12 Gbps Link Eye Pattern

Test Report

Rev. 1.0.2 - February 26, 2019

Table of Contents

References

[1]

Revision History

Revision	Modifications
1.0.1	• Original revision
1.0.2	• Legal and brand names update.

Test Setup

Introduction

The purpose of this test is to report EXOSTIV Probe connection performance with 12.5 Gbps link. A test setup has been defined in which a probe EP12000X has been configured with an IBERT test module. The probe is configured to generate and to detect 7-b PRBS pattern on all its transceiver channels (SFP+ and HDMI connectors).

The IBERT test modules have been configured with the same transceiver parameters used as default for the EXOSTIV probe. When links were established, eye pattern scan have been generated using the Xilinx Vivado transceiver link tool.

SFP+ Port

The SFP+ ports were tested with an external loopback, using SFP+ cable of different length. One end of the SFP+ cable is plugged in port S0 of the EP12000X probe, and the other end of the cable is plugged into port S1. The same loopback is applied on ports S2 and S3.

Two types of cables have been used. Please refer to Table 1 for more details.

Table 1: SFP+ cable properties

Feature	Cable type 1	Cable type 2
Manufacturer	Amphenol FCI	TE CONNECTIVITY
Part Number	10110818-2020LF	2127931-1
Shielded	No	Yes
Length	2 m	0.5 m

HDMI Port

The HDMI port was tested with development boards KC705 and VCU108 from Xilinx. Both boards were configured with the same IBERT module to generate 7-b PRBS pattern on the transceiver channels mapped to their FMC HPC connector.

As the HDMI port is more critical than the SFP+ port for high bit rates, a more complex test setup has been used. Different cables have been tested with different sources.

Table 2: HDMI cable properties

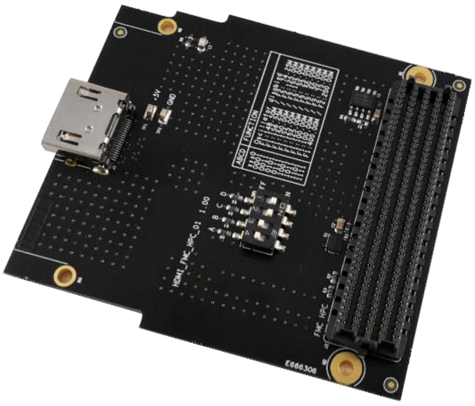
Feature	Cable type 1	Cable type 2	Cable type 3
Manufacturer	Molex	Samtec	Audioquest
Part Number	88768-9800	HPDPI-19-0750-01	Pearl
Connector type	Type-A	Type-A	Type-A
Length	1.5m	0.75m	0.6m

Table 3: Development boards

Feature	Board 1	Board 2
Manufacturer	Xilinx	Xilinx
Model	KC705	VCU108

To connect the development boards to the EP12000X probe using the HDMI port, a HDMI-FMC-HPC-01 module from Exostiv Labs was used. This module is an adapter mapping the transceiver lanes of the FMC HPC connectors of the development boards to a female HDMI connector type-A. A standard type-A HDMI cable can then be used for the interconnection.

Figure 1: HDMI to FMC adapter board



The link discontinuity is then spread over the following elements:

- development board routing
- FMC connector
- Adapter board routing
- HDMI connectors and cable
- Exostiv probe routing

IBERT Test Pattern

The Exostiv probe and the development boards have been loaded with an IBERT pattern generator and detector. The same pattern has been applied on all transceiver lanes used for the test.

Table 4: IBERT test pattern and transceiver parameters

Feature	Unit	Value
Test pattern	-	7-b PRBS
Reference clock	MHz	125
Link rate	Gbps	12.5
TX pre-cursor	dB	1.67
TX post cursor	dB	0.68
TX diff swing	dB	1018
RX DFE mode	-	Yes
RX termination voltage	mV	900

Eye Patterns

HDMI Link from KC705

Cable Type 1

A 1.5 meter HDMI cable from Molex has been used. The following pictures show the measured eye pattern for the 4 links.

Figure 2: Eye-pattern for 1.5m HDMI from KC705 (link 0)

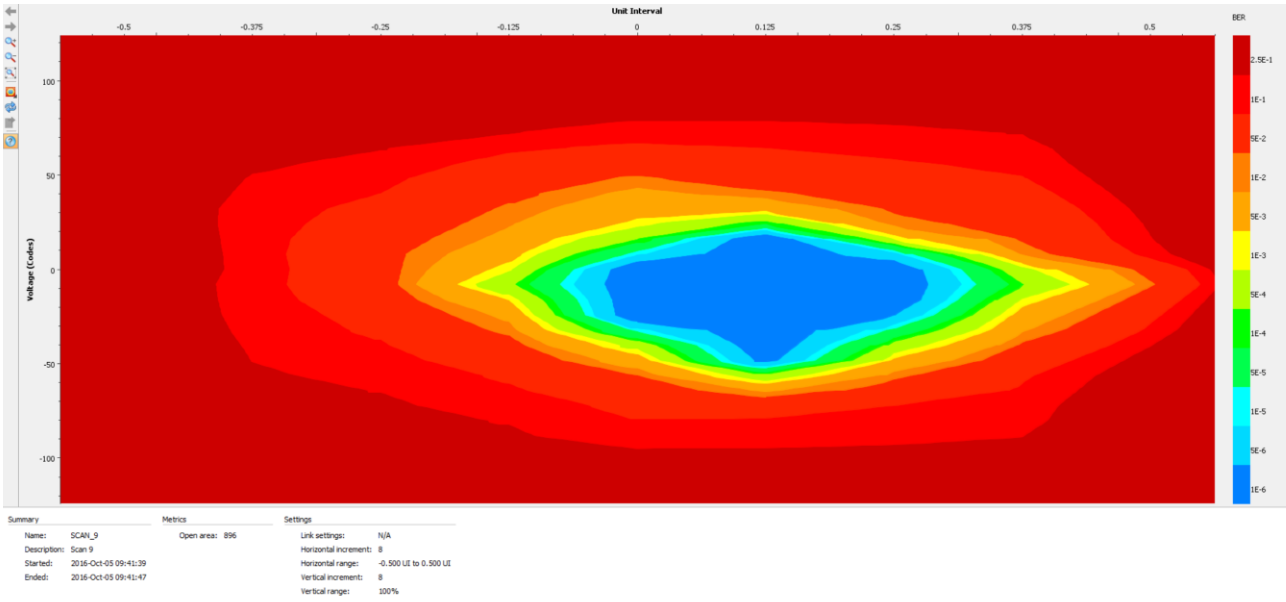


Figure 3: Eye-pattern for 1.5m HDMI from KC705 (link 1)

