

# Camera Link™

## Appendix D For The Camera Link Specification For The Interface Standard For Digital Cameras And Frame Grabbers

### *Preliminary Specifications*

Revision B

Frank Cuzze, 3M Product Development Engineer, Austin, Texas

March 26, 2004

<b>1. Mechanical Interface</b> .....	<b>3</b>
1.1 Overview	3
1.2 Camera Link™ Connector .....	3
1.2.1 Pin Assignment .....	3
1.2.2 Mechanical Drawings .....	4-5
1.2.3 Connector Retention .....	6
1.2.4 Contact Finish .....	6
1.2.5 Shell Finish .....	6
1.3 Camera Link Cabling .....	6
1.3.1 Cable Length .....	6
1.3.2 Number of Signal Conductors .....	6
1.3.3 Wire Gauge .....	6
1.3.4 Conductor Resistance .....	6
1.3.5 Insulation .....	6
1.3.6 Shield Requirement .....	6
1.3.7 Single Twisted Pair Transmission Skew (Intra-pair Skew) .....	7
1.3.8 Multiple Twisted Pair Transmission Skew (Inter-pair Skew).....	7
<b>2. Testing Requirements</b> .....	<b>7</b>
2.1 Environmental Requirements .....	7
2.1.1 Temperature Life .....	7
2.1.2 Cyclic Humidity .....	7
2.1.3 Thermal Shock .....	7
2.1.4 Corrosion Resistance .....	7
2.2 Electrical Requirements .....	8
2.2.1 Dielectric Withstanding Voltage .....	8
2.2.2 Insulation Resistance .....	8
2.2.3 Contact Resistance .....	8
2.2.4 Contact Current Rating.....	8
2.2.5 Impedance of LVDS Signal Lines .....	8
2.2.6 Bandwidth of LVDS Signal Lines .....	8
2.2.7 Crosstalk of LVDS Signal Lines .....	12
2.2.8 Skew Of LVDS Conductor Pair .....	12
2.2.9 Insertion Loss Of Camera Link Cable .....	12
2.3 Mechanical Requirements .....	12
2.3.1 Durability .....	12
2.3.2 Mating and Unmating Force .....	12
2.3.3 Vibration .....	12
<b>3. Camera Link 3M™ Cable Assembly</b> .....	<b>12</b>
3.1 Cable Assembly .....	12
3.1.1 Thumbscrew Overmolded Backshell .....	12
3.1.2 Thumbscrew Shell Kit .....	12
3.1.3 Ordering Information.....	12
3.1.4 Cable Assembly Part Numbers .....	13
3.1.5 Boardmount Receptacle Part Numbers .....	13

# 1. Mechanical Interface

## 1.1 Overview

This section describes the Camera Link™ connector and cable interface required on the display source and display device. General dimensions, tolerances and descriptions of those features which affect the intermateability of the receptacle and plug connectors are described in this section. The pinouts for the receptacle connector are also described in this section.

## 1.2 Camera Link Connector

The Camera Link connector shall be a two-row shielded ribbon contact connector with contacts on .050” spacing. A 360 degree “delta” shaped metal shell shall enclose the plug and receptacle contacts to provide shielding and proper polarity when mated. The contacts are designed to handle limited power, ground and signals.

### 1.2.1 Board Mount Connector Pin Assignment

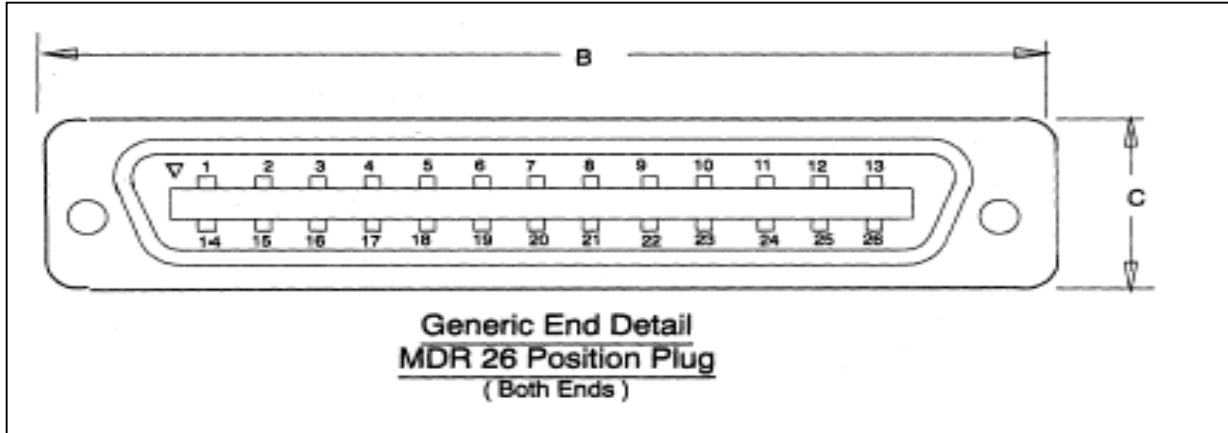
The assignment of signals to the connector pins shall be as shown in Table 1-1. There is no difference between the display source end of the cable and that of the display device. Thus, either end of the cable may be connected to the display source or display device.

