Japan Industrial Imaging Association Technical Report

JIIA CoaXPress Standard

Specification Change Notice
For
Return Loss and Eye Diagram

JIIA -CXPR-004-2012

Released on August, 30th, 2012

The Standardization Committee - CoaXPress Working Group

Japan Industrial Imaging Association

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Use, Relationships:

This Specification Change Notice (SCN) is used to record and transmit approved change pages to an existing paper specification. Once an Engineering Change Proposal has been approved, the SCN provides official notice to holders of the specification that the attached change can be incorporated into their copy of the specification.

Objective this document:

Based on past findings and studies, CoaXPress standard update from Ver.1.0 to Ver. 1.1 is scheduled. For early proliferation of CoaXPress Products, this is to announce new allowance of Return Loss and Eye diagram in the form of SCN ahead of Ver.1.1 release.
With immediate effect, companies submitting a product for Electrical Compliance Testing (ECT) will have them tested to the revised specification in this SCN. Pass/Fail criteria of ECT are carried out based on new allowance on this SCN.

Note: Companies that have previously had products fail an ECT, but believe that the test results would pass the revised specification in this SCN, should contact JIIA to have their results reviewed.

Scope of this SCN:

This SCN is applied to permitted value of CoaXPress Standard Ver.1.0 [JIIA NIF-001-2010] Article: 6.8 Return Loss at Connectors Table7, Annex B: Table 1 and Table 2

Specific Changes

Present:

CXP VERSION 1.0

Table 7 — Normative return loss frequency ranges for Host and Device

Highest bit rate	Frequency range where Return Loss shall be better than -15 dB	Frequency range where Return Loss shall be better than -10 dB	Frequency range where return loss shall be better than -7 dB
1.250 Gbps	5 MHz – 312 MHz	312 MHz – 625 MHz	-
2.500 Gbps	5 MHz – 625 MHz	625 MHz – 1.25 GHz	-
3.125 Gbps	5 MHz – 1.0 GHz	1.0 GHz – 1.25 GHz	1.25 GHz – 1.62 GHz
5.000 Gbps	5 MHz – 1.0 GHz	1.0 GHz – 1.5 GHz	1.5 GHz – 2.50 GHz
6.250 Gbps	5 MHz – 1.0 GHz	1.0 GHz – 1.5 GHz	1.5 GHz – 3.2 GHz

Annex B: Table 1 — High speed link parameters at the transmit (Device) side

Symbol	Parameter	Min.	Typ.	Max.	Units	Comment
ΔV_{TX}	Transmit amplitude	500	600	700	mV	At Tp2 into 75Ω.
		407	480	552	mV	At Tp2 into 50Ω. See note 1 below.
$\Delta V_{EYE}/\Delta V_{TX}$	Relative EYE opening	0.75			-	At Tp2 into 75Ω.
t_{rise}, t_{fall}	Rise, fall time		as short as possible	80	ps	At Tp2 into 75Ω, between 20% and 80% of amplitude.
T_j	Transmit jitter		as low as possible	20	%UI	At Tp2 into 75Ω. See note 2 below.

Annex B: Table 2 — Low speed link parameters at the transmit (Host) side

Symbol	Parameter	Min.	Typ.	Max.	Units	Comment
ΔV_{TXLF}	Transmit amplitude	110	130	160	mV	At Tp3 into 75Ω.
$\Delta V_{EYELF}/\Delta V_{TXLF}$	Relative EYE opening	0.75	-	-	-	At Tp3 into 75Ω.
t_{riseLF}, t_{fallLF}	Rise, fall time	7	11	15	ns	At Tp3 into 75Ω, between 20% and 80% of amplitude.
T_{jLF}	Transmit jitter	-	as low as possible	5	ns	At Tp3 into 75Ω. See note below.

Amendment:

