Signal Integrity Issues to Consider When Upgrading to Ultra320 SCSI

White Paper

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Introduction
Most developers would like to implement Ultra320 Small Computer System Interface (SCSI) by plugging in a new Ultra320 Host Bus Adapter (HBA) and new Ultra320 SCSI drives in place of the corresponding Ultra160 SCSI components. There are, however, several additional issues that need to be resolved before one can be assured that they have a reliable new system operating at twice the data rate of the old. Software, firmware and protocol issues must be addressed, resolved and verified. This paper deals with one of the basic sets of parameters that need to be determined regarding the environment in which the new equipment is operating.

Operating Environment
The environment under discussion includes the connectors, cables, terminators and backplanes over which the disk drives and host bus adapters communicate with one another. Developers would like to assume that the environment that worked for Fast 80 (Ultra160 SCSI) would support Ultra320 SCSI speeds at up to 320 MBytes/second. Considering that the data rate is double the previous rate, this may not be a valid assumption.

This is particularly true when going from a carrier of 40MHz to 80MHz. Some of the components, which worked well at the lower frequency, are approaching a ‘knee’ in the curve of their operating characteristics. Characteristics such as frequency-dependent losses, which were insignificant at 40MHz, become significant at 80MHz. Even more importantly, impedance discontinuities that were insignificant relative to the margin that was available in Ultra160 SCSI, can now cause reflections that reach beyond the margins available.

Signal Integrity Margin Measurement
Over the past two years, while we have been developing Ultra320 SCSI, we have had the opportunity to make measurements of the signal integrity margins at Ultra320 SCSI speeds for a significant number of customer environments. Most of these customers were shipping Ultra160 SCSI products. A few products were specifically designed to support Ultra320 SCSI. Of the many customer environments we worked with, most (over 80 percent) would have been able to reliably support Ultra320 SCSI with no modification. This is not to say that they still had the same margin that is present at Ultra160 SCSI speeds, but the margin was adequate for reliable data transmission.

Of the less than 20 percent of the environments whose margins were not adequate for reliable data transmission, most were designed several years ago when the SCSI data rate was significantly lower. They were already being stretched to work at Ultra160 SCSI speeds. Cable assemblies and their components, as well as bulk cable and connectors, have improved significantly over the past few years. New backplanes can easily be designed to accommodate these higher speeds if attention to detail is observed while following a few simple rules. Every new backplane that we evaluated during the customer development phase over the past two years has significant margin relative to signal integrity.

Cable is Key

For environments that don't have enough margin, many can be modified by simply changing the cable used to connect the HBA to the backplane. Any cable assembly over 1.5 meters in length used to connect HBAs to backplanes should be constructed of Ultra320 SCSI bulk shielded round cable. 'Twist and Flat' cable should be used only for short runs where the HBA and drives are in the same cabinet. Shorter cables provide more margin than longer ones. When using 'Twist and Flat' cables, the distance between flats should be at least 20 centimeters (8 inches). A few of the environments that are being used for Ultra160 SCSI will not be capable of supporting Ultra320 SCSI due to the backplane design. In these cases, a new backplane will have to be considered.

The Eye of the Storm

It is very difficult to evaluate the signal integrity margin in a system that is transferring data using Ultra320 SCSI protocol. This is because data transmission is intermittent and coming from a multitude of sources on the bus. To get a good view of what is going on, it is best to have only one data source operating at a time (for example, at the location of the HBA) and have a continuous pseudo-random data stream. Observations can then be made with an oscilloscope of the 'eye pattern' at the input of each receiver on the bus (for example, at the drive locations). This procedure should then be repeated with the data source at the various drive locations and with the receiver at the initiator location (see Figure 1).