3M™ Cable Assembly and Camera Link Pinouts*						
3M Cable v 51.2						
*Cable assembly compatible with both Camera Link configurations						
Medium and Full Configurations				Base Configuration		
Two Channel Link™ Chips				One Channel Link Chip + Camera Control + Serial Communication		
Camera Connector	Right Angle Frame Grabber	Channel Link Signal	Cable Name (Reference Only)	Camera Connector	Right Angle Frame Grabber	Channel Link Signal
1	1	Inner shield	Inner shield	1	1	Inner shield
14	14	Inner shield	Inner shield	14	14	Inner shield
2	25	Y0-	Pair 1-	2	25	X0-
15	12	Y0+	Pair 1+	3	24	X1-
3	24	Y1-	Pair 2-	3	24	X1-
16	11	Y1+	Pair 2+	16	11	X1+
4	23	Y2-	Pair 3-	4	23	X2-
17	10	Y2+	Pair 3+	17	10	X2+
5	22	Yclk-	Pair 4-	5	22	Xclk-
18	9	Yclk+	Pair 4+	18	9	Xclk+
6	21	Y3-	Pair 5-	6	21	X3-
19	8	Y3+	Pair 5+	19	8	X3+
7	20	100 ohm	Pair 6+	7	20	SerTC+
20	7	Terminated	Pair 6-	20	7	SerTC-
8	19	Z0-	Pair 7-	8	19	SerTFG-
21	6	Z0+	Pair 7+	21	6	SerTFG+
9	18	Z1-	Pair 8-	9	18	CC1-
22	5	Z1+	Pair 8+	22	5	CC1+
10	17	Z2-	Pair 9+	10	17	CC2+
23	4	Z2+	Pair 9+	23	4	CC2-
11	16	Zclk-	Pair 10-	11	16	CC3-
24	3	Zclk+	Pair 10+	24	3	CC3+
12	15	Z3-	Pair 11+	12	15	CC4+
25	2	Z3+	Pair 11-	25	2	CC4-
13	13	Inner shield	Inner shield	13	13	Inner shield
26	26	Inner shield	Inner shield	26	26	Inner shield

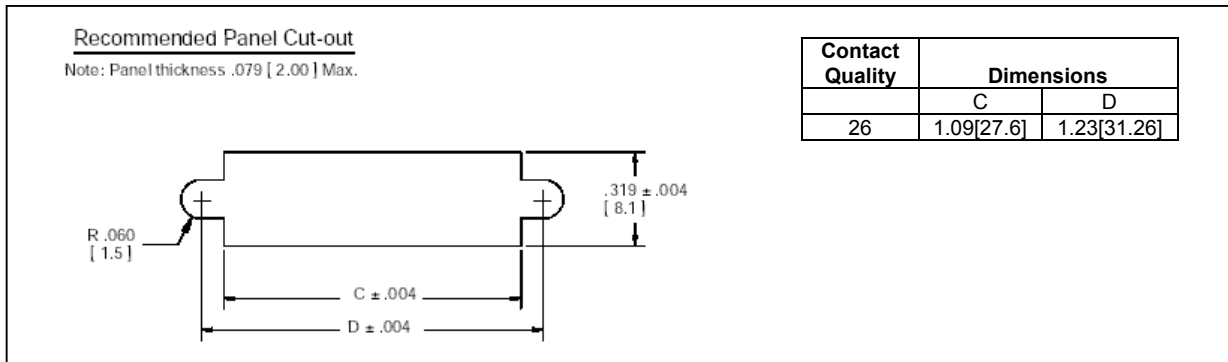
Camera Link Cable Assembly Wiring Diagram  
Table 1-1 Pin Assignment for Shielded Twisted Pair Cabling

