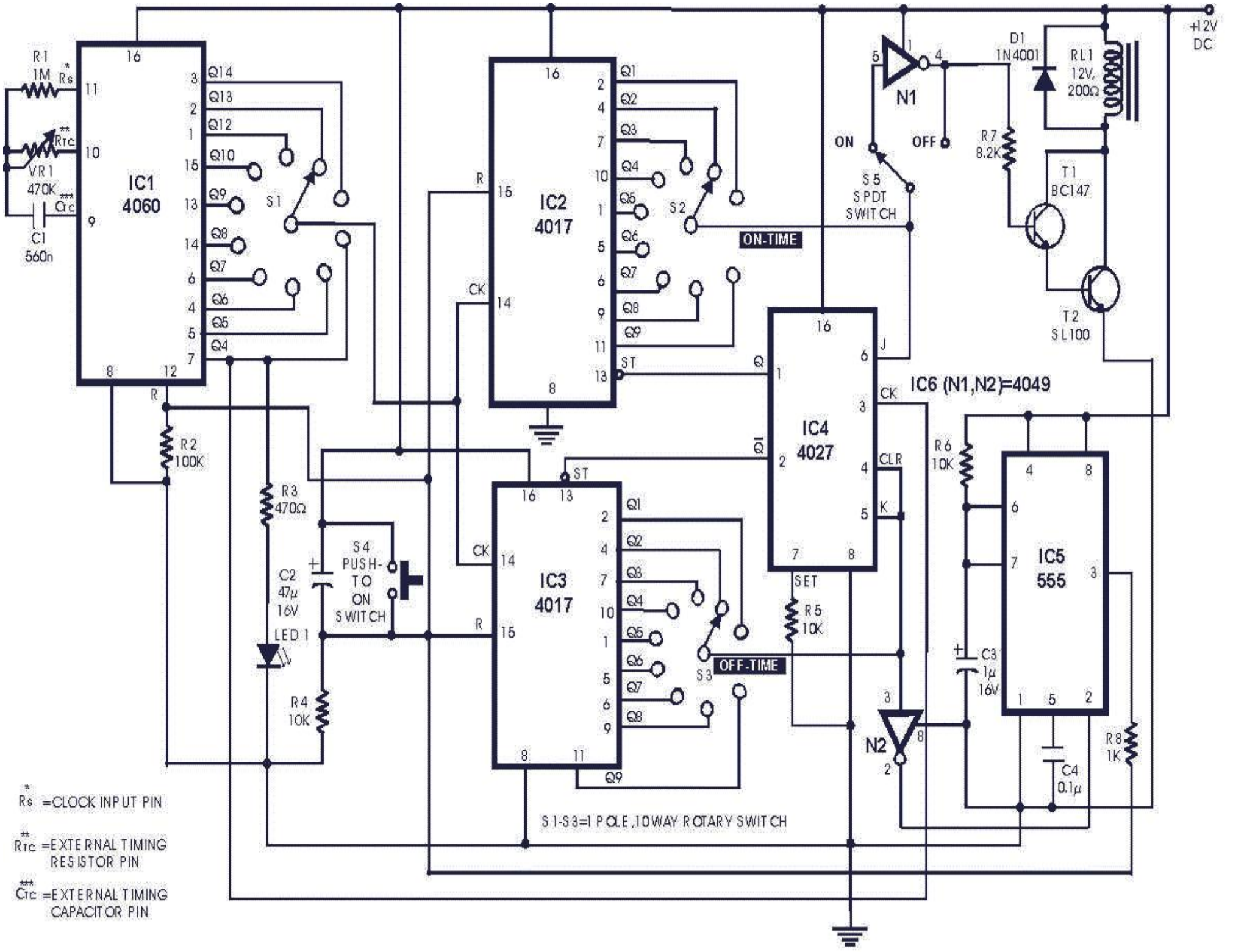