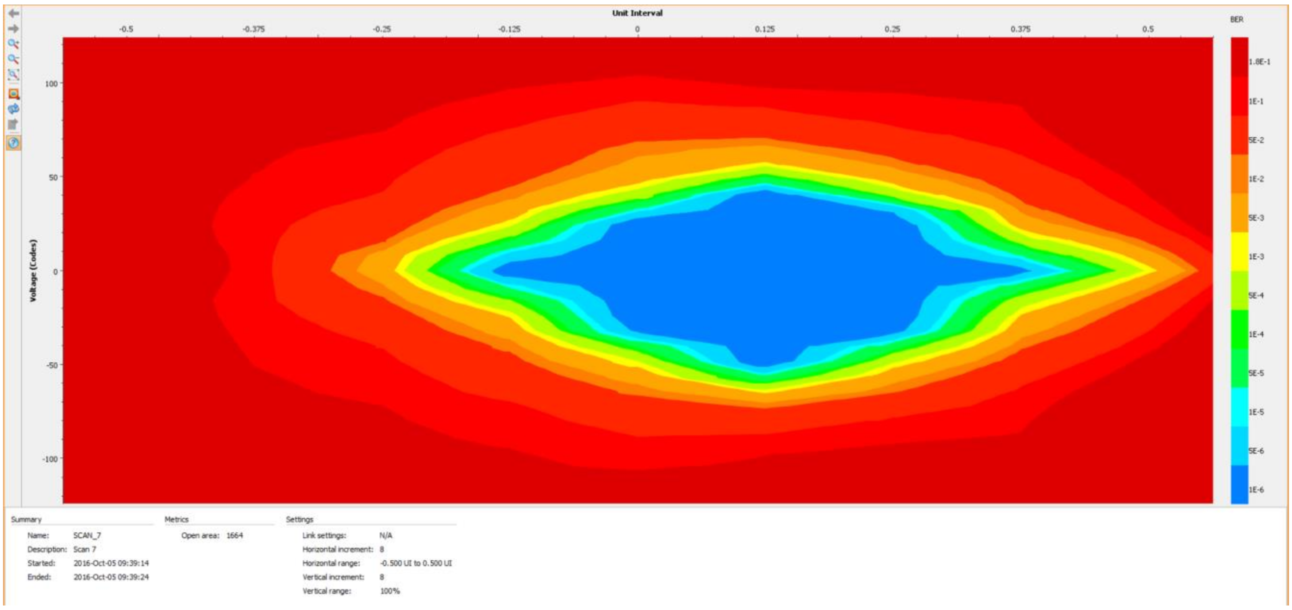


Figure 4: Eye-pattern for 1.5m HDMI from KC705 (link 2)

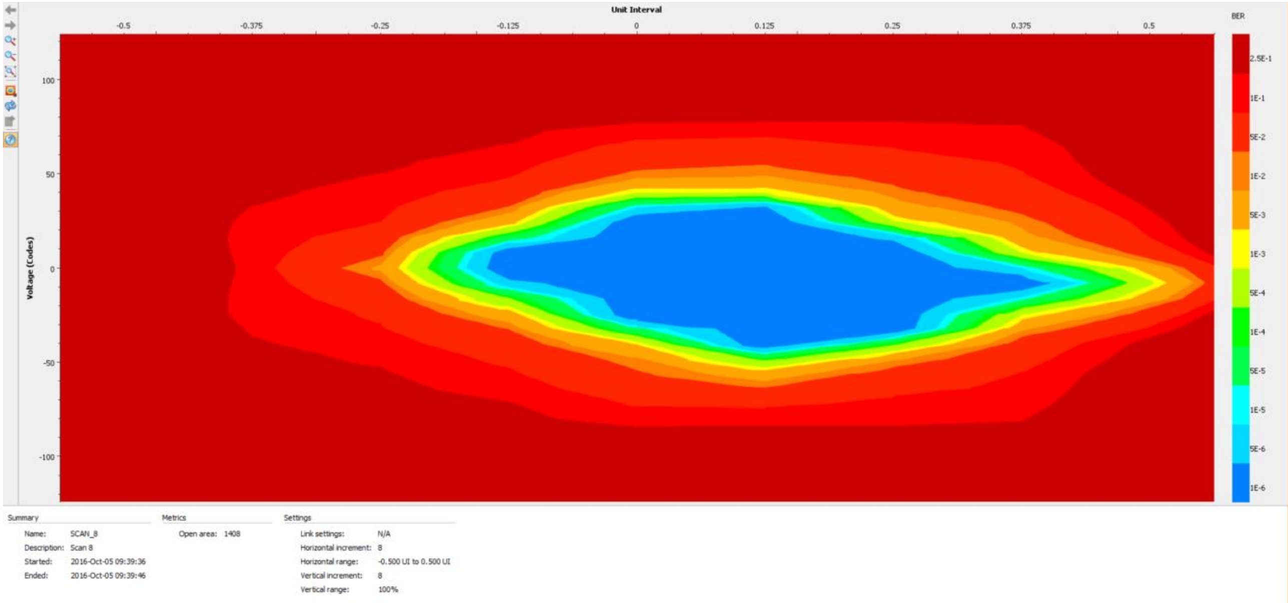
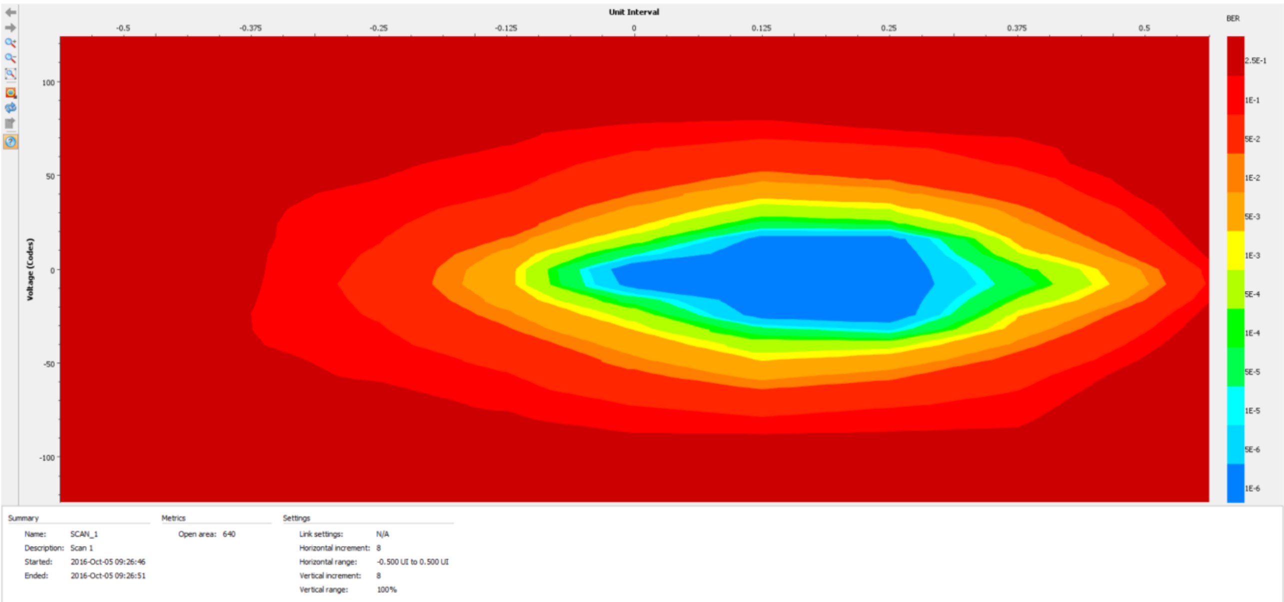


