Signal Integrity eSeminar Series Q&A: Being Successful with Fully Buffered DIMM (FBD) Designs

The following Questions and Answers were created from the live eSeminar broadcast of January 25, 2005. You can view the archived eSeminar by going to **www.agilent.com/find/archives** and selecting it from the list of archived eSeminars.

Q: Can Agilent's Real-tine Scope protocol utility decode FBD traffic? Since it's not 8B/10B traffic, what challenges have you encountered here?

A: Even though it's not 8B/10B encoded, when you look at the BIST signal itself, there are enough transitions for an effective clock to be recovered. But there are a couple of challenges associated with that, since the 8B/10B decoding in the scope is geared towards looking at signals like PCI Express or Fibre Channel, where you have an embedded clock. The FB-DIMM represents a more significant challenge. At this point, that challenge is really isolated towards the explicit reference clock that runs at 200 MHz for the 4.8 Gb/s signal, and correlating that measurement up against the 4.8 Gb/s signal in order to make jitter measurements relative to the reference clock or intrinsic jitter measurements that would highlight elements of deterministic jitter on the signal itself. Right now, in terms of protocol support, the 8B/10B decode capability of the Agilent scope will likely be modified to include the relevant capability for the FB-DIMM protocol in the future. But it's not available just yet today.

I think the main thing that you'll run into when using FBD, of course, with a scope is that it's multi-lane, and it's bit-striped, rather than byte-striped. This requires you to measure every single channel with a scope so that you can decode the whole frame, which would be expensive to probe all 24 channels of FBD. This probably the main issue in ever trying to fully decode frame traffic on fully-buffered DIMM with a scope.

Q: Is there a tester available for testing these FBD modules at 533 or 677 MHz? If yes, do you have any recommendations?

A: Yes, there are. I'm not myself an expert on the manufacturing testers, but I've learned about them over the last year. There is a tester available today that can support test at the full FBD rate. In fact, it can go as fast or faster than FBD2 is expected to go. That would be the Agilent 93000 tester, with what's called the Catapult add-on, which allows you to get up to 13 Gb/s per pin signaling. I would suggest that you contact your Agilent sales office and talk to the person who handles the manufacturing test solutions. They will be able to get you all sorts of detailed information on this.

Q: Is the FB-DIMM connector characterization fixture available now and, if not, when?

A: You're probably talking about the DIMM parametric test fixture. Some beta units of that fixture have been out in evaluation. The final unit is actually entering production right now, and we're starting to ship today. So the short answer to your question is yes, it is available as the Agilent N4236A.

Q: What is the total cost in test equipment to test the FBD and the environment?

A: If you go to slide 27 of the presentation there are a lot of tools that exist to assist with fully-buffered DIMM design, both from the pre-silicon phase all the way through the chip tester phase. What I've found is that there are different companies that are focused on different parts of the FBD technology puzzle. One of the most significant pieces, of course, is the AMB. The AMB is really the technology that makes fully-buffered DIMM possible, in that it is able to basically bridge the

DDR2 technology with the 4.8 Gb/s high-speed serial technology in a way that effectively allows you to use today's DDR memories with a high-speed serial/parallel bus that, up until this time, really is unprecedented in a standard server/workstation motherboard. So if you're looking at AMB design, that would probably require a different set of test tools than if you were looking at DIMM design or motherboard design.

The question is complicated because there are a lot of different tools. The short answer is you can probably spend anywhere from, say, $50,000 to over $1 million. It really just depends on how many different parts of the system you want to look at simultaneously, how large your design team is and how many different pieces of equipment they need, how much stuff you already have. Typically, if you are putting together test systems, you should look to be budgeting a minimum of $200K. If you have a large team, and you want to do a lot of stuff in parallel, to be honest, we've had folks who've spent close to $2 million on test equipment for this. Probably the key thing is to get in touch with your local Agilent sales representative so we can help you customize and find the right set of tools at the least cost that can help you be successful.

Q: Is this equipment, probe cards and such, currently shipping?

A: Yes, they are. This is one of the production DIMM parametric test fixtures that is shipping right now. The AMB parametric test fixture, we're expecting to get the final production units in next week, and those will be shipping then. As far as the logic analyzer probes are concerned, those have begun shipping. And we have significant backlog, actually, and we expect that backlog to be pretty much relieved in the next few weeks, probably. So I would say, if you're contemplating this stuff, you should get your order in so that we can get it shipped out against the backlog as soon as possible.

Q: How will you use the Mem BIST function of the AMB?