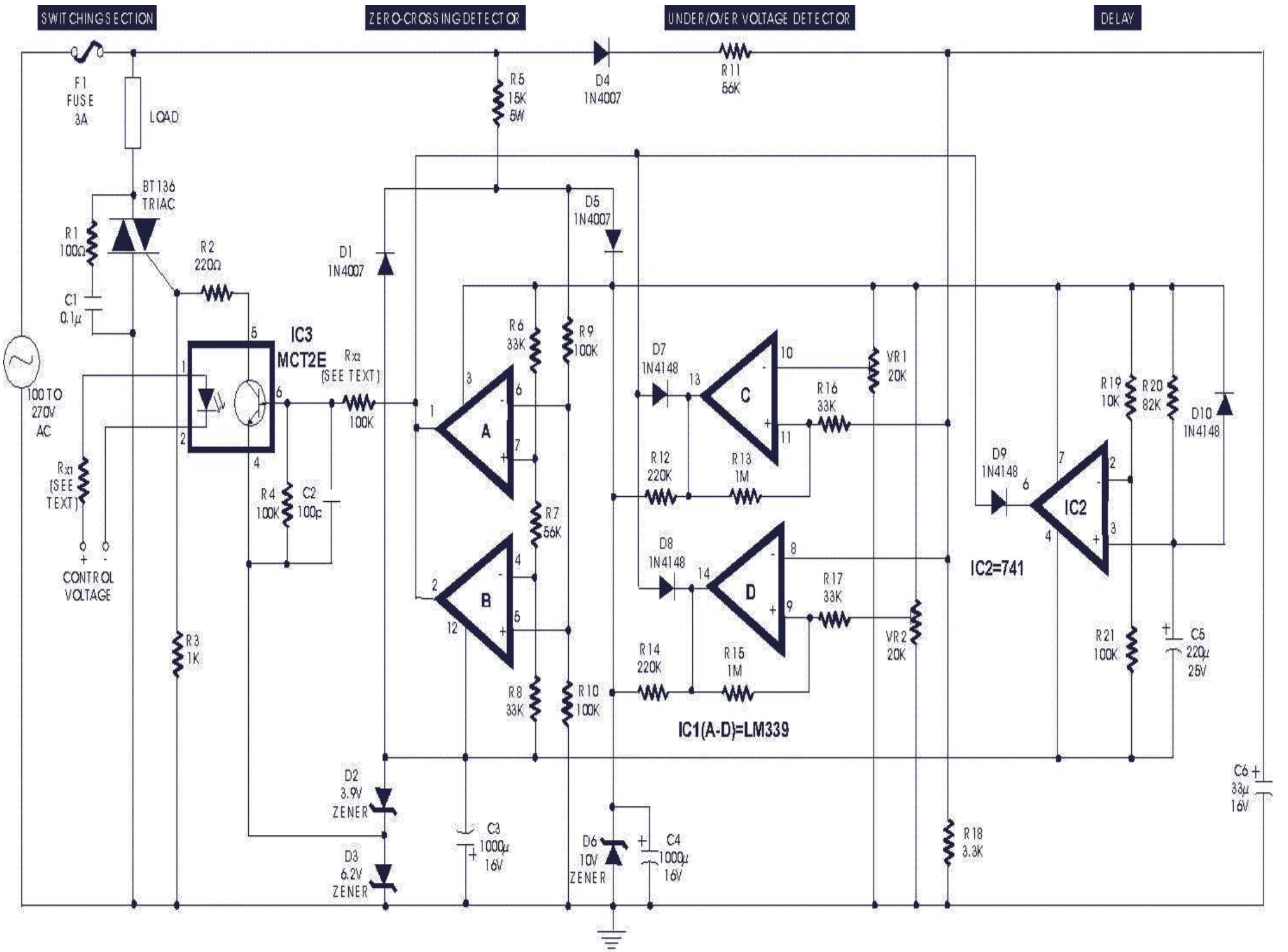


