The Pulse of the Industry

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Advances in electronics design, particularly semiconductor materials, call for new testing techniques. Pulse testing is one of those techniques.

SEMICONDUCTOR components continue to get faster and smaller. Just a few years ago, nanotechnology was rarely discussed. Today, nanotechnology is a reality and is one of the hottest topics in the research community. Computers now have processors with common speeds of more than 3GHz, with PCIExpress and Serial ATA being the high speed pipes flowing data to these blazing fast processors.

These technology changes have driven a change in test methods, as well. In the past, DC testing was sufficient to give researchers, designers, and production engineers all the information they needed to keep tabs on their development and manufacturing processes. This is no longer the case. Smaller device sizes mean that devices cannot effectively dissipate the heat from DC testing. And with higher speed devices, the transient response is much more important than steady state, because the devices never actually reach steady state conditions. Today, engineers are looking for other test and measurement techniques that will provide them the information they need.

One of the most flexible tools for the newest techniques is a pulse or pattern generator that is used to create the stimulus signal to test a device without damaging it. This can be as simple as a really fast DC signal or a controlled rise time to quantify the transient behavior.

What is a pulser?

Pulse testing involves delivering a pulse to the output precisely as the user has configured it. The exact pulse shape can be configured to supply the precise amount of voltage to the device with the desired timing. The user can set the output levels, the amount of offset voltage. Additionally, the period, pulse width, and rise and fall times are also set. This pulse is used to test a variety of things, such as transient testing of a device to determine its transfer function and thereby characterize the material under test.

Many applications require more than one pulse channel. A pulse generator can also be configured to control the timing between multiple outputs and coordinate trigger to other instruments.

Pulse or pattern generators are used in a wide variety of applications in both the lab and on the production line. In research environments, for instance, researchers often need to stimulate a device under test (DUT) with a single pulse, series of pulses, or some known data pattern at a specified data rate in order to characterize its performance. In these applications, pulse or pattern generators are often integrated into test systems that include other instruments such as digital multimeters (DMMs), electrometers, nanovoltmeters, switches, source-measure units (SMUs), and oscilloscopes.

Need for Pulse Sources

The need for pulse generators has been steadily growing over time, driven largely by the higher operating speeds of today's electronic circuits. Higher operating speeds require test equipment that can produce simulated clock and data signals at the rate that the circuits can perform in the real world.

Another factor is that analog components that are used in these circuits behave differently at higher speeds. This limits the applicability of traditional DC methods for characterizing circuit performance. Because pulse sizes can be made extremely small, on

Figure 1. Keithley's Series 3400 Pulse/Pattern Generators feature a frequency range from 1mHz to 165MHz with programmable rise and fall times down to two nanoseconds.

the order of a few nanoseconds, pulse testing overcomes the problems inherent in DC testing techniques. Voltage pulsing can produce much narrower pulse widths than current pulsing, so it's often used in experiments such as thermal transport, in which the timeframe of interest is shorter than a few hundred nanoseconds.

Also, as a general rule of thumb, as components have become smaller, the need for pulsed testing techniques has become more critical. Smaller devices are more susceptible to a phenomenon known as self-heating. Basically, this is the fact that a small current through the device causes the device to heat up and skew measurement results. Self-heating can destroy or damage a part or even change its response to test signals, masking the response the user is seeking. Self-heating is a concern that shows up in semiconductor testing as well as in testing nanoelectronic devices.

Pulse generators with a high degree of programmability allow engineers to program critical parameters such as pulse current amplitude, pulse interval, and the pulse width. High amplitude accuracy and programmable rise and fall times are necessary to control the amount of energy delivered to a device. Instruments that can deliver an extremely short duration pulse, on the order of a few nanoseconds wide, with tight control of critical signal parameters, are highly useful for testing sensitive devices.

Applications

The uses and applications for pulse generators are almost endless. One use is in clock simulation. Clock and digital data simulation is used to determine how a device behaves if the clock or data signal is not ideal. A pattern generator outputs pulses as defined by the user to test the limits of the device being tested.

Another test is pulsed I-V, or pulsed current-voltage testing, which is used to perform device characterization. Much like traditional I-V testing, pulsed I-V is used to determine the characteristics of a device as current or voltage increases. Pulses are used to minimize the effect of heat on the device and to obtain accurate measurement results when a DC signal would generate too much heat or is too slow to give good results.

Pulse generators are also being used for thermal analysis. In these applications, a known pulse is applied to a device and, as heat transfers through the device, some parameter such as temperature, current, or a physical property is measured. Additionally, pulse generators are used for device lifecycle or stress testing. This is typically done on a memory device such as Flash. In this case, the pulse generator is configured to output write/erase pulses to exercise a particular memory location a large number of times. The characteristics of the memory location are measured before and after the stress test to determine the amount of change to the memory cell as a result of the multiple write/erase cycles. KEITHLEY

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