Inside the MSO/DPO70000DX Series

The custom, Multi-Chip Module (MCM) ensures high-speed signals never touch the PCB before they are sampled.

With technological advancement maintaining the rapid pace of Moore's Law*1, test and measurement tasks are becoming increasingly difficult. High-performance applications, especially those requiring silicon characterization, serial data compliance, optical modulation analysis, double data rate (DDR) memory and wideband RF verification, demand test and measurement capabilities that were previously unattainable. This includes a combination of exceptional performance (bandwidth and sample rate) and flexibility (termination voltage and sensitivity), without negatively impacting signal fidelity.

The Tektronix MSO/DPO70000DX Series oscilloscopes, contain a custom, highly advanced, front-end Multi-Chip Module (MCM) that delivers 33 GHz bandwidth, 100 GS/s sample rate, variable termination voltage and unmatched sensitivity matching the characteristics of today's fastest signals.

Minimizing High-speed Signal Degradation

Traditionally, acquiring and processing high-speed signals required a series of connections and hand-offs at the front end of an oscilloscope. Signals were routed from the device under test (DUT) to the oscilloscope, passed through a coaxial cable to the PCB, through a ball grid array (BGA) package before they reach the first integrated circuit (IC) for analog amplification or attenuation. The signals were then routed out of the package and onto the PCB, where they were sent to the next package containing a track and hold (T/H) IC. Only after this gauntlet of connections, were the signals ready for sampling, analog-to-digital conversion, and storage. Unfortunately, this series of connections and hand-offs and then back out multiple times, degrades the signals before they could be sampled. This impaired BOTH oscilloscope bandwidth and signal fidelity.

Traditional Approach

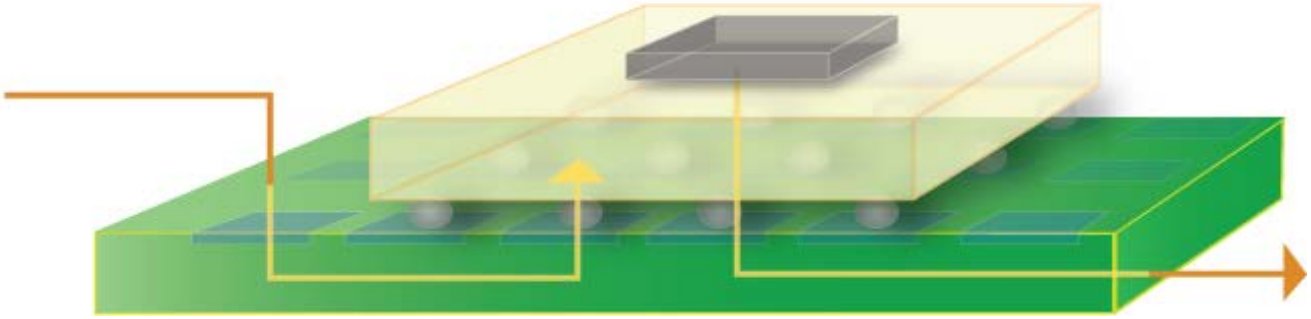

Figure 1. Traditional signal routing.

*1 http://en.wikipedia.org/wiki/Moore's_law

Inside the MSO/DPO70000D Series

To overcome these hurdles, the MSO/DPO70000DX Series oscilloscopes feature a custom-designed, highly integrated, front-end Multi-Chip Module (MCM). The MCM consolidates front-end acquisition and processing components, including coaxial input connectors, pre-amplifiers, track and hold chip and termination resistors, into a single package, **so high-speed signals never touch the PCB before they are sampled.**

