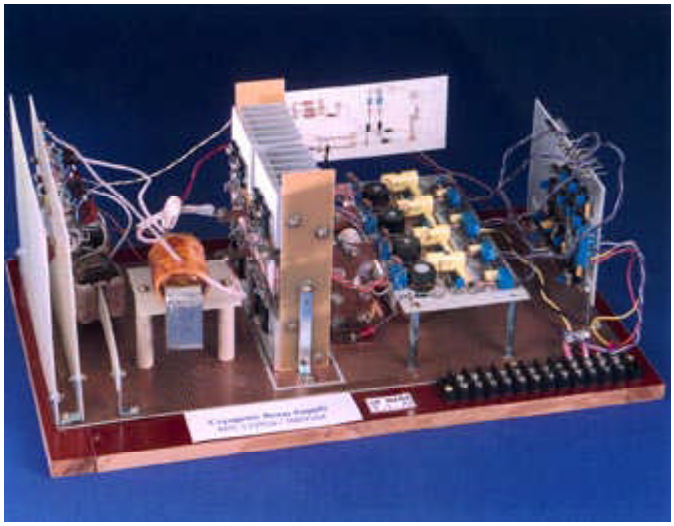
Electronics Demonstrated for Low-Temperature Operation

The operation of electronic systems at cryogenic temperatures is anticipated for many NASA spacecraft, such as planetary explorers and deep space probes. For example, an unheated interplanetary probe launched to explore the rings of Saturn would experience an average temperature near Saturn of about –183 °C. Electronics capable of low-temperature operation in the harsh deep space environment also would help improve circuit performance, increase system efficiency, and reduce payload development and launch costs.

An ongoing research and development program on low-temperature electronics at the NASA Glenn Research Center at Lewis Field is focusing on the design of efficient power systems that can survive and exploit the advantages of low-temperature environments. The targeted systems, which are mission driven, include converters, inverters, controls, digital circuits, and special-purpose circuits. Initial development efforts successfully demonstrated the low-temperature operation and cold-restart of several direct-current/direct-current (dc/dc) converters based on different types of circuit design, some with superconducting inductors. The table lists some of these dc/dc converters with their properties, and the photograph shows a high-voltage, high-power dc/dc converter designed for an ion-propulsion system for low-temperature operation.



High-voltage, 1-kW dc/dc converter designed for low-temperature ion propulsion system.

The development efforts of advanced electronic systems and the supporting technologies for low-temperature operation are being carried out in-house and through collaboration with other Government agencies, industry, and academia. The Low Temperature Electronics Program supports missions and development programs at NASA's Jet Propulsion Laboratory and Goddard Space Flight Center. The developed technologies will be transferred to commercial end users for applications such as satellite infrared sensors

and medical diagnostic equipment.

PROPERTIES OF CERTAIN CONVERTERS DESIGNED FOR LOW-TEMPERATURE OPERATION AT GLENN						
Circuit type	Voltage, V		Power, W	Frequency, kHz	Efficiency	
	Input	Output			At 25 °C	At –190 °C
Buck	42	28	175	50	---	---
Boost	24	48	150	50	---	95.90
Multiresonant buck	48	28	55	200	93.90	94.8
High-voltage full-bridge	80 to 110	500	825	50	90.18	92.19
Three-level buck-boost	42	120	180	50	95.70	94.90
Push-pull	30	5	10	40	---	---

Find out more about this research
http://www.grc.nasa.gov/WWW/epbranch/ephome.htm.

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