Figure 5: Eye-pattern for 1.5m HDMI from KC705 (link 3)



Cable Type 2

A 0.75 meter HDMI cable from Samtec has been used. The following pictures show the measured eye-pattern for the 4 links.

Figure 6: Eye-pattern for 0.75m HDMI from KC705 (link 0)

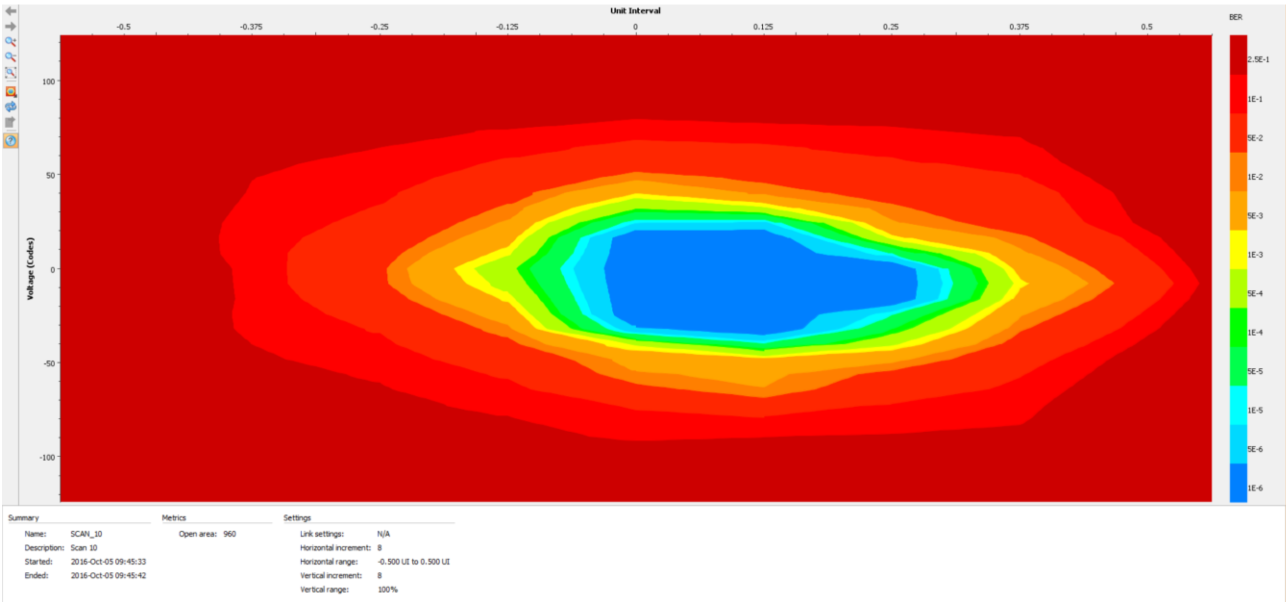


Figure 7: Eye-pattern for 0.75m HDMI from KC705 (link 1)

