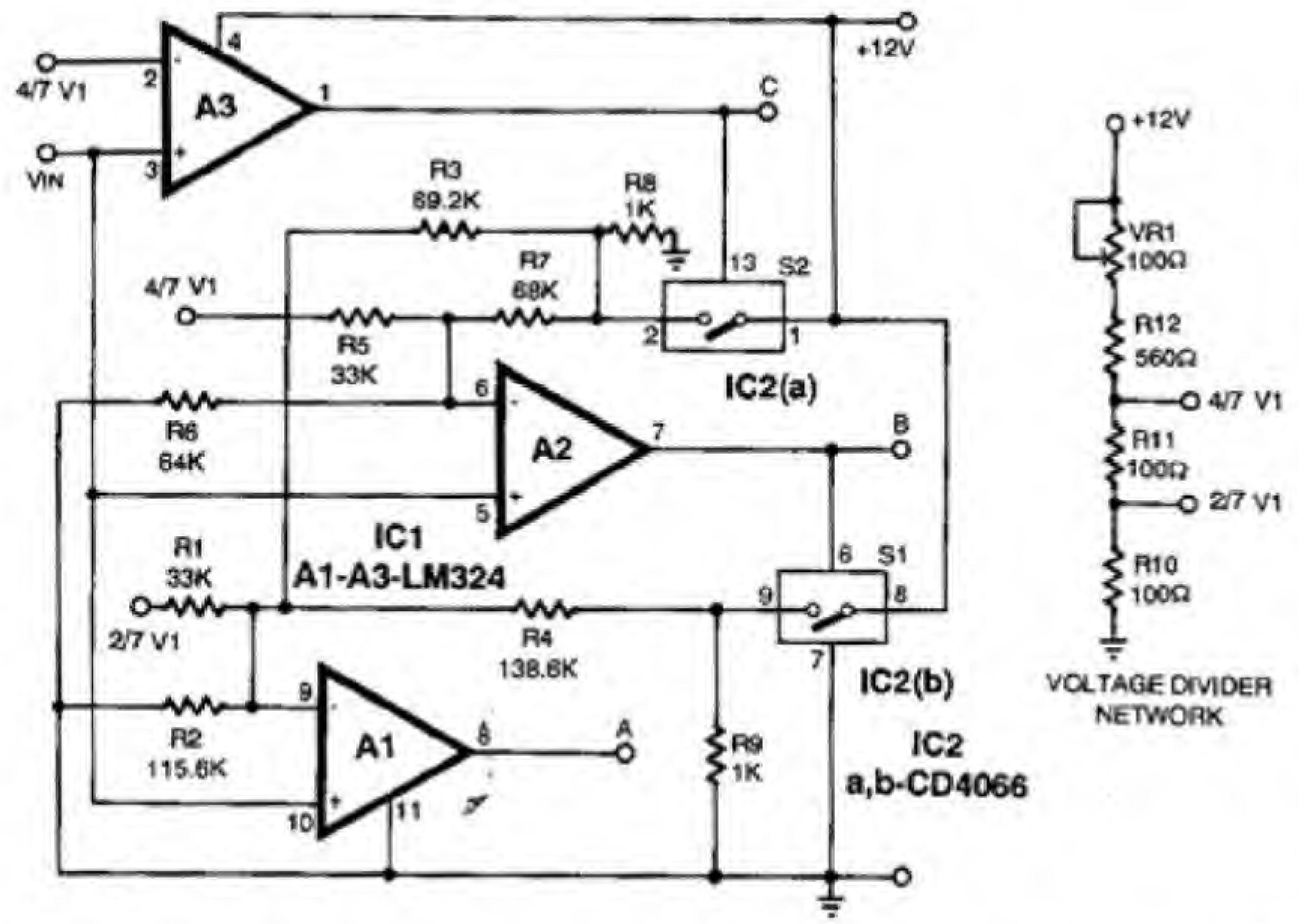
The charger should cost you around Rs 200 only.

Three Bit Flash Analogue to Digital Converter

Rajesh Bawankule

The simplest in concept and the fastest type of analogue to digital converter is flash type converter. The entire digital output word is present just after the propagation delay time of comparators and the encoding logic gates. A typical conversion time is 33 ns.

This circuit needs just three comparators and no combinational logic circuitry. The beauty of the circuit lies in the digital to analogue conversion



Step voltage	Binary outputs C	B	A	Desired voltage	Observed voltage	% Error
0	0	0	0	0	0	
$V_{IN}/7$	0	0	1	.714	.732	-2.52
2 $V_{IN}/7$	0	1	0	1.42	1.46	-2.8
3 $V_{IN}/7$	0	1	1	2.14	2.09	2.33
4 $V_{IN}/7$	1	0	0	2.857	2.9	-1.5
5 $V_{IN}/7$	1	0	1	3.57	3.47	2.8
6 $V_{IN}/7$	1	1	0	4.28	4.24	.934
7 $V_{IN}/7$	1	1	1	5	4.9	2.00

using resistors and comparators to achieve analogue to digital conversion action.

In this circuit, the reference voltages on inverting inputs of the comparators are not fixed but dynamic. They change depending upon the state of outputs of other comparators.

Non-inverting inputs of comparators A1, A2 and A3 are given input voltage of 5 volts maximum. Inverting terminal of A1 is given V_{IN},/7, i.e. 0.714 volts where V_{IN} is the full scale voltage which is 5 volts in this circuit. This is achieved by providing 2 $V_{IN}/7$ to voltage divider formed by R1 with R2, R3 and R4 in parallel.

Similarly, inverting terminal of A2 gets 2 $V_{IN}/7$, i.e. 1.42 volts which is achieved by dividing 4 $V_{IN}/7$ into two parts by using voltage divider comprising R5 with R6 and R7 in parallel.

To the third comparator 4 $V_{IN}/7$, i.e. 2.857 volts is directly given.

When input voltage is zero, outputs of all comparators are zero, giving binary 000. When input voltage crosses $V_{IN}/7$ level, output of A1 becomes high, giving us binary 001. When input goes slightly above 2 $V_{IN}/7$, output of comparator A2 becomes high which makes switch S1 on, thus connecting the other end of R4 to +12 volts. This end was previously connected to ground effectively.

Now voltage at inverting terminal of A1 rises to 3 $V_{IN}/7$, i.e. 2.14 volts and hence output of A1 becomes low, giving us output in direct binary 010. When input goes above 3 $V_{IN}/7$, output of A1 also becomes high giving binary output 011.

Similar process is followed in higher input voltages, giving us exact 3-bit binary. Values of all resistors are calculated by considering the increments in reference voltages with respect to outputs of other comparators.

Analogue switches CD4066 are used to provide exact 12 volts.

In the table outputs at expected and observed values are given, which clearly shows accuracy of this crude circuit idea.

The voltage divider used to get fixed reference voltages is shown in figure. In this circuit, odd values of resistors are obtained by connecting two or more resistors in parallel or series.

This circuit can be further extended as follows:

1. Bit length can be taken to higher bits. An 8-bit circuit will require just eight comparators whereas normal flash ADC requires 255 comparators.

2. Instead of providing derived fixed reference voltages we can obtain them using only one fixed reference, i.e. 12 volts, and different resistance values. This will simplify the circuit as well as reduce loading errors.

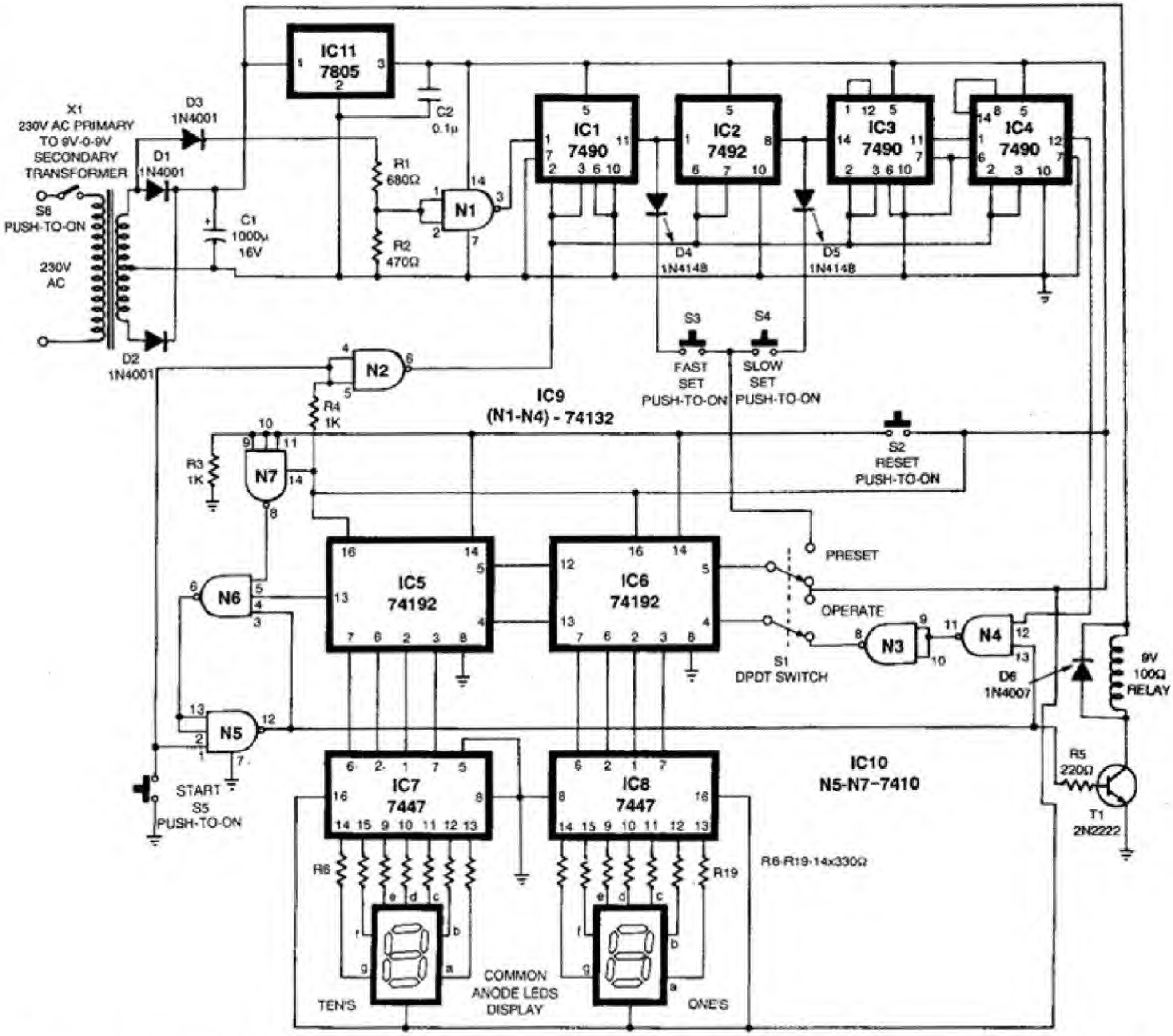
3. Peculiarly, this circuit employs 2^N-1 levels just to get 111 at full scale voltage. 2^N levels also can be employed. In that case increments in voltage will be $V_{IN}/8$ instead of $V_{IN}/7$.

4. Norton op-amps can be utilised in place of normal op-amps to simplify the circuit.

Programmable Digital Timer

P. Satya N. Reddi

The circuit presented here can be used for setting time intervals in the range of 1 to 99 minutes. The circuit does not use large resistors or capacitors to obtain the timing interval. Instead, it uses the 50Hz mains fre-



quency as a reference. The mains frequency is fairly accurate for this application.

The mains frequency is shaped up by schmitt-trigger gate N1 to obtain a square wave. This 50 Hz square wave is divided by IC1, IC2, IC3 and IC4. As a result a single pulse per minute is obtained at pin 12 of IC4.

The heart of the circuit consists of two presettable synchronous up-down BCD counters (IC5 and IC6) in cascade. Two seven-segment LED displays are included to indicate the number of minutes left in the timing interval.