Multi-Chip Module Approach

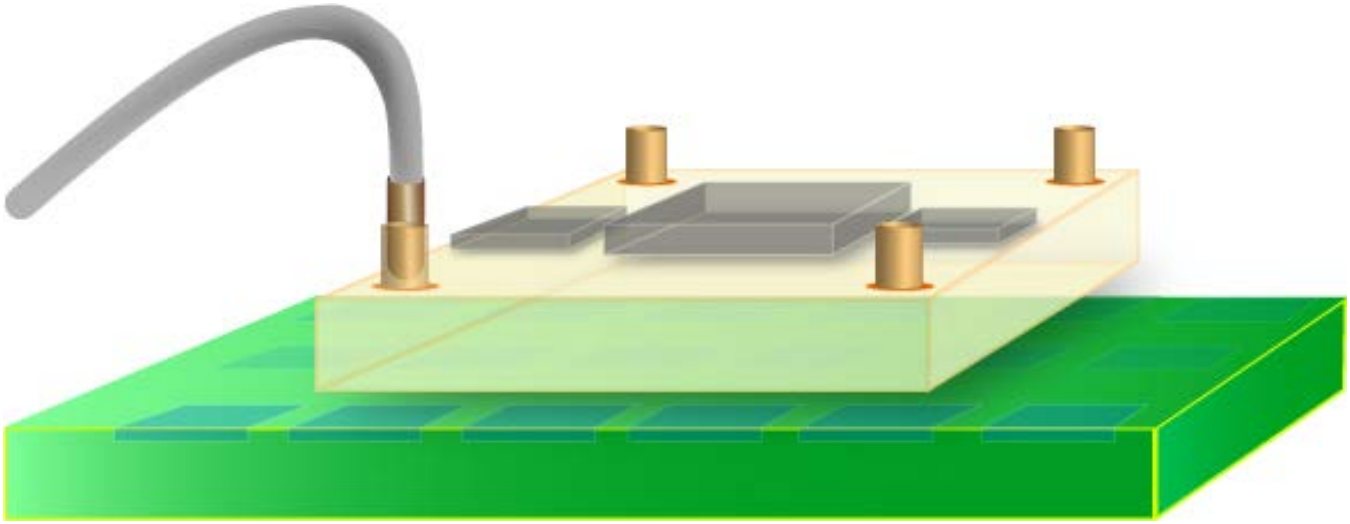

Figure 2. Tektronix new MCM signal routing.

As a result, the MSO/DPO70000DX Series delivers the industry's lowest noise and class leading signal acquisition performance across multiple channels.

Employing IBM's 8HP Silicon Germanium Technology

The custom, front-end MCM package of the MSO/DPO70000DX Series brings together a number of previously discrete components, including:

- Two pre-amplifier chips
- One 8-way track and hold (T/H) chip with analog filters
- 50 Ohm termination resistors
- High-performance, 100 GHz bandwidth connectors
- Elastomeric interface to the PCB

Because it's a self-contained module, the MCM reduces the number of connections through which signals travel as well as the number of possible sources of error. Gone are the multiple signal transitions through single-chip packages and PCB layers that degrade signal fidelity and oscilloscope bandwidth prior to sampling. And using high-performance cables, high-speed signals are passed from the scope's input directly to the MCM and the ICs within. The signals only touch the PCB after they have been captured by the T/H chip, which delivers 100 GS/s sample rate with industry-leading noise performance.

The ICs on the MCM were fabricated using IBM's 8HP silicon germanium (SiGe) BiCMOS Specialty Foundry technology. With an excellent balance of speed, accuracy and high integration, SiGe technology supports exceptional performance across multiple channels while minimizing noise found in older chip sets.

IBM's 8HP technology is a 130 nanometer (nm) SiGe bipolar complementary metal oxide semiconductor (BiCMOS) process that offers 2x performance over the previous generation. SiGe technology leverages highly-reliable and mature fabrication processes associated with the 50-year-old silicon industry, but with performance levels comparable to that of exotic materials such as Indium Phosphide (InP) and Gallium Arsenide (GaAs). Unlike those alternatives, SiGe BiCMOS provides access to high-speed bipolar transistors on the same die as standard CMOS, enabling a class of circuitry which marries extreme performance with large-scale integration.

The MCM features robust packaging that boosts reliability. A high-performance, silver-filled elastomer connects the MCM to the PCB. As opposed to rigid BGA connections that can crack or fail, the flexible elastomeric connection is more resistant to stress, vibration and other environmental factors.