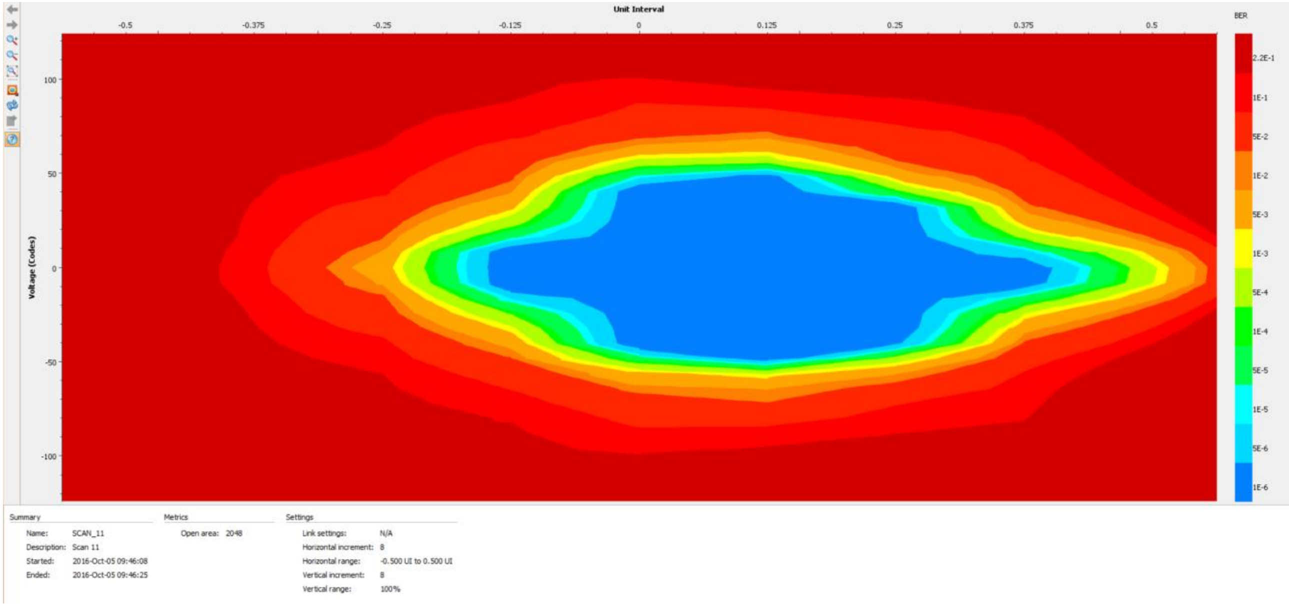


Figure 8: Eye-pattern for 0.75m HDMI from KC705 (link 2)

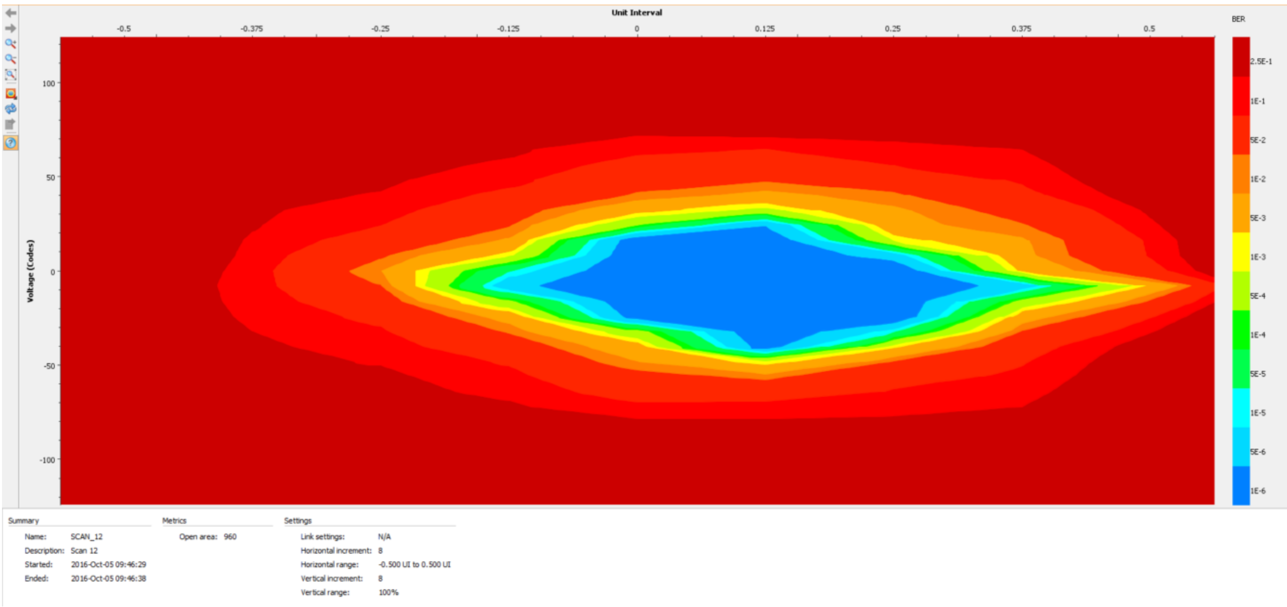
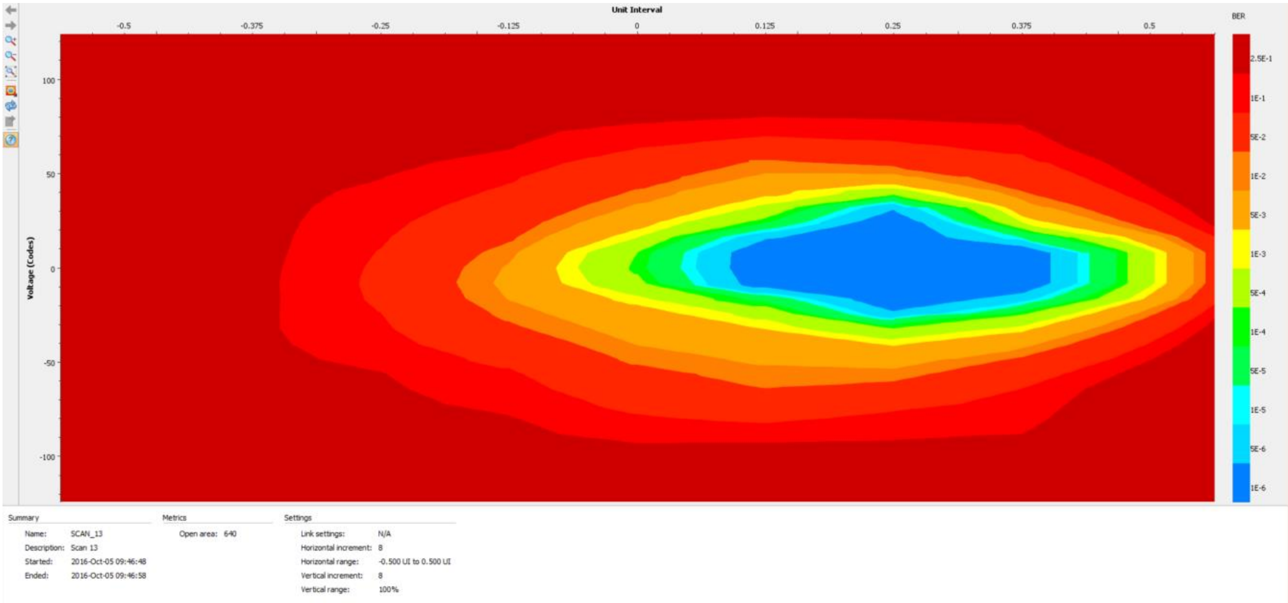


Figure 9: Eye-pattern for 0.75m HDMI from KC705 (link 3)



HDMI Link from VCU108

Cable Type 1

A 1.5 meter HDMI cable from Molex has been used. The following pictures show the measured eye-pattern for the 4 links.