To preset the timer, S1, a DPDT switch, is thrown into Preset position after a momentary push of the Reset switch S2. The display now shows 00. Press S3 or S4 until the display shows the number of minutes you want to time. Throw S1 back to Operate position. Pressing S5 once sets the NAND latch formed around N5 and N6. The output of gate N5 goes high and saturates transistor T1 and the relay is energised.

IC5 and IC6 start counting in the down counting mode as soon as the output of gate N5 goes high. The borrow pin (13) of IC5 is used to reset the latch N5-N6 after completion of timing interval. The borrow output of IC5 goes low when IC5 and IC6 are on their terminal count. This output goes low on the high to low transition of the clock and the output of gate N5 goes low de-energising the relay.

During the timing operation, the display stays on for about 30 seconds at the beginning of each minute being timed. The display shows the number of minutes left in the timing operation. ❑

Multi-Pattern Running Light

K. P. Viswanathan

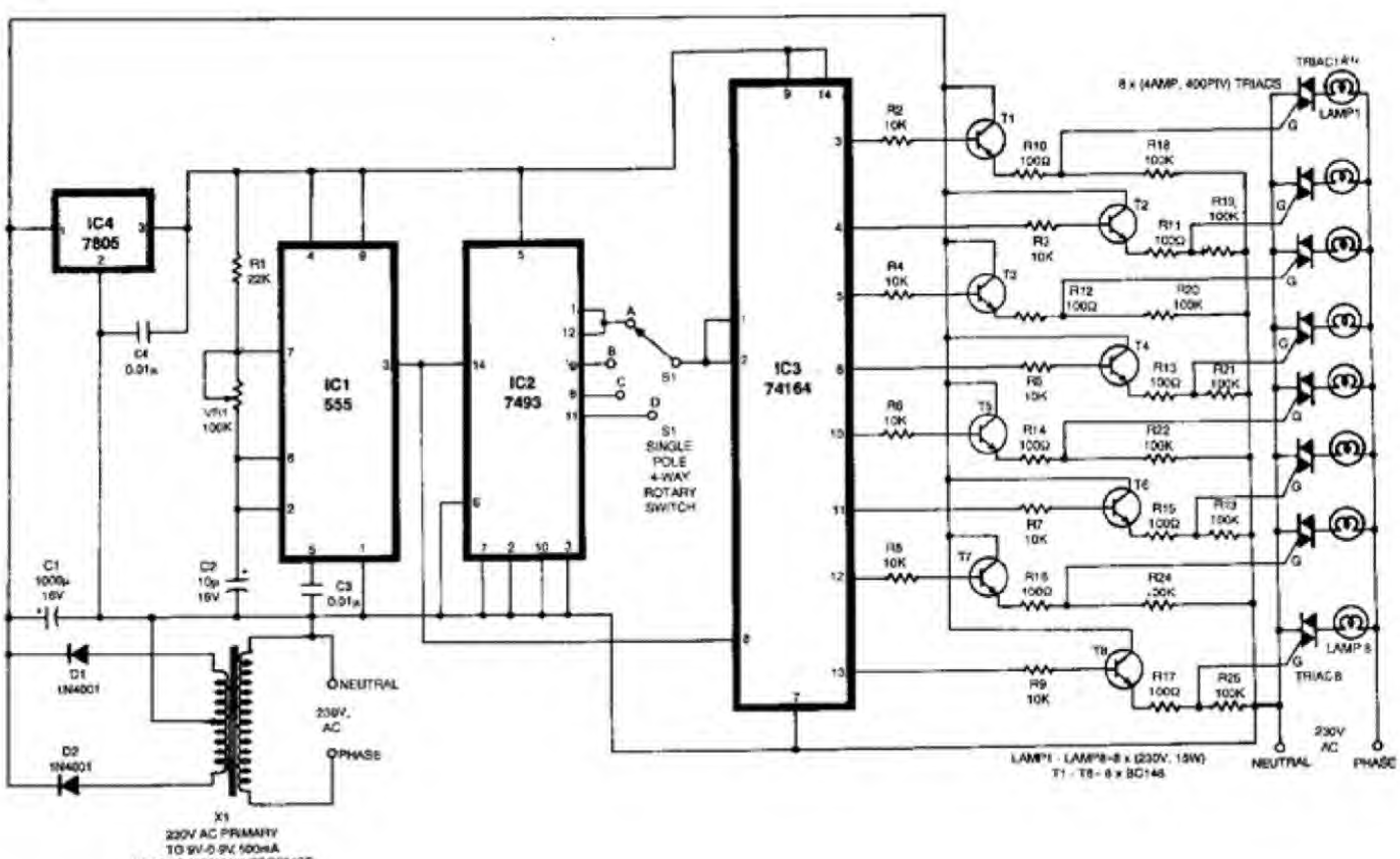
Running lights effect is not a new idea for a hobbyist. But this eight-channel running light becomes unique as four running patterns can be selected. In the first pattern, out of eight lights, alternate lights go 'on' and 'off'. In the second pattern, two adjacent lights go 'on' and the following two go 'off'. This pattern is shifted from left to right. In the third pattern, four adjacent lights go 'on' and these are shifted to right. In the fourth pattern all the eight lights go 'on' and 'off' one by one from left to right. All the lights are of ordinary 230V bulbs controlled by triacs.

The heart of the circuit is a serial-in-parallel-out shift register IC 74164 (IC3). When clock pulses are applied at pin 8, for every clock pulse, output at pin 3 is shifted to pin 4 and output at pin 4 is shifted to pin 5 and so on, as per the logic state given at input pins 1 and 2.

An oscillator is a wire around IC1 (555) and the square pulses are applied to IC2 (7493) and IC3 (74164). The frequency of oscillations can be varied with VR1.

IC2 is a divide by 16 counter and its output pins are 12, 9, 8 and 11. By connecting these outputs through rotary switch to inputs of IC3, four different patterns can be selected as mentioned above.

Switching circuits constitutes transistors and triacs. As output of IC3 cannot drive triacs directly, 8 transistors (BC148) are used for driving 8 triacs. Triacs of 4 Amps, 400 PIV (peak inverse voltage) can handle 30 nos. of



15 watt bulbs with proper heatsink.

Power supply is taken from 9V-0-9V 500mA step down transformer which after rectification and filtering goes to regulator 7805 (IC4) for proper operation of TTL ICs.

Readers' Comments:
I am interested in assembling the circuit of 'Multi Pattern Running Light' published in EFY Oct.'92 issue.

While thanking the author for this wonderful project, I request him to inform me:

Can I use IC 74154 with 16 outputs instead of IC 74164?

What will be the changes in the circuit if it is possible?

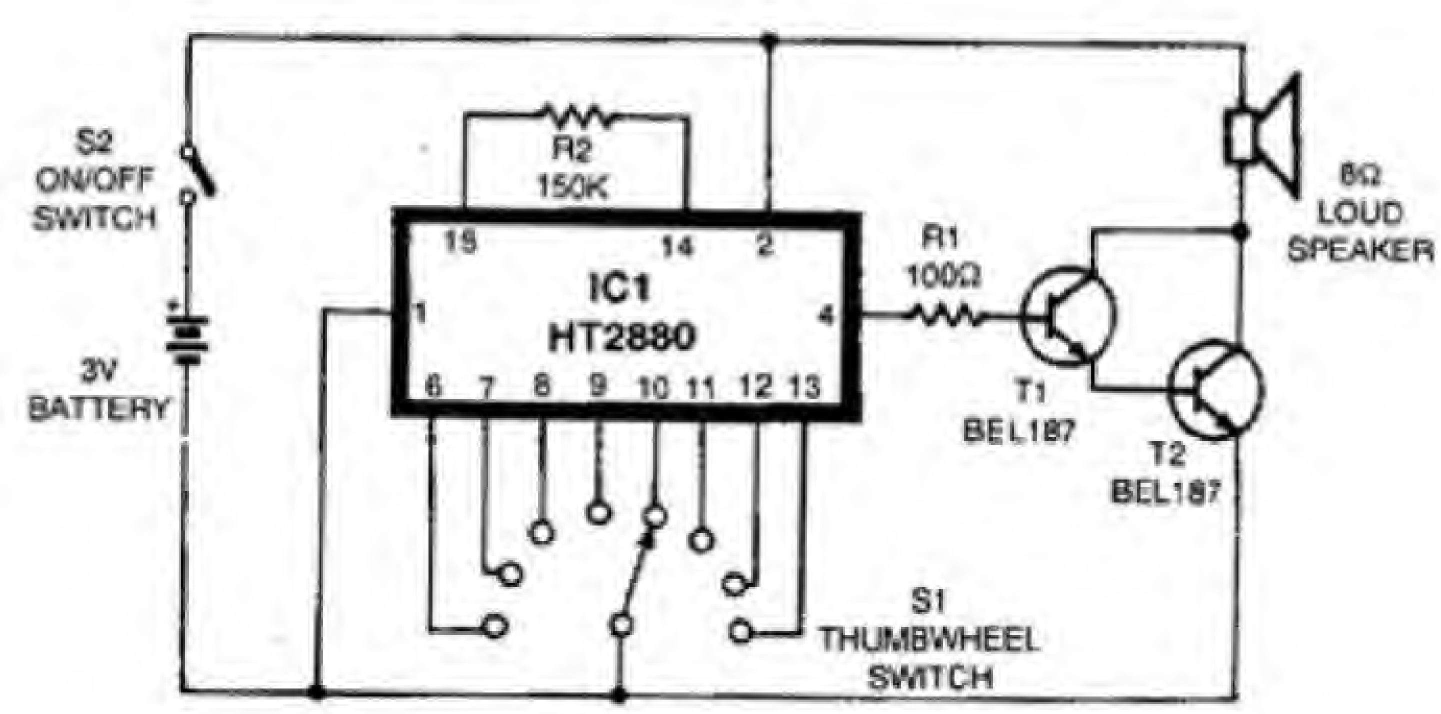
K. RAJARAM
Mysore

The author, Mr K.P. Vishwanathan, replies:
IC 75154 cannot be used in place of IC 74164 as the former is a 4-line-to-16-line decoder and the latter is a serial-in-parallel-out shift register.

Eight-Sound Generator

Rajesh Shinde

The circuit described here generates eight types of sounds, viz. two types of machine gun sounds, two types of bombarding, dual tone melody, game sound, animal sound and rifle sound. It operates on 3V battery. Total cost of the circuit is around Rs 35 without speaker, switches and power supply.



The tunes can be played by rotating thumbwheel switch S1 (single-pole, 8-way selector) followed by a push-to-on switch as shown.

