Camera Link Assembly
Test Plan

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1. Objective

The objective of performing the sequence of tests described in this test plan is to characterize the Camera Link Cable Assembly for product release and provide insight into variability of performance over time. This will be accomplished by testing all assemblies as defined by the Camera Link spec and specifically Camera Link Specification – v2.0. Tests will be performed in a static environment.

2. Design Specifications

Connector pin out and wiring diagrams are contained in the above referenced Camera Link Specification – v2.0.

3. Performance Specifications

Table 1 summarizes the performance specifications of Camera Link Specification – v2.0.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eye Mask violations at 280Mbps (40MHz clock)</td>
<td>0</td>
<td>Hits</td>
</tr>
<tr>
<td>Eye Mask violations at 462Mbps (66MHz clock)</td>
<td>0</td>
<td>Hits</td>
</tr>
<tr>
<td>Eye Mask violations at 595Mbps (85MHz clock)</td>
<td>0</td>
<td>Hits</td>
</tr>
<tr>
<td>Near End Crosstalk (NEXT)</td>
<td>4%</td>
<td>Input Voltage</td>
</tr>
<tr>
<td>Far End Crosstalk (FEXT)</td>
<td>4%</td>
<td>Input Voltage</td>
</tr>
<tr>
<td>Skew (Inter and Intra pair) at 40MHz clock</td>
<td>390</td>
<td>picoseconds</td>
</tr>
<tr>
<td>Skew (Inter and Intra pair) at 66MHz clock</td>
<td>290</td>
<td>picoseconds</td>
</tr>
<tr>
<td>Skew (Inter and Intra pair) at 85MHz clock</td>
<td>190</td>
<td>Picoseconds</td>
</tr>
<tr>
<td>Impedance</td>
<td>100 ± 10</td>
<td>Ohms</td>
</tr>
</tbody>
</table>

Table 1. Camera Link Electrical Performance Specifications

4. Assembly Interface Board

To allow connecting the completed assembly to test equipment a test board will be needed. Given the highest data rate of 600 Mbps, an adequate board connection to the test equipment will be made using SMA connectors. The board will have a 3M MDR Mini-Ribbon receptacle to allow connection to the Camera Link assembly. Figure 1 is a photograph of an existing test vehicle.
The board has matched electrical length 100 ohm differential traces from the MDR connector to the SMA connectors and includes a cal trace to allow measurement of setup skew and test board trace loss. Using impedance controlled time-matched cables will help minimize skew in the test setup.

5. Time Domain Testing

Time domain testing involves the use of an oscilloscope/TDR and a pattern generator connected as shown in Figure 2.

The pattern generator is used to generate the data pattern needed for the eye mask measurement as well as a low speed clock signal to be used for the skew and crosstalk measurements. The input signal in applied to the test board, propagates through the board and cable assembly under test and exits the data output test board to be analyzed by the oscilloscope. For impedance measurements the pattern generator is not needed and the oscilloscope is used in TDR mode. A more detailed description of each test method is described below.
Intra-Pair Skew (Within Pair Skew)

**Input signal** (pattern generator setup 1): 1V p-p differential, 100Mbps bitrate, 1 MHz clock with 500 ps risetime hardware filters placed on Data Output ports.

**Output signal** (oscilloscope setup 1): Measure $\Delta t$ between data+ and inverted data- at appropriate voltage level of received clock signal.

Procedure:
- Apply input signal to Input Test Board Pair 1
- Connect output signal from Output Test Board Pair 1 to oscilloscope Ch 1/2
- Record measured mean value of $\Delta t$ for Pair 1
- Capture screen image from oscilloscope to file
- Repeat for Pairs 2 through 11

Inter-Pair Skew (Pair to Pair Skew)

**Input signal** (pattern generator setup 1): 1V p-p differential, 100Mbps bitrate, 1 MHz clock with 500 ps risetime hardware filters placed on Data Output ports.

**Output signal** (oscilloscope setup 2): Measure absolute time crossing at appropriate voltage level of received clock signal

Procedure:
- Apply input signal to Input Test Board Pair 1
- Connect output signal from Output Test Board Pair 1 to oscilloscope Ch 1/2
- Record measured value of time crossing for Pair 1
- Capture screen image from oscilloscope to file
- Capture waveform from oscilloscope to file (For graph in Excel, set timescale to 380 ps/div)
- Repeat for Pairs 2 through 11

Near End Crosstalk (NEXT)

**Input signal** (pattern generator setup 1): 1V p-p differential, 100Mbps bitrate, 1 MHz clock with 500 ps risetime hardware filters placed on Data Output ports.

