

Małgorzata Kozłowska

SiC technology enters the market

Silicon carbide is one of the most promising technologies in the area of high-power power electronics devices, expected to provide new impetus for the development of modern rolling stock and electric buses. The technological revolution forecast for several years is now becoming reality – MEDCOM has introduced SiC products into series production and the first vehicles equipped with converters based on silicon carbide have already rolled onto the tracks.

Medcom's state-of-the-art converters in the Dragon 2 locomotive

SiC converters developed by Medcom have been used, among others, in the new Dragon 2 locomotives manufactured by lead-

ing Polish rolling stock company Newag. The vehicle was presented for the first time in mid-July this year, on the tracks of the Railway Institute in Żmigród, Poland, and in September, it will be displayed at the Innotrans fair in Berlin.

The Dragon 2 locomotive was designed with heavy freight trains in mind and is the first 6-axes electric locomotive in Europe compliant with the Technical Specifications for Interoperability (TSI 2014), equipped with a level 2 ETCS. It is also the first Polish locomotive equipped with power electronics manufactured using silicon carbide technology.

Apart from the converters, Medcom also supplies traction inverters and battery chargers for the Dragon 2 locomotive.

PSM-175 SiC – an efficient and compact new-generation converter

PSM-175 SiC is the largest auxiliary power converter and the first one in Poland manufactured entirely using high-frequency technology. Silicon carbide transistors are installed both in the DC/DC converter block (lowering the voltage from 3 kV to 0.6 kV) and in the inverter block. In order to make full use of their potential, the product additionally features fast 32-bit microcontrollers and high-frequency magnetic components, as well as proven signal processing algorithms. PSM-175 SiC also has an extended diagnostics and operating parameter recording system, and the communication module is equipped with Ethernet, CAN, USB, MMC, and RS232 interfaces.

All of Newag's locomotives will be equipped with a set of two fully redundant converters with a power of 175 kVA each. In order to make optimal use of the liquid cooling system and the available space, DC/DC converter blocks were mounted in the propulsion inverter containers, while the DC/AC converter blocks were installed in a separate container with forced air-cooling.

„Thanks to the SiC power modules, new algorithms, and state-of-the-art processors and software, but also our engineers' experience in optimizing the mechanical design of the converters, we have created a compact product with efficiency as high as 96%. This is a value which is impossible to achieve in similar products of this type, but based on silicon. We have reduced the weight of the device by about 400 kilograms, decreased the dimensions of the magnetic components several times over, and at the same time minimized the system's cooling requirements, which allows us to use smaller pumps, radiators, and fans” says Piotr Wroński, Vice-President at MEDCOM.

Apart from the compact design and high efficiency, PSM-175 SiC also displays high voltage stability (+/-5%). Moreover, the product has been designed in a way making it possible to adapt it to various output power supply sources – including power supply from a combustion engine and generator. Thanks to that, it can be used in hybrid vehicles with a special combustion module for use on non-electrified route sections. Even with lower voltage values, Medcom's converter is able to generate full power for all the power consuming devices in the locomotive.

„Silicon carbide is displacing silicon elements, because it has unique properties thanks to which power electronics devices



The electric buses charging station made by MEDCOM in PKM Jaworzno

are becoming considerably smaller and lighter. High-power electronics systems based on SiC transistors increase converter efficiency up to 99% and limit energy losses by as much as 50%. This translates into lower vehicle operating costs. Moreover, SiC allows us to use much higher switching frequencies and higher operating temperatures unattainable in silicon semiconductors" adds **Paweł Choduń, MEDCOM**.

50 Moderus Gamma trams in Poznań

SiC power electronics has also been selected by the Polish tram manufacturer Modertrans, delivering Moderus Gamma low-floor trams to Poznań, Poland. As part of this contract, Medcom will equip a total of 50 vehicles, including 30 single-ended trams. Deliveries are already in progress and include static converters using full-SiC technology (PSM-50 SiC), traction inverters using IGBT technology (FT-50-600), and the TCMS system.

„Our aim was to create a compact device for supplying traction motors and auxiliary circuits in the Moderus Gamma tram. One-box solution, compared to installation of separate enclosures, gives advantages of smaller number of cables, smaller surface area of the container mounted on the roof of the vehicle, and lower total weight of the product. The use of SiC technology in the design of the PSM-50 SiC static converters allowed us to meet all the requirements set for the device. We managed to fit four FT-50-600 traction inverters and one PSM-50 SiC converter in a single container. We supply two containers of this type for each tram. Constructing the converter using SiC technology let us achieve better characteristics in terms of efficiency, switching speed, operating temperature, and output voltage stability. Thanks to high-frequency magnetic components, we also reduced the size of the converter compared to products manufactured using IGBT technology. The control system features state-of-the-art microcontrollers and signal processing algorithms, and the container has a forced air-cooling system,” says **Janusz Biliński, MEDCOM**.

Modern vehicles need efficient and compact power electronics

The contract with Modertrans is currently Medcom's largest order for deliveries of devices manufactured using SiC technology and one of several being completed at the same time in the Polish and European markets. Silicon carbide has been successfully used by MEDCOM in chargers for electric buses (including completed deliveries to several Polish cities, as well as the Italian, German, and Belgian markets). It has also been confirmed that MEDCOM's SiC converters will be used by the Japanese company Toyo Electric.

„We have been working on the development of SiC products for many years now and we are certain that it is one of the most promising technologies in the field of high-power power electronics. We are already able to use power electronics devices based on silicon carbide in every railway vehicle and electric bus out there. And I obviously mean products manufactured using full SiC technology, in which both transistors and diodes in the converter are made of silicon carbide. We are still introducing new devices based on silicon, but we realize that in the coming years, their share in the market will continue to decrease. Modern electric vehicles require the use of ever smaller and lighter power electronics devices with even higher energy efficiency, and SiC makes that possible” says **Piotr Wroński, MEDCOM**.



The new Dragon 2 locomotive with SiC converters developed by Medcom



The newest compact propulsion system and auxiliary power supply for Moderus Gamma



Propulsion system, auxiliary power supply and charging system



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