Design And Construction Of A Remote Controlled Fan Regulator

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ABSTRACT

We have designed a remote controlled fan regulator, which can be used to adjust the speed of the fan by using any kind of remote, most commonly, a TV remote. The device would allow a person to control the speed of a fan by simply pointing the remote towards a sensor and then pressing any key. Whereas there have been methods of controlling fan speed using other methods, like using the sound of clapping, our method is by far the cheapest and simplest.

In the final stage, we have done the hardware implementation of the controller by fabricating a printed circuit board.

INTRODUCTION

Fan is an unavoidable electrical appliance in our day to day life. While the basic fan has evolved very little, the methods of controlling its speed have changed vastly, from bulky regulators using resistances, to the present day miniature solid state regulators.

In our paper, we have devised a method to control the fan using a remote. Though there have been ways to control speed using remote, the novelty of our method lies in the fact that any kind of remote can be used to control its speed.

For example, consider a TV remote. Just like the fan, a TV is also considered a basic necessity nowadays. And if there is a TV, there is a remote. This remote can used to control the fan speed. Thus it is a universal method.

This innovation is highly recommendable for elder people, who have problems like arthritis, and cannot walk to the switch board to change the speed. It is also a great benefit to sick people.

CONCEPT

The block diagram of the remote controlled fan regulator is given below:

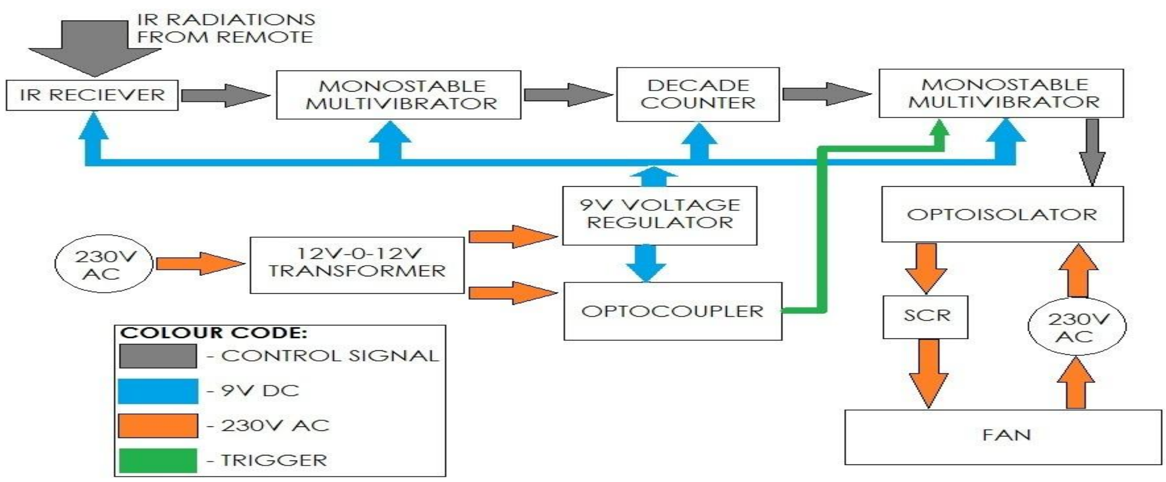

Figure 1: Block diagram of Remote Controlled Fan Regulator

- **Receiver Module**: The receiver is made from a commonly available TSOP1738 IR receiver. It converts the IR signal into an electrical signal and is fed in the monostable multivibrator module. It needs a supply voltage of 4.5V-5.5V DC. However, since we use 9V DC on the board, we use a 5.1V Zener diode to bring the supply voltage to operable limits.

- **Monostable Multivibrator**: Both the monostable multivibrators consist of the popular NE555 timer IC. They are wired in the monostable mode. Their function is to fire a single pulse, of known width, from their output when there is a trigger signal from the preceding blocks. While, for the first multivibrator, trigger is sent from the IR receiver, for the second multivibrator, trigger is sent from the Opto-coupler.

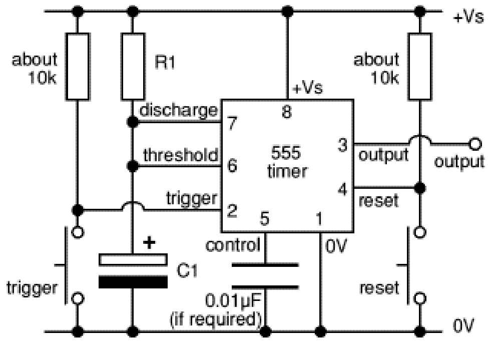

Figure 2: Monostable mode of operation of NE555 IC

- **Counter Module**: It consists of a CD4017 decade counter IC. It has one input pin, ten outputs pins from Q0 to Q9 and one reset pin. Here, we are using the outputs Q0 – Q4, and shorting Q6 and reset pins. The outputs Q0 – Q4 are routed to the threshold-discharge pins of the second multivibrator via a resistor and capacitor network. The resistances R5 – R9 and the capacitance C5 fix the output pulse width of the multivibrator.