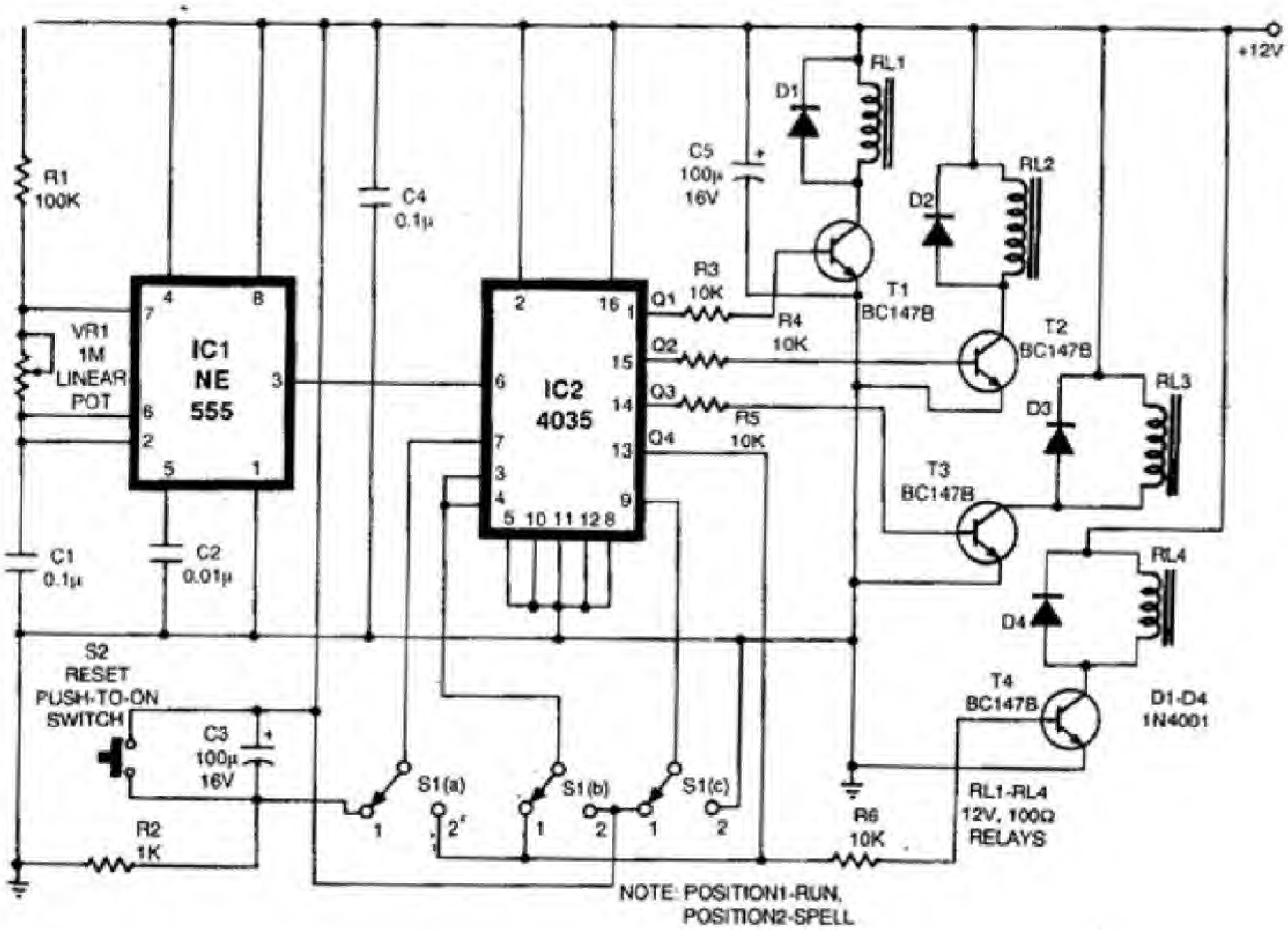
HT2880 is a CMOS LSI ROM chip designed for toy applications. It can also be used for door-bells, alarms etc. The transistors T1 and T2, which are connected in a darlington pair configuration, amplify the signal generated at pin 4. Note that pin nos 3, 5, 16, 17 and 18 of the IC are not connected anywhere.

A Novel Display

D.S. Vidyasagar

There are many display circuits already published in EFY. But this circuit is very special in its own way because it contains all the facilities required for any type of decoration.

Lighting decoration broadly consists of two main categories—the running effect and the spellar effect. Running effect is well-known to every electronics hobbyist. The spellar effect consists of many outputs driving the load-lamps; all of them go high one after another, and eventually all outputs become high simultaneously showing a complete display. Thereafter all the



outputs go low and the cycle is repeated. Both these effects can be obtained by using this circuit with just a flap of a switch!

As shown in the circuit, IC1 is wired as a free-running astable multivibrator whose frequency can be controlled through VR1. This changes the speed of running or spelling effect. The output of IC1 is directly connected to the clock input pin 6 of IC2 which is a CMOS shift register.

If switch S1 is kept in position 1, it connects pins 3 and 4 of IC2 to pin 13 of the same IC. Also, pin 9 is held high. So binary number 1000 is loaded in the register. This causes initially Q1 to go high and Q2, Q3 and Q4 low. Now as Q4 is connected back to pin 3 and 4, the number 1000 is circulated continuously through the registers in IC2 and as a result the four outputs sequentially go high. Thus a running effect is obtained.

Now keeping switch S1 in position 2, pin 7 of IC2 is connected to pin 13. Pins 3 and 4 are held high and pin 9 is grounded. As pins 3 and 4 are high, all the outputs of IC2 go high one by one on each consecutive clock pulse. When Q4 goes high, pin 7 of IC2 also goes high. This makes all the outputs low because all the parallel inputs are now grounded. Thus the operation repeats *(ad infinitum)*, and the spellar effect is obtained.

If more than four outputs are required, then more CD4035 ICs can be cascaded in the same fashion. Only their clock inputs should be driven from the same clock source in parallel.

The reset switch S2 should be pushed on, in 'run' mode to bring all the outputs of IC2 low initially.

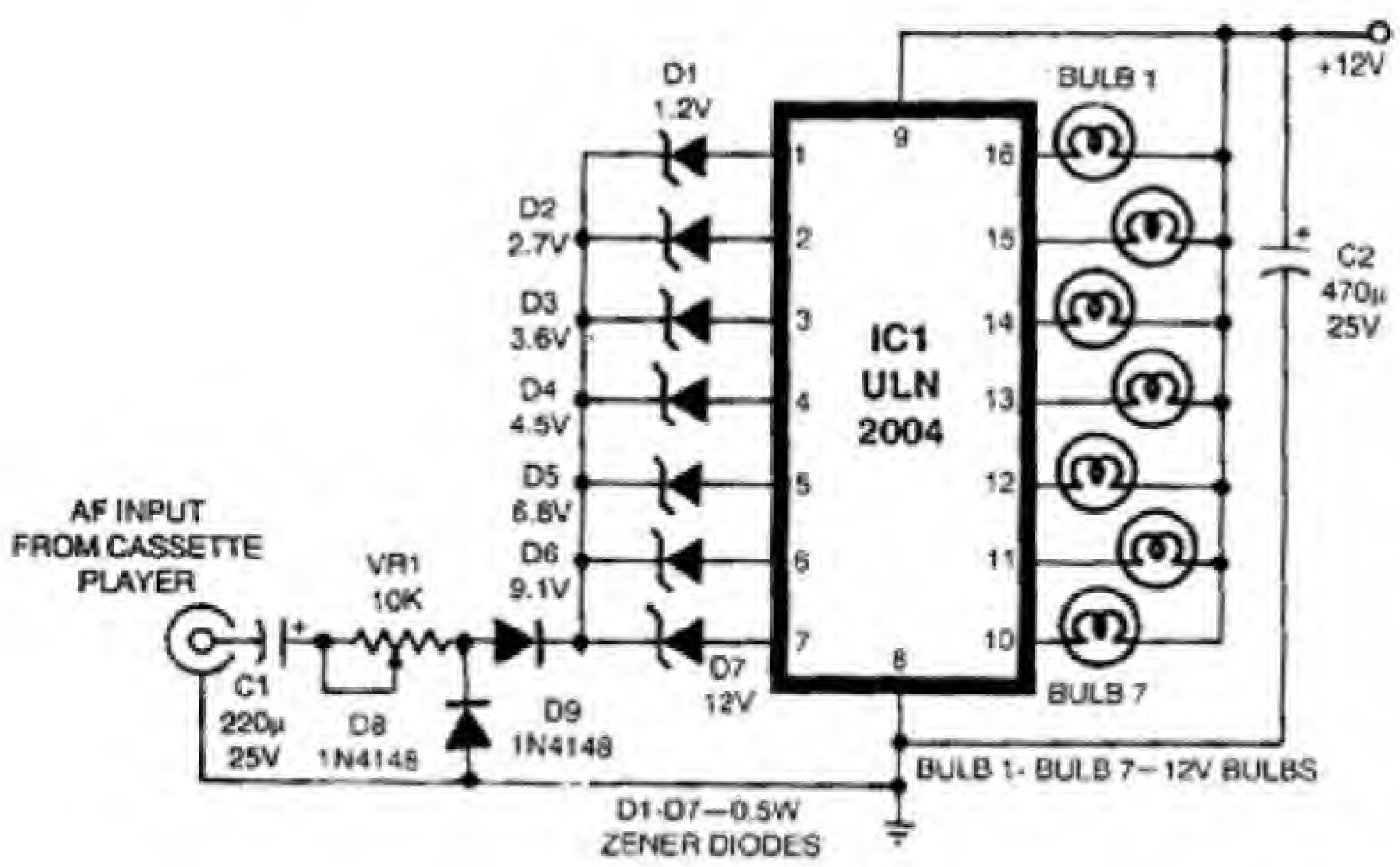
The outputs Q1 to Q4 of IC2 can be used to drive a general-purpose relay driver circuit. Since the circuit operates on +12V DC, any general-purpose power supply can be used to power the unit.

Note: It is advised that while changing switch S1, power supply of the circuit should be kept off. However to avoid this problem, as IC2 is a CMOS IC, it can be replaced with TTL shift register IC 7495 by making minor modifications in the circuit.

Audio Running Lights

Pradeep G.

Here is a circuit for audio running lights which uses filament bulbs instead of LEDs. Note, no special running light ICs (such as LB1405) have been used. The circuit employs seven-channel darlington array IC ULN2004 and seven reverse biased zener diodes having different breakdown voltages.



At low audio level, zener diodes having low breakdown voltages will conduct and corresponding lamps will light up. When output level increases, the other diodes will also conduct.

As a result, you can see a very fine display of 'moving' light bulbs from top to bottom or from left to right, as per their arrangement.

AF input signal fed via capacitor C1 is rectified by diodes D8 and D9. This rectified audio signal is given to the cathodes of all zener diodes.

Adjust VR1, for satisfactory operation of the IC. At minimum input the first lamp will glow and at maximum input all the bulbs will light up.

Note: Zener diode values are not critical. If the given values are not available, nearest available, values may be used.

Hearing Aid

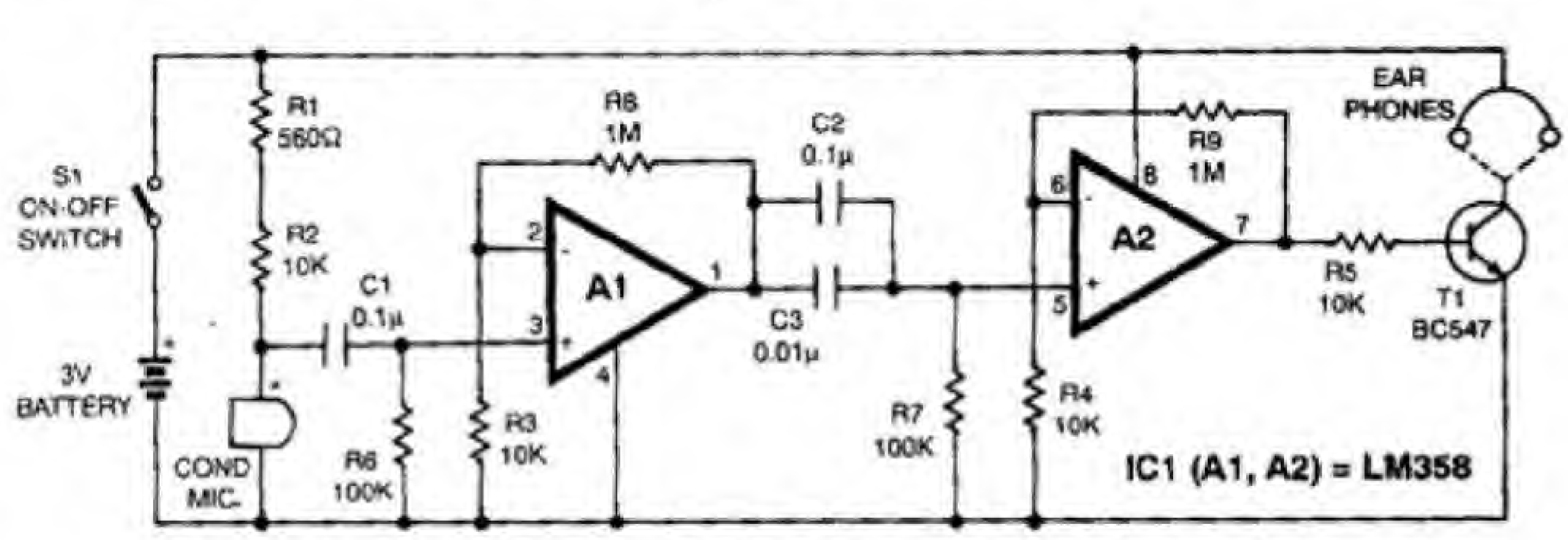
Kalpesh Dalwadi

The hearing aids available in the market are fully transistorised and generally use a single pen cell. The circuit presented here uses an IC for the same purpose which gives better sensitivity and performance.