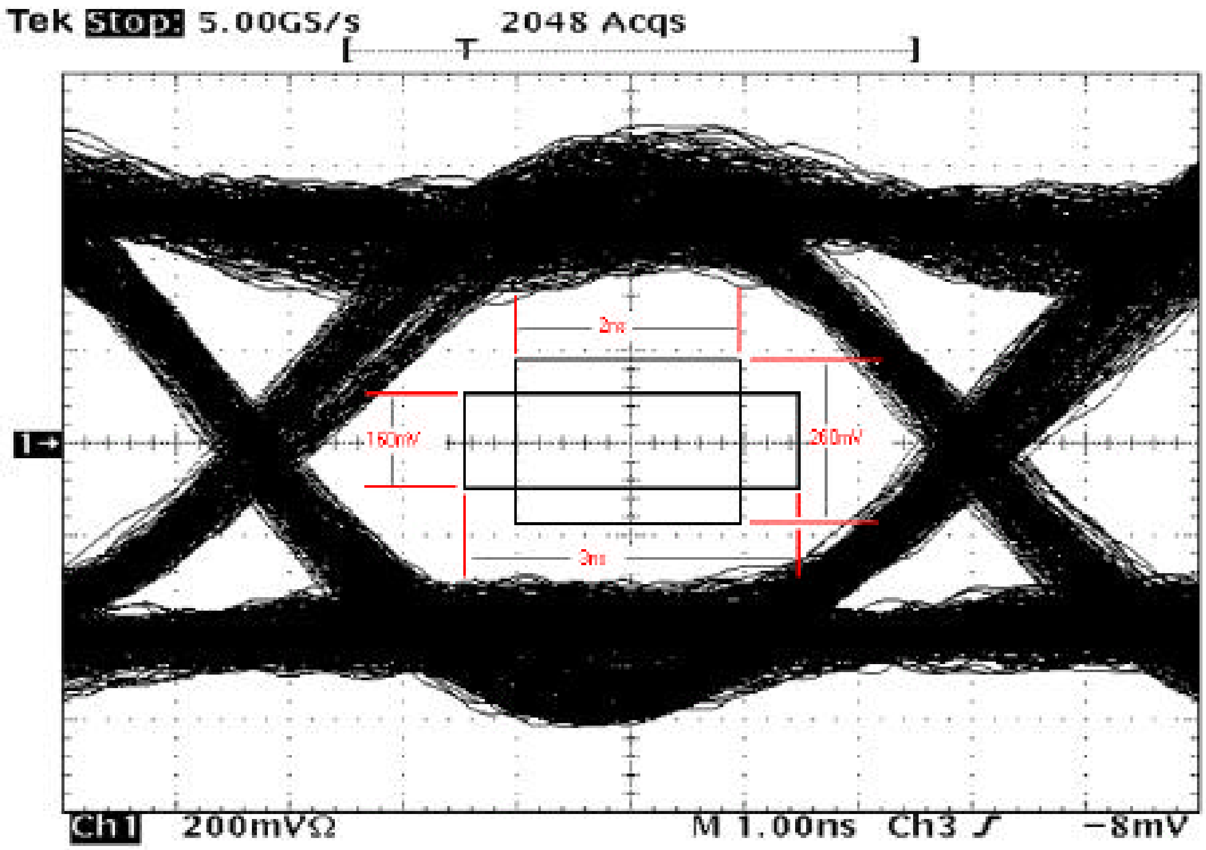

FIGURE 1

The rectangular boxes in the ‘eye’ denote the receiver input specification for SCSI Parallel Interface-4 (SPI-4). The difference from the edge of these boxes to the ‘eye’ is the margin of the system for this driver/receiver combination. One needs to search all combinations of data bits and driver receiver combinations (HBA/drive locations) using a random data pattern to find the ‘worst case’ set. Using that set, extensive statistical data can be gathered to determine the margin (probability of error).

Summary

It is important to do this type of testing as soon as possible so these issues can be resolved before any Ultra320 SCSI protocol testing is done. The results of careful signal integrity margin testing can make a significant difference in the performance of the resulting Ultra320 SCSI system and is a cost-effective way to predict that the performance will meet requirements.

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