Overview on SiC device applications in Traction and DC Grid

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RESUME - The talk will first explain the state of the art in traction and grid using the standard silicon IGBTs. The first prototypes of traction SiC converters based on SiC MOSFET & JBS will be described with the performance achieved. Then, using the calculated characteristics with higher voltage SiC, we will propose some prospective in traction converters, e-transformers, MVDC & HVDC DCDC converters for grid applications

Mots-clés—Traction, Grid, SiC MOSFET, e-transformers, MVDC, HVDC converters

1. INTRODUCTION

Power component technologies evolve very fast. In 1995, ALSTOM Transport introduced the first traction drive using IGBT (Insulated Gate Power Component) power components; since this date, all the ALSTOM traction drives use IGBT components. Since 2008, SiC components have reached industrial maturity and are available up to 1700V blocking voltage today. These components offers much better characteristics than silicon IGBT :

- Very low switching energy (20X lower than IGBT) enabling high frequency operation
- Much higher operational temperature (>200°C possible)
- Possibility to increase component blocking voltage (>20 kV possible).

2. CONTENU DE LA COMMUNICATION

ALSTOM Transport has launched a wide R&D program to define the traction drive of the future using these SiC power components, the main objective of this program is a more efficient power conversion from the catenary to the wheel and global reduction of weight and volume of the traction drive.

ALSTOM Grid has developed very high power ACDC converters for point to point DC connection. These converters are used for connection of off-shore wind farm to the AC network using 320kVDC. The architecture is based on Multilevel Modular Converter and IGBT pack 3300V 1500A are used to make the elementary converter (H bridge). The availability of much higher voltage components (15 kV) with current capability of 2000 Amps and very low on-state packaged in "fail to short" package will drastically improve these converters. SiC components have the potentiality to meet these requirements.

Supergrid Institute will focus on the new generation of DC grid and meshed DC grid. Power electronics is a key enabler to develop the MVDC and HVDC DCDC converters that will be the building blocks of these future networks. Among all the PE technologies, high voltage SiC has been identified as one of the most critical breakthrough.

The talk will first explain the state of the art in traction and grid using the standard silicon IGBTs. The first prototypes of traction SiC converters based on SiC MOSFET & JBS will be described with the performance achieved. Then, using the calculated characteristics with higher voltage SiC, we will propose some prospective in traction converters, e-transformers, MVDC & HVDC DCDC converters for grid applications.

The SiC market is oriented to MOSFET & JBS for blocking voltage up to 3,3 kV. A first key aspect is to place the limit for these two technologies and it will be tightly linked with the requirements of the applications, we will discuss that for the application cases.

The SiC technologies for very high voltages are still under consideration and we will also discuss the potential alternatives with regards to the applications.

Switching to SiC devices will impact the system level management but from customer standpoint, the same or better reliability and availability is required, it is why we will discuss the following items:

- The acceptable durability and robustness required for the SiC devices and in particular for MOSFET devices
- The EMC management induced by SiC devices coming from high dV/dt and higher switching frequency
- The packaging required for high voltage and high current, involving the paralleling of high numbers of chips
- And finally, the economic approach or how we can estimate the acceptable cost for SiC devices taking into account the acquisition cost and reduction of lifetime cost thanks to increase of energy efficiency.