Operational amplifiers are used here in their simplest from as non-inverting AC amplifier with a gain of 100.Op-amp A1 forms the first-stage amplifier. Second-stage amplification is given through op-amp A2. Hence the total gain is 10,000.

Resistors R1 and R2 provide biasing to the condenser microphone, and capacitor C1 is used for coupling. Finally, transistor T1 drives the earphones.

This circuit is small enough to fit into a match-box as it uses only one IC and few discrete components. It is very sensitive and can pick even weak signals from a circular area of over ten metres diameter. This circuit can also work as a baby-phone by using a speaker instead of an earphone.



The circuit costs around Rs 35.

Readers' Comments:

Hearing Aid circuit published in EFY Nov.'92 issue is not working at all. Anything wrong with the circuit?

SKY WAVES RADIO E. ELECT.
Ulhasnagar

❑ I have assembled the hearing aid circuit on a veroboard and am using the earphone normally used with small transistor radio, but without success.

On replacing the earphone with an LED, I found the LED glowing on weaker signals. Please guide me. I hope the circuit has been tested before publication.

V.P. OBEROI
New Delhi

The author, Mr Kalpesh Dalwadi, replies:

I used a condenser microphone (34K8P) in my prototype. As total gain of the amplifier is very high (10,000), the microphone impedance is of prime importance.

Even if the readers have used a condenser microphone bearing some other number, they may have to experiment with different values of the series biasing resistors, R1 and R2, of the microphone.

In case a microphone other than a condenser type is being used, the reader may have to experiment with change of the coupling capacitor as well, whose value may not exceed 10µF, 10V in any case.

No other change is required whatsoever. In fact my prototype is working very satisfactorily and is not suffering from any kind of problem. Readers who may still experience some problem should check the connections properly and use IC C358 (NEC Japan).

The circuit is very sensitive and a hissing sound is coming in the earphone which is irritating.

DR S.K. SHARMA

To reduce the hissing noise the feed back resistors R8 and R9 value may be reduced form 1 Megohm to 680 kilo-ohm.

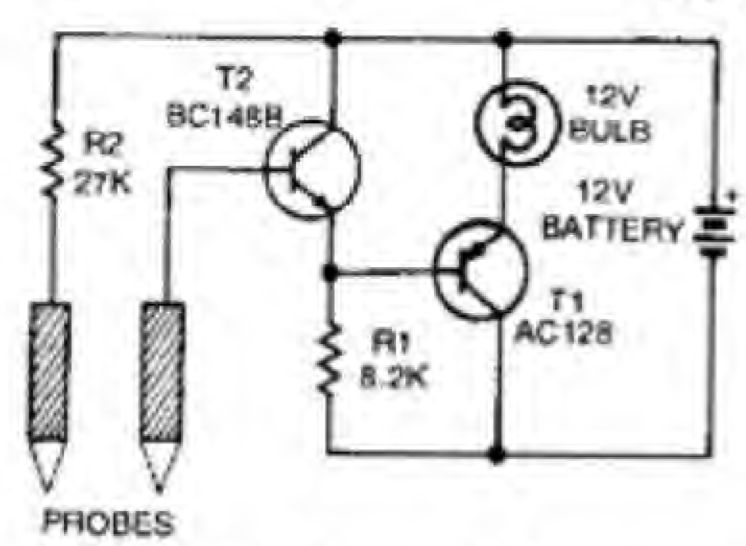
AUTHOR

Fuel Level Drop Indicator

K. R. Raghavendra

This circuit lights up a bulb when fuel in your vehicle or generator tank goes below a level.

Probes must be fixed on an insulating material and fitted in the fuel tank at the (low) level where indication is needed. As long as fuel keeps a conducting path between probes, T1 gets a positive bias and remains non-conducting. When fuel stops touching the probes, T1 begins to conduct and the bulb glows.



Authors' comment:

The above-mentioned circuit was published in EFY Oct. '92 issue for the purpose of water level indication in a radiator tank and not for the fuel tank. Since the vehicle was being used by my brother, and due to the long gap between the designing and submission of the circuit for publication to EFY, I got confused and stated that the circuit was meant for fuel indication. I have found that the circuit will not function as a fuel level drop indicator since organic fluids are insulators. I deeply regret the inconvenience caused to the readers.

However, the same circuit is useful as water drop indicator for radiator tanks, water tanks and swimming pools, etc. The circuit can also be used for fuel drop indication by suitable modification suggested in my previous letter (EFY Jan.'93, p. 14)

K.R. RAGHAVENDRA
Mysore

Automatic Suction Tank Motor Controller

Nilesh K. Rajbharti

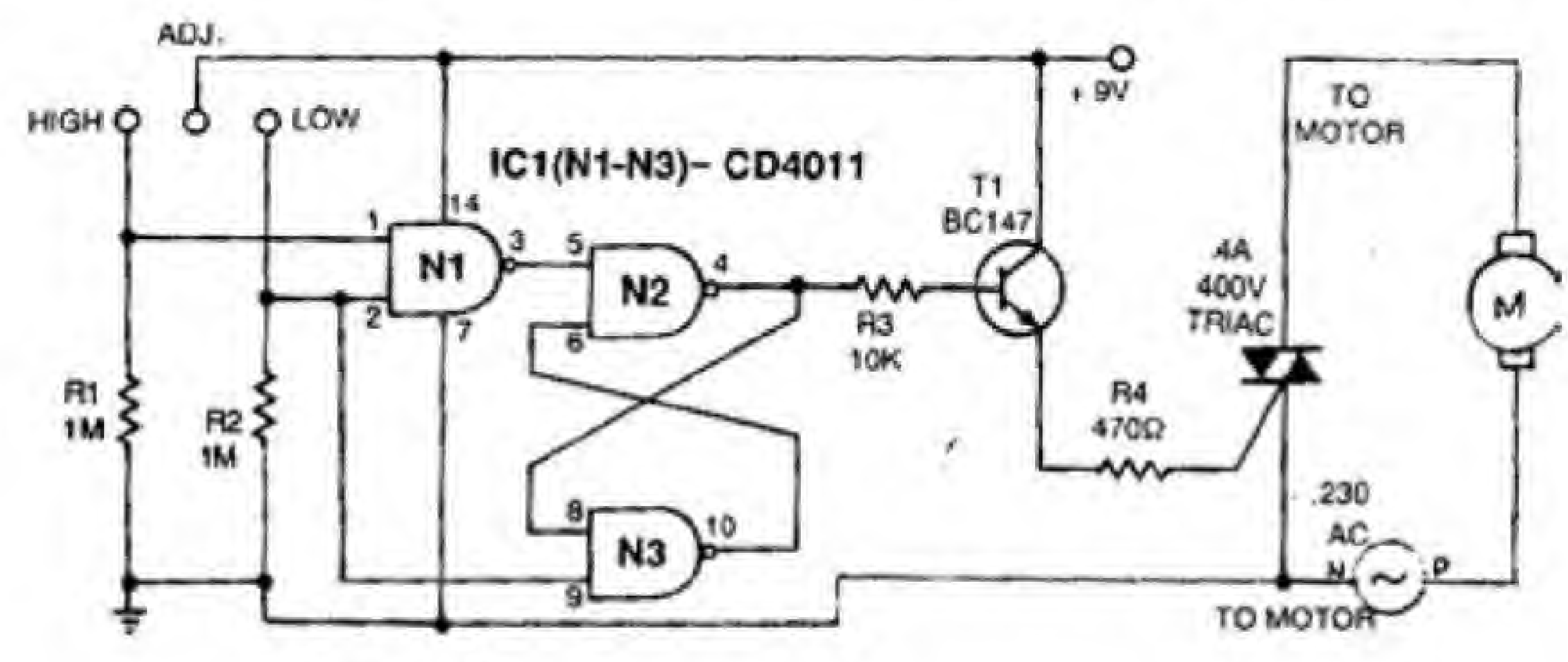
Many of us use water pumps for drawing water from an underground tank. Whenever the water level in the tank goes low we have to switch 'off' the motor and when it reaches a high level we have to switch 'on' the motor. The circuit given here solves this problem.

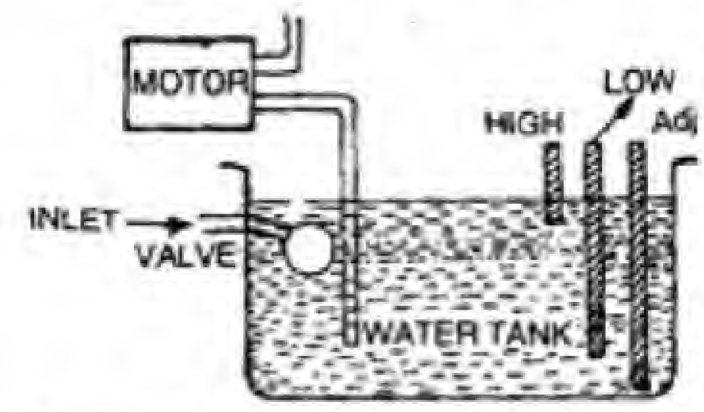
Truth table for digital circuit

Condition	H	L	Y	Remarks
Empty tank	0	0	0	
Water is filled up to 'L'	0	1	0	
Full tank	1	1	1	Motor is 'on'
Water falls below 'H'	0	1	1	Still motor is 'on'
Again tank is empty	0	0	0	Off

The circuit uses RS flip-flop. The arrangement of sensor probes in the tank is shown in the diagram.

It is evident from the truth table that the circuit identifies the point after which the higher level becomes '0' from '1' and keeps the motor 'on' even if the higher level is at zero state. This is because of the property of RS flip-flop under 'no change' condition.



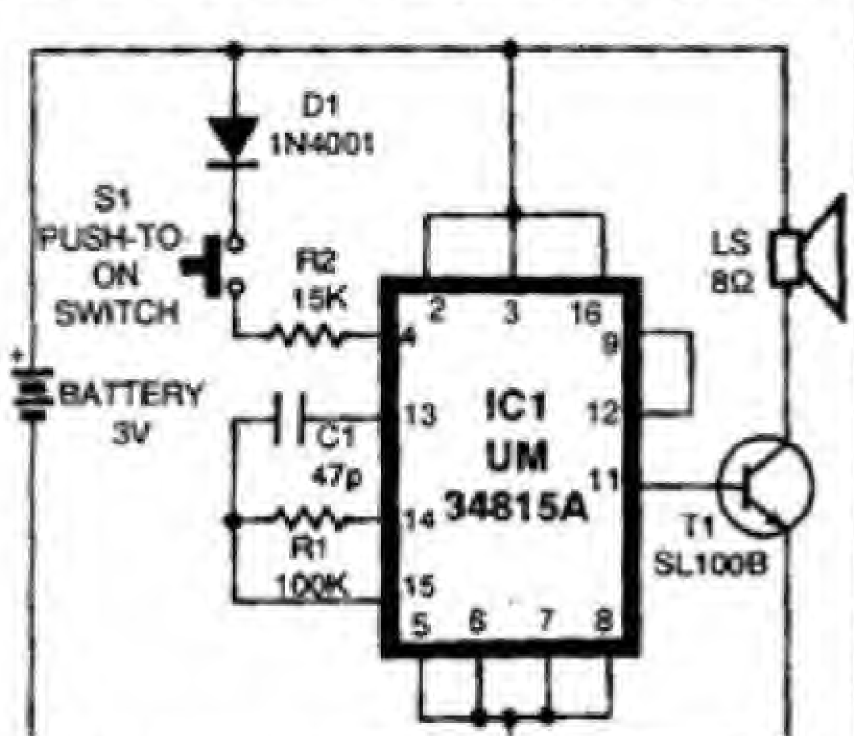


Three-way cables can be used as three sensors, wound on a wooden stick, with their insulation cut at one end. Power may be derived from a suitable power supply or battery.