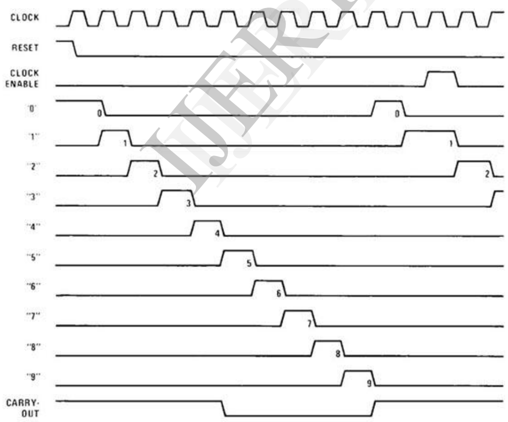

Figure 3: Timing diagram of CD4017 Decade Counter IC

- **Opto-isolator**: The main purpose of an Opto-isolator is to prevent high voltages or rapidly changing voltages on one side of the circuit from damaging components or distorting transmissions on the other side. In our project we use a MOC3021 opto-isolator IC to control the 230V AC voltage on the load using a low voltage signal from the second multivibrator. However, the two stages have a complete electrical isolation.

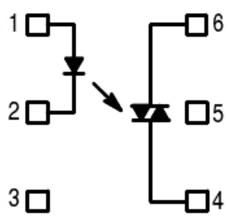

Figure 4: Internal structure of MOC3021

- **Opto-coupler**: It is essentially an Opto-isolator, but functioning as a zero detector. It sends out pulses when it detects a zero crossing on the stepped down input 12V AC line. These pulses are used to trigger the second multivibrator. We use the opto-coupler IC MC2TE.

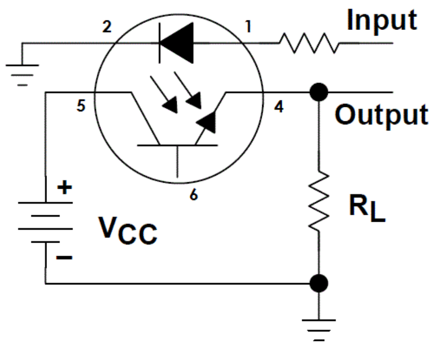

Figure 5: Internal structure of MC2TE

- **Triac module**: We are using a BT136 triac to control the fan speed, using the MOC3021 Opto-isolator to trigger it. Since we do not have any beforehand experience of working with 230V AC, the application circuit is as directed by manufacturers on their datasheet with little modification.

- **Voltage Regulator**: We need a low voltage for power supply to entire low voltage control circuit. We step down the 230V AC to 12V-0-12V using a centre tapped transformer. This voltage is rectified to DC and using a LM7809 IC, converted to 9V DC which is used to power the control circuitry.