Figure 10: Eye-pattern for 1.5m HDMI from VCU108 (link 0)

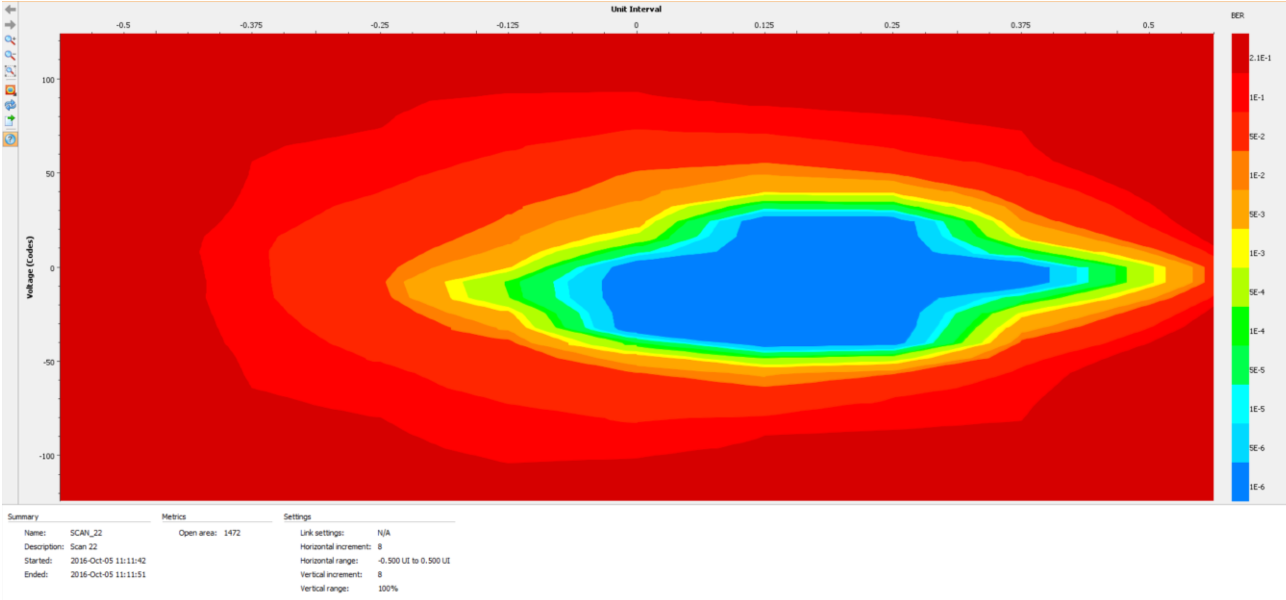


Figure 11: Eye-pattern for 1.5m HDMI from VCU108 (link 1)

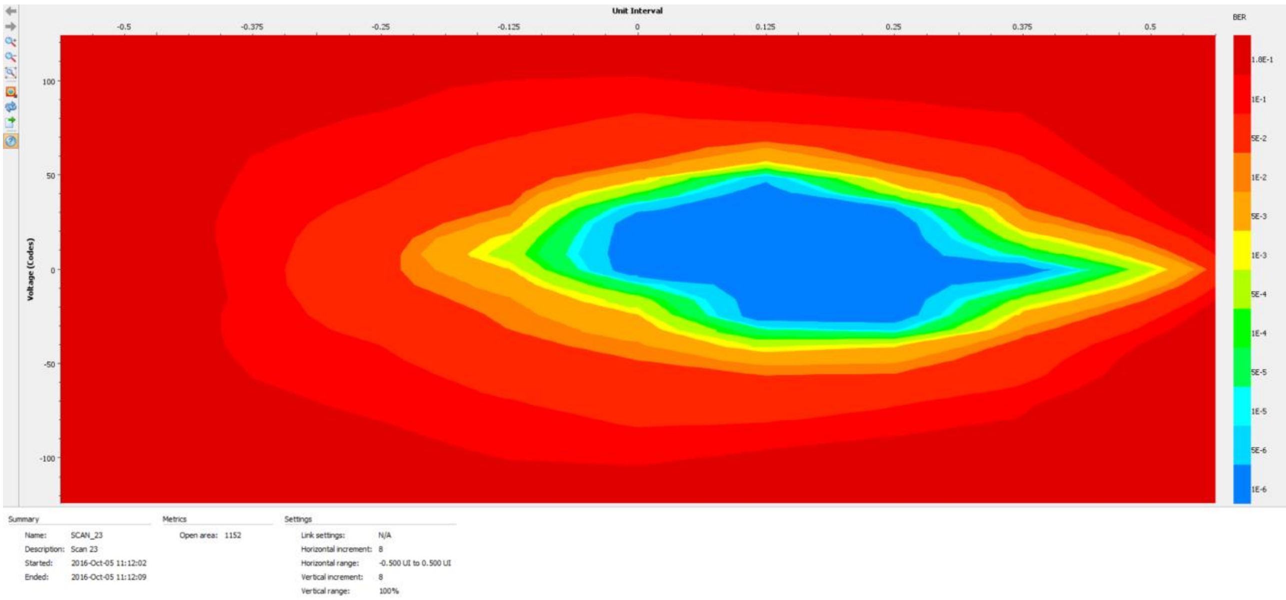


Figure 12: Eye-pattern for 1.5m HDMI from VCU108 (link 2)