12-Hindi Song Tunes Producer

Iyer Mahesh Nagarajan

Musical door-bells, musical horns, touch sensitive door-bells etc are not new projects, especially for EFY readers, but this music producer (twelve popular Hindi film song tunes in sequence) gives a new dimension to musical door-bells. Whenever a switch is pressed it plays a popular Hindi film-song tune. 12 such tunes can be heard in sequence.



The UM 3481/82/83 or IC 481/82/83 and IC 4822/33 etc. also fall in the same category of musical ICs as they can easily replace each other. Please note:

UM-3481 .... contains 8 christmas carols
UM-3482......... contains 12 tunes commonly used in door-bells
UM-3483 .... contains 10 tunes
UM-3484 .... contains Westminster plus chime function.

The heart of the circuit incorporates integrated circuit UM34815 A. This integrated circuit falls in the group of door-bell IC chips.

The UM348151A is a 16-pin DIL IC. It contains a ROM (read only memory) with 512 musical notes, tone generator, rhythm generator, modulator, oscillator's frequency divider and preamplifier. Very few components have to be externally connected to set up the timing of the built-in oscillator and to build an external AF amplifier/driver circuit.

The circuit can be operated by pressing switch S1 when a Hindi song-tune is played in an ascending order serially, i.e. song tune-1, song tune-2, ...etc.

Transistor T1 (SL100B) is used as an amplifier-driver connected to on-chip preamp output (pin 11) to drive any 8-ohm or 4-ohm speaker directly. The speed of the tune being played can be changed by varying the values of resistor R1.

The circuit would cost around Rs 80 (including speaker).

Simple Frequency Meter

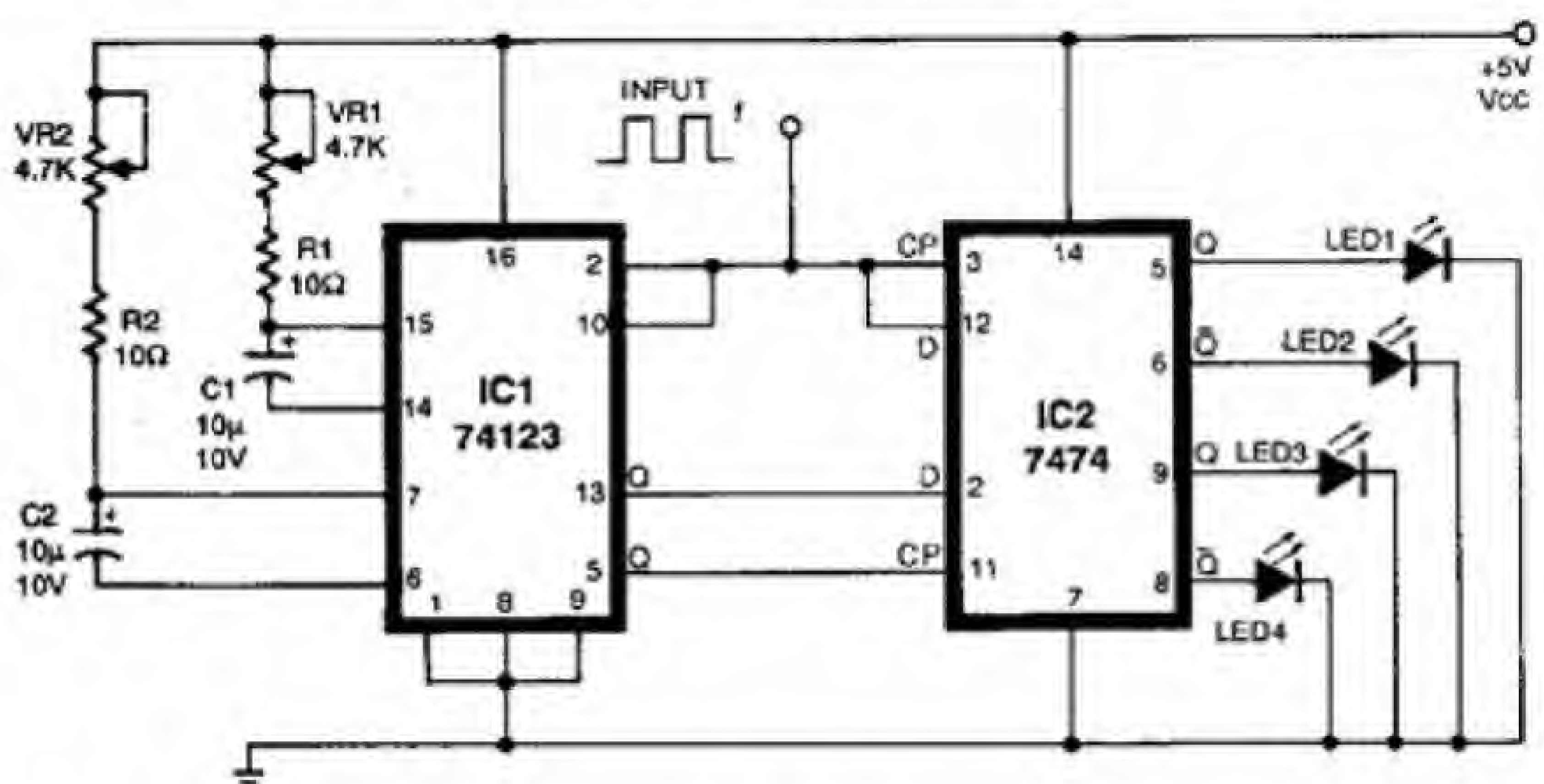
Saravanen Mallesan

Here is a simple frequency meter with which input frequency can be determined by simply measuring the values of two resistors and a little bit of calculation.

A retriggerable monostable multivibrator and a D flip-flop can form a simple, yet reliable frequency comparator that compares an input frequency with a predetermined reference. To determine whether an input frequency (f) falls between two known frequencies, f1 and f2, two one-shot/flip-flop combinations are used, as shown.

Here both the one-shot and the flip-flop ICs are wired for positive-edge triggering. Each input pulse causes the monostable's output to go high for the period of its preset timing interval. The flip-flop is triggered simultaneously, but its output is determined by the state of its D input at the time of trigger threshold.

If the period of the input frequency is shorter than the preset timing of the monostable, a constant high level will be present at the D input, forcing the flip-flop's Q output to remain high. If the input frequency period becomes greater than that of the monostable, the flip-flop's Q output will go low.



VR1, VR2 and C1, C2 determine the value of the time period of f1 and f2. Some typical values for measuring a range of input frequencies is given in Table I.

TABLE I	
Value of C = C1 = C2	Input Frequency to be measured
C=47 µF	4 Hz to 2 kHz
C=10 µF	19 Hz to 9 kHz
C=100 µF	2 kHz to 1 MHz
*R = R1 = R2 = 4.7k Linear Pot	

One way to measure the frequency is to increase f2 by decreasing the value of R2 until LED3 goes 'off' and LED4 goes 'on'. Then R1 is decreased so that LED1 goes 'on' and LED2 goes 'off'. Now both LED1 and LED4 glow and the values of R1 and R2 are measured. Frequencies f1 and f2 are calculated by the formulae

$$f1 = \frac{1}{1.1R1C1} \quad \text{and} \quad f2 = \frac{1}{1.1R2C2}$$

and the input frequency 'f' falls in between f1 and f2. If

f1 < f < f2, LED1 and LED4 glows;
f2 < f < f1, LED2 and LED3 glows.

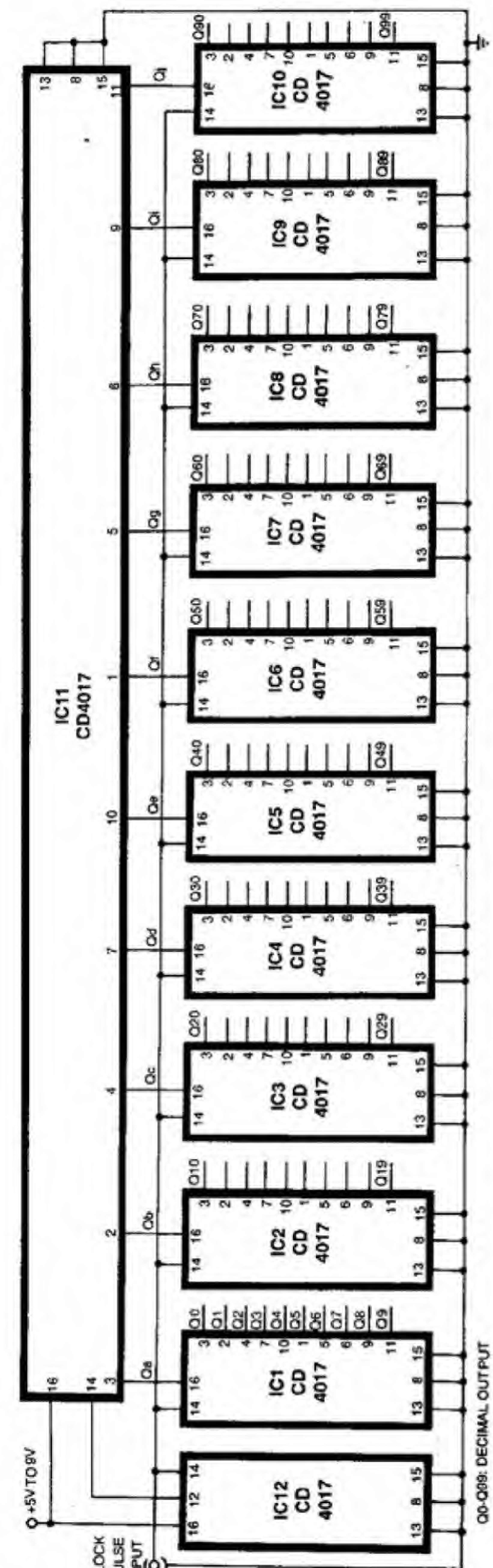
It can be further noted that the values of the resistors and the capacitors can be taken according to one's application.

100 Rung Exclusive Counter

Amrit Bir Tiwana

Digital counters are frequently needed in all kinds of counting circuits, test gear, sequential displays, timers, etc for up to ten outputs (exclusive and independent), or 16 at the most. But the problem arises when it comes to using more than these many outputs.

In such a case, the 4017-based CMOS counter can be put to use as a



100-stage counter. The circuit configuration uses a dozen 4017 counter ICs.

IC12 sends clock pulses to IC11 at one tenth of its input frequency, which in turn allows Qa through Qj to go high in sequence. IC1 is activated first through Qa output, whose outputs Q0 to Q9 go high sequentially for the next ten pulses. It then turns the positive rail of IC1 to zero, and switches IC2 to active state whose outputs go high for the next ten pulses. This continues until the 100th output goes high. In this way, the outputs Q0 through Q99 go high one after the other, turning the previous to low state in succession.

Thus a 100-stage counter may be implemented using a few discrete 4017s. If less than 100 outputs are needed, a counter stage may be dropped for every ten outputs. The last needed output may be connected to the reset terminal (pin 15) of the 4017 counter.

Inexpensive Guitar Amplifier

Arup Kumar Roy

Whereas an electric guitar with 60W PMPO (peak music power output) costs around Rs 5000, here is a cost-effective solution to convert a Hawaian guitar to an electric guitar. The circuit can also be used as an ampli-speaker with a tape recorder or a radio receiver.

The unit can easily be assembled on a standard TBA810 ampli-speaker PCB available in the market. It can also be housed in an ampli-speaker box.

Do not try altering the single-transistor preamplifier and power supply stages, or you may end up with severe distortion and unwanted noises.

The circuit has been extensively tested and retested to the satisfaction of our musically-gifted friends. It has been tried successfully even with standard electric guitars.