A: The Mem BIST function can be used in a few ways. Let's say, for example, you're using the logic analyzer. You can put the Validation DIMM into Mem BIST mode, and you can see what the traffic is, going to and from the AMB. The other fixture that probably has the most utility with Mem BIST is the AMB parametric fixture. This is the fixture that gives you direct access to all of the AMB pins, both the DDR and the high-speed channel side. And so there you might put the AMB into Mem BIST mode and then hook up an oscilloscope or a logic analyzer to the DDR-side pins of the AMB and make parametric or functional measurements.

Q: What is the limitation of memory size? Are there any higher data rate FBD?

A: The data rate and the size are somewhat unrelated in FBD. The plan is to be able to use the highest capacity DRAM's possible on some FBD systems. There is work that's beginning now on FBD2, looking out a couple of years. But the main advantage of FBD is that instead of having two DIMM's per channel, you can have up to eight DIMM's per channel. That, in itself, is going to give a huge increase in memory capacity.

Q: What tests should you perform to stress the design to know the design margin?

A: Well, there are different types of stressing that you could do. One would be just to stress the link itself. For example, with fully-buffered DIMM memory, you can have up to eight DIMM's on one particular memory channel. So one thing that you might want to do to stress the channel, would be to drive as much data into the channel as possible in order to really stress it out. Another type of stress on the channel itself would be to do what we would refer to as receiver sensitivity testing, where you would really stress the physical-layer characteristics of the signal itself. And this is something you could do with a BERT, with its built-in pattern generation capability, to add, effectively, a known amount of jitter or a closely-controlled amount of jitter onto the signal itself, in order to determine where you might start to see failures in terms of receiver lock on the 4.8 Gb/s signal.

Q: Will Agilent and your interposer partner support other FB-DIMM raw cards?

A: Yes. The Interposer, by its nature, will support any FBD raw card. The four original ones, called raw card A, B, C, and D are well known. There are actually more raw cards that are under development right now, and the Interposer will support all of them.

Q: Can I use the Intel Channel Test Card for physical-layer validation?

A: Yes. The Intel Channel Test Card (CTC) is capable of providing some amount of physical-layer validation. You can look at eyes. You can probe various points on it. And what's nice about is Intel has created some software that allows you to control and set up the AMB into various test modes that facilitate physical-layer evaluation, for example, in the slide we showed, using that software to set up the AMB into a built-in self-test

mode that provided us with a 440-bit repeating pattern. However, since it is such a fast, high-speed serial link and if that's where your interest is in terms of characterization, we have found that the Intel Channel Test Card really is best used for functional validation. And if you're trying to evaluate different DIMM manufacturers, for example, or different AMB's, where you want to isolate maybe one AMB from one vendor to another, and you want to look at different characteristics, there isn't sufficient probing nor sufficient reference-quality probing, where the impedance lanes are extremely tightly controlled, within a 5% or less tolerance, to allow you to effectively evaluate the specifics of the device that you're looking at. We find that, when you're probing and looking at extremely high-speed, high bit-rate performance devices, the probing technology that you use is really crucial. Otherwise, you could end up seeing effects that really aren't represented adequately, or you're not getting a good view into what's really going on, simply because you're getting essentially what amounts to interference from the probing device. And so if you're really interested in isolating the physical-layer elements, while there is some amount of testing you can do with the Intel Channel Test Card, it would probably be worthwhile to also look at some reference-quality test fixturing as well to make sure that you're making as quality a measurement as possible.

I would also point out that the CTC design is modeled after an actual motherboard design. So, when you're doing system-level parametric validation, you want to be able to see what a real motherboard is going to look like. And in an event like that, a probe like the Parametric Slot Probe can be used effectively with the CTC or with any motherboard in order to do characterization of connector and a typical backplane. But in the end, probably the most important characterization is going to be with the motherboard that you're doing or the system that you plan to have your DIMM's or AMB's work in. So you want an example of that physical implementation to work with, in addition to something like the CTC or one of the test fixtures that we provide.

Q: I'm designing a motherboard for a server application. Which physical-layer test fixture should I use to test the motherboard?

A: Probably the one that you would use would be the Agilent N4238A DIMM Parametric Slot Probe. This is an unloaded version of that board. And this is designed to plug into any FBD slot and give you access to, at a parametric level, the gold fingers of the connector and the motherboard.

Q: Can I get a copy of the presentation?

A: Yes, go to eSeminar archive. When the window opens there will be a row of button at the bottom left of the window, such as “Overview”, “Speakers”, and “Resources”. If you click on Resources, the Agilent Resource page will be displayed, where you can get a copy of the presentation plus find many valuable links for more information on the subject. There is also a Digital discussion forum (**www.agilent.com/find/forums**) if you would like to pose/review other questions.

Printed in the USA March 29, 2005