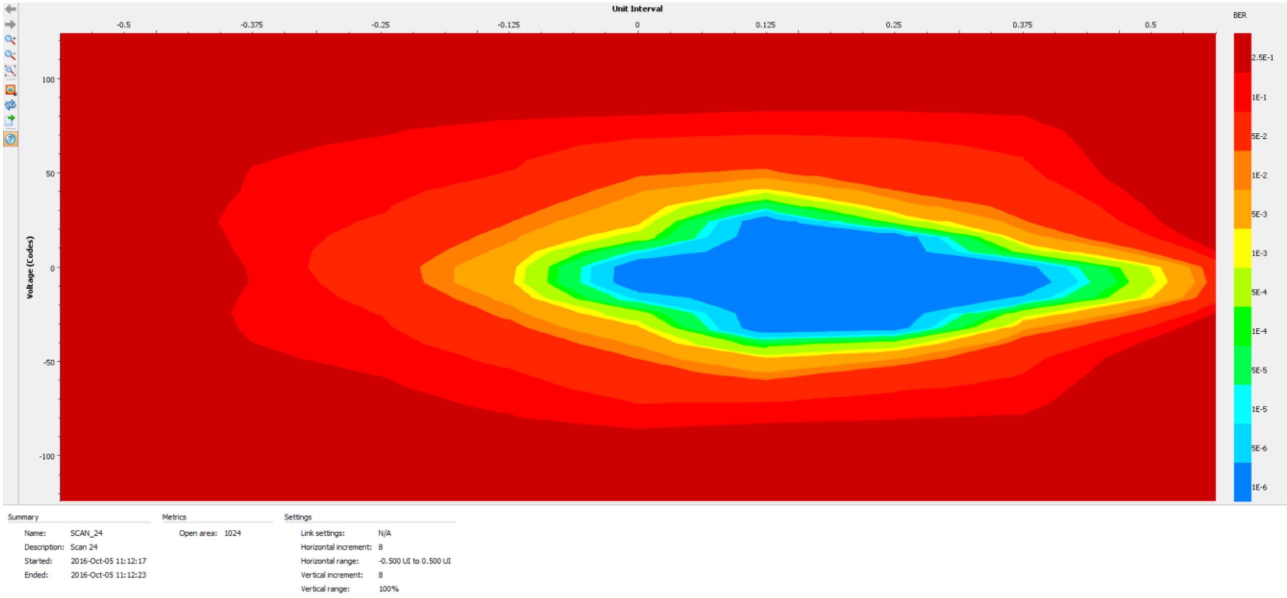
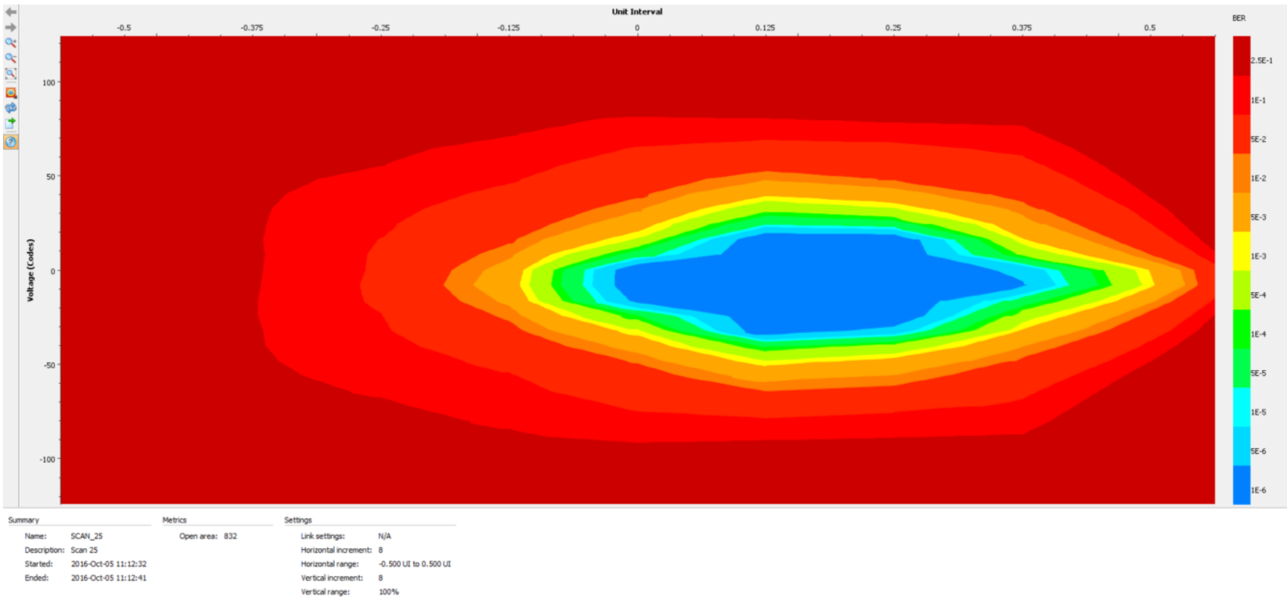


Figure 13: Eye-pattern for 1.5m HDMI from VCU108 (link 3)



HDMI Link Summary

Table 5 provides a summary of the eye-pattern opening areas for the tests performed.

Table 5: Eye opening summary

Link	KC705 - Cable 1	KC705 - Cable 2	VCU108 – Cable 1
0	896	960	1472
1	1664	2048	1152
2	1408	960	1024
3	640	640	832

Notes: 1. Tests made with cable type 3 are not shown in this document. The link was also up without any transmission error. Globally the eye-opening is smaller than with cable 1. Which was not expected as the cable is shorter and should normally present less attenuation.

SFP+ External Loopback

Cable Type 1

External loopback using 2.0 meter SFP passive cable from FCI.