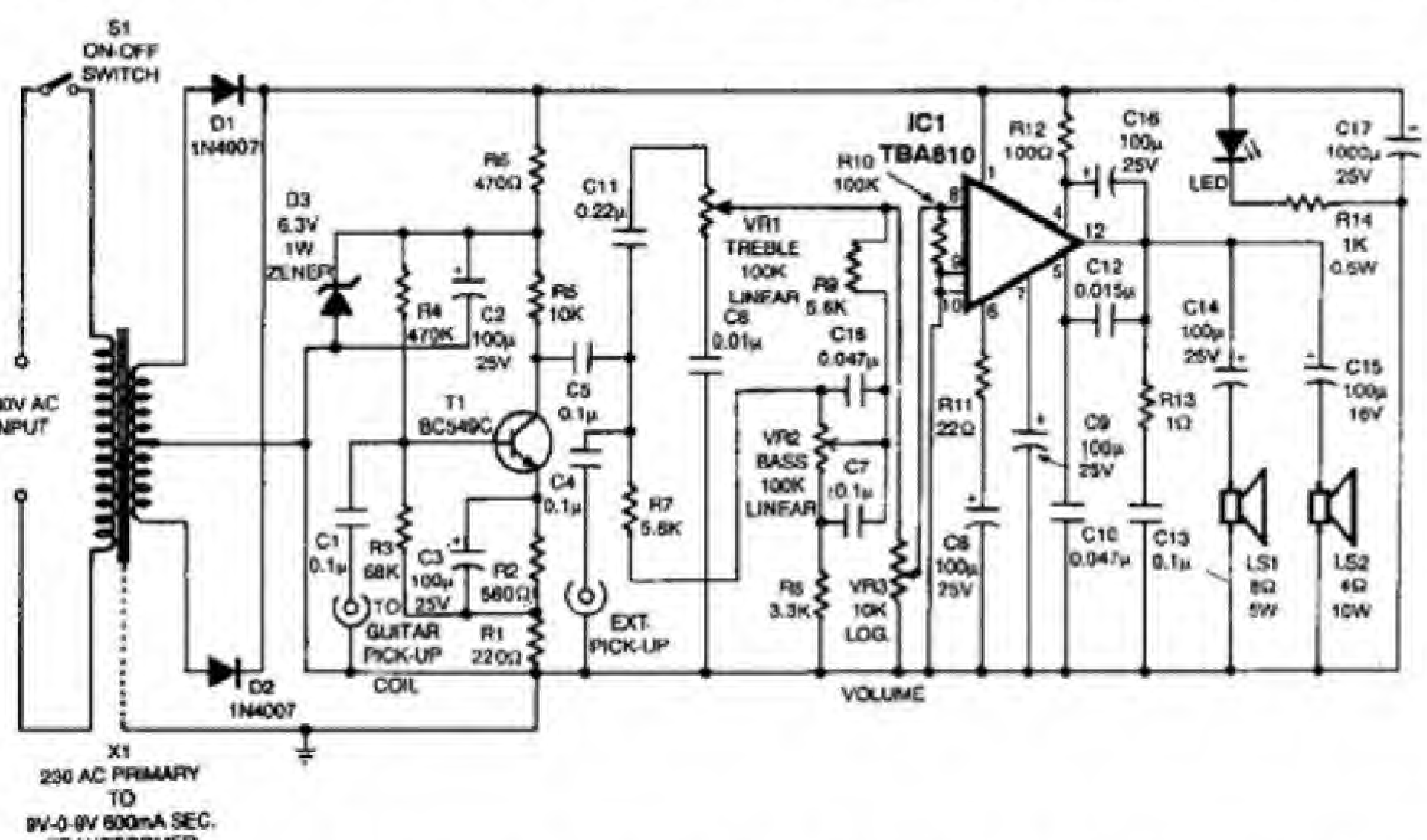
Pick-up coil, the heart of the unit, is available in musical instrument shops as a 'magnetic touch pick-up for Hawain guitars'. Its price varies from Rs 70 to as much as Rs 120. Only a good-quality, high-gain pick-up should be used.

After assembling the circuit, for testing, switch it on and hit the pick-up gently with a screwdriver. This should produce some amplified sound.

After having tested it satisfactorily, you may place the pick-up coil of the unit below the strings of the guitar, about 2.5 cms away from the resonance hole, towards the bridge side of the guitar. Play the guitar and find out the optimum position for finally mounting the pick-up coil.

Always maintain sufficient distance between the guitar and the speaker to avoid feedback (a shrill sound). While operating on AC mains, ensure that a good earth connection exists, or else humming sound will be produced. This humming sound will disappear if you touch the chassis of the unit.

With the volume control at the maximum, the unit should give about 7 watts of noiseless PMPO.

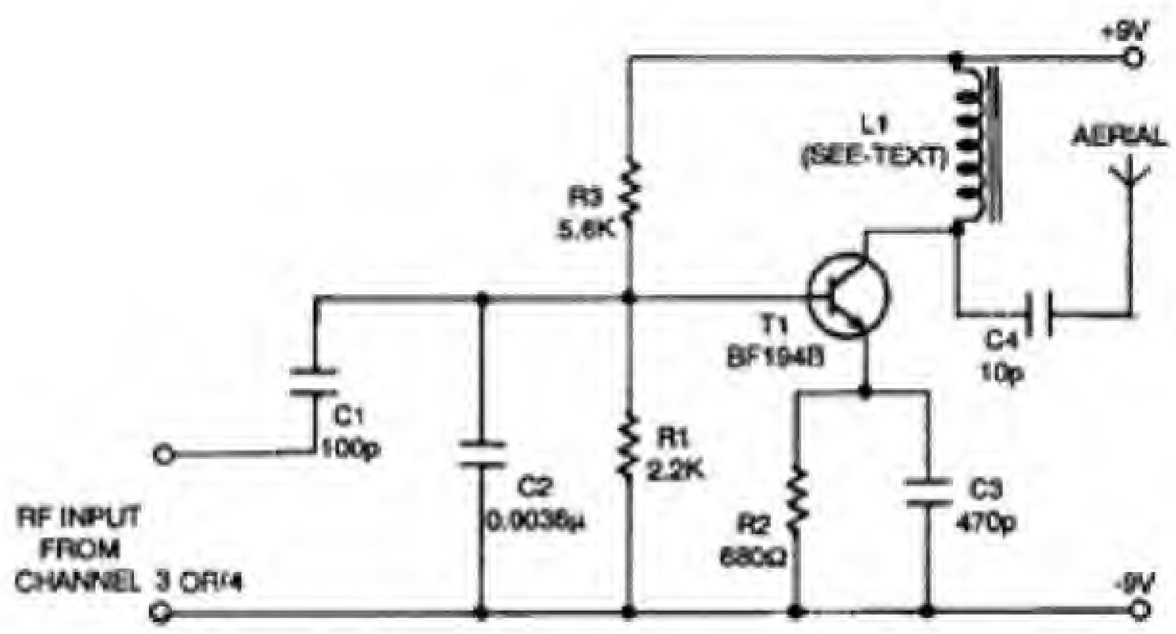


Video Transmitter

Y.D.Nanadan

This circuit can be used to transmit the signals of channels 3 or 4 of Doordarshan TV up to 15 to 20 metres.

The circuit is wired around an npn HF transistor. Channel 3 signal from a



VCR or VCP is fed at the base of the transistor through a coupling capacitor. The output is taken from its collector and given to the coil for transmission through an antenna.

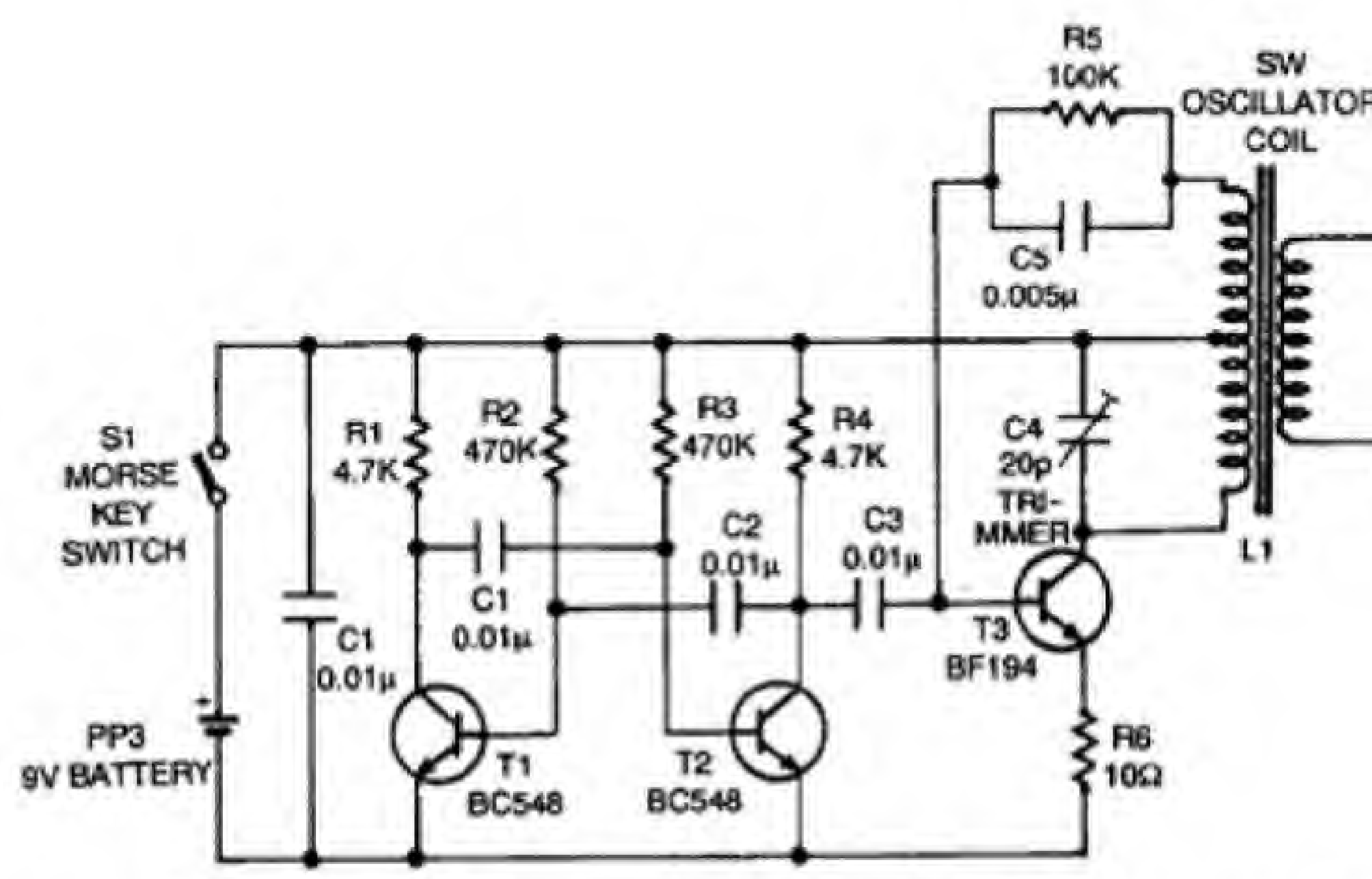
The antenna should be a shielded wire of not more than two metres. The coil should be made carefully by winding 10 turns of 24SWG copper wire over an 8mm coil former.

Wireless Code Practice Oscillator

Pradeep G.

Hams (amateur radio enthusiasts) practice Morse code using an AF oscillator with loudspeaker. Using the CPO (code practice oscillator) circuit shown here, the need for a loudspeaker can be eliminated.

The AF signal is generated here by astable multivibrator wired around transistors T1 and T2. The signal is modulated with RF signal generated through transistor T3. These signals can be received on a shortwave radio receiver placed nearby (within 10 metres). No wiring is required between the CPO and the receiver.



L1 is an ordinary shortwave oscillator coil with a movable ferrite rod. The Morse key may be connected in series with the battery, as shown. The circuit can be housed in a plastic soap-box; it should not be enclosed in a metallic box.