The MCM also features an advanced heat sink and board attach mechanism that provides cooling for the ICs and added stability for the MCM package. Heat pipes reduce thermal issues and eliminate the need for a dedicated fan. The heat sink was designed by Tektronix mechanical engineers to dissipate heat efficiently and improve the long term functioning use of the instrument in laboratory or manufacturing floor conditions.

Delivering Bandwidth, Sample Rate and Signal Fidelity

Due in large part to the unique design and SiGe technology of the front-end MCM, the MSO/DPO70000DX Series oscilloscopes deliver:

- 33 GHz analog bandwidth on all channels
- 100 GS/s sample rate
  - 100 GS/s on two channels
  - 50 GS/s on four channels
  - 10 TS/s equivalent time sampling on all channels for repetitive signals
- 9 picosecond rise time
- Low internal noise and jitter
- High sensitivity with a minimum scale of 6.25 mV/division

Such performance specifications meet electronic designers' current and forthcoming needs for more accurate characterization of high-speed serial data. It also enhances analysis of optical carriers using complex modulation for 100 GbE and higher data rates where complex signaling requires accurate bit capture. For RF designers, the MSO/DPO70000DX series provide the ability to directly measure microwave signals with low added noise, high sensitivity, and high spurious free dynamic range.

Enabling Variable Termination Voltage

In addition to an industry-leading combination of bandwidth, sample rate and signal fidelity, the MSO/DPO70000DX Series delivers unsurpassed measurement flexibility. In fact, they are the first and only high-performance oscilloscopes to offer variable termination voltage (V_{term}).

While oscilloscope inputs have traditionally been terminated to ground, the signals being measured often are not ground referenced. Several modern applications - including those with DC-coupled signals - now require a positive or negative termination voltage for operation and characterization. Pulling these high-speed signals to ground can impair measurement results at a minimum, by requiring special fixturing to level-shift and/or attenuate the signal, and can potentially damage the DUT.

Historically, adjusting the measurement system's termination voltage required a special probe or a custom attenuator network that introduced additional measurement noise and required additional cost. The MSO/DPO70000DX Series delivers variable V_{term} up to ±3.5 Volts to the device under test (DUT), and with a split-path circuit design in the front-end MCM, support for a large offset range. This allows users to adjust the oscilloscope to mirror the conditions and behavior of the DUT, and measure the high-speed signals in an

environment analogous to the one in which they will eventually operate. Without introducing a custom circuit that attenuates or could distort the signal.

With the reduced voltage ranges of modern high-speed signals, there is also a need for broad and flexible measurement views. Combined with the V_{term} capability, the MSO/DPO70000DX Series delivers an extended offset range of ±3.5 Volts. More than a zoom feature, this allows variable voltage views and measurements at full dynamic range. Using the combination of V_{term} and offset to center the oscilloscope's reference point in the operating range of the DUT maximizes the available dynamic range and minimizes the noise of the measurement system.

Summary

High-performance technology applications are pushing the limits of modern test equipment. Tasks such as silicon characterization, serial data compliance, optical modulation analysis, double data rate (DDR) memory and wideband RF verification not only require exceptional bandwidth, sample rate and signal fidelity, but also flexibility to adjust the oscilloscope's measurement conditions and view.

Tektronix MSO/DPO70000DX Series oscilloscopes feature a custom, highly advanced, front-end that helps address and overcome such challenges. The unique design of the Multi-Chip Module (MCM) enables high sensitivity, variable termination Voltage (an industry first for high-performance oscilloscopes), and a large offset range for unsurpassed measurement flexibility. And by bringing together formerly discrete components - such as pre-amplifiers, track and holds and the termination network - into a single package, the MCM ensures that the integrity of high-speed signals are maintained before they are sampled. This delivers an industry leading combination of bandwidth (33 GHz), sample rate (100 GS/s) and signal fidelity.

For more information, please visit www.tek.com/DPO70000.

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