Rare Earth Free e-Drives Featuring Low Cost Manufacturing

ReFreeDrive

Collaborative Project
Grant Agreement Number 770143

Start date of the project: 1st October 2017, Duration: 36 months

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 770143

Work Package no.: 6
Title of the WP: Prototypes Manufacturing
Deliverable no.: 6.9
Title of the deliverable: Power Electronics for the 75kW power setting

Contractual Date of Delivery:	**29/02/2020**
Actual Date of Delivery:	**27/02/2020**
Lead contractor for this deliverable:	**R13 Technology S.r.l.**
Author(s):	**Emidio Della Loggia (R13), Flavio D'Innocenzo (R13)**
Participants(s):	**Giuseppe Fabri (UAQ)**
Work package contributing to the deliverable:	**WP6**
Nature:	**Report (Confidential)**
Version:	**1.2**

Abbreviations

DC: Direct Current
IFPEN: IFP Energies Nouvelles
KPI: Key Performance Indicator
PCB: Printed Circuit Boards
PE: Power Electronics
RFD: ReFreeDrive
SiC: Silicon Carbide
UAQ: University of L'Aquila
WP: Work Package

1 Executive Summary

This deliverable D6.9 provides an overview on the activities concerning the manufacturing of the medium power range inverter Power Electronics (PE) for the ReFreeDrive (RFD) Project based on the design accomplished within the Work Package 5 (WP5), task 5.3.

The main objective of WP6, task 6.3, is to manufacture the medium power range inverter (75kW) attempting to build synergies and common strategies whenever possible between medium (75kW) and high (200kW) power range inverter fulfilling the requirements defined within the WP2 for the 75kW motor applications.

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

Table 1: CL-KPI of 75 kW power electronics drive

PE KPI	75kW baseline	Nissan Leaf 2012 (75kW baseline)	RFD GOALS	75 kW Design
Specific Power (kW/kg)	10 - 12	4,9	13,7	7
Power Density (kW/ liter)	10 - 12	5,7	12,9	9,47
Efficiency (%)	95 - 97	95	98-99	98,7
Power electronics Cost ($/kW)	5 - 7	10	3,8	6

The previous design phase related to the deliverable 5.3 within WP5 was delivered without impact on the project progress. The current 6.9 deliverable focuses on the 75kW Power electronics (PE) manufacturing tasks. Inverter design and manufacturing for the medium power range inverter has been led by R13 with the support of University of L'Aquila (UAQ) for the definition of the layout end integration, and Mavel in what mechanical design is concerned. As well, component and supplier choice information were regularly discussed with IFP Energies Nouvelles (IFPEN) (200kW inverter design and manufacturing) in order to increase the synergy between high and Medium Power Range PE. Figure 1 shows the manufactured Direct Current (DC) Bus Bars, Silicon Carbide components (SiC) and the assembled 75 kW PE prototype.

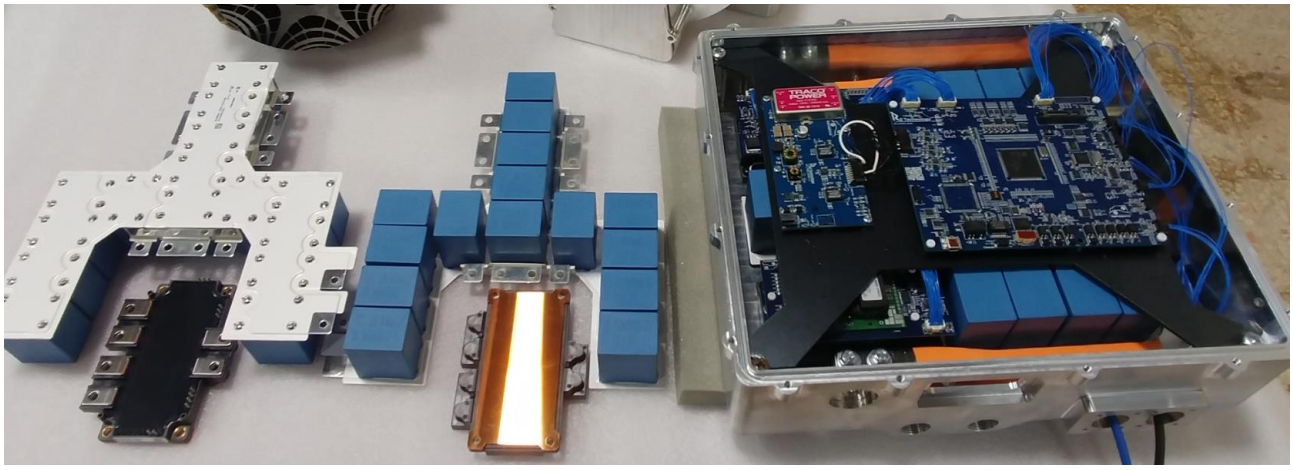

Figure 1: DC bus bars with SiC components (left) and assembled 75kW PE (right).

The PE KPIs in case of 75kW are less performant with respect to the outstanding values of the 200kW application; this is mainly due to:

- Same housing for all the power settings;
- The Silicon Carbide (SiC) devices on the market are not optimized for the voltage levels of the 75kW PE (400V).

The submission date of the present deliverable D6.9 has been postponed due to delays in manufacturing of housings and Direct Current (DC) laminated bus bars, supplying of resolvers and other parts. These activities could not have been anticipated due to open points in the PE integration with the motors.

For what it can be foreseen the delays have been properly managed to minimize the impact on the next steps of the project. There is no impact of the D6.9 delay in the following task (WP7, task 7.1).

The medium power range PE is fully manufactured and preliminary tested to anticipate as much as possible WP7 activities and reduce risks.

The medium power range SiC based inverter will be validated and used within the next WP7 along with the motor testing.

The main goals of WP6 task 6.3 activities consist in:

- Printed Circuit Boards(PCBs) design and manufacturing
- Spare components manufacturing
- Selecting electronics components and purchasing
- Assembling the power electronics and control unit boards
- Mechanical assembly related to the boards
- Preliminary tests

The impact of the WP6 task 6.3 is:

- Availability of medium power setting e-drives for e-motor testing and vehicle demonstration;
- Increased know-how on design procedures dedicated to SiC power modules;
- Increased know-how on SiC power module operating characteristics;
- 400V/800V laminated DC bus bar design and manufacturing know-how;
- Increase of knowledge on liquid cooled e-drives manufacturing and vehicle interface.