which corresponds to slightly more than half the bandgap of silicon. In NGSPICE modified to simulate SiC JFETs, this parameter is changed to a value of 1.6, corresponding to slightly more than half the bandgap of SiC. The second modification consists of changing the temperature dependence of MOSFET transconductance and saturation parameters. The unmodified NGSPICE source code implements a $T^{-1.5}$ temperature dependence for these parameters. In order to mimic the temperature behavior of experimental SiC JFETs, a $T^{-1.3}$ temperature dependence must be implemented in the NGSPICE source code.

Following these two simple modifications, the "Level 1" MOSFET model of the NGSPICE circuit simulation program reasonably approximates the measured high-temperature behavior of experimental SiC JFETs properly operated with zero or reverse bias applied to the gate terminal. Modification of additional silicon parameters in the NGSPICE source code was not necessary to model experimental SiC JFET current-voltage performance across the entire temperature range from 25 to 500 °C.

This work was done by Philip G. Neudeck of Glenn Research Center. Further information is contained in a TSP (see page 1).

Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Glenn Research Center, Innovative Partnerships Office, Attn: Steve Fedor, Mail Stop 4–8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-18342-1.

TDR Using Autocorrelation and Varying-Duration Pulses

Signal-to-noise ratios may be increased.

John F. Kennedy Space Center, Florida

In an alternative to a prior technique of time-domain-reflectometry (TDR) in which very short excitation pulses are used, the pulses have very short rise and fall times and the pulse duration is varied continuously between a minimum and a maximum value. In both the present and prior techniques, the basic idea is to (1) measure the times between the generation of excitation pulses and the reception of reflections of the pulses as indications of the locations of one or more defects along a cable and (2) measure the amplitudes of the reflections as indication of the magnitudes of the defects.

In general, an excitation pulse has a duration T. Each leading and trailing edge of an excitation pulse generates a reflection from a defect, so that a unique pair of reflections is associated with each defect. In the present alternative technique, the processing of the measured reflection signal includes computation of the autocorrelation function

$$R(\tau) \equiv \int x(t)x(t-\tau)dt$$

where t is time, $x(t)$ is the measured reflection signal at time t, and τ is the correlation interval. The integration is performed over a measurement time interval short enough to enable identification and location of a defect within the corresponding spatial interval along the cable. Typically, where there is a defect, $R(\tau)$ exhibits a negative peak having maximum magnitude for τ in the vicinity of T. This peak can be used as a means of identifying a leading-edge / trailing-edge reflection pair.

For a given spatial interval, measurements are made and $R(\tau)$ computed, as described above, for pulse durations T ranging from the minimum to the maximum value. The advantage of doing this is that the effective signal-to-noise ratio may be significantly increased over that attainable by use of a fixed pulse duration T.

This work was done by Angel Lucena, Pam Mullinex, PoTien Huang, and Josephine Santiago of Kennedy Space Center and Pedro Medelius, Carlos Mata, Carlos Zavala, and John Lane of ASRC Aerospace Corp. Further information is contained in a TSP (see page 1).
KSC-12856

Update on Development of SiC Multi-Chip Power Modules

Modules and a modular power system have been built and tested.

John H. Glenn Research Center, Cleveland, Ohio

Progress has been made in a continuing effort to develop multi-chip power modules (SiC MCPMs). This effort at an earlier stage was reported in "SiC Multi-Chip Power Modules as Power-System Building Blocks" (LEW-18008-1), *NASA Tech Briefs*, Vol. 31, No. 2 (February 2007), page 28.

The following unavoidably lengthy recapitulation of information from the cited prior article is prerequisite to a meaningful summary of the progress made since then:

- SiC MCPMs are, more specifically, electronic power-supply modules containing multiple silicon carbide power integrated-circuit chips and silicon-on-insulator (SOI) control integrated-circuit chips. SiC MCPMs are being developed as building blocks of advanced expandable, reconfigurable, fault-tolerant power-supply systems. Exploiting the ability of SiC semiconductor devices to operate at temperatures, breakdown voltages, and current densities significantly greater than those of conventional Si devices, the designs of SiC MCPMs and of systems comprising multiple SiC MCPMs are expected to afford a greater degree of miniaturization through stacking of modules with reduced requirements for heat sinking.
- The stacked SiC MCPMs in a given system can be electrically connected in series, parallel, or a series / parallel combination to increase the overall power-handling capability of the system. In addition to power connections, the modules have communication connections. The SOI controllers in the modules communicate with each other as nodes of a decentralized control network, in which no single controller exerts overall command of the system. Control functions effected via the network include synchronization of switching of power devices and rapid reconfiguration of power connections to