**Output signal** (oscilloscope setup 3): Measure averaged amplitude of received clock signal

Procedure:
- Place 50 Ohm loads on all connectors on both boards.
- Apply input signal to Input Test Board Pair 2
- Connect output signal from Input Test Board Pair 1 to oscilloscope Ch 1/2
- Connect output signal from Input Test Board Pair 3 to oscilloscope Ch 3/4
Measure averaged amplitude from Pair 1 and Pair 3
On oscilloscope, Press Local, then Clear Display button.
Record both values
Capture screen image from oscilloscope to file
Repeat for following pairs:
Input to Pair 4, Output from Input Test Board Pair 3 and Pair 5
Input to Pair 6, Output from Input Test Board Pair 5 and Pair 7
Input to Pair 8, Output from Input Test Board Pair 7 and Pair 9
Input to Pair 10, Output from Input Test Board Pair 9 and Pair 11

Far End Crosstalk (FEXT)

**Input signal** (pattern generator setup 1): 1V p-p differential, 100Mbps bitrate, 1 MHz clock with 500 ps risetime hardware filters placed on Data Output ports.

**Output signal** (oscilloscope setup 3): Measure averaged amplitude of received clock signal

Procedure:

Place 50 Ohm loads on all connectors on both boards.
Apply input signal to Input Test Board Pair 2
Connect output signal from Output Test Board Pair 11 to oscilloscope Ch 1/2
Connect output signal from Output Test Board Pair 9 to oscilloscope Ch 3/4
Measure averaged amplitude from Pair 1 and Pair 3
Record both values
Capture screen image from oscilloscope to file
Repeat for following pairs:
Input to Pair 4, Output from Output Test Board Pair 3 and Pair 5
Input to Pair 6, Output from Output Test Board Pair 7 and Pair 5
Input to Pair 8, Output from Output Test Board Pair 7 and Pair 9
Input to Pair 10, Output from Output Test Board Pair 9 and Pair 11

595MHz Eye Mask Measurement

**Input signal** (pattern generator setup 2): 700mV p-p differential, 595Mbps, 2^7-1 with 500 ps risetime hardware filters placed on Data Output ports.

**Output signal** (oscilloscope setup 4): Measure transmission of received data pattern using eye mask measurement. On oscilloscope, load setup file for 595 MHz eye mask.

Procedure:

Apply input signal to Input Test Board Pair 1
Connect output signal from Output Test Board Pair 1 to oscilloscope Ch 1/2
Record measured value of eye opening and jitter (p-p) for Pair 1
Capture screen image from oscilloscope to file
Repeat for Pairs 2 through 11

462MHz Eye Mask Measurement

**Input signal** (pattern generator setup 2): 700mV p-p differential, 462Mbps, $2^7-1$ with 500 ps risetime hardware filters placed on Data Output ports.

**Output signal** (oscilloscope setup 4): Measure transmission of received data pattern using eye mask measurement. On oscilloscope, load file for 462 MHz eye mask.

Procedure:
- Apply input signal to Input Test Board Pair 1
- Connect output signal from Output Test Board Pair 1 to oscilloscope Ch 1/2
- Record measured value of eye opening and jitter (p-p) for Pair 1
- Capture screen image from oscilloscope to file
- Repeat for Pairs 2 through 11

280MHz Eye Mask Measurement

**Input signal** (pattern generator setup 2): 700mV p-p differential, 280Mbps, $2^7-1$ with 500 ps risetime hardware filters placed on Data Output ports.

**Output signal** (oscilloscope setup 4): Measure transmission of received data pattern using eye mask measurement. On oscilloscope, load file for 280 MHz eye mask.

Procedure:
- Apply input signal to Input Test Board Pair 1
- Connect output signal from Output Test Board Pair 1 to oscilloscope Ch 1/2
- Record measured value of eye opening and jitter (p-p) for Pair 1
- Capture screen image from oscilloscope to file
- Repeat for Pairs 2 through 11

Impedance:

**Input signal** (oscilloscope setup 5): Differential TDR (oscilloscope Ch 1/2) pulse with 500 ps Risetime (software filters).