### 1.2.2 Mechanical Drawings

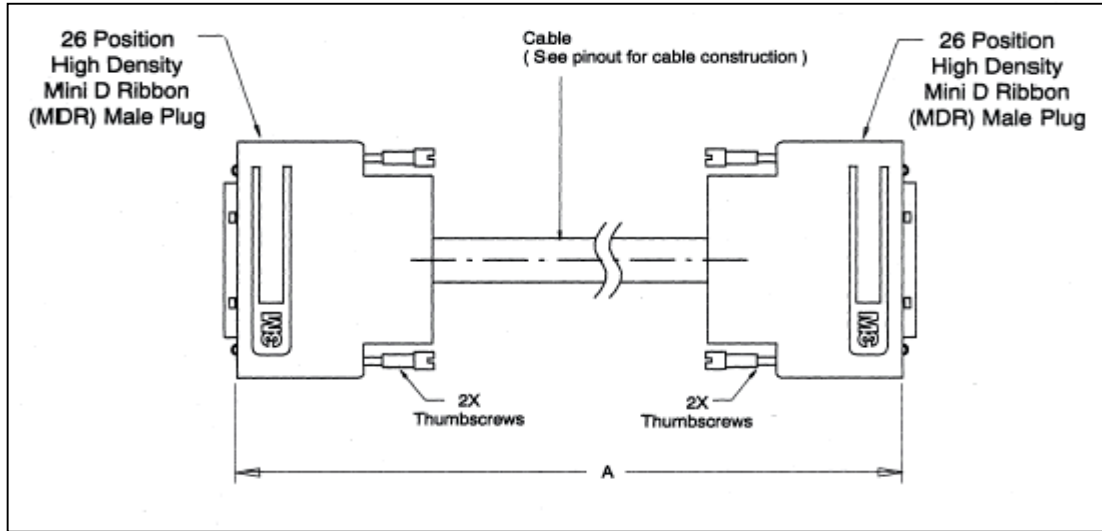
This section depicts the dimensions and mechanical outline of the connector receptacles on the display source, display device and cable assembly. The cable assembly plug used on the display source and display device is shown in Figure 1-1. The panel cutout for the display source and display device is shown in Figure 1-2. The cable assembly is shown in Figure 1-3. The board mount receptacle is shown in Figure 1-4. These figures are for illustrative purposes, only.



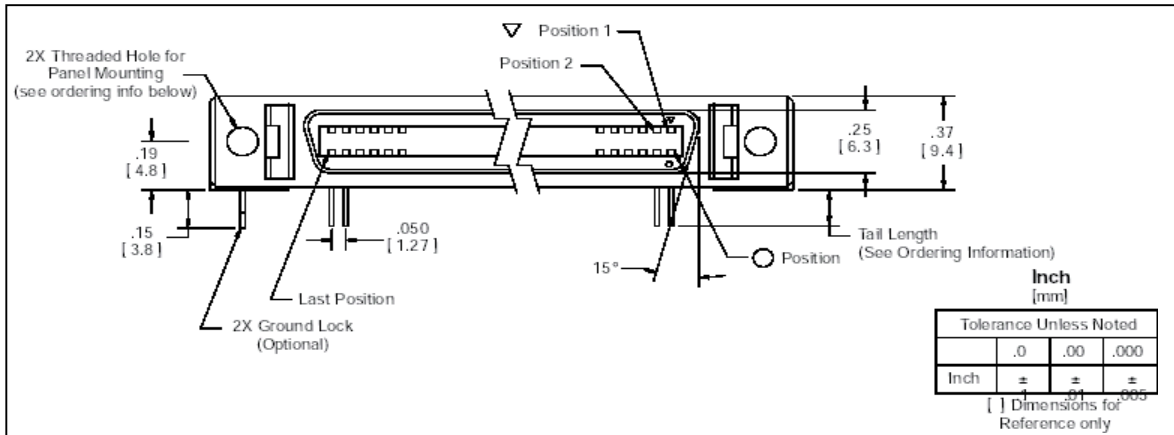
**MDR Cable Assembly Plug**  
Figure 1-1



**MDR Board Mount Panel Cut Out Drawing**  
Figure 1-2



**MDR Cable Assembly**  
**Figure 1-3**



**MDR Board Mount Receptacle Drawing**  
**Figure 1-4**

### **1.2.3 Connector Retention**

The receptacle on the display source and the plug on the cable assembly shall be retained by two 4-40 screws on each end to ensure the proper mating of the connector reference surfaces. Proper mating is critical to minimizing radiated emissions and electromagnetic interference.

### **1.2.4 Contact Finish**

The contacts of the connector receptacles of the display source and cable assembly shall be plated with a noble metal or noble metal alloy that meets the following minimum requirements 0.76 um gold over 2.0 um nickel.

