University of Idaho Turns to Tektronix DPO7000 Oscilloscope and Probes for High-Frequency Power Circuit Testing & Verification

Customer Solution Summary

March 2009

Challenge

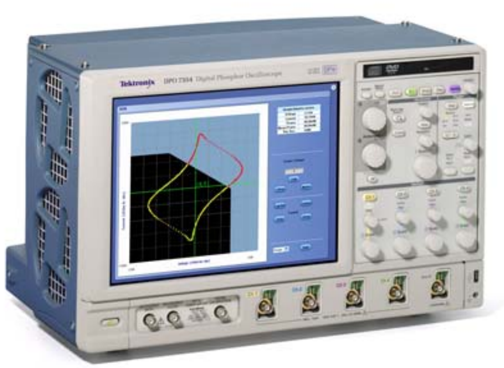
To accurately and efficiently test and verify high frequency power circuits and switching regulator under a variety of test conditions using an oscilloscope together with probes that could be adapted to micromanipulator holders.

Solution

The Tektronix DPO7254 Oscilloscope with a TDP1000 Differential Probe, TAP2500 Active Probe and TCP0030 Current Probe were used to measure the high frequency signals characteristic of power electronics on a chip.

Benefits

- The Tektronix instrumentation and probes delivered extremely accurate and repeatable results together with low-impedance and the probes were easily adapted to MRCI's existing probe holders.
- The analysis techniques and storage capabilities of the oscilloscope provided for easy viewing and analysis of test data.



Test Tools for Verifying Power & Frequency Requirements of Cutting-edge Designs

The Microelectronics Research and Communications Institute (MRCI) at the University of Idaho develops technologies in microelectronics, power electronics, microwave ferrite research, battery development, intelligent control, computer security, communications systems, and neural networks. Professor Herbert L. Hess of the MRCI drives over a dozen projects around power electronics, electric machines and drives and battery charging.

Many of Hess' projects involve high frequency power circuits on chips that require in-depth testing and verification. In order to run tests on the chips and to monitor aspects of other projects, his team needed test equipment that could accommodate the power and frequency requirements of these cutting-edge designs. The output of the new chips was predicted to be of high frequency along with some high frequency noise components. This meant that a fast oscilloscope with both differential and active probes was needed in order to test critical on-chip circuits. For testing switching regulators, current probes were also required.

"Another important requirement was that probes had to be compatible with 100x100 micron pad structures," Hess said. "Since we already had a Cascade Microtech probe station, we

Figure 1
Output of the buck converter using DPO7254 Oscilloscope

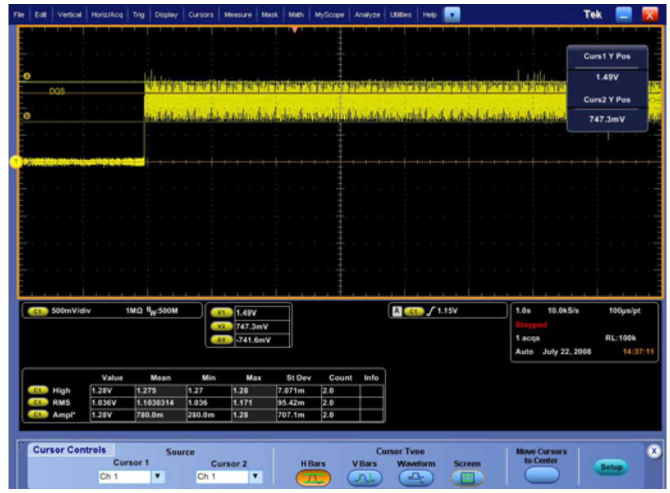


Figure 2
Output with high temperature (~120 degrees F) testing as measured using a DPO7254 Oscilloscope

were hoping to find a family of probes that could be easily adapted to our micromanipulator holders."