**Output signal** (oscilloscope setup 5): Measure differential impedance at maximum and minimum value

Procedure:
- Apply oscilloscope Ch1/2 input signal to Input Test Board Pair 1
- Measure the impedance between 100 to 300 picoseconds after the connector.
- Record measured maximum and minimum impedance for Pair 1
- Capture screen image from oscilloscope to file
Repeat for Pairs 2 through 11

Eye Mask Test Files

The programs that supply the eye-mask are listed below. These were written and used on an Agilent 86100C DCA-J Digital Communications Analyzer.

280MHz Eye Mask

MASK_FILE_861XX
"Camera_Link_280MHz_Serial"

/* Description:
   This is a fixed voltage level eye-mask for the ATA Camera Link Serial Specification V1.2
   Dated January, 2007
*/

/* Top Region */
/* Region Number */  2
/* Region Type */  STD
/* Number of vertices */  4
   +0.0, Max
   +0.0, +1.0
   +1.0, +1.0
   +1.0, Max

/* Middle Region */
/* Region Number */  1
/* Region Type */  STD
/* Number of vertices */  6
   +0.47180, +0.500000
   +0.47180, +0.642857
   +0.62300, +0.642857
   +0.62300, +0.500000
   +0.62300, +0.357143
   +0.47180, +0.357143

/* Bottom Region */
/* Region Number */  3
/* Region Type */  STD
/* Number of vertices */  4
   +0.0, Min
   +0.0, +0.0
   +1.0, +0.0
   +1.0, Min

setup

:MTES:SCAL:YTRACK OFF
:MTES:SCAL:Y1 -0.350
:MTES:SCAL:Y2 +0.350
:MTES:SCAL:MODE XONLY
:MTES:SCAL:XDEL 3571.4285E-12
:MTES:SCAL:DEF
:MTES:AMET NRZEYE
462MHz Eye Mask

MASK_FILE_861XX
"Camera_link_462MHz_Serial"
/* Description:
   This is a fixed voltage level
   eye-mask for the ATA Camera
   Link Serial Specification V1.2
   Dated January, 2007
*/
/* Top Region   */
/* Region Number */  2
/* Region Type  */  STD
/* Number of vertices */  4
   +0.0,  Max
   +0.0,  +1.0
   +1.0,  +1.0
   +1.0,  Max

/* Middle Region  */
/* Region Number */  1
/* Region Type   */  STD
/* Number of vertices */  6
   +0.42283,  +0.500000
   +0.42283,  +0.642857
   +0.67237,  +0.642857
   +0.67237,  +0.500000
   +0.67237,  +0.357143
   +0.42283,  +0.357143

/* Bottom Region  */
/* Region Number */  3
/* Region Type   */  STD
/* Number of vertices */  4
   +0.0,  Min
   +0.0,  +0.0
   +1.0,  +0.0
   +1.0,  Min

setup
:MTES:SCAL:YTRACK OFF
:MTES:SCAL:Y1 -0.350
:MTES:SCAL:Y2 0.350
:MTES:SCAL:MODE XONLY
:MTES:SCAL:XDEL 2164.5021E-12
:MTES:SCAL:DEF
:MTES:AMET NRZEYE

end_setup

595MHz Eye Mask
MASK_FILE_861XX

"Camera_Link_595MHz_Serial"

/* Description:
   This is a fixed voltage level
   eye-mask for the ATA Camera
   Link Serial Specification V1.2
   Dated January, 2007
*/

/* Top Region */
/* Region Number */  2
/* Region Type */  STD
/* Number of vertices */  4
   +0.0,      Max
   +0.0,      +1.0
   +1.0,      +1.0
   +1.0,      Max

/* Middle Region */
/* Region Number */  1
/* Region Type */  STD
/* Number of vertices */  6
   +0.38674,   +0.500000
   +0.38674,   +0.642857
   +0.70845,   +0.642857
   +0.70845,   +0.500000
   +0.70845,   +0.357143
   +0.38674,   +0.357143

/* Bottom Region */
/* Region Number */  3
/* Region Type */  STD
/* Number of vertices */  4
   +0.0,      Min
   +0.0,      +0.0
   +1.0,      +0.0
   +1.0,      Min

/*_____________________________________________________*/

setup

:MTES:SCAL:YTRACK OFF
:MTES:SCAL:Y1 -0.350
:MTES:SCAL:Y2 +0.350
:MTES:SCAL:MODE XONLY
:MTES:SCAL:XDEL 1680.6723E-12
:MTES:SCAL:DEF
:MTES:AMET NRZEYE

derm_setup