Rare Earth Free e-Drives Featuring Low Cost Manufacturing

ReFreeDrive

Collaborative Project
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Abbreviations

PE: Power Electronics
WP: Work Package
DC: Direct Current
WBG: Wide Band Gap
SiC: Silicon Carbide
PSU: Power Supply Unit
CPU: Central Processing Unit
JLR: Jaguar Land Rover
DRV: Driver
GA: Grant Agreement
KPI: Key Performance Indicator

1 Executive Summary

The present report provides an overview on the activities concerning the design of the High Power Range Power Electronics (PE) for the ReFreeDrive Project. The main objective of Work Package 5 (WP5), task 5.2, is to design a high power range inverter (200kW) fulfilling the requirements defined within the WP2 for the 200kW motor applications.

The main goals of these activities consist in:

- Proposing power architecture solution according to the requirements
- Designing the High Power Range e-Drive
- Selecting components (power modules and technology, sensors, capacitors, mechanical connections, etc…)
- Studying the Mechanical Integration of the High-Power Range e-Drive with the motor housing

The Key Performance Indicators (KPIs) at component level in Table 1 are:

Table 1: PE KPI for 200kW application (Grant Agreement (GA) reference)

PE KPI	200 kW baseline	Tesla S60 (200kW baseline)	RFD GOALS	200 kW (Design)
Specific Power (kW/kg)	10 - 12	13,3	13,7	18-20
Power Density (kW/ liter)	10 - 12	11,7	12,9	20-22
Efficiency (%)	95 - 97	TBD	98-99	98,5
Power electronics Cost ($/kW)	5 - 7	TBD	3,8	TBD

This report details the main steps of designing a high power inverter based on the specifications defined in WP2. According to the targeted Direct Current (DC) battery voltage (800V) and the power level (200kW), Wide Band Gap (WBG) devices based on Silicon Carbide (SiC) technology are selected to meet the inverter boundary condition requirements. The activities mainly focused on:

- Calculating and selecting all the key components
    - Power semiconductors
    - DC capacitors
    - Gate drivers
    - Sensors (current, position, voltage)
    - BusBars
    - Connectors
- Defining electronic boards to be developed

  - Power Supply Unit (PSU) Board
  - Central Processing Unit (CPU) Board
  - Drivers (DRV) Boards
- Drawing the schematics entries for each of the previous board
- Proposing a mechanical design for each board according to the constraints
- Studying the mechanical integration within the housing which is shared with the motor

The results of the first mechanical integration show that the estimated inverter volume is 5.04L, which is in line with the volume constraints given by Jaguar Land Rover (JLR) (7.92L). The first estimations show that the 200kW inverter fulfils the GA KPIs requirements (according to Table 2).

This report is organized as follows:

- Section 2 gives a reminder of the PE boundary conditions for the 200kW motor applications.
- Section 3 details the PE development based on the selected solution. Details about calculations and components selection are also given.
- Section 4 is dedicated to the mechanical integration of the High Power Range e-Drive on the motor housing.

In D5.2 there have been no deviations in content or time from the deliverable objectives set out in the ReFreeDrive GA.