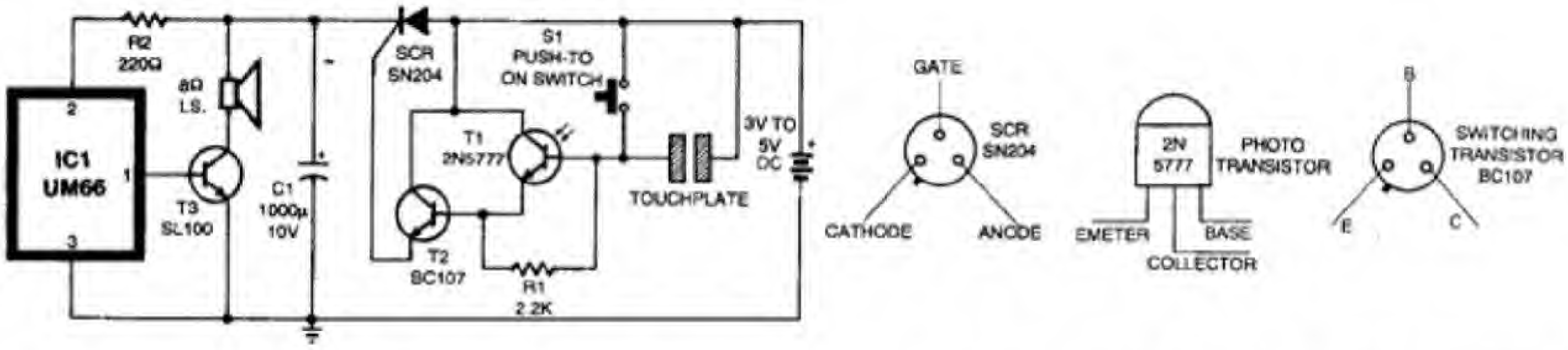
The circuit would cost around Rs 15, excluding the battery. Instead of a 9V PP3 battery, four to six cells in series may be used.

Light and Touch-Operated Musical Bell

Shashi Babu Thawait

This novel circuit uses a phototransistor (T1) with an npn transistor in emitter-follower mode to increase sensitivity of the circuit. So even if very little light falls on the photo-transistor, it gives a triggering pulse to SCR gate and the SCR starts conducting.

When SCR conducts, IC UM66 starts producing music. After the music has halted, no current flows through the SCR and the SCR switches off, till the light falls once again on the photo-



transistor.

If a touch-plate is inserted in parallel to switch S1, as shown in the circuit, whenever the plate is touched by someone it gives a triggering pulse to the SCR which again produces music through the IC. So the same circuit can be operated either by light or touch. Pushbutton switch S1 permits the circuit to be operated in the normal way, i.e. by pushing the bell switch.

The circuit would cost approximately Rs 50.

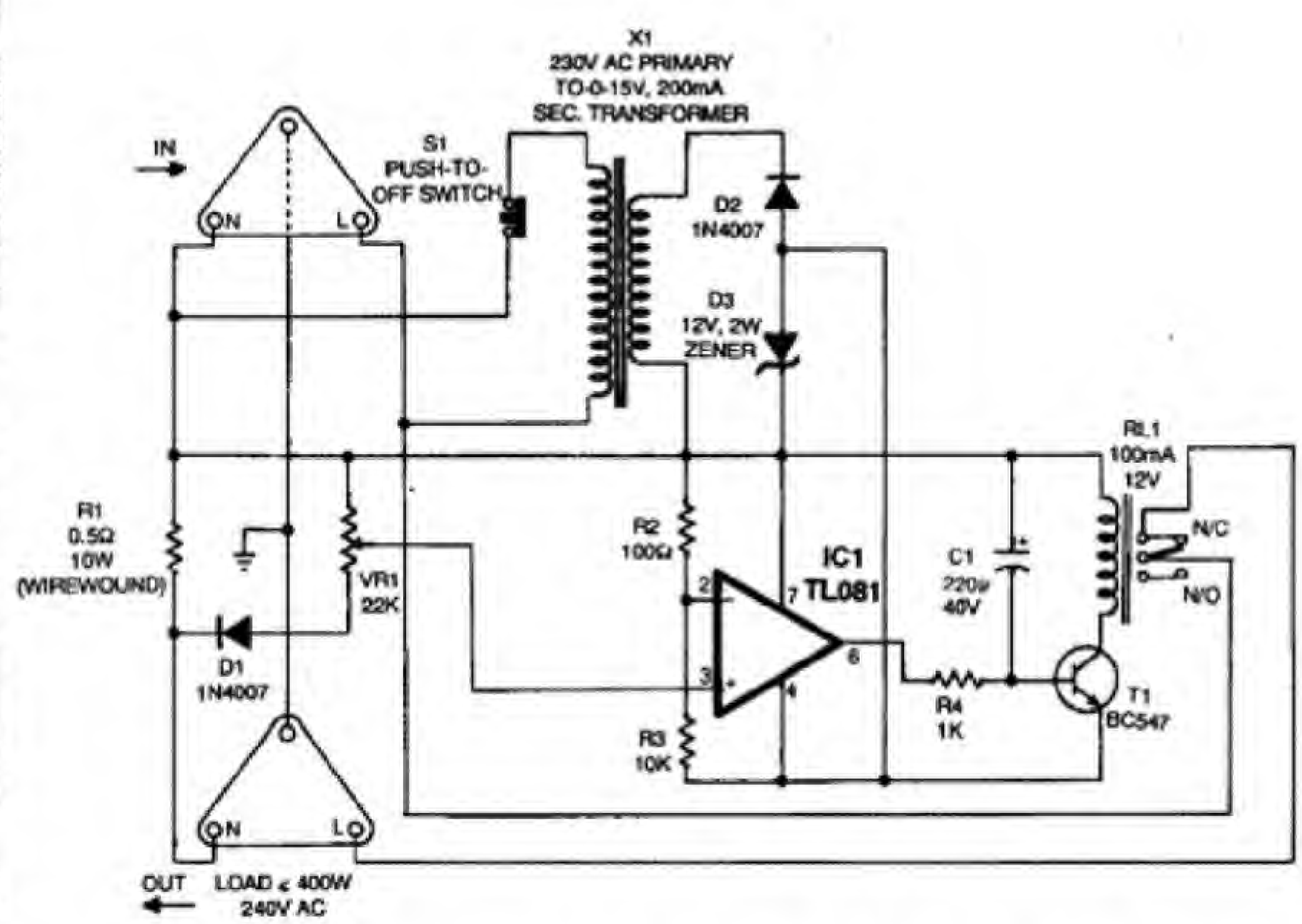
Electronic Fuse

Amrit Bir Tiwana

Fuse protection for electronic circuits seems to be an outmoded idea, for there are circuits (in computers etc) that consume high currents initially at power-on which later reduce to a lower stable value. In case higher rated fuses are employed in such equipment to accommodate the initial surge currents, it defeats the very purpose of protection. Slow-blow fuses often turn out to be too slow while quick-action fuses may blow out at the mere hint of a surge.

An electronic fuse of the kind described here provides an ideal solution in such cases. It offers another advantage as replacing of a fuse in this case is done at the mere pressing of a button.

The circuit has a 'slow-blow' feature. When a gadget draws more than the prescribed current, the circuit monitors it for some time, and if the situation persists it 'blows up' the fuse.



The circuit uses a JFET type TLO81 op-amp. A small reference voltage is set up across the IC's inverting input, and in case the sample voltage fed across resistor R1 (in series with the load) exceeds it, the output is taken high and the relay energised to disconnect the load.

In case it is desired to latch up the relay, a twin-contact relay may be used. The other set of contacts in that case can be wired in parallel to the emitter/collector of transistor T1.

The assembled circuit can be mounted on the upper stack of the transformer, whereas the relay can be placed at the point where the switch would have been.

Readers' Comments:

The 'Electronic Fuse' circuit published in EFY Dec.'92 issue provides overload protection and does not blow out for over current due to earth fault because of resistor R1 present in neutral line. Can we use R1 in series with the line R1 may be used in live wire instead of neutral wire.

Since resistors of values lower than those specified are not easily available, the load at a higher rating is not feasible, whereas by parallel connections it is possible to raise the specified limit significantly.

Also this circuit is meant for AC supply only. wire instead of neutral to detect over current due to earth fault?

How can the operational load of the fuse be increased?

Is it possible to use this fuse for DC supply as well as AC?

RAMESHWAR
Itarsi (M.P.)

The author, Mr Amrit Bir Tiwana, replies:

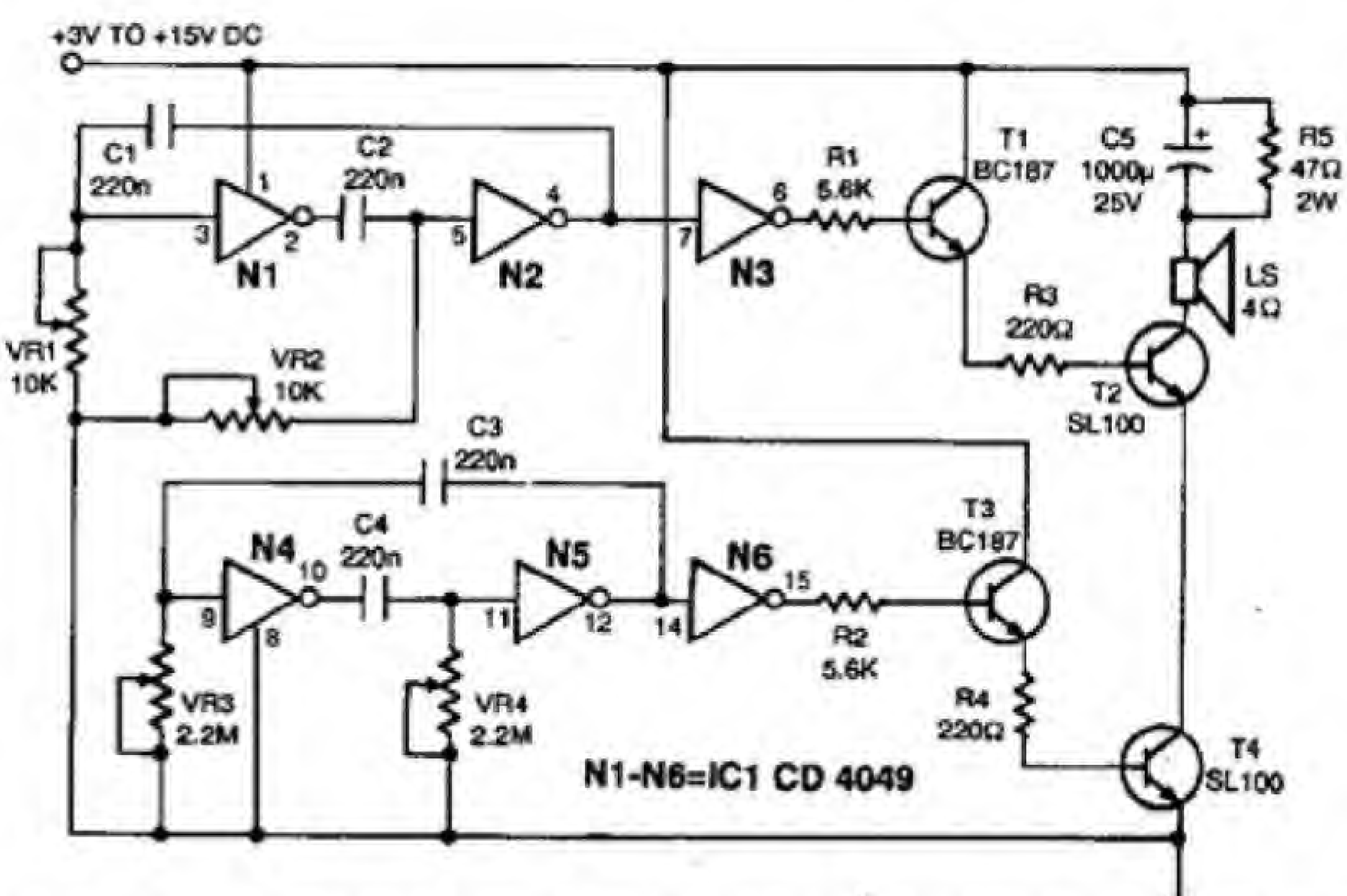
R1 may be used in livewire instead of neutral wire.

