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Achieving Fast Pulse Measurements for Today's High Power Devices

Green initiatives and energy efficiency standards worldwide have motivated engineers to find ways to design more efficient semiconductor devices and integrated circuits, and measuring the true state of these devices without the effects of self-heating is critical. Test instruments with only DC capability can deliver enough power to a device to cause heat dissipation that alters its characteristics. Pulsed characterization is a solution to this issue.

The use of a pulsed stimulus demands faster measurements. Traditional precision SMUs (source-measure units) use integrating ADCs. Although it offers the advantage of high accuracy and excellent noise immunity, this ADC technology does not lend itself to high speed digitization or waveform capture. For applications that require these capabilities, Keithley's Model 2651A High Power SourceMeter® Instrument also includes two high speed ADCs for measuring current and voltage simultaneously. These ADCs use sampling technology similar to an oscilloscope and take snapshots of the signal over time. Each high speed ADC in the Model 2651A samples at a rate of up to 1MHz with 18-bit resolution, which is much higher than the typical 8-bit resolution of an oscilloscope, resulting in more precise transient characterization in comparable bandwidths. Coupled with the ability to measure asynchronously from the source, this feature makes the Model 2651A ideal for many waveform capture and transient characterization applications.

Using the Model 2651A for Fast Pulse Measurements

Figure 1 illustrates some of the variables you can set to generate the pulses and the timing that best meet the needs of the devices being tested. **Figure 2** illustrates five examples of pulsed signals and measurements that can be made with the Model 2651A.

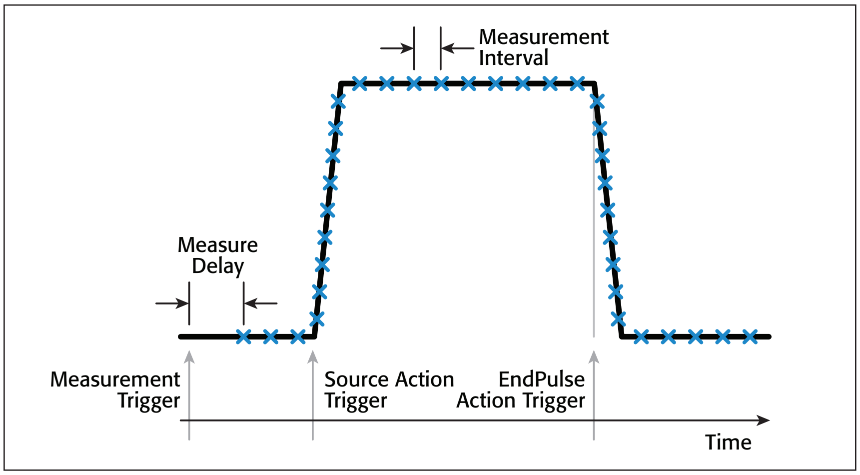

Figure 1: Precisely specify a pulse using the Model 2651A.

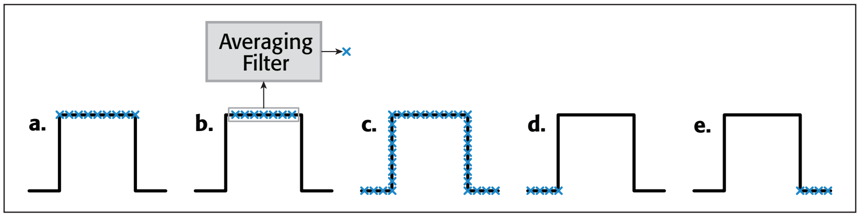

Figure 2a: Measuring at the top of the pulse.
Figure 2b: Performing a spot mean measurement at the top of the pulse.
Figure 2c: Digitizing the entire pulse.
Figure 2d: Triggering measurements to begin before the pulse.
Figure 2e: Triggering measurement to begin after the pulse.