Table 7 — Normative return loss frequency ranges for Host and Device

HOST side			
Highest bit rate	**Frequency range where Return Loss shall be better than -15 dB**	**Frequency range where Return Loss shall be better than -10 dB**	**Frequency range where return loss shall be better than -7 dB**
1.250 Gbps	5 MHz – 312 MHz	312 MHz – 625 MHz	-
2.500 Gbps	5 MHz – 625 MHz	625 MHz – 1.25 GHz	-
3.125 Gbps	5 MHz – **625 MHz**	**625 MHz** – 1.25 GHz	1.25 GHz – 1.62 GHz
5.000 Gbps	5 MHz – **625 MHz**	**625 MHz** – 1.5 GHz	1.5 GHz – 2.50 GHz
6.250 Gbps	5 MHz – **625 MHz**	**625 MHz** – 1.5 GHz	1.5 GHz – 3.2 GHz
Device Side			
Highest bit rate	**Frequency range where Return Loss shall be better than -10 dB**	**Frequency range where Return Loss shall be better than -7 dB**	**Frequency range where Return Loss shall be better than -4 dB**
1.250 Gbps	5 MHz – **312 MHz**	**312 MHz** – 625 MHz	-
2.500 Gbps	5 MHz – **312 MHz**	**312 MHz** – 1.25 GHz	-
3.125 Gbps	5 MHz – **312 MHz**	**312 MHz** – 1.25 GHz	1.25 GHz – 1.62 GHz
5.000 Gbps	5 MHz – **312 MHz**	**312 MHz** – 1.5 GHz	1.5 GHz – 2.50 GHz
6.250 Gbps	5 MHz – **312 MHz**	**312 MHz** – 1.5 GHz	1.5 GHz – 3.2 GHz

Annex B: Table 1 — High speed link parameters at the transmit (Device) side

Symbol	Parameter	Min.	Typ.	Max.	Units	Comment
ΔV_{TX}	Transmit amplitude	**450**	600	700	mV	At Tp2 into 75Ω.
		366	480	552	mV	At Tp2 into 50Ω. See note 1 below.
$\Delta V_{EYE}/\Delta V_{TX}$	Relative EYE opening	**0.70**			-	At Tp2 into 75Ω or 50Ω .
t_{rise}, t_{fall}	Rise, fall time		as short as possible	**90**	ps	At Tp2 into 75Ω or 50Ω, between 20% and 80% of amplitude.
T_j	Transmit jitter		as low as possible	20	%UI	At Tp2 into 75Ω or 50Ω,. See note 2 below.

Annex B: Table 2 — Low speed link parameters at the transmit (Host) side

Symbol	Parameter	Min.	Typ.	Max.	Units	Comment
ΔV_{TXLF}	Transmit amplitude	**90**	130	**180**	mV	At Tp3 into 75Ω.
$\Delta V_{EYELF}/\Delta V_{TXLF}$	Relative EYE opening	0.75	-	-	-	At Tp3 into 75Ω.
t_{riseLF}, t_{fallLF}	Rise, fall time	**5**	11	**20**	ns	At Tp3 into 75Ω, between 20% and 80% of amplitude.
T_{jLF}	Transmit jitter	-	as low as possible	5	ns	At Tp3 into 75Ω. See note below.

Description of Proposal:

Annex A is describing acceptability of this SCN.

Termination:

Operation of this SCN is terminated by effective of CoaXPress Standard Ver.1.1.

Annex A

Approved Engineering Change Proposal

"AN119 CoaXPress physical layer test with non-CXP compliant devices version 0.2 2-Jan-2012" submitted by EqcoLogic NV.

Approved Engineering Change Proposal

AN1119

CoaXPress physical layer test with non-CXP compliant devices

Version 0.2

2 Jan 2012

EqcoLogic N.V.

1 Introduction

1.1 Purpose

EqcoLogic proposes a relaxed set of parameters for the updated physical layer of CoaXPress. (See attached appendix section 3 of this document).

To evaluate whether this is acceptable, this document shows that even with parameters that are worse than the proposed relaxed parameters there is still margin for the most difficult situations.

To this end, an evaluation kit was used to generate very bad transmit parameters and it is demonstrated that still good signal reception is possible.

1.2 Scope

The experiments explained in this document show that error free communication is possible, even with the proposed relaxed physical layer parameters for the next version of the CoaXPress standard.

1.3 Audience

This document is not confidential. It can be distributed without NDA. The intended audience of this document is engineering management and engineers involved in CoaXPress and the CoaXPress standardisation.

1.4 Version history

Version	Date	Author	Comments
0v2	2 January 2012	Bram Devuyst	Section 2.1 Background added
0v1	29 December 2011	Bram Devuyst	New document

1.5 Document References

[1] CoaXPress Specification v1.0

[2] DS-EQCO62T20.3-1v3 – EQCO62T20.3 datasheet – EqcoLogic NV

[3] DS-EQCO62R20.2-1v3 – EQCO62R20.2 datasheet – EqcoLogic NV

2 Article

2.1 Background

The original CoaXPress specification v1.0 was written with very stringent physical layer requirements to ensure reliable operation. Experience has shown that it is difficult to reach some of the physical layer requirements with a lot of margin. It is also clear now that error free communication is still possible, even if some of the physical layer requirements are not met.

EqcoLogic has proposed to relax the physical layer specs in the next update of the CoaXPress specification v1.1.