Since resistors of values lower than those specified are not easily available, the load at connections it is possible to raise the specified limit significantly.

This circuit is meant for AC supply only.

Multisound Buzzer

Kalpesh T.Dalwadi



The circuit presented here is built around CD4049 CMOS inverters. Basically, the circuit comprises HF and LF oscillators. An HF oscillator produces different audio frequencies by properly adjusting potentiometers VR1 and VR2, while tone is produced by the LF oscillator. The latter may be continuous or interrupted, and can be adjusted using potentiometers VR3 and VR4.

N1 and N2, along with VR1, VR2, C1 and C2, form the free-running astable multivibrator which produces the HF sound. The LF oscillator comprises N4, N5, VR3, VR4, C3 and C4. N3 and N6 are used as buffers.

Transistors T1 through T4 form AND logic and also drive the 16-ohm speaker. Different sounds such as a bird's, a cricket's and a rising/falling siren's can be produced by properly adjusing potentiometers VR1 through VR4.

The circuit can be fitted in any system that needs an aural indication. To enhance the volume, while keeping the current consumption low, connect the speaker as shown in the diagram (optional).

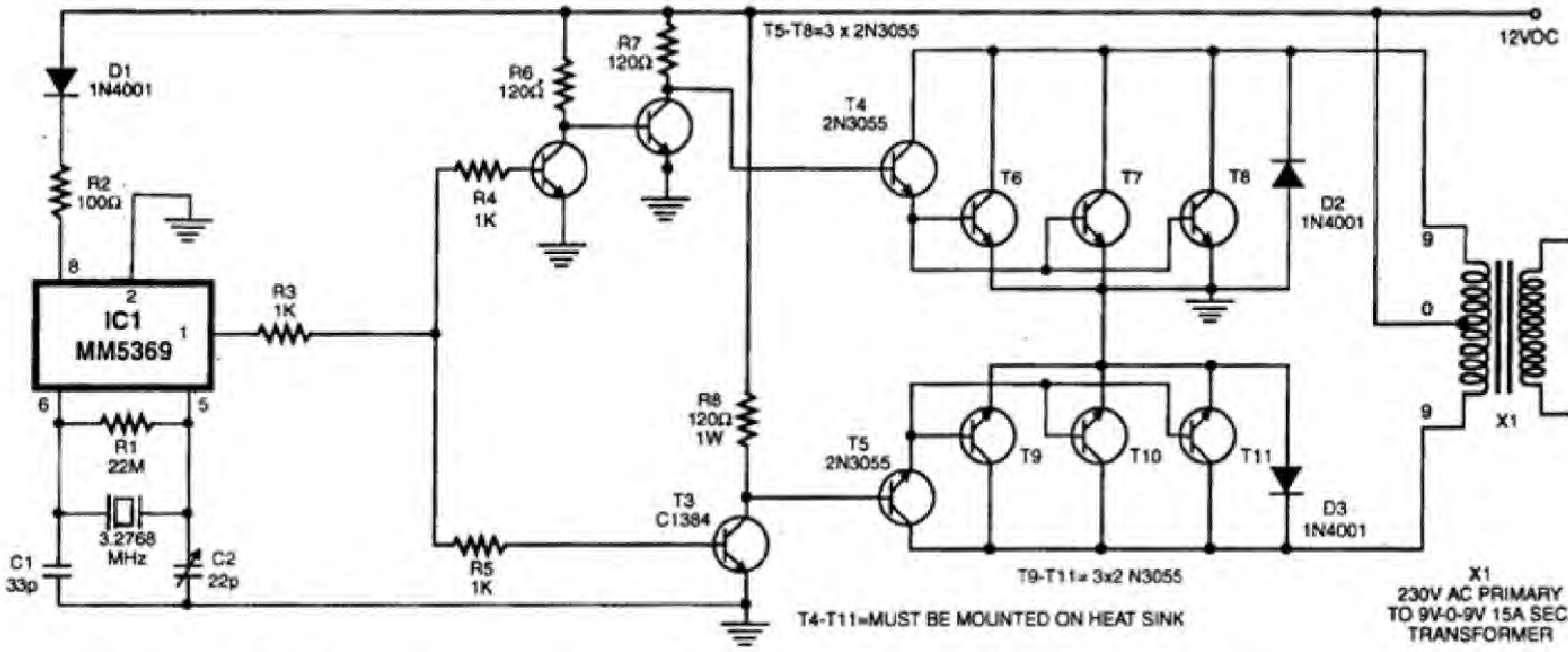
Crystal Controlled Inverter

Manu Abraham

The inverter presented here provides a stable output frequency even when there is a change in the DC voltage applied to the inverter. This stable output frequency is derived from a 3.2768

The crystal operates in its fundamental mode with a frequency of 3,276,800 Hz. C2 the trimmer can be used to adjust the damping in the network and cause a small change in the

of transistor T2. Transistors T4 & T6, T7, T8 and T5 & T9, T10, T11 are connected as darlington pair configurations. The advantage is that the transistors T4 & T5 provide enough base drive



MHz crystal. The heart of the circuit is the popular flip flop IC MM 5369 which is a commonly used timebase circuit. The crystal oscillates at its fundamental frequency of 3,276,800 Hz. MM5369 chip contains a cascade of 16 flip flops. Due to this the chip is used as by 16 counter in other words, the chip divides the input frequency by a factor of 2^{16} times. Thus we get an output frequency

i.e. 3,276,800 Hz/2^{16} = 50 Hz.

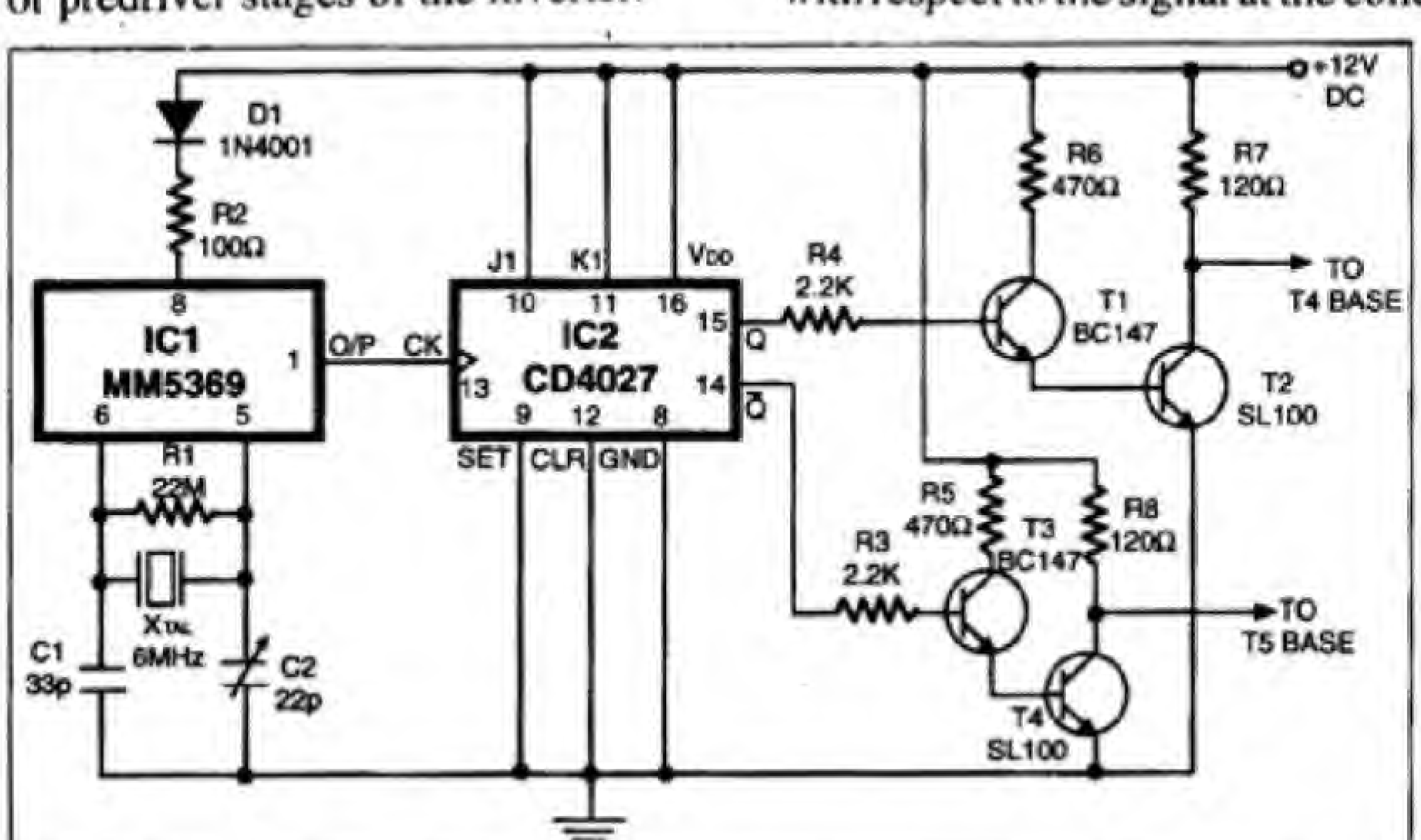
This frequency is available at pin 1 of the flip flop. The resonant frequency of the crystal can be adjusted by means of the trimmer capacitor. The CMOS chip (MM 5369) cannot deliver or sink more than 10mA, therefore a current amplifier is necessary to drive the driver or predriver stages of the inverter.

frequency of oscillation of crystal. Capacitor C1 is used to balance the network, so as to compensate for C2. R1 is used as a load so as to maintain the crystal oscillating in its fundamental mode of operation. Resistor R2 is used to limit the current flowing through the chip. Diode D1 serves as a protection for the CMOS chip in event of a reversal of polarities at the battery terminal.

Resistors R3, R4 and R5 are used to split the current so as to ensure that each transistor gets its share of base drive from the chip. Transistor T1 and T2 are connected as inverters, such that the total inversion produced by them is 360° or 0°. Transistor T3 is also connected as an inverter and the output at the collector of T3 is at a phase difference of 180° with respect to the signal at the collector for the power stages flows through the transformer which is connected to the collectors of T4 and T5. Since this additional current flows through the transformer rather than through resistors and dissipated as heat in them, it causes an increase in the efficiency of the inverter. Diodes D2 and D3 are used to protect the power stages from excessive PIV generated in the transformer due to the switching action of the power transistors.

The transformer is a step up type 270VA with a primary of 9V-0V-9V/15A and a secondary of 230V. It can be bought readymade as a usual 230V 9-0-9V/15A, 270VA step down transformer which is used in the circuit exactly the other way round and works satisfactorily.

Tech Editors' Note: It is observed that the division factor of IC1 (MM5369) is not 2^{16} = 65536 but 60,000 and its frequency using a Xtal of 3.2768MHz equals 54.6Hz. To obtain an exact frequency of 50Hz, one may use a Xtal of 6MHz to obtain 100Hz and follow it up by a flip-flop to obtain a symmetrical (square wave) 50Hz output. The modification is given here in the above figure.



Modified circuit of crystal controlled inverter

Top 20 Projects (Out of 105)

- Full Featured Touch Control Programmable Power Supply
- Digital Frequency Counter
- Clap-operated Remote Control for Fans
- Digital Volume Control
- Electronic Number Shooting Game
- The Universal Timer
- Digital Car Lock with Alarm
- Electronic Switch Starter
- Staircase Light Switch
- Conversion of DMM into Frequency Counter
- Battery Charger with Overcharge and Deep-discharge Protection
- Electronic Ballast for Tubelight
- Self Switching-off Power Supply
- Telephone Amplifier cum Broadcaster
- Fully Automatic Induction Motor Starter
- Programmable Frequency Multiplier Using PLL565
- Rain Sound Generator
- Automatic Suction Tank Motor Controller
- Video Transmitter
- Light and Touch-operated Music Bell
- Multisound Buzzer

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