

Student project proposal

Project title

Electronics Upgrade and Electromagnetic Compatibility of a Reduced Scale Hyperloop Pod

Project type ☐ MSc thesis ☐ BA semester project ☒ MSc semester project

Project responsible and e-mail

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Project description

The proposed project is part of the epfloop team's research into the electrification of transport, and more specifically into the propulsion and levitation of high-speed vehicles (referred to as pods) [1]. The goal of the project is to improve the onboard electronics of the reduced scale epfloop pod, with a focus on electromagnetic compatibility (EMC). The pod relies on multiple analogue sensors, measuring the air gap, temperatures and battery cell voltages whose signals are strongly disturbed by electromagnetic interference caused by the pod's propulsion system. These disturbances degrade the measurements used to control and monitor the pod, and therefore its reliability.

The core of the project is an experimental EMC study: characterising the interference and its coupling paths, implementing passive and active mitigation measures (e.g. shielding of the cables and/or of the onboard controller, grounding, and filtering of the sensor signals), and quantifying the improvement through measurements before and after each action.

In addition, the aim will be to upgrade the onboard electronics to make them more robust and reliable. This includes actions, such as replacing the current onboard controller (sbRIO) with a more powerful one, designing any new PCB, redesigning the existing electronics with up-to-date electrical diagrams and schematics, and adding the current measurement of the battery energy storage system (BESS).

Tasks of the student

- Become familiar with the electrical architecture of the pod: power electronics, BESS, sensors, onboard controller (sbRIO), PCBs, communication modules...
- Characterise the electromagnetic interference:
 - Measure and quantify the disturbances on the air-gap sensor signals with the power electronics switched off and on.
 - Identify the main sources of interference and their coupling paths.
- Mitigate the interference:
 - Implement passive and active measures, e.g. shielding of the cables and/or of the sbRIO, improved grounding and cable routing, and tuning of the low-pass filters.
 - Quantify the improvement by repeating the measurements after each action.
- Redesign the onboard electronics:
 - Update the existing electronics with up-to-date electrical diagrams and schematics.
 - Design, manufacture and test any required PCBs for the new electronics.
 - Rebuild the electronics to make them more robust and reliable.
- Improve the current measurement of the BESS by adding a shunt resistor or a different sensor type (e.g. Hall sensor).

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- Integrate the remaining subsystems into the pod: the onboard camera, the power supply of the Ethernet switch (cabling and power converter if needed) and the main battery charging cable.
- Test the complete system.

Requirements

- Strong background in electronics (analogue electronics, signal conditioning, filtering).
- Knowledge of electromagnetic compatibility (EMC); experience with EMC measurements is a plus.
- Experience in PCB design (e.g. KiCad or Altium).
- Basic knowledge of power electronics and battery systems.
- Experience with laboratory measurement equipment.
- Interest in hands-on laboratory work on a real vehicle prototype.

This project offers the opportunity to combine electronic design and EMC measurements with hands-on work on a real prototype.

Literature

[1] www.epfloop.ch