WORKING OF THE CIRCUIT

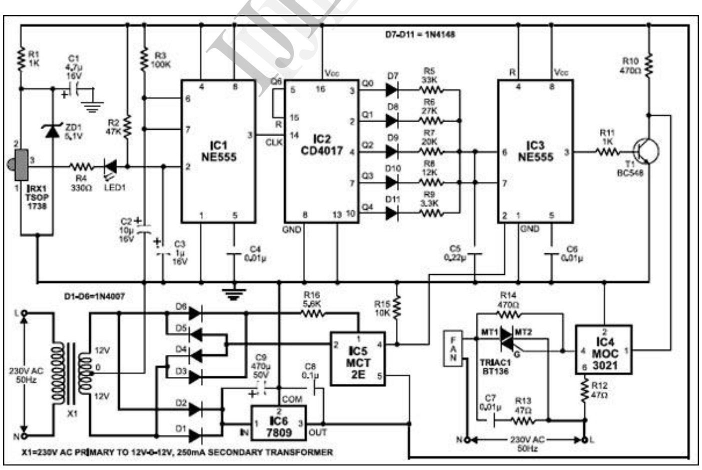

Figure 6: Circuit Diagram

- ➢ When a key is pressed on the remote, an infrared pulse (typically in the range of 36 kHz) is emitted from the remote. The receiver module converts the IR pulse to an electrical signal, which is used to trigger the first monostable multivibrator.
- ➢ The multivibrator stage produces an output pulse whose width is precise and equal to $1.1xR_3xC_2$. This pulse is coupled to the counter clock input.
- ➢ The counter is a decade counter, using the CD4017. Out of the ten outputs of decade counter IC2 (Q0 through Q9), only five (Q0 through Q4) are used to control the fan. Q5 output is not used, while Q6 output is used to reset the counter.
- ➢ As a pulse arrives at the clock input of the counter, the output changes from its present state to the next state, as illustrated in Figure 3. As the remote button are pressed, the counter output changes from (say,) Q0 to Q5. Now, when the remote button is pressed, the output changes to Q6. However, as Q6 and Reset pin is shorted on the IC, the output resets to Q0.
- ➢ A second NE555 timer IC is also wired as a monostable multivibrator. The output from the counter is applied to resistors R5 through R9. If Q0 is high, capacitor C5 is charged through resistor R5; if Q1 is high, C5 is charged through resistor R6, and so on. Combination of one of the resistors R5 - R9 and capacitor C5 controls the pulse width of this timer block. This timer block is triggered by pulses from the Opto-coupler MCT2E IC.

- The Opto-coupler MCT2E serves as a zero crossing detector and fires pulses whenever the input 12V AC supply crosses zero. Thus it fires pulses at a rate of 50Hz and triggers the timer block. This setup is used to get a continuous pulse train from the monostable multivibrator, whose pulse width is determined by R5 - R9 & C5 network.
- The pulse train is supplied to an Opto-isolator, MOC3021 (IC4). The MOC3021 drives the triac BT136. Resistor R13 and capacitor C7 combination is used as snubber network for the triac. The triac network ultimately drives the fan.
- As keys are pressed on the remote, the output from CD4017 advances from Q0 to Q4. The width of the pulse from the second multivibrator decreases, firing angle of the triac increases and in turn the speed of the fan increases. Thus the speed of the fan increases when we press any button on the remote control. When the output of CD4017 is at Q5, there is no output and fan is turned off.
- The circuit is powered by regulated 9V. The 230V AC is stepped down by transformer X1 to deliver a secondary output of 12V-0-12V. The transformer output is rectified by full-wave rectifier comprising diodes D1 and D2, filtered by capacitor C9 and regulated by LM7809 regulator to provide 9V regulated output.

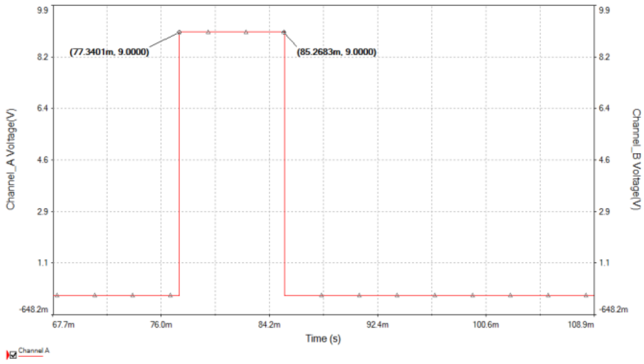

Figure 7: Monostable operation

RESULTS AND DISCUSSIONS

Output from CD4017 IC	Pulse Width of NE555 (t=1.1RC)	Fan Speed
Q0	7.26ms	5 (Lowest)
Q1	5.94ms	4
Q2	4.4ms	3
Q3	2.64ms	2
Q4	0.726ms	1 (Highest)
Q5	0	Off
Q6 -> Q0 (Reset)	7.26ms	5

Table 1: CD4017 output and respective fan speed

- **SOFTWARE SIMULATION:** The software simulation using MultiSim allowed use to efficiently design the circuit without going into hardware.
  Given below are some of the instances of circuit simulation and waveform observation using MultiSim.

