Rare Earth Free e-Drives Featuring Low Cost Manufacturing

ReFreeDrive

Collaborative Project
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Title of the deliverable: Application software for IM and SynRel motor control

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Lead contractor for this deliverable:	**UAQ**
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Abbreviations

IM: Induction Motor

SynRel: Synchronous Reluctance Motor

PMa: Permanent Magnet assisted

MTPA: Maximum Torque Per Current

1 Executive Summary

The present report provides an overview on the activities (task 5.1) inherent the development of suitable control algorithms for the electric motors and power electronics designed in WP3, WP4, WP5 and described in D3.1, D3.2, D4.3, D4.4, D4.5.

The main goals of these activities are:

- **Task 5.1.1** Design and Setup of a dedicated simulation environment.
- **Task 5.1.2** Design of a control algorithm for Induction Motors (IM).
- **Task 5.1.3** Design of a control algorithm for Permanent Magnet assisted Synchronous Reluctance Motors (PMa SynRel) and Pure SynRel Motors (SynRel).

The main results of the task 5.1 are reported in the followings.

Task 5.1.1: three models have been developed to simulate respectively the power electronics, the vehicle performance and the detailed motor-drive behaviour. The model of the power electronics has been used to select the most adequate Silicon Carbide components by evaluating current ratings, power losses and thermal behaviour. The model of the vehicle has been used to evaluate the impact of the KPI on the motor-drive design and the impact of the motor-drive performance on the vehicle one. The detailed multi-physics model of the motor-drive has been developed by mean of the co-simulation approach by using different cooperating tools: Matlab, Simplorer, Ansys Maxwell. The model accurately simulates the dynamic performance of the motor-drive including the non-linearity of the motor and the effect of the control strategy on it. It has been used to check the effectiveness of the control strategies in task 5.1.2 and 5.1.3.

Task 5.1.2: The theory of the control strategy of IM has been analysed and customized for the target motors. The non-linearity has been taken into account by mean of co-simulation. Optimum control strategies have been formalized to optimize the motor performance in terms of maximum toque per ampere, maximum efficiency per Torque. The Control scheme integrating speed control loop, torque control loop and current control loop have been defined for the further integration on the target hardware.

Task 5.1.3: The theory of the control strategy of SynRel and PMa SynRel has been analysed and customized for the target motors. The non-linearity has been taken into account by mean of co-simulation. Optimum control strategies have been formalized to optimize the motor performance in terms of Maximum Torque Per Ampere (MTPA), maximum efficiency per Torque. The Control scheme integrating speed control loop, torque control loop and current control loop have been defined for the further integration on the target hardware.

Innovative co-simulation approach has been used to verify and tune the control strategies.

The impact of the tasks described in D5.1 are:

- Innovative co-simulation approach for dynamic simulation of motor drives developed and tested on target motors
- New simulation and evaluation tools for Silicon Carbide performance evaluation developed;
- Motor control strategies available for project development and future uses;
- Simulation model available for project development and future uses;
- Increased know-how of the partner involved on motor control algorithms for IM and Reluctance motors;
- Increased confidence of the partners on behaviour of target electric motors.

The recognized barriers and risks do not seem to affect the development of the project strategy.

According to the consortium agreement each partner involved can use their own work and related results included in this deliverable for dissemination.

In D5.1 there have been no deviations in content or time from the deliverable objectives set out in the ReFreeDrive Grant Agreement. Activities have been anticipated from M19 (April 2019) to M7 (April 2018) to support the motor design tasks.