TESTING ELECTRICAL CHARACTERISTICS OF NOVEL SILICON CARBIDE STATIC INDUCTION TRANSISTORS (SITS) FOR USE IN HIGH-TEMPERATURE PACKAGING APPLICATIONS

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ABSTRACT Over the years, there has been a steady increase in the research of Silicon Carbide (SiC) based device technology. This summary will demonstrate a basic switching circuit that will be used to obtain the SiC static induction transistors (SITs) ON-resistance, mutual conductance, two output characteristics, and the response time.

BACKGROUND The SITs can be defined as a type of v-channel field effect transistor (FET) in which the distance between the source and depletion layer of the drain is so reduced that the negative feedback of the channel resistance will not affect the direct current characteristics. SITs have several major advantages including high speed (excellent high frequency characteristics and high speed switching), low noise, non-saturating current/voltage characteristics, negative current/temperature characteristics, and are ideal for high power applications. Currently there are no SiC SITs commercially available, however these components are under research and development by several manufactures, including Northrop Grumman, Cree, Infineon, and Rockwell. Fortunately, the University of Arkansas (UofA) obtained a few experimental Northrop Grumman static induction transistors and Cree Schottky diodes. The UofA Silicon Carbide group has begun to utilize these components by building a SiC SIT half-bridge as seen in Figure 1.

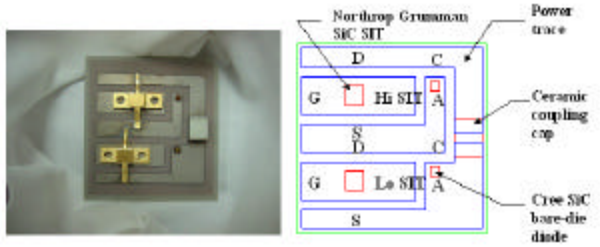

Figure 1. SiC SIT Half-Brige (500Watts)

Figure 2 illustrates the experimentally obtained turn-ON characteristic curves of one of the SIT devices used in the half-bridge circuit. These SiC SITs were developed by Northrop Grumman for use in low voltage, high frequency radar applications.

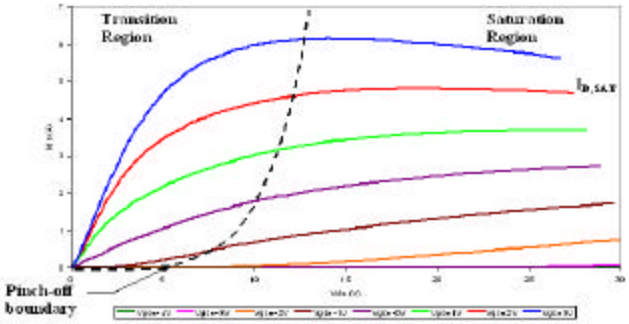

Figure 2. SIT #1203 I-V characteristic curve

WORK TO BE DONE A basic switching circuit as seen below in Figure 3 will be used to obtain four different electrical characteristics. Note that the driving circuit determines the switching speed of the circuit. As seen in Figure 3, R_S is the output resistance in the drive circuit and it is necessary to make R_S small in order to obtain fast switching. The ON-resistance will be the measurement of V_{DS} vs I_D for different values of V_{GS} and temperature. The mutual conductance will be obtained by positioning two switches to obtain different drain currents and the difference of the drain current over the ΔV_{GS} is the resulting gain of the SIT. Output characteristics such as large current/low voltage region and small current/high voltage region will be implemented using varies values of V_{SG}. Finally, the response time (i.e. delay time, rise time, storage time, and fall time) will be defined as the difference between the output waveform and the input waveform.

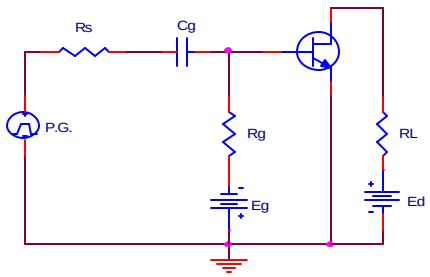

Figure 2. Basic SIT Switching Circuit