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A Study on the CryoTel® DS 1.5 Cryocooler for Higher Cooling Capacity

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The CryoTel® DS 1.5 is a split type Stirling cryocooler which was developed by Sunpower for systems requiring compact size, high efficiency, and high reliability. The DS 1.5 has a lift of about 1.4 watts at 77 K with 30 watts of input power. The cooler design includes gas bearings on the pistons and displacer for non-contact operation, and achieves low vibration by using dual opposed pistons inside the wave generator and a passive balancer on the cold head to offset the displacer motion. The efficiency of the DS 1.5 is ranked highly compared to other cryocoolers at 16% Carnot efficiency, but there are many customers who want more lift with the same size and reliability. Therefore, Sunpower performed a feasibility study of the DS 1.5 to maximize the lift without increasing the size. This paper describes the analysis and test results of increasing the cooler power density by using a higher operating frequency and charge pressure. Prototype testing showed good agreement with the model. Testing performed at various frequencies and charge pressures with a few internal component changes resulted in a maximum lift of 2.4 watts with an input power of 43 watts, achieving 15.9 % of Carnot. The prototype high capacity DS 1.5 achieved 0.7 watts more lift with only one percentage point lower efficiency, and with negligible cooler mass increase. The impact on the cool-down time on a thermal mass system was simulated and the cool-down time was 40% faster while consuming less input energy overall. Sunpower plans to build more units to gain a broader range of performance data and will then decide whether to proceed with a commercial product.

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