### **1.2.5 Shell Finish**

The connector shell shall be plated with a minimum of 4 um Electroless nickel.

## **1.3 Camera Link™ Cabling**

A Camera Link cable assembly shall consist of a cable meeting the requirements of Appendix D with a Camera Link plug on each end. Acceptable cables for Camera Link will use shielded twisted pairs. It is up to the manufacturer of the Camera Link equipment to use the gauge and type of cable required to meet applicable regulatory requirements, and the specifications of Appendix D. Adherence to this standard does not guarantee regulatory compliance.

### **1.3.1 Cable Length**

The maximum cable length shall be 10m.

### **1.3.2 Number of Signal Conductors**

The Camera Link cable shall comprise 11 twisted shielded pairs and 4 individual drain conductors.

### **1.3.3 Wire Gauge**

Each conductor in an Camera Link cable shall be tin plated copper stranded wire , 7/36, and no less than 28AWG. The drain wires shall be tin plated copper stranded wire , 7/36, and no less than 28AWG.

### **1.3.4 Conductor Resistance**

The resistance of a single conductor of a Camera Link cable shall not exceed 3 Ohms when the conductor is of the maximum length, 10m, specified in this standard.

### **1.3.5 Insulation**

Each conductor in the cable shall be separately insulated. The minimum insulation resistance shall be 100 meg Ohms.

### **1.3.6 Shield Requirement**

The Camera Link cable shall be encompassed with a single braided shield, and a single foil shield. The foil shield is under the braided shield and both shields surround all conductors in the cable. The overall shield shall provide a minimum of 90% coverage.

For shielded twisted pair cable, each twisted pair shall be shielded individually. Each shield shall provide a minimum of 100% coverage.

### 1.3.7 Cable Jacket

The outer diameter of the cable shall be 9.0 mm nominal, and will be made out of poly vinyl chloride, PVC.

### 1.3.8 Single Twisted Pair Transmission Skew (Intra-pair Skew)

The differential time of transmission, single pair transmission skew, of a pulse through a single differential pair in a Camera Link™ cable shall not exceed 50ps/m.

### 1.3.9 Multiple Twisted Pair Transmission Skew (Inter-pair Skew)

The differential time of transmission, pair to pair transmission skew, of a pulse through any two differential pairs in a Camera Link cable shall not exceed 50ps/m.

## 2. Testing Requirements

The performance and testing requirements for the Camera Link connector plug, and receptacle are described in this section. Test procedures and requirements from ANSI/EIA/TIA 364 are used, where applicable.

### 2.1 Environmental Requirements

#### 2.1.1 Temperature Life

The connector plug, and receptacle shall be tested according to ANSI/EIA/TIA 364-17, method A with test condition 3 at +85 degrees C. Test time is run under condition B, Table 3, for 250 hours, using method A, without load, while connectors are mated.

#### 2.1.2 Cyclic Humidity

The connector plug and receptacle shall be tested according to ANSI/EIA/TIA 364-31, Test conditions B, Method III omitting 7B. Contact resistance shall be measured according to ANSI / EIA/TIA 364-23. Contact resistance shall not exceed 35 mil Ohms. Contact resistance for the assembly shall not change by more than 25 mil Ohms from the original resistance measured.

#### 2.1.3 Thermal Shock

The connector plug and receptacle shall be tested according to ANSI/EIA/TIA 364-32, Condition 1 for 5 cycles mated. Contact resistance shall be measured according to ANSI/EIA/TIA 364-23. Contact resistance shall not exceed 35 mil Ohms. Contact resistance shall not change more than 25 mil Ohms from the original resistance measured.

#### 2.1.4 Corrosion Resistance

The connector plug and receptacle shall be tested for 30 cycles mated and unmated. The connector plug and receptacle shall be tested according to JEDA-25-1974, using H<sub>2</sub>S + 3 ppm, at 70-80% RH, at 40°C for 96 Hours. Contact resistance shall not exceed 35 mil Ohms. Contact resistance shall not change more than 25 mil Ohms from the original resistance measured.

The procedure for the corrosion test is as follows.

1. Initial low level contact resistance, LLCR, measurement
2. Insertion & Withdrawal / 30 cycle
3. LLCR, measurement
4. H<sub>2</sub>S Gas  
H<sub>2</sub>S 3 +/- 1ppm, 70 - 80%RH, 40 degrees, 96 hrs
5. LLCR, measurement

## **2.2 Electrical Requirements**

### **2.2.1 Dielectric Withstanding Voltage**

The connector plug and receptacle shall be tested according to ANSI/EIA/TIA 364-20, using a test voltage of 400 VRMS with the connector unmated and unmounted, at a barometric pressure of 15psi. Leakage current should not exceed 10.0 mil amps max between two adjacent contacts.

