ECE251L – Digital Logic Design

Final Project

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Problem Statement;

Problem Statement: The project aims to design a digital fan regulator capable of controlling the speed of fans using an induction motor. The speed control is nonlinear, occurring in discrete steps. The challenge is to implement a circuit that allows the alteration of voltage applied to the fan motor within a range of 130V to 230V RMS in a maximum of seven steps.

Objective:

The objective is to create a digital fan regulator circuit that can effectively vary the speed of an induction motor in discrete steps. This involves utilizing a triac for voltage control, a relaxation oscillator for generating a sawtooth waveform, and an optocoupler (MOC3011) for triac firing angle modulation. The project also aims to achieve electrical isolation between high-voltage and digital sections to ensure user safety.

Design Circuit

The circuit comprises a triac, a relaxation oscillator, an optocoupler, a multiplexer (CD4051), a BCD up-/down-counter (CD4510), NAND gates, and a BCD-to-7-segment decoder (CD4543). The relaxation oscillator generates a sawtooth waveform, which is fed to the triac through the optocoupler for voltage control. The BCD counter controls the firing angle of the triac, and the BCD-to-7-segment decoder displays the step number on a 7-segment display.

Component Information:

The following table summarizes the main components used in the circuit and their functions:

|  |  |
| --- | --- |
| **Component** | **Function** |
| **Triac** | A three-terminal device that can switch AC currents and voltages |
| **Relaxation Oscillator** | A circuit that produces a periodic non-sinusoidal waveform |
| **Optocoupler (MOC3011 and 4N33)** | A device that transfers electrical signals between two isolated circuits using light |
| **Multiplexer (CD4051)** | A device that selects one of eight inputs and routes it to a single output |
| **BCD Up-/Down-Counter (CD4510)** | A device that counts up or down in binary-coded decimal (BCD) format |
| **NAND Gates** | A logic gate that produces a low output only when both inputs are high |
| **BCD-to-7-Segment Decoder (CD4543)** | A device that converts a BCD input to a 7-segment display output |

Running and Testing

The circuit is powered by a supply derived from rectified mains. The relaxation oscillator’s power supply is maintained through a series resistor (10-kilo-ohm, 10W). The multiplexer, controlled by the BCD counter, varies the pedestal voltage using resistors and optocoupler 4N33. Clock pulses for the BCD counter are generated by astable multivibrators. Testing involves ensuring proper functioning of the relaxation oscillator, BCD counter, and the 7-segment display.

Figure 7. Fnal Circuit Desin.

Results

The circuit successfully controls the speed of the fan motor in discrete steps. The BCD-to-7-segment decoder accurately displays the step number, providing feedback to the user. Electrical isolation between high-voltage and digital sections ensures user safety during operation.

Conclusion

The digital fan regulator project effectively achieves its objective of controlling the speed of a fan using an induction motor in nonlinear steps. The implemented circuit, with its components and design choices, provides a safe and reliable solution for fan speed regulation.

References

The design and implementation are based on electronic principles and components widely used in digital electronics. Specific datasheets for components such as the triac, optocouplers, and ICs were referred to during the project. Standard electronics textbooks and online resources on fan control circuits also contributed to the project’s development. Some of the online sources are:

* [Light Controlled Digital Fan Regulator Circuit - Engineering Projects](https://bestengineeringprojects.com/light-controlled-digital-fan-regulator/)
* [Design and Construction of a Remote Controlled Fan Regulator](https://www.ijert.org/research/design-and-construction-of-a-remote-controlled-fan-regulator-IJERTV2IS60472.pdf)
* [Temperature Based Fan Speed Controller - RCC Institute of Information Technology](https://rcciit.org/students_projects/projects/aeie/2018/GR7.pdf)
* *CD4510 - an Up/Down counter with preset function*. (2023, January 3). Build Electronic Circuits. <https://www.build-electronic-circuits.com/4000-series-integrated-circuits/ic-4510/>
* [DM7400 Quad 2-Input NAND Gates (mit.edu)](https://web.mit.edu/6.131/www/document/7400.pdf)
* *7809 Voltage regulator*. (n.d.). Components101. <https://components101.com/regulators/7809-voltage-regulator-pinout-datasheet-specifications>
* *7 segment display*. (n.d.). Components101. <https://components101.com/displays/7-segment-display-pinout-working-datasheet>
* html.alldatasheet.com. (n.d.). *4N25 datasheet(1/6 Pages) MOTOROLA*. 6-Pin DIP Optoisolators Transistor Output. <https://html.alldatasheet.com/html-pdf/2846/MOTOROLA/4N25/255/1/4N25.html>
* [2W10 Datasheet, Bridge Rectifier. (datasheetspdf.com)](https://datasheetspdf.com/pdf/1216569/SEPELECTRONIC/2W10/1)
* *Potentiometer*. (n.d.). Components101. <https://components101.com/resistors/potentiometer>
* html.alldatasheet.com. (n.d.-b). *4N25 datasheet(1/6 Pages) MOTOROLA*. 6-Pin DIP Optoisolators Transistor Output. <https://html.alldatasheet.com/html-pdf/2846/MOTOROLA/4N25/255/1/4N25.html>