Appendix: Proposal for CoaXPress "v1.1" on page - 14 - shows the proposal from EqcoLogic. This was shared with the CoaXPress Google group in September 2011 and presented to the consortium on the CoaXPress meeting on the Vision Show 2011 in Stuttgart.

2.2 Setup

The goal of this experiment is to prove that there is enough margin with the current v1.0 CoaXPress standard with respect to the parameters for the physical layer. This document will show the results of a measurement with a non CXP compliant camera board.

Figure 1 shows the setup that was used to verify the full communication link.

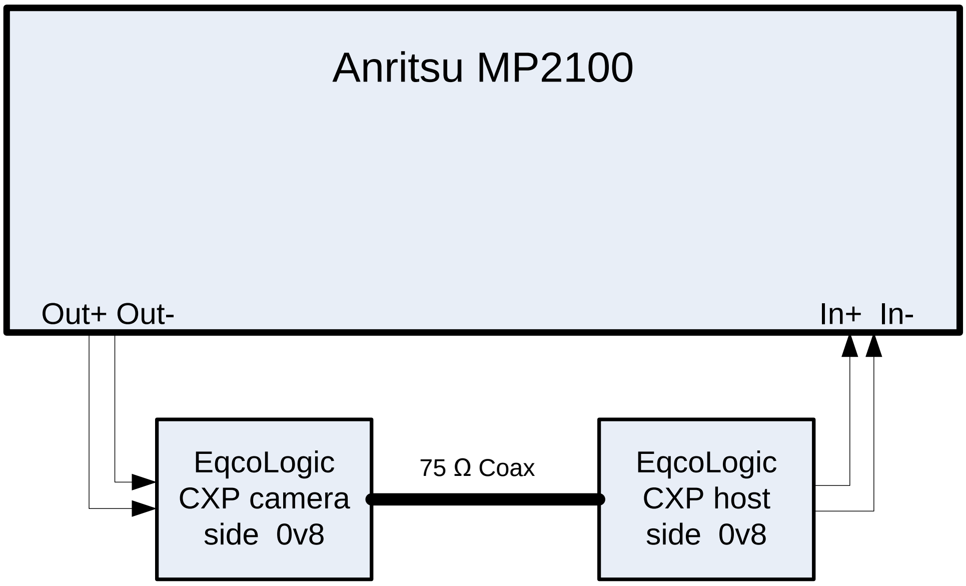

Figure 1: Setup for physical layer test

2.3 Modified camera board

Figure 2 shows the schematic of a modified EQCO62T20 evaluation board that is used during this experiment. An extra load capacitance of 250 fF was added. This capacitor will have a negative impact on signal integrity and return loss, and the eye opening will be worse. The supply voltage has been lowered to 1 V to further decrease the transmit amplitude.

A normal host side board was used.