Figure 14: Eye-pattern for 2.0m SFP+ (link 0)

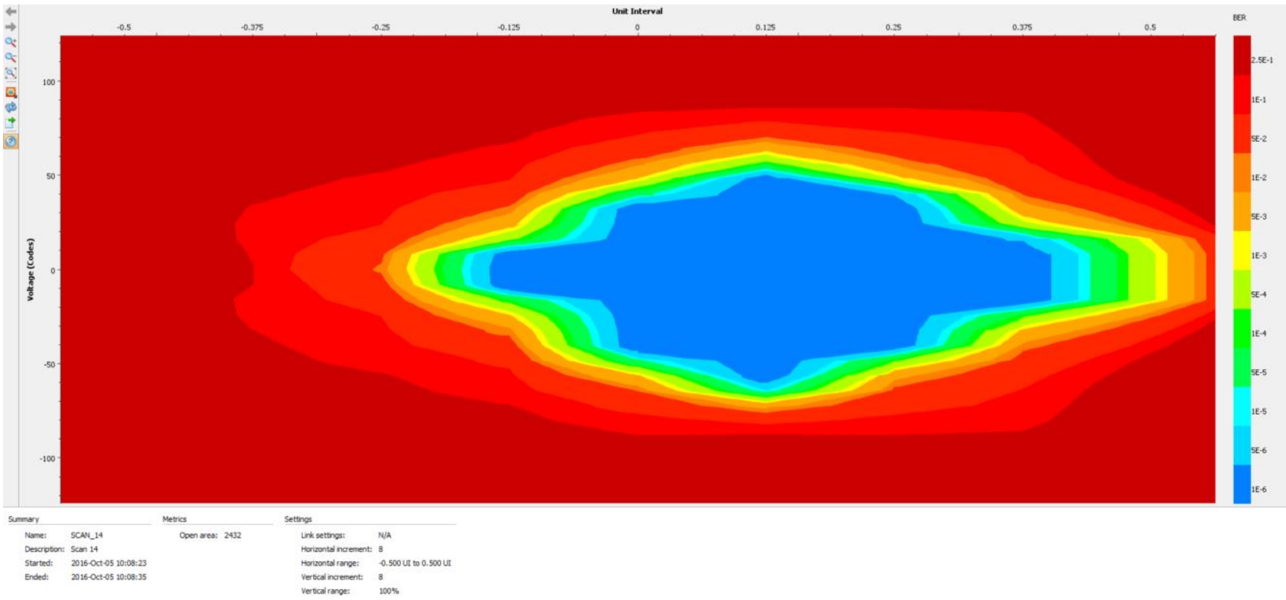


Figure 15: Eye-pattern for 2.0m SFP+ (link 1)

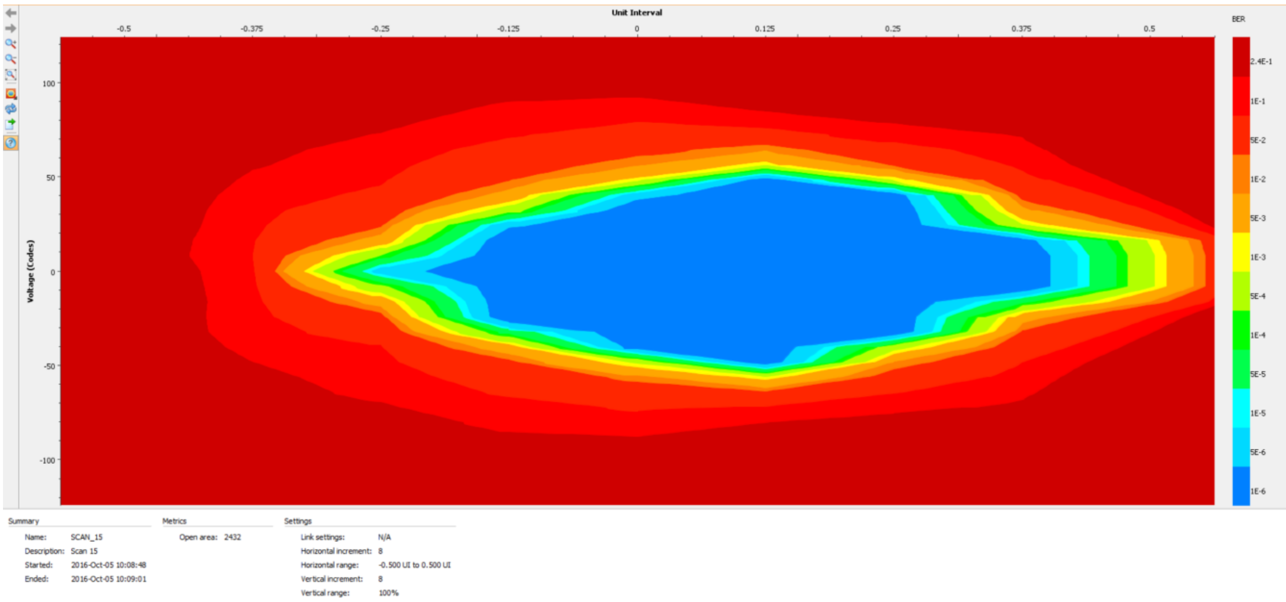


Figure 16: Eye-pattern for 2.0m SFP+ (link 2)