### **2.2.2 Insulation Resistance**

The connector plug and receptacle shall be tested according to ANSI/EIA/TIA 364-21, using Method C with a test voltage of 100VDC and the connector unmated and unmounted. Minimum insulation resistance shall be 100 Meg Ohms between adjacent contacts and between each contact and the connector shell.

### **2.2.3 Low Level Contact Resistance**

The connector plug and receptacle shall be tested according to ANSI/EIA/TIA 364-23. The resistance shall be no more than 35mil Ohms per mated contact pair initially. Throughout all tests there shall be no more than 25 mil Ohms change from the original resistance measured.

### **2.2.4 Contact Current Rating**

The connector plug and receptacle shall be tested according to ANSI/EIA/TIA 364-70 at a minimum current of 1.0A with a temperature rise of no more than 30 degrees C, with all pins driven.

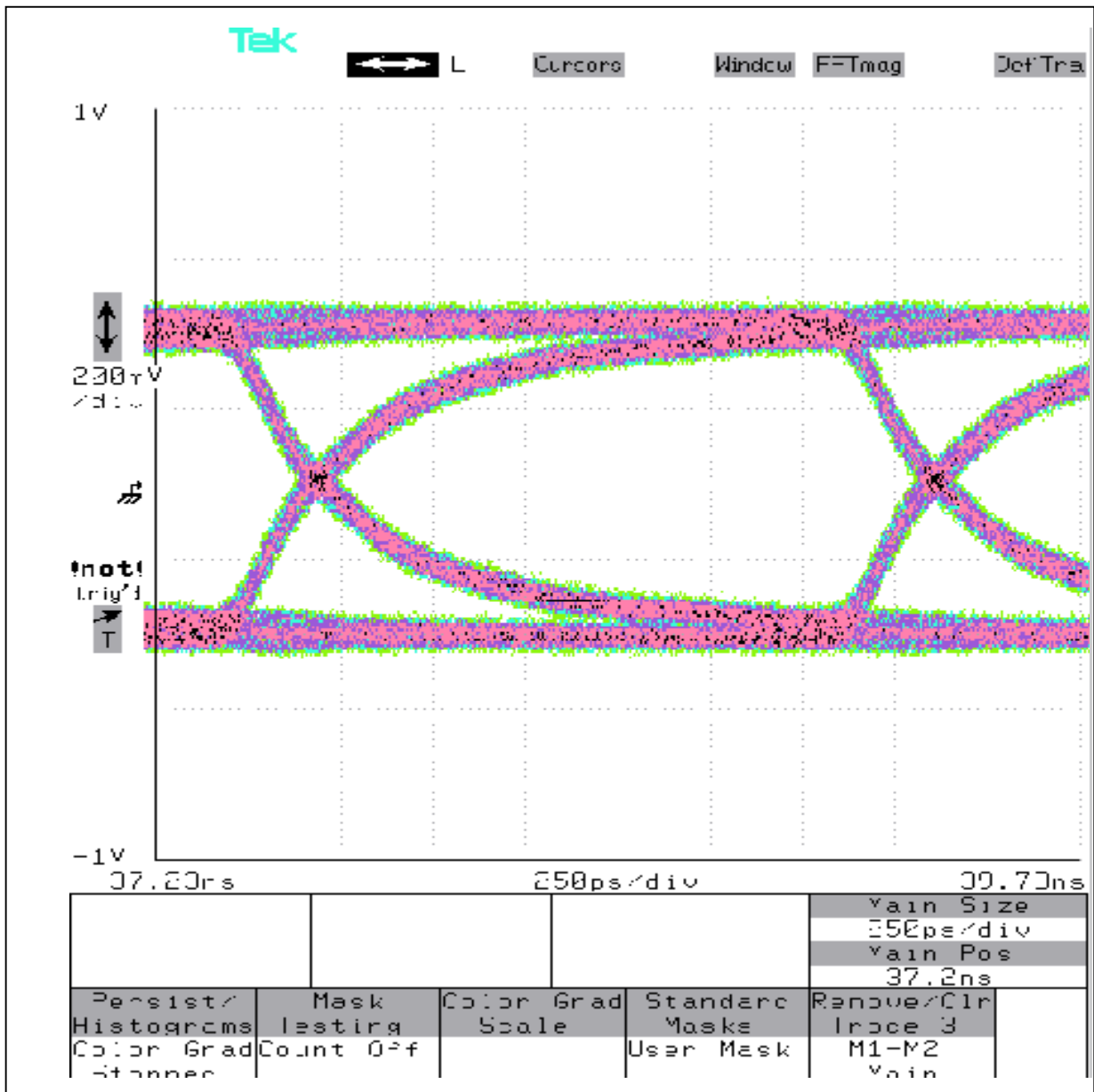
### **2.2.5 Impedance of LVDS Differential Signal Lines**