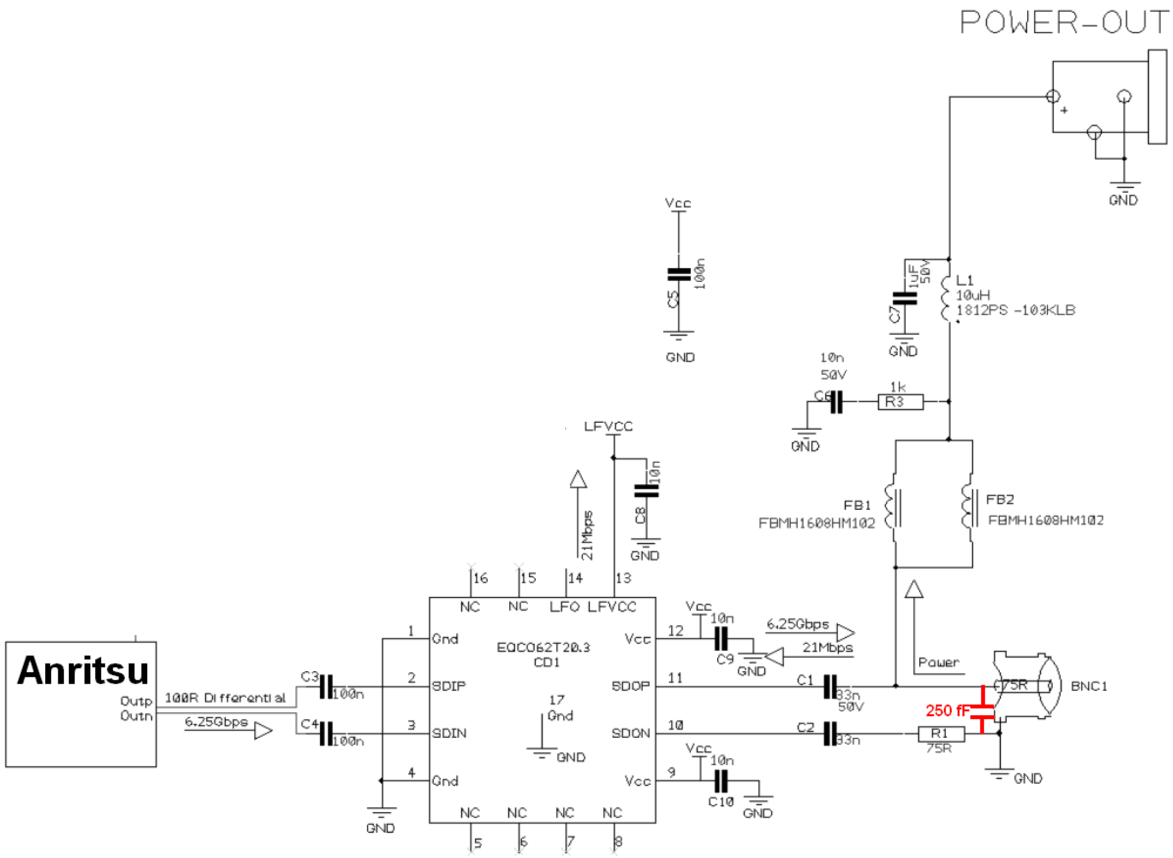

Figure 2: Camera board with extra load capacitance

2.4 Return loss

2.4.1 Camera side

Figure 3 shows the measured return loss of the camera side board. This is clearly out of spec for the current v1.0 CoaXPress standard and still slightly out of spec for the proposed relaxed spec.

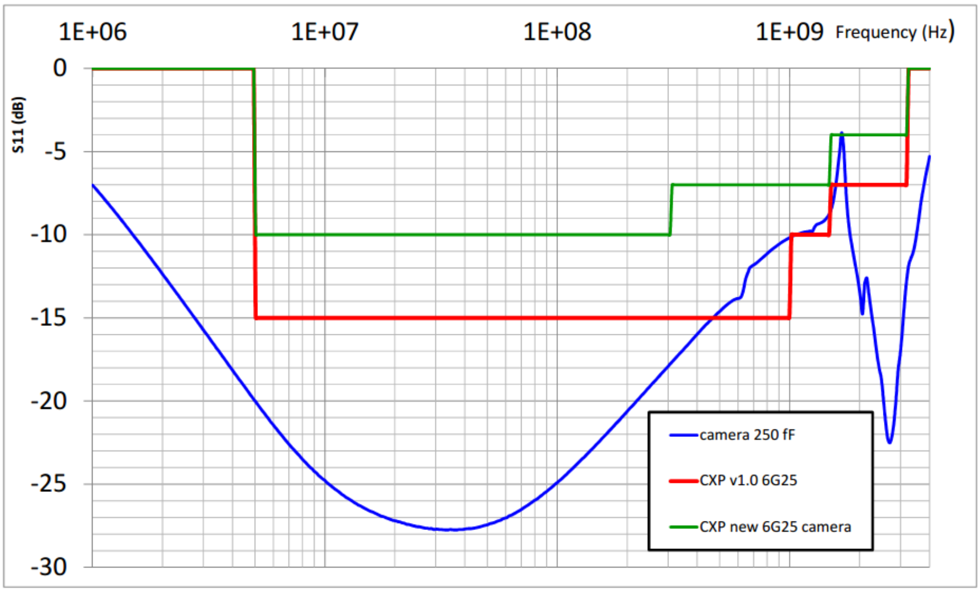

Figure 3: camera side return loss

2.4.2 Host side

Figure 4 shows the return loss of the host side board. This is within spec for both the current version of the spec and the new proposal.

