SYNCHRONOUS AC/DC CONVERTER USING ADVANCED UNIPOLAR POWER ELECTRONICS DEVICE

T. Matsukawa (1), H. Chikaraishi (2), Y. Sato (3), R. Shimada (4) and M. Ishida (1)

(1) Department of Electrical and Electronic Engineering, Mie University
1515, Kamihama-cho, Tsu, Mie, 514-8507, JAPAN
matukawa@elec.mie-u.ac.jp
(2) National Institute for Fusion Science, Toki, Gifu, JAPAN
(3) Daido Institute of Technology, Nagoya, JAPAN
(4) Research Laboratory for Nuclear Reactors,
Tokyo Institute of Technology, Tokyo, JAPAN

To yield the magnetic field for plasma confinement, the power supply system should output its high DC current to the corresponding magnetic field coil. For that purpose, many large capacity AC/DC converters are required to be installed as the main part of power supply system. For designing the large capacity AC/DC converter, it is important issue that the operational loss of AC/DC converter should be minimized to get high efficiency and good economical solution in operation. To reach operational loss minimization, the on-state resistance in power electronics device as switching unit of AC/DC converter is the key parameter. The unipolar power electronics device, the typical one being power-MOSFET, has many advantages for application to large capacity AC/DC converter. And, power-MOSFET device is well known one to be used in various AC/DC converter circuits including synchronous one. Recently, an advanced unipolar power electronics device has been developed, namely trench-gate type or super-junction type power-MOSFET, and has some excellent characteristics of lower on-state resistance, which promises to reduce its conductive loss, than that of conventional power-MOSFET.

In this paper, the synchronous AC/DC converter using super-junction type power-MOSFET is proposed, and its electrical characteristics are discussed in both simulation and experimental method. Related to further application of the advanced power-MOSFET for high current operation of large capacity synchronous AC/DC converter, the more reduction of on-state resistance is also studied with cooling down power-MOSFET device to the cryogenic temperature of liquid nitrogen and connecting power-MOSFET devices in parallel. As it is ordinary to have liquid nitrogen equipment for superconducting magnetic field coil, cooling down technology by liquid nitrogen is easy and useful to reduce on-state resistance of power-MOSFET. Parallel connection of many power-MOSFET devices is available to reduce total value of on-state resistance with increasing current rating and keeping current sharing among power-MOSFET devices equally.