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M2Po2A-03: Impact of high-power semiconductor performance in cryogenic temperatures

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Power electronics for electric aircraft applications are necessary components in controlling stator windings independently at high power. The added benefits of using liquid fuel to cool conductors to utilize their high current density has driven power electronics to be cooled by proxy. While small scale semiconductors were negatively impacted by cryogenic operating temperatures, experiencing freeze-out, systems rated for high power applications have not been discussed. In this work we test the performance of IGBT power electronics in temperatures ranges from room temperature to cryogenic temperatures down to 77 K in liquid nitrogen (LN2) with a focus in temperatures estimated for electric aircraft motors using liquid natural gas (LNG) as the cooling medium around 120 K. The performance measures will be determined by its basic ability to turn on and off based on the input signal provided by a function generator. Along with its fundamental testing criteria, we test the quality of the output signal by measuring rise time, fall time, and the quality of the output over the temperature range all within the operating frequency range of 15-20kHz. The experimental data is then collected over a range of operational frequency possible for the given motor design, and we also consider various power output matching a single stator contribution in a full motor design. To date, the electronics have maintained its ability to switch on and off in low power approach down to 120K.

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