The connector, plug and cable shall be tested using a time domain reflectometry method normalized to 500ps rise time, with single-ended 1:1 S:G ratio. The impedance of the source and the impedance of the load shall be 100 Ohms. Only the shell shall be grounded. The impedance of each differential pair shall be 100 Ohms +/-10 Ohms.

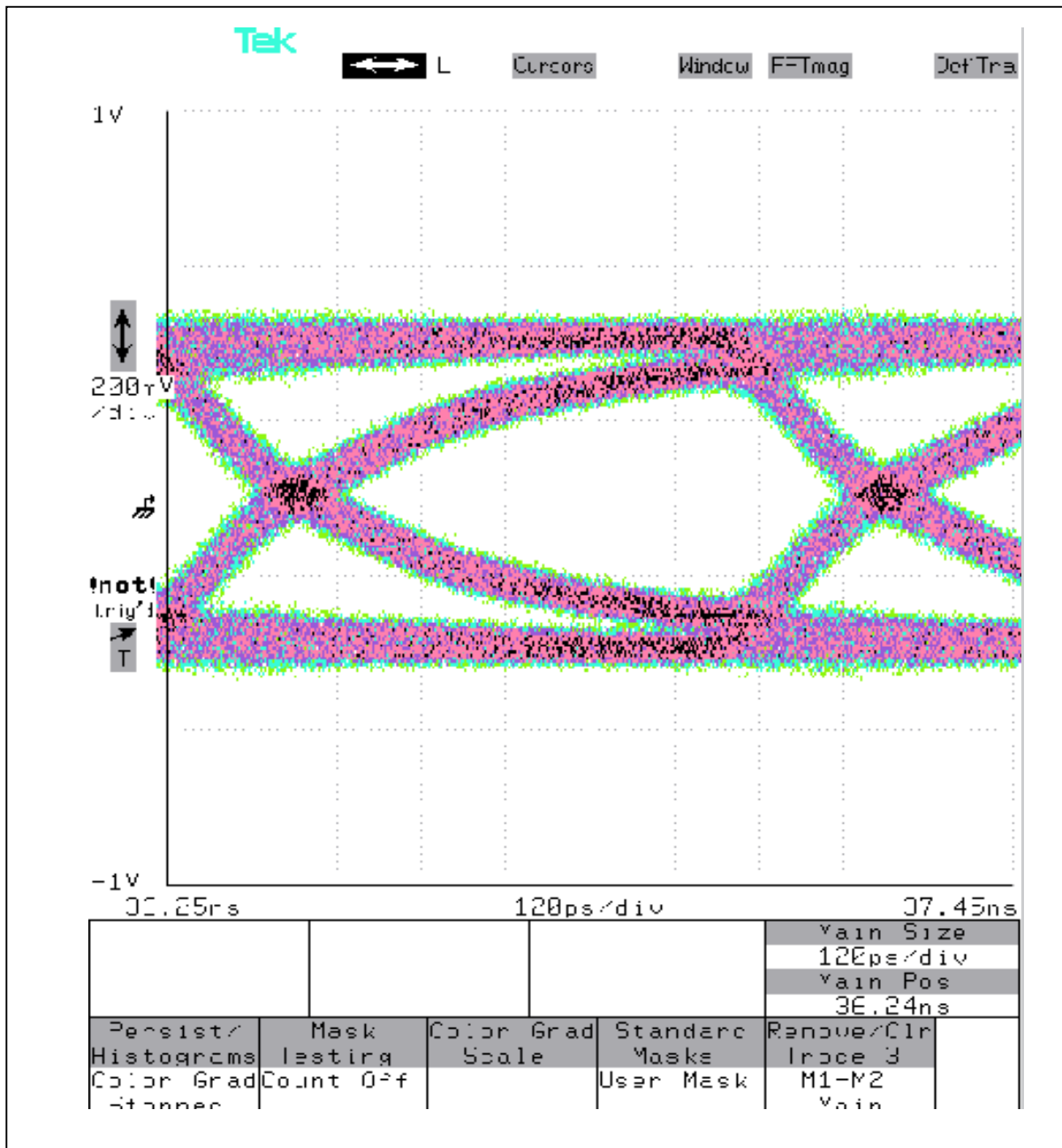
### **2.2.6 Bandwidth of LVDS Differential Signal Lines**

