Invited Speaker: Dr Khaled Ahmed, University of Strathclyde, Glasgow, UK

Unlocking Opportunities for DC Grids by Fault Tolerant DC-DC Converters

Summary:

DC grid is a promising choice for future DC transmission system. It can be defined as a DC transmission network, which includes more than two terminals with at least one meshed DC line. With DC grids there are multiple power-flow paths between two grid terminals. Power flow between two DC grid terminals may not be affected (or partially affected) by tripping a single DC line. DC grids will require some protection technology in order to isolate faulted lines/units allowing remaining part of the grid to continue power transfer. Normally, any number of new terminals can be added to an existing DC grid.

It is expected that DC grids will eventually evolve into large meshed networks, which will inevitably have multiple DC voltage levels. A DC-DC converter will be needed in order to connect two DC grids operating at different DC voltage levels. One evident DC-DC application is to connect DC cables (which have DC voltage up to 600 kV) with overhead DC lines, which may have a higher DC voltage. The existing HVDC (high-voltage direct-current) links have wide range of highly optimized DC voltage levels and their possible integration into the DC grid will require DC-DC converters. It is also expected that medium-voltage DC grids, either distribution or collection systems (like those with offshore wind farms) will rapidly develop following acceptance of DC transmission grids, and their connection to DC transmission will require high-stepping ratio DC-DC converters. This role is similar to a transformer function in traditional AC systems.

Nevertheless, even in a DC grid with a single nominal DC voltage there might be a need for DC-DC converters in order to regulate the power flow in some cables or DC voltage level at some nodes. These DC-DC converters may have low stepping ratio and perform a similar function to tap-changing transformers and phase-shifting transformers in AC systems. The power flow in DC grids will be primarily controlled using AC/DC converters located at grid terminals (connecting points with external AC grids).

The main objective of the talk is to discuss the fault tolerant high power DC-DC converters with clarifying different topologies advantages and disadvantages. The current, future, and challenges of high power DC-DC converters development will be covered. The talk will discuss DC-DC converter operation, control and interactions with DC/AC systems. The connection between VSC (Voltage Source Converter) and LCC (Line Commutated Converter) DC systems will be analysed via DC-DC converters. The talk covers also the latest modular multilevel converter based DC-DC converter topologies. AC and DC faults analysis for different DC-DC converter technologies will be presented. The talk is supported with simulation on MATLAB/SIMULINK software and practical prototype results.