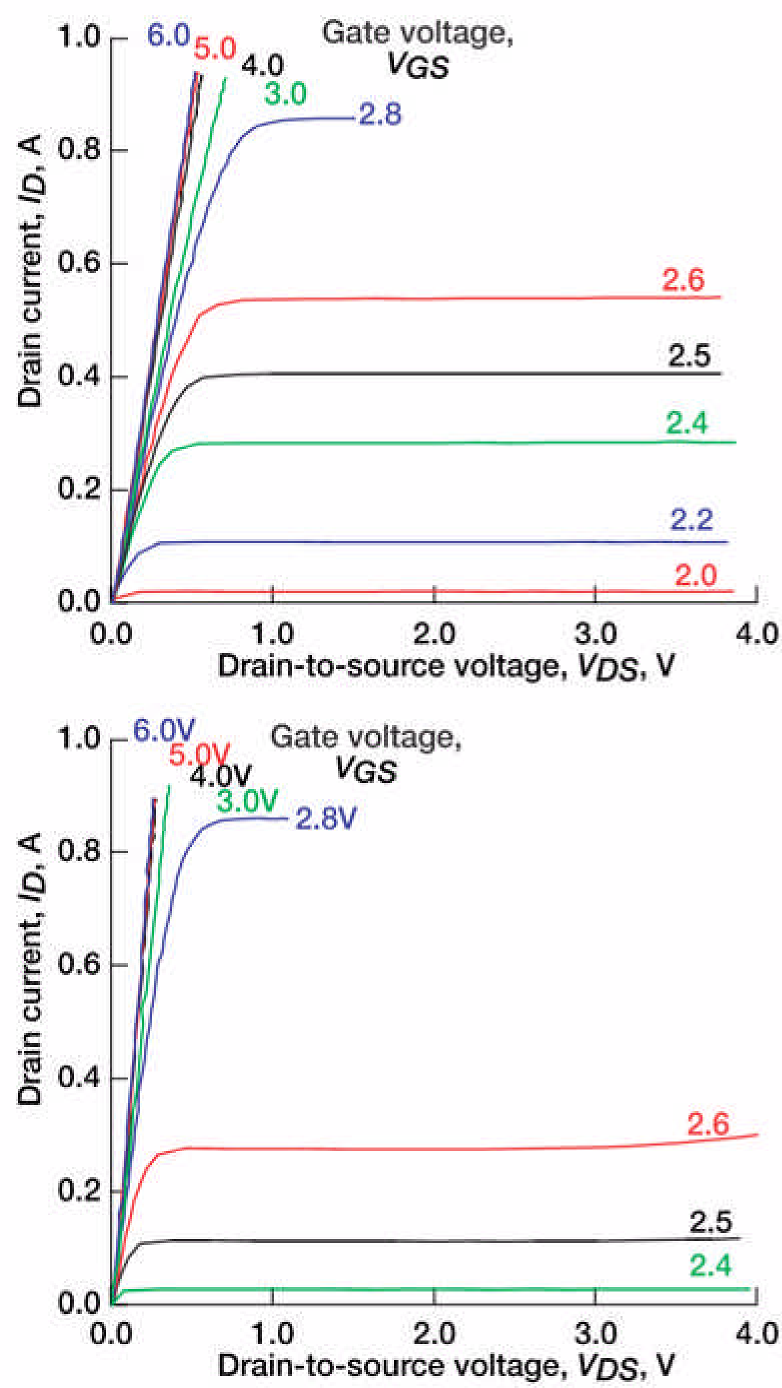
Power Electronics Being Developed for Deep Space Cryogenic Applications

Electronic circuits and systems designed for deep space missions need to operate reliably and efficiently in harsh environments that include very low temperatures. Spacecraft that operate in such cold environments carry a large number of heaters so that the ambient temperature for the onboard electronics remains near 20 °C. Electronics that can operate at cryogenic temperatures will simplify system design and reduce system size and weight by eliminating the heaters and their associated structures. As a result, system development and launch cost will be reduced.

At the NASA Glenn Research Center, an ongoing program is focusing on the development of power electronics geared for deep space low-temperature environments. The research and development efforts include electrical components design, circuit design and construction, and system integration and demonstration at cryogenic temperatures. Investigations are being carried out on circuits and systems that are targeted for use in NASA missions where low temperatures will be encountered: devices such as ceramic and tantalum capacitors, metal film resistors, semiconductor switches, magnetics, and integrated circuits including dc/dc converters, operational amplifiers, voltage references, and motor controllers. Test activities cover a wide range of device and circuit performance under simple as well as complex test conditions, such as multistress and thermal cycling. The figure shows the effect of low-temperature conditions on the switching characteristics of an advanced silicon-on-insulator field effect transistor. For gate voltages (V_{GS}) below 2.6 V, drain currents at -190 °C are lower than drain currents at room temperature (20 °C).



Switching characteristics of an advanced silicon-on-insulator field effect transistor. Top: At 20 °C. Bottom: At -190 °C.

Researchers in the Low Temperature Electronics Program at Glenn collaborate with other NASA centers, various Government agencies, aerospace companies, and academia to develop technologies that will support NASA missions such as Next Generation Space Telescope and Mars 07, as well as commercial advanced satellites.

Find out more about the research of Glenn's Electro-Physics Branch
http://www.grc.nasa.gov/WWW/epbranch/ephome.htm

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