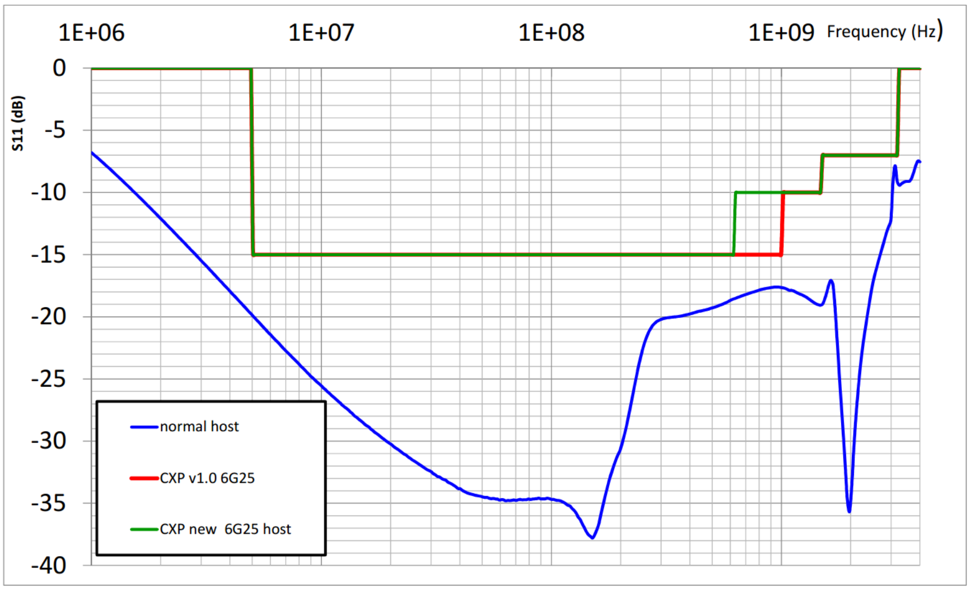

Figure 4: host side return loss

2.5 Camera eye

Figure 5 shows the output eye of the camera board. Due to the intended cripling of the output (the additional 250 fF capacitor and reduced VCC supply) the output eye is looking less nice, which is to be expected.

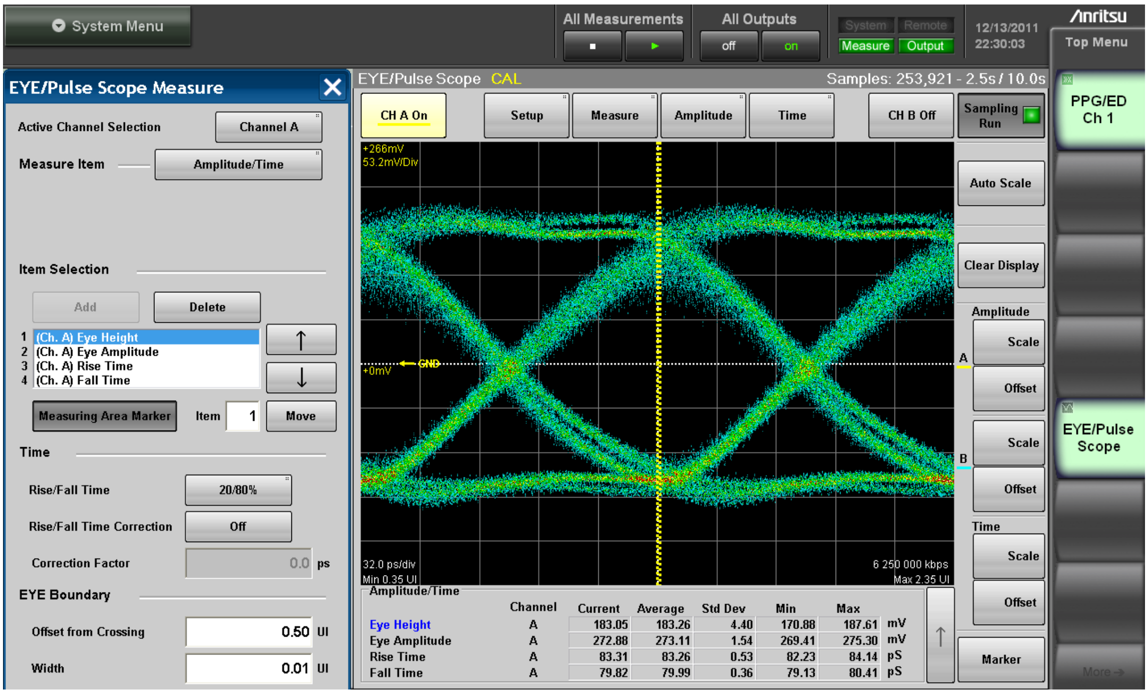

Figure 5: output eye camera board

The eye amplitude measured in 50 Ω is 273 mV. This gives an amplitude of 365 mV in 75 Ω, when also taking into account the 7 % calibration error of the scoop.

The eye opening is 67 % (183mV / 273 mV). Rise time is 83.3 ps, fall time is 80.0 ps.

The output jitter is estimated to be 45 ps.

All parameters except the rise/fall times don't meet the CoaXPress specification.

2.6 Host eye

A host board has been added in the setup. The system should be tested at 2 cable lengths:

Short cable (0.1 m Belden 1694A):

Reflections, caused by bad return loss, have biggest impact on signal integrity.

