

Qualification of Northrop Grumman MiniCoolerPlus Thermal Mechanical Unit for a Space-Flight Mission

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Northrop Grumman Space Systems (NGSS) introduced their new class of pulse tube cryocooler, the Mini Cooler Plus (MCP) in 2019 [Ref]. This thermal mechanical unit (TMU) is an extension of our space qualified pulse tube coolers and is designed to provide a long-life (over ten years), low-mass, high cooling capacity for hyperspectral and infrared imaging payloads in tactical airborne and space applications. The cooler is of modular split configuration allowing flexibility in the compressor (wave generator) and cold head placements to meet the available envelope. The cold head assembly can be oriented at any position relative to the compressor assembly and the transfer line (length and shape) can be customized to individual applications. The TMU weighs less than 3kg and can lift 1.5 W at 45 K or 11 W at 110K with 150 W electrical input at 300 K reject. This paper reports on qualification testing of a MCP unit to a technology readiness level (TRL) of 6 for a planned upcoming spaceflight mission and presents the test data obtained in its flight configuration over a range of input powers and reject temperatures. The cooler was subjected to launch vibration and thermal cycling conditions for the range of operating and standby conditions appropriate to its space application. The measured load lines and unchanged refrigeration performance of the cooler throughout the qualification program demonstrated the readiness of the design for flight. A functional testing of the unit was also performed with Northrop Grumman's TRL9 CCE (Control Electronics) and the exported vibration signature of the TMU without active vibration control were also characterized in all axes.