Customer Validates Signal Integrity on 100 MHz DDR SDRAM With Mixed-Signal Oscilloscope

Application Note 1452

Customer Success Story

The challenge

When you are working on digital designs, sometimes you need to look at the analog characteristics of key digital signals, but under specific target conditions. Qualifying the condition of interest usually requires more than the two or four channels found on traditional oscilloscopes. A mixed-signal oscilloscope (MSO), which provides both the 2 or 4 analog channels of a traditional scope, plus 16 time-correlated digital channels, can often be the best tool.

Charlie, an engineer at a major computer manufacturer, recently faced the task of turning on a 100 MHz DDR memory that was part of a prototype computer system. When he turned on the prototype for the first time, error correction codes (ECCs) led Charlie and his colleagues to suspect a signal integrity problem on the data bit D0, but only during data "reads." To confirm their hypothesis, they wanted to compare the signal integrity of that bit to other known, good bits. This Application Note explains how Charlie used an MSO to observe the signal of interest under the right conditions and verify its signal integrity.

The memory and memory controller "smart" buffer that needed debugging, along with key signals, can be seen in Figure 1.

Charlie's main challenge in his quest to look at the signal integrity of the D0 bit was observing this data bit, but only during a "read" condition. Probing D0 at the memory controller was necessary to truly observe the signal integrity during a "read," since data was transmitted from the memory but was received at the input of the memory controller.

The solution

To capture a memory "read," Charlie used an Agilent 54832D MSO that had 4 analog and 16 digital channels. A memory read from the device occurred when RAS was high, CAS was low, write enable (WE) was high, chip select (CS) low, and the clock was going high, as shown in the timing diagram in Figure 2. Charlie set up the scope trigger on these conditions by connecting 5 of the 16 digital MSO channels to the control lines and then defining a trigger based on these signals. Charlie held an active probe manually and moved it to various data bits, probing on the pins of the memory controller integrated circuit to create eye diagrams.

"We were looking to see if the eye was too small or leaning over on one side, if the amplitude was too high or low, or if there was excessive noise," said Charlie.

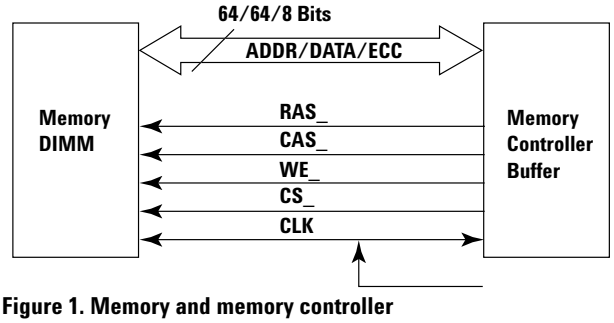

Figure 1. Memory and memory controller

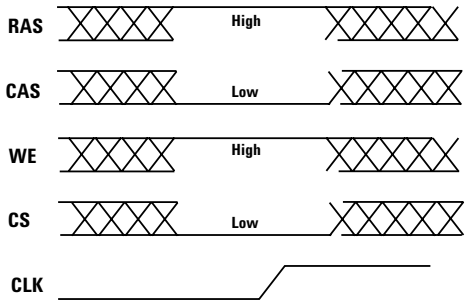

Figure 2. Conditions for a memory "read"

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Figure 3. A view of data bit D0 with analog scope channel 1 exclusively for data "reads" (bottom) by setting a trigger on the five control lines (top)

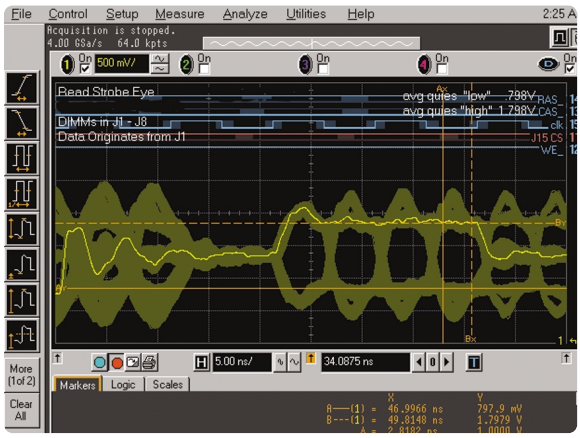
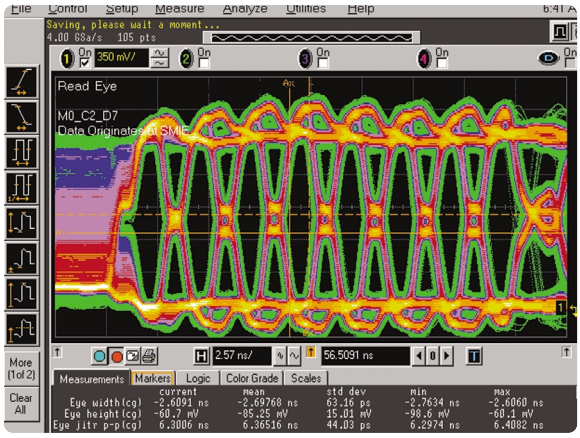


Figure 4. Statistical eye measurements on data bit D0 during multiple "read" cycles



Using the control signals for the trigger, as seen at the top of Figure 3, he was able to observe bit D0 with an analog scope channel, and exclusively on "reads." A standard four channel scope could not have been able to qualify this capture.

While triggering on this read condition, but with color grading and statistical measurements turned on, Charlie checked eye width, height, jitter and signal integrity as shown in Figure 4.

The MSO's tight time correlation between analog and digital channels provided accurate "read" eye. By comparing the D0 eye diagram with the other known, good bits, it was clear that the signal integrity on bit D0 was not an issue and not the source of the problem.

MSO Video Demo:
www.get.agilent.com/scope/msodemo
MSO Product Info:
www.agilent.com/find/mso

Armed with this information, Charlie and his colleagues turned their attention away from signal integrity instead to the programmable registers inside the memory controller, where internal clocking was controlled. The problem was fixed there by changing register values for timing.

"We could not have done this with a standard two- or four-channels oscilloscope," said Charlie. "We might have been able to verify the signal integrity using a logic analyzer in conjunction with a scope. But the MSO approach was so simple, and it allowed us to get this measurement quickly and easily."

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