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## **Input current ripple and vibration suppression in second generation control electronics**

In collaboration with the Jet Propulsion Laboratory, Iris Technology is developing second generation cryocooler control electronics. The present development retains key features from the TRL 6 Low Cost Cryocooler Electronics (LCCE) design. Architected for cost sensitive missions, LCCE and this second generation "LCCE-2" are also extremely robust. Class S active electronic components and space grade discretes are used to achieve the required 300 krad Total Ionizing Dose (TID) and >0.97 reliability at three (3) years of mission life. The LCCE provides high efficiency (>92% typical) power conversion, precision temperature control, and is highly customizable through uploadable register values. An extensive data stream is provided to the ground station through the payload computer interface, including temperatures, voltages, and currents. LCCE-2 extends on this performance through the addition of two new features: input current ripple suppression and active vibration suppression. A linear cryocooler electronics module is essentially a programmable inverter, converting the DC input into an AC input at the commanded amplitude and frequency. This naturally results in a sinusoidal variation in the "DC" current draw into the electronics at twice the cryocooler drive frequency, on the order of several amps for the nominally 100W LCCE. This manifests as an unacceptable current ripple back onto the spacecraft bus. LCCE-2 incorporates a high efficiency (>93%) active input ripple filter (IRF) circuit to reduce the ripple by greater than 30 dB. Active vibration suppression is required to reduce the vibrations imparted by the driven linear cryocooler into the payload. LCCE-2, through the addition of an accelerometer circuit and additional firmware that modulates the drive signal of one of the two opposing compressor motors, reduces the exported vibration for the first three harmonics. The overall LCCE-2 design and performance is discussed herein with a focus on these new features.

**Primary author:** KIRKCONNELL, Carl (Iris Technology)

**Co-authors:** Dr JOHNSON, Dean (Jet Propulsion Laboratory); Dr RODRIGUEZ, Jose (Jet Propulsion Laboratory); Mr FROHLING, Kerry (Iris Technology); Mr ELLIS, Michael (Iris Technology); Mr PURCELL, Richard (Iris Technology); Mr LUONG, Thomas (Iris Technology)

**Presenter:** KIRKCONNELL, Carl (Iris Technology)

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