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SOLIDSTATE RELAY WITH UNDER/OVER VOLTAGE PROTECTION

Electomechanical relays suffer

from the disadvantages of mak-
ing undesired audio noise and generating radio frequency interference during changeover of contacts, accompanied by sparking. Besides, the switching speed of electromecanical relays is comparatively very slow due to the mechanical inertia of their moving contacts.
Circuit of a solidstate relay for loads operated from AC mains is presented here. It incorporates such features as cutting off of the load on sensing under or over voltage conditions of the mains supply to the load, delayed switching, and provision of suitable isolation between the high voltage and low voltage at control side.
The circuit comprises four sections, viz, delay section, under/over voltage detector, zero crossing detector, and switching section. The outputs of the former three sections are combined to serve as one of the two control inputs for the switching section while the other control voltage is provided externally to switch on the LED of opto-isolator MCT2E (IC3). The external control voltage can either be provided by an independant source or generated from the mains itself.
Two sections (A and B) of the quad comparator LM339 (IC1) have been used as zero crossing detector while the other two sections (C and D) have been used as under and over voltage detectors. IC2 (op-amp 741) used in the delay section has also been configured as a comparator.
The positive and negative supply voltages for IC1 and IC2 have been derived from the mains using zeners D2 and D3 (in series), and D6 in conjunction with resistor R5 (15 kilo-ohm, 5-watt) and diodes D1 and D5. Both the voltages are smoothed by filter capacitors. The voltage developed across 6.2V zener D3 is used as supply for the transistor within opto-coupler MCT2E. The functioning of the various sections is as follows:
The switching of the supply to the load here is accomplished via triac BT136. Actually the triac cannot be triggered at zero volts as its on-state current needs to be greater than its holding current. Therefore a limit of ± 10 volts (approx. 3% of peak) may be construed as zero for the zero-crossing detector circuit configured around comparators A and B. The reference voltage derived from -10 and +10 volts supply developed across capacitors C3 and C4 is applied to pins 7 and 4 through resistors R6 through R8 while mains sample is applied to pins 6 and 5 via resistors R5, R9, and R10. Since these comparators have open collector output, their output pins have been shorted for logical AND operation. During the short zero crossing period, the transistor within MCT2E could conduct, provided the output of comparators C and D and of IC2 is not low (negative) during the zero-crossing period. Otherwise the output of comparators A and B will sink towards a negative voltage and
MCT2E transistor will not be able to conduct.
The reference voltage for comparators C and D of this section is derived from +10 volts developed across capacitor C4. The reference voltage can be varied with the help of presets VR1 and VR2. Sampled mains voltage developed across R18 and smoothed by capacitor C6 is common for both these comparators. Positive feedback in these comparators is meant to provide schmitt trigger action for providing necessary hysterisis. Resistors R12 and R14 are the pull-up resistors connected to +10V. The output devices of both the comparators will be off within a range of voltages and the cathodes of diodes D7 and D8 are held high (blocking state). If the input mains sampled voltage exceeds reference voltage of comparator C, or is less than reference voltage of comparator D, the output device of corresponding comparator is ‘on’ and cathode of D7 (or D8) is held at negative potential. This will cause the combined junction of all comparators to go negative and hence MCT2E transistor will not be able to conduct during zero-crossings. The high or over voltage and low or under voltage limits can be set with the help of presets VR1 and VR2, respectively.
IC2 pin 2 is set to a reference potential with the help of resistors R19 and R21 connected across +10 and
-10 volts supply. On switching on the power supply to the circuit, capacitor C5 slowly charges via resistor R20. Till the potential across capacitor C5 or pin 3 of IC2 is below that of reference pin 2, IC2 ouput is low (negative), which does not permit MCT2E transistor to conduct during the power-on delay period.
Diode D10 allows fast discharge of capacitor C5 during mains failures. Delay provided by this circuit is approx. one minute. This period can be changed by changing values of capacitor C5 or resistor R20.
Resistor R1 and capacitor C1 across triac act as snubber network which protects the triac from transients and improves its switching efficiency.
If the mains voltage is within the set limits and the initial power-on delay period is over, the MCT2E transistor will conduct during zero-crossing periods and fire the triac if external con
rol votage passes approximately 15 mA of current through LED of MCT2E opto-coupler via resistor RX1. Value of RX1 can be calculated from the formula:
RX1 = Vcontrol/15 kilo-ohms.
RX2 is to be test selected between 10 and 100 kilo-ohms to set the threshold value for conduction of MCT2E and firing of the triac under circuit control.
Triac BT136 is specified for a current rating of 4 amperes or a load of 500 watts at the mains voltage of 220 to 250 volts AC. For higher loads up to 16 amperes, or about 3kW load, BT139 may be used.
It is to be noted that zero-volt-crossing switching cannot be accomplished for inductive loads because of phase difference between voltage and current. A power factor correcting capacitor may therefore be connected in parallel to the load to achieve near-unity power factor.
The circuit possesses fast switching characteristics and even a single cycle of AC mains can be supplied to the load. Thus this circuit can be usefully employed in proportional control of power, typically in temperature control systems.
In this circuit the triac is triggered in two different modes. During positive half cycles it is triggered in Mode I- while during negative half cycles it is triggered in Mode III-. Table I depicts the various modes of operation of a triac along with typical turn-on gate current requirement. For proper heat dissipation the triac may be mounted on a heatsink.



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Musical Bell

The circuit presented here is that
of a musical bell which may be
programmed for generation of a number of musical notes. The complete working of the circuit is explained below.
IC1 timer (NE555) is wired as an astable multivibrator operating in audio band. Frequency of the timer IC may be varied with the help of potmeter VR1. The output of IC1 at the selected frequency of operation is coupled to the clock input of IC2 (CD4017). IC2 divides the input frequency by an integer 'n'. The value of 'n' depends on its output pin number which is connected to its own reset pin 15. In this circuit the maximum value of 'n' that may be selected is 8. This selection is carried out with the help of CD4051 (IC3) which is a CMOS 8-input analogue multiplexer whose function here is to make an electrical connection between specified output of IC2 and pin 15 of IC2 . The output of IC2, which is connected to its pin 15, depends on the binary number present at the address input pins 9 through 11 of IC3 CD4051. Thus by changing the binary number applied to the address control input of IC3, the value of 'n' as also the frequency division ratio can be changed.
The final output Q1 after frequency division available at pin 2 of IC2 is amplified by transistor T1(SL100). Different frequency division ratios produce different tones from the speaker. The different tones are connected serially in a particular sequence to produce various musical notes. This is achieved through IC4 (CD4060) which is a 14-bit binary counter. Delay time of tone is adjusted with the help of potmeter VR2. Changing the arrangement of tones in the sequence (and also the delay introduced in each tone) will result into different musical notes. Switches S1, S2 and S3 serve this purpose.
Try different positions of switches S1, S2 and S3 and delay control potmeter VR2 to abtain different notes into the speaker. Use potmeter VR1 to change the tone.

