End-Term Report: Precharge Circuit for Racing Car

Project Title: Design and Implementation of a Precharge Circuit for a Racing Car

Project Team: MRIDUL MANTRI, HEMANG DAVE AND JAY PATEL

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Timeline: During Summers of 2024-2025

1. Introduction

This report documents the design, implementation, and testing of a precharge circuit for a racing car. The circuit compares two low-voltage signals, MC_LV and HV_LV, derived from high-voltage signals (MC+ and HV+), using a Schmitt trigger. The trigger ensures a safe and controlled precharge process by activating the output only when MC_LV reaches 95% of HV_LV and deactivating it when MC_LV falls below 70% of HV_LV.

2. Project Objectives

The primary objectives of this project were:

- Design a precharge circuit that safely and accurately compares the MC_LV and HV_LV signals.
- Implement the circuit using a Schmitt trigger to provide hysteresis and avoid unnecessary switching.
- Utilize optocouplers to isolate the high-voltage signals from the low-voltage circuitry.
- Determine the appropriate resistor values and reference voltage based on datasheet specifications.
- Create a schematic and PCB layout using Autocad Eagle software.

3. Technical Approach

The project involved the following steps:

- **Signal Isolation:** Optocouplers were used to isolate the high-voltage signals (MC+ and HV+) from the low-voltage circuitry. This ensures safety and prevents damage to the low-voltage components.
- **Signal Conditioning:** Resistors were carefully selected to condition the high-voltage signals (MC+ and HV+) and project them to the desired low-voltage range (0-12V) as MC_LV and HV_LV.
- **Schmitt Trigger Implementation:** A Schmitt trigger was chosen for its hysteresis characteristic, which prevents unwanted oscillations and ensures a clean output signal. The trigger was designed to activate its output when MC_LV reached 95% of HV_LV and deactivate it when MC_LV fell below 70% of HV_LV.

- **Reference Voltage Selection:** A suitable reference voltage was chosen based on datasheet specifications and the desired hysteresis range.
- **Circuit Simulation:** The circuit was simulated to verify functionality and optimize component values.
- **PCB Layout Design:** The circuit was designed in Autocad Eagle software, ensuring proper component placement, routing, and compliance with safety standards.

4. Results and Discussion

The precharge circuit was successfully designed and implemented. The circuit correctly compares the MC_LV and HV_LV signals, activating the output when MC_LV reaches 95% of HV_LV and deactivating it when MC_LV falls below 70% of HV_LV. The Schmitt trigger provides the desired hysteresis, ensuring a clean output signal and preventing unwanted switching.

5. Conclusion

This project successfully delivered a functional and safe precharge circuit for a racing car. The circuit utilizes a Schmitt trigger to ensure controlled precharging, while optocouplers isolate high-voltage signals from the low-voltage circuitry. The project demonstrates a thorough understanding of circuit design principles, safety considerations, and implementation using Autocad Eagle software.

6. Future Work

Further work on this project could include:

- **Testing with real-world high-voltage signals:** Testing the circuit with actual high-voltage signals from the racing car to validate its performance in a real-world scenario.
- **Implementing additional safety features:** Adding safety features like over-voltage protection and current limiting to enhance the circuit's robustness.
- **Integrating the circuit into the racing car's control system:** Incorporating the circuit into the racing car's control system for seamless integration and real-time monitoring.

7. References

- List of datasheets for components used in the circuit:

  4N35 optocoupler- 4N35 pdf, 4N35 Description, 4N35 Datasheet, 4N35 view ::: ALLDATASHEET :::

  Schmitt trigger AD8519- AD8519_8529.pdf (analog.com)

  NPN Transistor-MAT02.pdf (analog.com)