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C1Or2B-02: Development of a coaxial dipole designs using superconducting gas-insulated lines

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Power systems in electric transportation applications and some power grids are being designed with medium voltage DC (MVDC) systems to achieve high power density and take advantage of the new developments in power electronics. The coaxial dipole superconducting gas-insulated line (S-GIL) is a high temperature superconducting (HTS) cable design which shows great potential to provide a high power dense gas cooled HTS cable. Our previous research focused on developing a monopole S-GIL where the helium gas functions both as cryogen and the dielectric medium. We reported both conceptual designs of S-GIL and 1 m long prototype capable of operating at significantly higher voltages than what is possible with solid insulated gaseous helium (GHe) cooled HTS cables. GHe cooled HTS are of interest because of their enhanced current ratings by operating below 60 K. While the monopole S-GIL design shows great promise, it is somewhat inefficient in its cryogenic design because of the requirement of one cryostat per pole. A coaxial dipole S-GIL reduces the number of cryostats required while also reducing the self-field effect on critical current and reduces/eliminates the magnetic field leaking out of the cable system. This paper discusses the conceptual design of a gas cooled coaxial superconducting dipole, fabrication of a prototype, and characterization of the dipole in terms of maximum possible voltage. The data from the measurements will be used to discuss the design options and optimization of the coaxial dipole S-GIL as well as to determine its applicability for MVDC systems. The paper discusses the challenges in the designs in terms of required insulator supports and achieving gas flow without causing unacceptable pressure drop and temperature gradient across long cable systems.

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