# New SMU capabilities meet power electronics manufacturers’ demands

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Power electronics manufacturers are increasingly turning to compound materials, including silicon carbide (SiC) and gallium nitride (GaN), to create the newest high power electronics. These materials offer much higher power density, smaller size, better high temperature performance, higher frequency response, lower leakage, and lower ON resistance than traditional silicon, for greater operating efficiency.

Compound semiconductor technologies aren’t as mature as silicon technology, which challenges those responsible for designing and characterizing these devices, as well as for those involved in quality assurance, failure analysis, and process monitoring. However, while now returning to growth after years of stagnation, semi power device manufacturers are realizing the test instrumentation they've been using for many years no longer meets their new product development requirements, in part because they lack the low current measurement capability required to characterize next-generation devices and materials. In many cases, they also lack the power necessary to support testing devices at today’s higher levels. Many T&M vendors continue to struggle to develop instrumentation suitable for addressing these test requirements.

In the absence of standard instrumentation solutions that can provide the necessary dynamic range, many power semi manufacturers have been forced to attempt to integrate their own test systems using in-house resources and a collection of discrete instruments like power supplies, voltmeters, and ammeters. However, integrating a system that combines high power capability with low current measurements is a major technical challenge, and such custom-designed systems typically require large test engineering teams to develop and maintain them; in addition, traditional GPIB-based systems are relatively slow. Unfortunately, in-house engineering staffs were often among the earliest casualties of the recession, which means custom solutions are practical only for production test applications. Although commercial ATE systems have long been used for power semi production test applications, their high cost, size, and lack of characterization and low current measurement capabilities make them equally impractical for R&D and QA/FA applications.

Fortunately, a number of test and measurement (T&M) manufacturers have begun applying the integrated sourcing and measurement capabilities of SMU (source measurement unit) instruments to this challenge. Essentially, SMUs are fast-response, read-back voltage and current sources with high accuracy measurement capabilities, all tightly integrated in a single enclosure. In the early stages of this effort, the major shortcoming of these instruments was their limited dynamic range—the SMUs then available simply couldn't deliver the power levels required to characterize high power semi devices accurately. More recently, however, instrumentation vendors have begun tailoring their SMU designs specifically for the needs of power semi manufacturers. When evaluating the various SMU options and configuring a system, power semi manufacturers must take a variety of factors into account:

• Power level. Characterizing with high currents, high voltages, or both, is essential to capturing important parametric data on a device's performance at the extremes of its operating range. SMUs are now available that offer 2000 W of pulsed power capability and 200 W of continuous DC power, which can source and measure currents from 1 pA to 50 A. For applications that demand even higher current pulsing, it's now possible to expand the top limit to 100 A by linking two units in parallel. Similarly, for test applications that demand sourcing high voltages, the latest SMU designs support sourcing up to 3,000 V (180 W) of either continuous DC or pulsed power. When evaluating high voltage sourcing solutions, however, it's important to look carefully at other specs as well; some SMU instruments that tout their ability to source up to 3,000 V are limited to just 12 W of power.

• Safety. Ensuring, the safety of both system operators and other equipment in the test system should always be a major concern but especially when configuring systems capable of sourcing thousands of Volts or hundreds of Amps. The latest generation of SMUs often includes doubly redundant safety features, such as test fixtures that prevent instrument operation if the SMUs or other instruments connected to it are not properly grounded or if the safety interlock is not engaged. For example, the Model 8010 High Power Test Fixture designed for Keithley's Models 2651A (Figure 1) and 2657A (Figure 2) High Power System SourceMeter instrument provides connections for testing packaged high power devices at up to 3000 V or 100 A, making it safer and simpler to configure a device test system that includes both high and low power SMUs. For higher volume testing applications that require the use of an existing test fixture, handler, or probe station, new protection and connection accessories simplify integrating new SMUs into a system without the risk of destroying any lower power instrumentation in the system if a device failed.

• Sensitivity. As mentioned previously, characterizing the leakage currents of SiC and GaN devices demands instrumentation with sub-picoamp resolution. The Model 2657A's 1fA resolution supports measuring the very low leakage currents common in next-generation devices.

• Noise immunity. The quality of the connections from the instrumentation to the device under test is crucial to obtaining meaningful results. Characterizing the low-level leakages common to power semi devices typically requires the use of special triaxial cables to provide sufficient noise immunity to allow accurate measurements.

• Higher speed. Throughput is key to the success of any production application. Keithley's Series 2600A System SourceMeter instruments employ a feature known as Test Script Processor, or TSP technology, which optimizes command transfer, command processing, and command execution times by embedding the actual test program (or script) into the instrument's non-volatile memory.

• System synchronization, flexibility, and scalability. The ability to configure, reconfigure, and expand a test solution readily is essential as power electronics products move from design and development to actual production. In Keithley's SMU architecture, TSP technology is used in combination with the TSP-Link virtual backplane simplify creating high speed, scalable integrated systems with up to 32 nodes. System builders can create powerful multi-channel power semi test systems that rival the speed of large ATE systems that cost tens of thousands of dollars more. Built-in 500 ns trigger controllers enable precision timing and tight channel synchronization between instruments.

More information on handling the challenges of characterizing high power electronics is available on Keithley Instruments' website at http://www.keithley.com/data?asset=56479 [1].

**Links:**
[1] http://www.keithley.com/data?asset=56479