To meet these requirements, Hess started with a Tektronix DPO7254 oscilloscope with 2.5 GHz hardware analog bandwidth. The DPO7000 Series, of which the DPO7254 is a member, represent the new generation of real-time digital phosphor oscilloscopes and have the flexibility to tackle a wide range of challenging signal integrity issues including verifying, characterizing, debugging, and testing sophisticated electronic designs. This series offers solid performance in signal acquisition and analysis, operational simplicity, and a broad set of debugging tools. It also has a large 12.1 in. XGA touch screen and an intuitive user interface for easy access to the maximum amount of information.

"Differential probes are adaptable for a wide range of applications in power electronics and are absolutely essential to perform any credible testing and verification,"

Herbert L. Hess
Professor, Microelectronics Research and Communications Institute (MRCI) at the University of Idaho

The circuits tested on the chips included buck converter circuits, inductors and transformer circuits. The chips were 2.5mm X 2.5mm in size. The pad size on each chip was 80µm X 80µm.

For these applications, Hess paired the DPO7254 with a TDP1000 differential probe and a TCP0030 current probe. The probes readily adapted to the micromanipulator holders on the MRCI's Cascade Microtech probe station. In addition, a TAP2500 Active Probe was used for some of the testing.

On Target Measurements

For measuring the outputs on the buck converters, the differential probe proved to be the way to go. "Differential probes are adaptable for a wide range of applications in power electronics and are absolutely essential to perform any credible testing and verification," Hess noted. "Measuring the output with the Tektronix TDP1000 probe provided results that were quite comparable to calculated values."

As it turned out, the measured values also provided for analysis of the noise in the output signal. The high-frequency noise was easily observed with the use of the probe and the analysis techniques of the oscilloscope. Figure 1 shows the plots of a sinusoidal wave with expected jitter clearly evident.

Following normal room temperature testing, the chips were subjected to testing under extreme environment conditions. For example, the chips were placed in a laboratory oven where the temperature was increased periodically from 0°C to about 180°C.

The same measurements were taken as before. With this setup, the probes were not in the high-temperature environment but were connected to the chips through a test board. Figure 2 shows a voltage output obtained from the buck converter at about 120°C. Here the buck converter output with switching noise as expected is shown.

Following these tests, the TCP0030 current probe was used to test the current coming of out of the inductors on the chip. The probe was also connected to the chips via the micromanipulator holder on the probe station. As with the differential probe, the values that were obtained after calculation with the tested values correlated well with the expected inductance values of the inductors on the chip. In a similar manner, an on-chip transformer structure was also tested.

The instrumentation was also tapped to test an infrared beam for a passive biodiversity sample. This was in order to set a movement-triggered response. For this purpose, the current needed to be monitored on this system. The TCP0030 probe was employed to tune the series inductor along with the voltage of the source power converter.

"This technique was especially helpful in monitoring the current pulse and making sure that it stayed within the specifications of under five amps," Hess said. "As further confirmation of test equipment's accuracy, we verified that the rise time was accurately measured in the tens of microseconds using high speed photography."

The DPO7254 was further used for analysis, processing and management of test data. The analysis techniques and storage capabilities of the oscilloscope made these tasks fast and easy.

"For our testing purposes we found the DPO7254 along the Tektronix probes to have the versatility and performance needed to do an exceptional job of meeting our requirements," Hess added. "The DPO7254 oscilloscope, TDP1000 differential probe, TAP2500 active probe and TCP 0030 current probe allowed for high-frequency testing and provided high precision results for on-chip circuits. The probes and the oscilloscope have high sensitivity, making them ideal for small-scale and high frequency testing"

TAP2500 active probe with accessories

Product Links:

DPO7000
http://www.tek.com/products/oscilloscopes/dpo7000/
TCP0030
http://www2.tek.com/cmswpt/psdetails.lotr?ct=PS&ci=13420&cs=psu&lc=EN
TAP2500
http://www2.tek.com/cmswpt/psdetails.lotr?ct=PS&ci=13422&cs=psu&lc=EN
TDP1000
http://www2.tek.com/cmswpt/psdetails.lotr?ct=PS&ci=13425&cs=psu&lc=EN

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