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Experimental tests on a superconducting hybrid DC circuit breaker

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High Voltage Direct Current (HVDC) transmission systems using Voltage-Source Converters (VSC) are widely recognized as having significant potential for long distance high power delivery, particularly for offshore wind farm connections. The US Navy has also proposed a Medium Voltage DC (MVDC) distribution architecture for the all-electric shipboard power systems. NASA is also evaluating turboelectric aircraft propulsion systems using MVDC electrical networks to meet the N+3 / N+4 emission targets. DC circuit breakers are a critical technology for managing faults in multi-terminal DC networks. DC current breaking however is much more challenging compared tothan for AC systems because there is no natural zero-crossing of the current to isolate the fault. A superconducting hybrid DC circuit breaker consisting of a superconducting coil, a mechanical switch, one (or more) semiconductor(s) and varistor(s) has been proposed and patented. A low voltage superconducting hybrid DC circuit breaker prototype has been built and has demonstrated interrupting 500 A DC within 4.5 msecs. The superconducting coil for this prototype used a multi-strand MgB2 round wire with a stainless steel sheath. This paper will focus on the operation of the superconducting hybrid DC circuit breaker and the design of each component. The paper will also include a detailed analysis of the test results and the implications for practical design of the superconducting hybrid DC circuit breaker. This paper will attempt to show that a hybrid superconducting coil can be used to produce option represent a competitive candidate DC circuit breaker for MVDC networks.
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