Long cable (50 m Belden 1694A):

Bad launch parameters (transmit amplitude, rise/fall time, eye opening) and channel loss have biggest impact on signal integrity.

Both the output eye and the bit error rate were measured.

2.6.1 Short cable test

Figure 6 shows the host eye with a short coax cable (0 m Belden 1694A) between the camera and the host board. Error free communication is possible and the eye diagram shows that there is still a lot of margin.

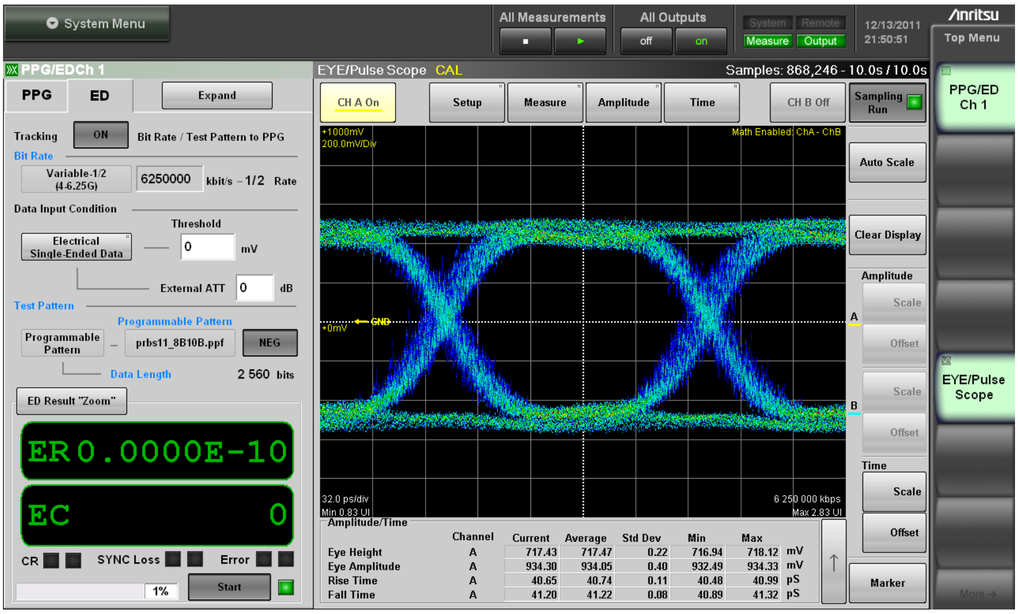

Figure 6: Host eye with short cable

2.6.2 Long cable test

Figure 7 shows the host eye with a long coax cable (50 m Belden 1694A) between the camera and the host board. Error free communication is possible and the eye diagram shows that there is still some margin left.

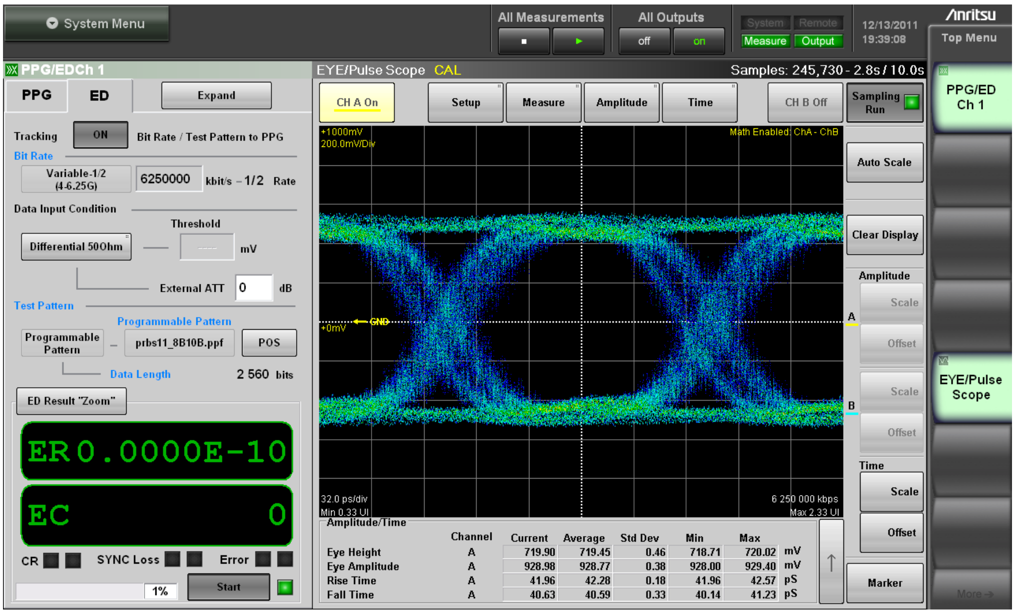

Figure 7: Host eye with long cable

2.7 Conclusion

Table 1 gives an overview of all parameters that have been measured. The measured parameters that are out of spec for both v1.0 and "v1.1" are marked in red, the parameters that are only out of spec for v1.0 are marked in orange.