The connector, plug and cable shall be tested according to EIA/TIA 364-107, using a 1V signal with 500 ps rise time. Bandwidth testing of the LVDS differential signal lines is shown below in figures 2.1 and 2.2 for two baud rates driving a pseudo random bit pattern over a 3 meter length of cable. The eye opening for the 600 Mbps data rate shall be 40% with a 150 ps jitter.





Eye Diagram  
 V51.0/F26-30/3m  
 500 Mbps  
 Figure 2-1

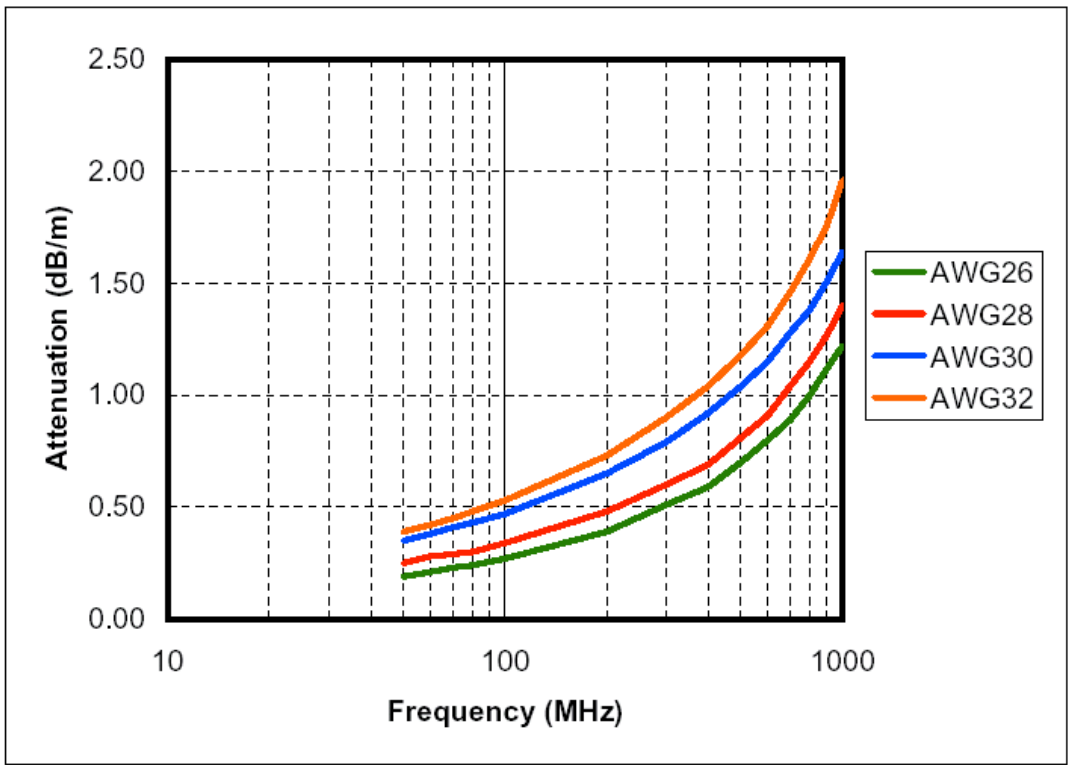


Eye Diagram  
 V51.0/F26-30/3m  
 1.2Gbps  
 Figure 2-2

**100 ohm TWINAX LOSS**

Unit : dB/m

Conductor O.D.	0.48mm	0.38mm	0.30mm	0.24mm
Frequency (MHz)	AWG26	AWG28	AWG30	AWG32
50	0.19	0.25	0.35	0.39
60	0.21	0.28	0.38	0.42
70	0.23	0.29	0.41	0.45
80	0.24	0.30	0.43	0.48
100	0.27	0.34	0.47	0.53
200	0.39	0.48	0.65	0.73
300	0.51	0.60	0.79	0.90
400	0.59	0.69	0.92	1.04
500	0.70	0.81	1.04	1.18
600	0.80	0.91	1.15	1.31
700	0.89	1.04	1.28	1.46
800	1.00	1.15	1.38	1.61
900	1.12	1.27	1.51	1.76
1000	1.22	1.40	1.64	1.96



Insertion Loss of Camera Link™ 28 AWG Shielded Twisted Cable Pairs  
Figure 2-3

### **2.2.7 Crosstalk of LVDS Differential Signal Lines**

The connector, plug and cable shall be tested according to EIA/TIA 364-90, using a 1V signal with 500 ps rise time. Both the near end crosstalk, NEXT, and far end crosstalk, FEXT, shall be measured, with only the shield grounded. The measured crosstalk shall not exceed 4%.