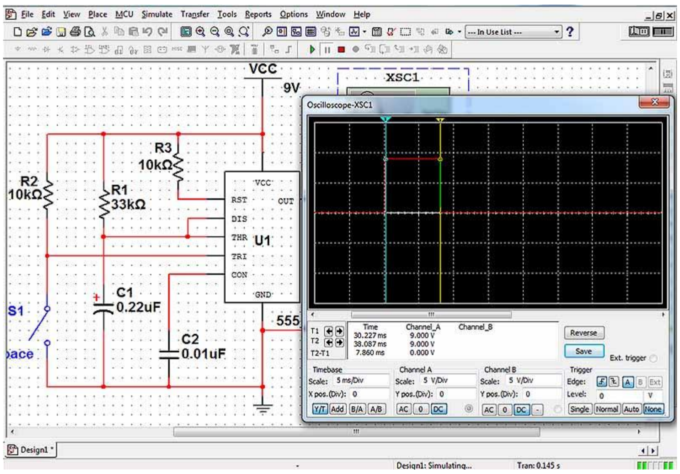

Figure 7: Simulation of 555 monostable block

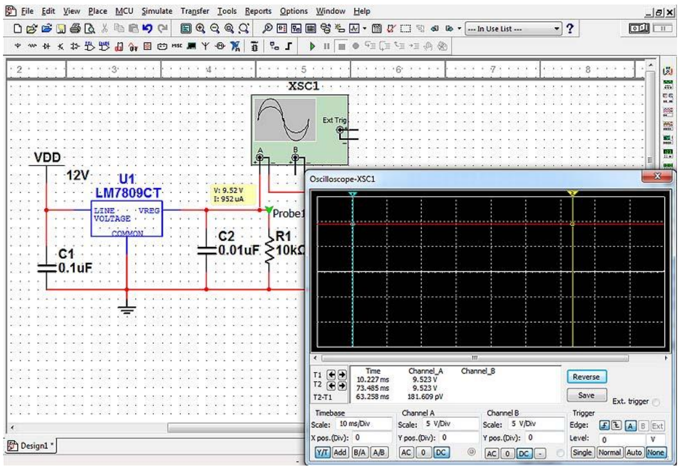

Figure 8: MultiSim simulation of voltage regulator block

- **PRINTED CIRCUIT BOARD**: We have designed a prototype of our fan regulator on a printed circuit board. We have designed the layout in a software Eagle CAD and have used a solution of **H_20_2 + HCl** in the ratio of 2:1 respectively for etching purpose.

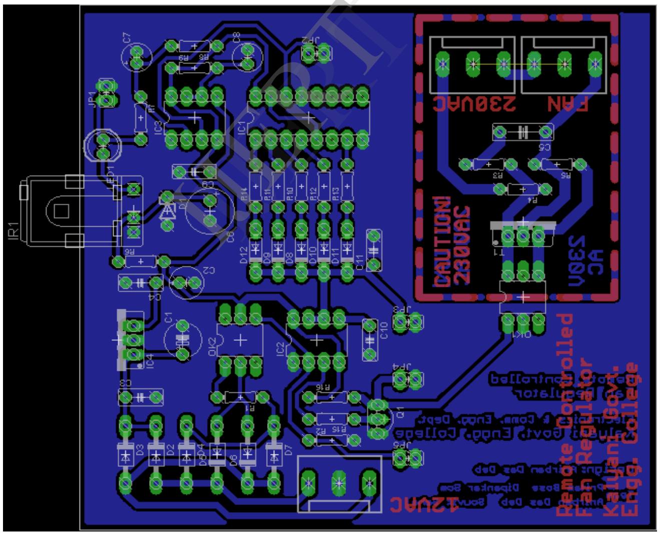

Figure: Printed Circuit Board

ENVIRONMENTAL IMPACT ASSESSMENT

Environmental Impact Assessment was a crucial step in PCB fabrication due to the use of Hydrogen Peroxide [H_20_2] and Hydrochloric Acid [HCl] which are hazardous to some extent. Copper is also very harmful to the environment.

However, this is where the advantage of our etching solution comes into light. **The H_20_2 + HCl solution that we used was completely recyclable.** During etching, as the etching power of the solution diminishes, the clear solution turns greenish. When the etching rate falls below acceptable rates, we simply add more H_20_2 till the solution turns colourless, and we can etch again.

This property is indeed useful as it reduces wastage to a great extent and is perfect for low budget, small scale etching processes.

In case one does need to dispose the spent solution, it poses least problem. This is because of the low quality of commercial chemicals available in the local market. Their concentration is very low and if properly diluted, it can be properly disposed.

ADVANTAGES

The advantages of the remote controlled fan regulator are:

- The circuit uses commonly available components and thus the ultimate production cost will be cheaper than other substitutes available in the market.
- The circuit uses the whole bandwidth of remote IR, and hence can be controlled by any kind remote.
- The range of remote IR is quite large. Thus the regulator can be controlled across a large room.
- Even though we have used five speed levels, 10 different speed levels can be incorporated, with only some minor changes.
- The net power consumption of the circuit is very low due to the usage of digital components in the main modules. The power components like the voltage regulator, SCR, Opto- isolator and Opto-coupler have very low thermal dissipation losses, which will help to increase the lifetime of the module.
- There is no subsequent cost after the installation of the circuit.
- The circuit is maintenance free. When there is a defect, the whole PCB can be replaced.
- The circuit can be powered from the 230V AC line itself.

DISADVANTAGES

The circuit has the following disadvantages:

- IR radiation from remotes is designed to spread to large area. If the regulator sensor is placed near the television/AC, then the fan speed can be changed whenever the remote is pressed for controlling the other device.

REFERENCES

In making this design we have referred to the following books:

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BIBLIOGRAPHY OF AUTHORS

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