Digitizing the Top of a Pulse

Characterizing the slope of the measured voltage at the top of the pulse is important for applications such as thermal impedance of power diodes and LEDS. This capability is also useful for characterizing pulse amplitude flatness. The Model 2651A can digitize the top of a pulse when measurements are made synchronously with the source. Sample results taken using a resistor are shown in **Figure 3**.

Performing a Spot Mean Measurement at the Top of the Pulse

Often, analysis software is used to average sampled data to improve accuracy. This is not necessary when using the Model 2651A. Its averaging and median filters make it possible to return spot mean measurements automatically. Example test results are shown in **Figure 3**.

Digitizing the Entire Pulse Including the Rising and Falling Edges

Characterizing how a pulse is transmitted through a device or system is useful for some applications. These applications require that the entire pulse be digitized, including the rising and falling edges. This measurement is possible with the Model 2651A's ability to measure asynchronously to the source operation.

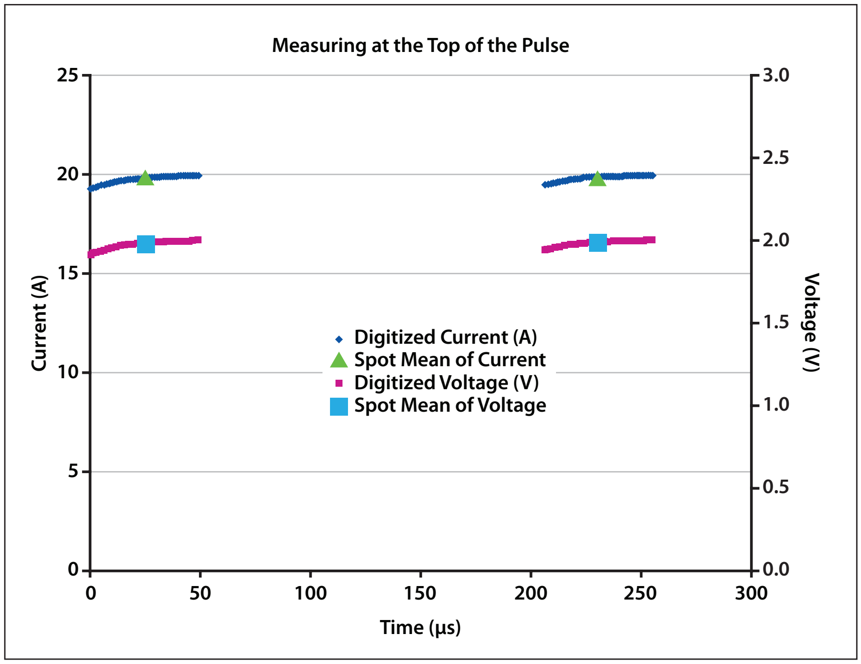

Figure 3: Results of digitizing the top of a pulse and performing a spot mean measurement at the top of the pulse.

