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Development of a novel insulation aging test system based on the high-voltage high-frequency square pulse generator

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In the recent decades, together with power electronics technological advancements, an emerging technology, solid state transformer (SST), has attracted great attention and been extensively investigated for smart grid, while mainly focusing on the research of available and efficient circuit topologies. As the core component of SST, the high frequency power transformer, which replaces the traditional 50/60 Hz transformer to the achievement of voltage converting and power transmission, operates in the high voltage, high power, and high frequency (HV-HP-HF) condition, subjected to the square impulse voltage with steep front edge, high amplitude and high pulse repetition frequency. Compared with the conventional transformer, less space is expected and oil-free operation is preferred in the high frequency transformer. As a consequence, the insulating system would face austerity challenge. With the advancements of SST to increasingly high voltage and power rating, severe insulation issues and challenges need to be addressed. In order to investigate the dielectric properties and ageing of insulation materials of the high frequency transformer subjected to the square pulse output from electrical electronic inverter, a novel insulation aging test system, consisting of a high direct-current voltage source, a full bridge converter utilized single-tube IGBTs with a control circuit, drive circuits and overcurrent protection circuits, and test unit, was developed to simulate the real operation condition. The designed and final performance specifications are as follows, the bi-directional voltage with the maximum of 5kV, the adjustable peak-to-peak value from 0 to 10 kV, the adjustable frequency from 100Hz to 1 kHz, duty circle closer to 50%, the rise time about 300ns, at least 5kW output power depending on the high direct-current voltage source, additional over-current and over-voltage protection functions.

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