Parameter	Measured	CoaXPress v1.0	CoaXPress "v1.1"
Transmit amplitude (in 75 Ω)	365 mV	500 mV	450 mV
Relative eye opening	67 %	75 %	70 %
Rise time (20-80)	83.3 ps	80 ps	90 ps
Fall time (20-80)	80.0 ps	80 ps	90 ps
Jitter pp	45 ps	32 ps	32 ps
S11 camera	Out of spec		
S11 host	Within spec		
Cable length (Belden 1694A)	50 m	40 m	40 m

Table 1: Overview of all parameters

This experiment shows that error free communication with the EQCO62x20 chipset is still possible, even if most of the parameters don't even meet the relaxed CoaXPress specification.

3 Appendix: Proposal for CoaXPress "v1.1"

CXP VERSION 1.0

Table 7 — Normative return loss frequency ranges for Host and Device

Highest bit rate	Frequency range where Return Loss shall be better than -15 dB	Frequency range where Return Loss shall be better than -10 dB	Frequency range where return loss shall be better than -7 dB
1.250 Gbps	5 MHz – 312 MHz	312 MHz – 625 MHz	-
2.500 Gbps	5 MHz – 625 MHz	625 MHz – 1.25 GHz	-
3.125 Gbps	5 MHz – 1.0 GHz	1.0 GHz – 1.25 GHz	1.25 GHz – 1.62 GHz
5.000 Gbps	5 MHz – 1.0 GHz	1.0 GHz – 1.5 GHz	1.5 GHz – 2.50 GHz
6.250 Gbps	5 MHz – 1.0 GHz	1.0 GHz – 1.5 GHz	1.5 GHz – 3.2 GHz

Annex B: Table 3 — High speed link parameters at the transmit (Device) side

Symbol	Parameter	Min.	Typ.	Max.	Units	Comment
ΔV_{TX}	Transmit amplitude	500	600	700	mV	At Tp2 into 75Ω.
		407	480	552	mV	At Tp2 into 50Ω. See note 1 below.
$\Delta V_{EYE}/\Delta V_{TX}$	Relative EYE opening	0.75			-	At Tp2 into 75Ω.
t_{rise}, t_{fall}	Rise, fall time		as short as possible	80	ps	At Tp2 into 75Ω, between 20% and 80% of amplitude.
T_j	Transmit jitter		as low as possible	20	%UI	At Tp2 into 75Ω. See note 2 below.

Annex B: Table 4 — Low speed link parameters at the transmit (Host) side

Symbol	Parameter	Min.	Typ.	Max.	Units	Comment
ΔV_{TXLF}	Transmit amplitude	110	130	160	mV	At Tp3 into 75Ω.
$\Delta V_{EYELF}/\Delta V_{TXLF}$	Relative EYE opening	0.75	-	-	-	At Tp3 into 75Ω.
t_{riseLF}, t_{fallLF}	Rise, fall time	7	11	15	ns	At Tp3 into 75Ω, between 20% and 80% of amplitude.
T_{jLF}	Transmit jitter	-	as low as possible	5	ns	At Tp3 into 75Ω. See note below.

CXP Proposal VERSION 1.1

Table 7 — Normative return loss frequency ranges for Host and Device

HOST side			
Highest bit rate	**Frequency range where Return Loss shall be better than -15 dB**	**Frequency range where Return Loss shall be better than -10 dB**	**Frequency range where return loss shall be better than -7 dB**
1.250 Gbps	5 MHz – 312 MHz	312 MHz – 625 MHz	-
2.500 Gbps	5 MHz – 625 MHz	625 MHz – 1.25 GHz	-
3.125 Gbps	5 MHz – **625 MHz**	**625 MHz** – 1.25 GHz	1.25 GHz – 1.62 GHz
5.000 Gbps	5 MHz – **625 MHz**	**625 MHz** – 1.5 GHz	1.5 GHz – 2.50 GHz
6.250 Gbps	5 MHz – **625 MHz**	**625 MHz** – 1.5 GHz	1.5 GHz – 3.2 GHz
Device Side			
Highest bit rate	**Frequency range where Return Loss shall be better than -10 dB**	**Frequency range where Return Loss shall be better than -7 dB**	**Frequency range where Return Loss shall be better than -4 dB**
1.250 Gbps	5 MHz **– 312 MHz**	**312 MHz** – 625 MHz	-
2.500 Gbps	5 MHz – **312 MHz**	**312 MHz** – 1.25 GHz	-
3.125 Gbps	5 MHz – **312 MHz**	**312 MHz** – 1.25 GHz	1.25 GHz – 1.62 GHz
5.000 Gbps	5 MHz **– 312 MHz**	**312 MHz** – 1.5 GHz	1.5 GHz – 2.50 GHz
6.250 Gbps	5 MHz – **312 MHz**	**312 MHz** – 1.5 GHz	1.5 GHz – 3.2 GHz