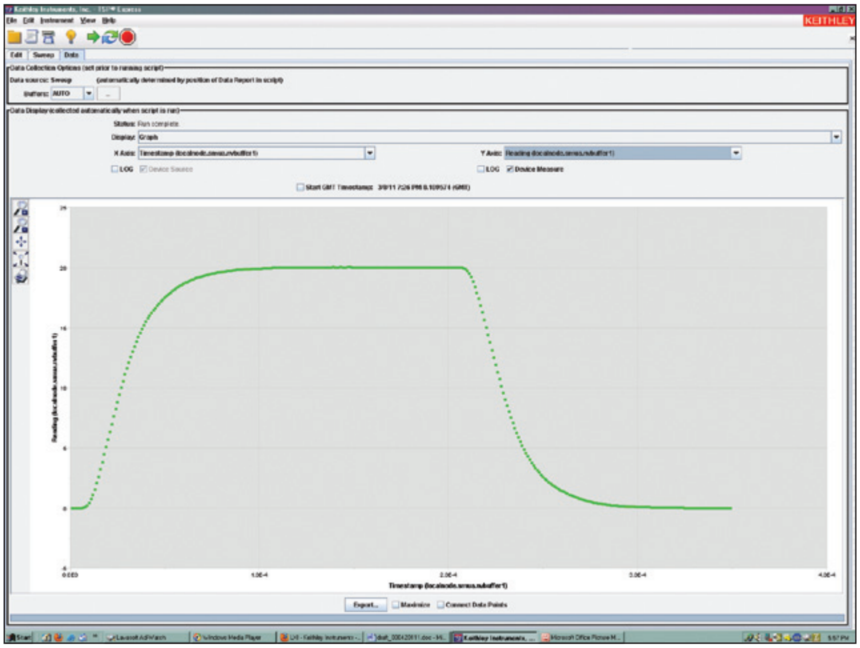

Figure 4: Results of digitizing the entire pulse. There is a 0.1Ω resistive load.

Pre-Pulse Characterization: Triggering Measurements Before the Pulse

Pulses can be used to provide power stresses to the device. It is useful to note the device state before the stress is applied. This can be done by programming a pulse with a non-zero idle level and triggering the measurements before the pulse.

Post-Pulse Characterization: Triggering Measurements After the Pulse

When using pulse testing to stress a device, the device must also be characterized after the stress is applied. This is typically done by sourcing a predefined test voltage or current after the pulse. The test level is chosen so as not to cause any additional thermal or electrical stress to the device. The measurement can be made by sourcing a pulse with a non-zero idle level. The Model 2651A can also be used to see how the device recovers from the stress.

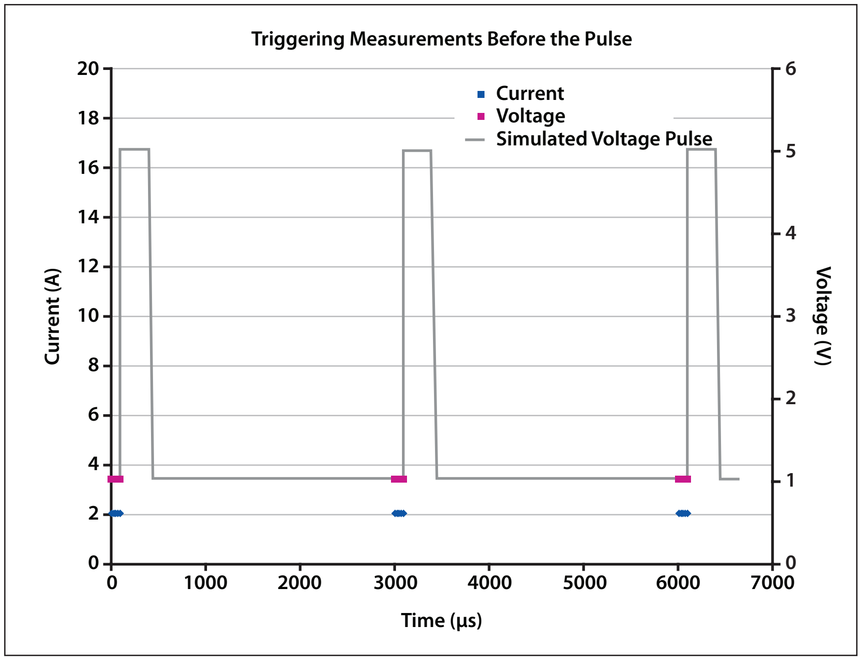

Figure 5: Results of pre-pulse characterization.There is a 0.5Ω resistive load.