### **2.2.8 Skew of LVDS Differential Signal Lines**

The connector, plug and cable shall be tested using a 1V signal with 500ps rise time. Intrapair skew will not exceed 50 ps/m between the conductors within a pair. The interpair skew will not exceed 50 ps/m between pairs.

### **2.2.9 Insertion Loss of Camera Link™ Cable**

The insertion loss of a 100 Ohm 28 gauge shielded twinax pair shall be between 0.35 dB/m at 100 MHz to 1.40 dB/m at 1000 Mhz.

## **2.3 Mechanical Requirements**

### **2.3.1 Durability**

The connector plug and receptacle shall be tested according to ANSI/EIA/TIA 364-09, two mated pairs for 30 cycles. The resistance shall be no more than 35mil Ohms per mated contact pair initially. Throughout all tests there shall be no more than 25 mil Ohms change from the original resistance measured.

### **2.3.2 Mating and Unmating Force**

The connector plug and receptacle shall be tested according to ANSI/EIA/TIA 364-13, inserted and extracted at 25 mm per minute. The mating force shall not exceed 3.9kgf nor be less than 1kgf.

### **2.3.3 Vibration**

The connector plug and receptacle shall be tested according to ANSI/EIA/TIA 364-28, Condition 1. Continuity shall be measured according to ANSI/EIA/TIA 364-46 for all contacts. No discontinuities shall be longer than 1 us.

## **3. Camera Link Cabling Information**

The Camera Link interface uses a cable assembly manufactured by 3M, with MDR-26 pin connectors on both ends, and has several options available to the customer.

### **3.1 Cable Assembly**

The Camera Link cable assembly is available in two shell configurations, and various lengths. Table D-1 describes the specifications for the following options:

#### **3.1.1 Thumbscrew Overmolded Backshell**

The inner IDC assembly is wrapped with a copper foil tape, which connects the outer chassis cable shield to the face of the MDR plug. A final overmolded shell is made from PVC material.

#### **3.1.2 Thumbscrew Shell Kit**

An inner metal shroud connects the chassis ground from the cable to the face of the MDR plug. A plastic “shell boot” is slipped over the metal shrouds, providing the finished shell.

#### **3.1.3 Ordering Information**

Cable assemblies and boardmount receptacles are available from 3M. For more information on 3M products, see the 3M Web site at: [http://www.3m.com/us/electronics\\_mfg/interconnects/](http://www.3m.com/us/electronics_mfg/interconnects/)

### 3.1.4 Cable Assembly Catalog Part Numbers

Thumbscrew Shell Kit  
**14B26-SZLB-XXX-0LC**

Thumbscrew Overmolded Backshell  
**14T26-SZLB-XXX-0LC**

#### **XXX = Length Field**

100 = 1 meter  
200 = 2 meters  
300 = 3 meters  
450 = 4.5 meters  
500 = 5 meters  
700 = 7 meters  
A00 = 10 meter

### 3.1.5 Board Mount Receptacle Catalog Part Numbers

The following table lists the 3M™ boardmount receptacle part numbers.

<b>Part Number</b>	<b>Type</b>	<b>Mount</b>
N10226-52XXVC	MDR 26 Right Angle	Thru-hole
10266-55G3VC	MDR 26 Right Angle	Thru-hole
10226-6212VC	MDR 26 Vertical	Thru-hole
10226-1A10VE	MDR 26 Right Angle	SMT
10226-1210VE	MDR 26 Right Angle	SMT
10226-2200VE	MDR 26 Vertical	SMT
10226-R21XS	MDR 26 Vertical	Compliant Pin

**3M Boardmount Receptacle Part Numbers  
Table 3-2**

Camera Link is a certification mark of Automated Imaging Association.

Channel Link is a trademark of National Semiconductor.

3M is a registered trademark of 3M Company. All other tradenames referenced are the service marks, trademarks, or registered trademarks of their respective companies.



#### **Electronic Solutions Division**

6801 River Place Blvd.  
Austin, TX 78726-9000  
800/328-1368  
www.3M.com/esd