Annex B: Table 1 — High speed link parameters at the transmit (Device) side

Symbol	Parameter	Min.	Typ.	Max.	Units	Comment
ΔV_{TX}	Transmit amplitude	~~500~~ **450**	600	700	mV	At Tp2 into 75Ω.
		~~407~~ **366**	480	552	mV	At Tp2 into 50Ω. See note 1 below.
$\Delta V_{EYE}/\Delta V_{TX}$	Relative EYE opening	~~0.75~~ **0.70**			-	At Tp2 into 75Ω or 50Ω .
t_{rise}, t_{fall}	Rise, fall time		as short as possible	~~80~~ **90**	ps	At Tp2 into 75Ω or 50Ω, between 20% and 80% of amplitude.
T_j	Transmit jitter		as low as possible	20	%UI	At Tp2 into 75Ω or 50Ω,. See note 2 below.

Annex B: Table 2 — Low speed link parameters at the transmit (Host) side

Symbol	Parameter	Min.	Typ.	Max.	Units	Comment
ΔV_{TXLF}	Transmit amplitude	~~110~~ 90	130	~~160~~ 180	mV	At Tp3 into 75Ω.
$\Delta V_{EYELF}/\Delta V_{TXLF}$	Relative EYE opening	0.75	-	-	-	At Tp3 into 75Ω.
t_{riseLF}, t_{fallLF}	Rise, fall time	~~7~~ 5	11	~~15~~ 20	ns	At Tp3 into 75Ω, between 20% and 80% of amplitude.
T_{jLF}	Transmit jitter	-	as low as possible	5	ns	At Tp3 into 75Ω. See note below.

Rationale for proposed changes:

- ***Return Loss at HOST*:** Minor change (1.0 GHz => 625 MHz): allows a larger range of BNC connectors to be used, including multi-lane connectors

- ***Return Loss at Device*:** The return-loss at the device side was originally defined in order to limit the effect of double reflections (this is a possible problem <u>at short cable lengths only</u>): high-speed signals that originate at the device, reflect at the host, and subsequently reflect at the device and will arrive as cross-talk at the input of the host (after having travelled 3 times through the cable). At short lengths receiving the high-speed signal is very easy. This has been modeled now more carefully, and it can be stated that the return-loss *at the device can be relaxed*.

  Relaxation is further also required because there is very limited return-loss margin at present, making it difficult for camera makers to pass CoaXPress qualification. With the proposed values, multilane 5W5 and High-Density BNC also pass more easily.

- ***Device side transmit signal*:** Relaxation of parameters: allows a larger range of BNC connectors and chip-sets to be used at the high-speed transmit side. Eases compliance.

- ***Host side transmit signal*:** Relaxation of parameters: allows a larger range of BNC connectors and chip-sets to be used at the high-speed transmit side. Eases compliance.

- ***Measurement into 50Ω/75Ω:***

  a. There is no mathematical conversion possible for rise time measured into 50Ω or into 75Ω ! Depending on the origin of the limitation of the bandwidth in the device (capacitive or inductive, or both), the measured rise time is a few percent too optimistic or too pessimistic.

b. 75Ω oscilloscopes do not exist,

c. There do not exist matching pads from 75Ω and 50Ω that give a calibrated rise time degradation. The best commercial available matching pad has a (minimal) guaranteed performance up to 3GHz. A 3dB bandwidth limitation at 3GHz, gives a rise time degradation of more than 100 ps, which is more than 100% of the to be measured value! So uncertainties on measured rise time through a matching pad is very high (in the order of many tens of ps!)

d. Since most of the rise time is depending on the used chip, the extra capacitive/inductive bandwidth limiters are of less importance, and the measured 50Ω becomes quite correct.

e. t_{rise}, t_{fall}, $\Delta V_{EYE}/\Delta V_{TX}$ and T_j are therefore proposed to be measured into 50Ω

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