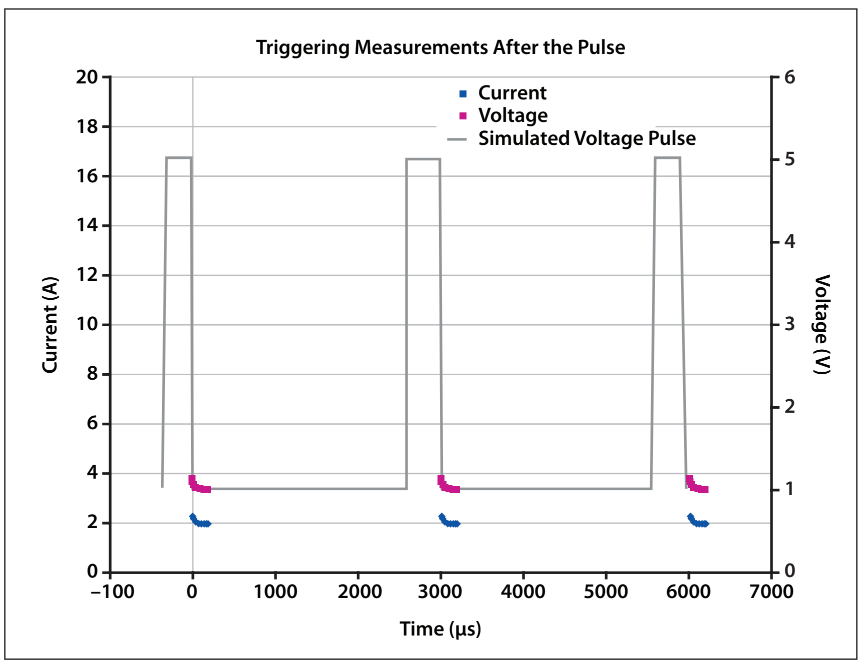

Figure 6: Results of post-pulse characterization. There is a 0.5Ω resistive load.

Precision Pulsing and High Speed Measurements

The Model 2651A minimizes the unwanted effects of self-heating during tests by accurately sourcing and measuring pulses as short as 100µs and also by allowing you to customize the pulses to your exact needs; for example: program the pulse widths from 100µs to DC and duty cycles from 1% to 100%. Keithley's TSP® Express software, a simple application served from within the instrument, can be used to program pulses and perform measurements with the high speed 18-bit ADC. **Figure 7** shows a sample configuration screen from TSP Express software.

Additionally, you can precisely time the measurements of pulsed signals as well as enable measurements to be made asynchronously from source operations, such as before, during, and after a pulse.

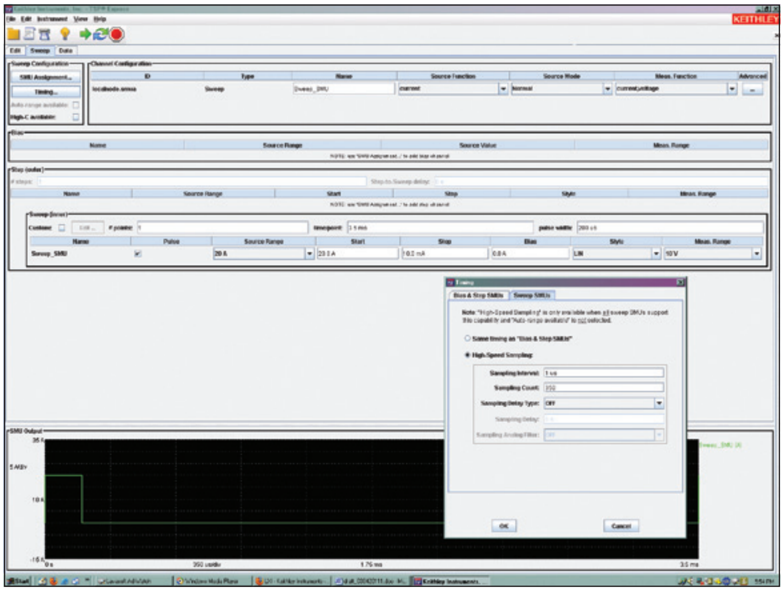

Figure 7: Use TSP Express software to configure pulses and perform measurements quickly with the high speed ADC.

Conclusion

The Model 2651A provides a more detailed look at measurements of pulsed waveforms. It can be used for a variety of transient characterization applications previously not possible with a source-measure unit.

For complete details on how to implement the measurements discussed in this document, see the Keithley application note titled "Measuring Pulsed Waveforms with the High Speed Analog-to-Digital Converter in the Model 2651A High Power System SourceMeter Instrument."

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