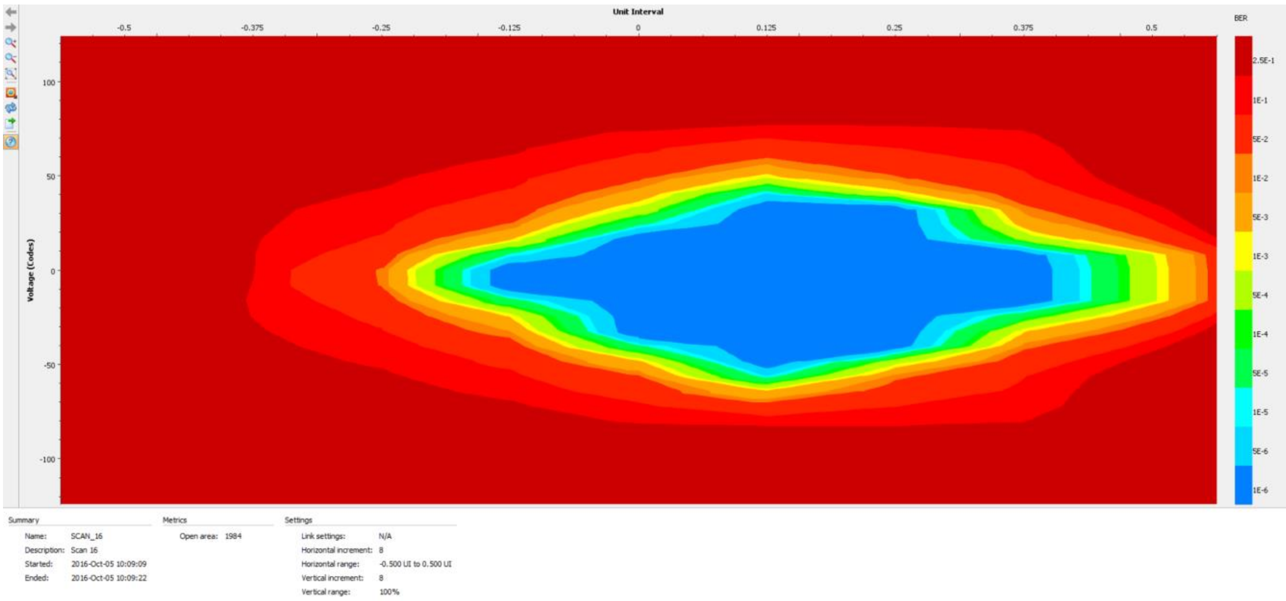
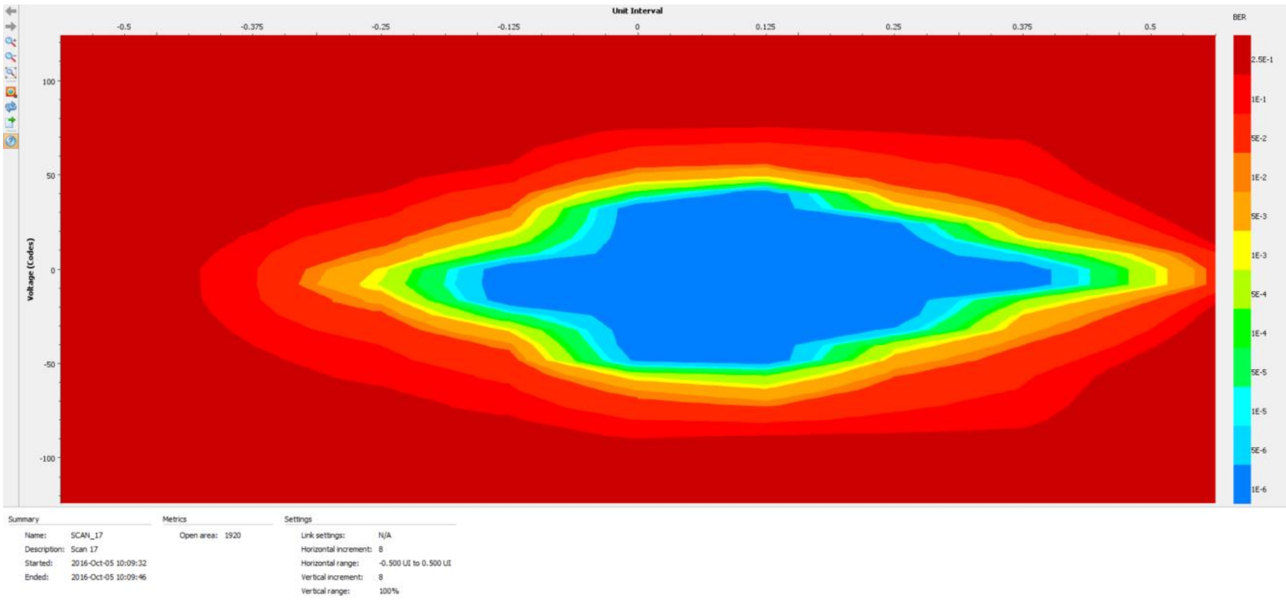


Figure 17: Eye-pattern for 2.0m SFP+ (link 3)



Cable Type 2

External loopback using 0.5 meter SFP passive cable from TE.

Figure 18: Eye-pattern for 0.5m SFP+ (link 0)

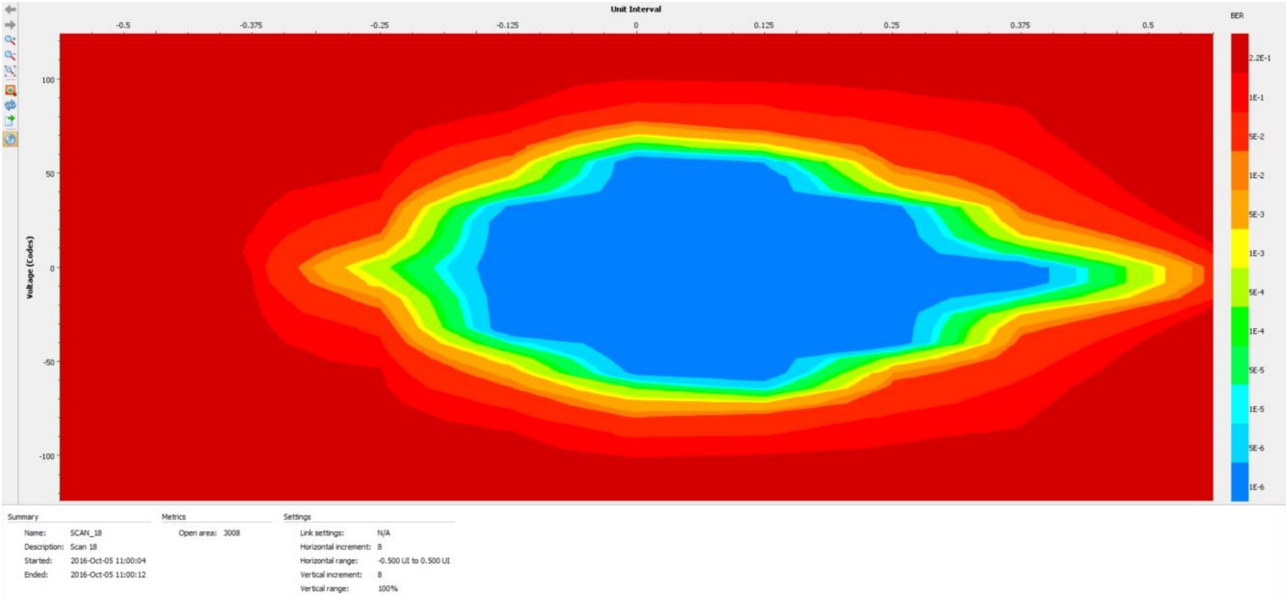


Figure 19: Eye-pattern for 0.5m SFP+ (link 1)

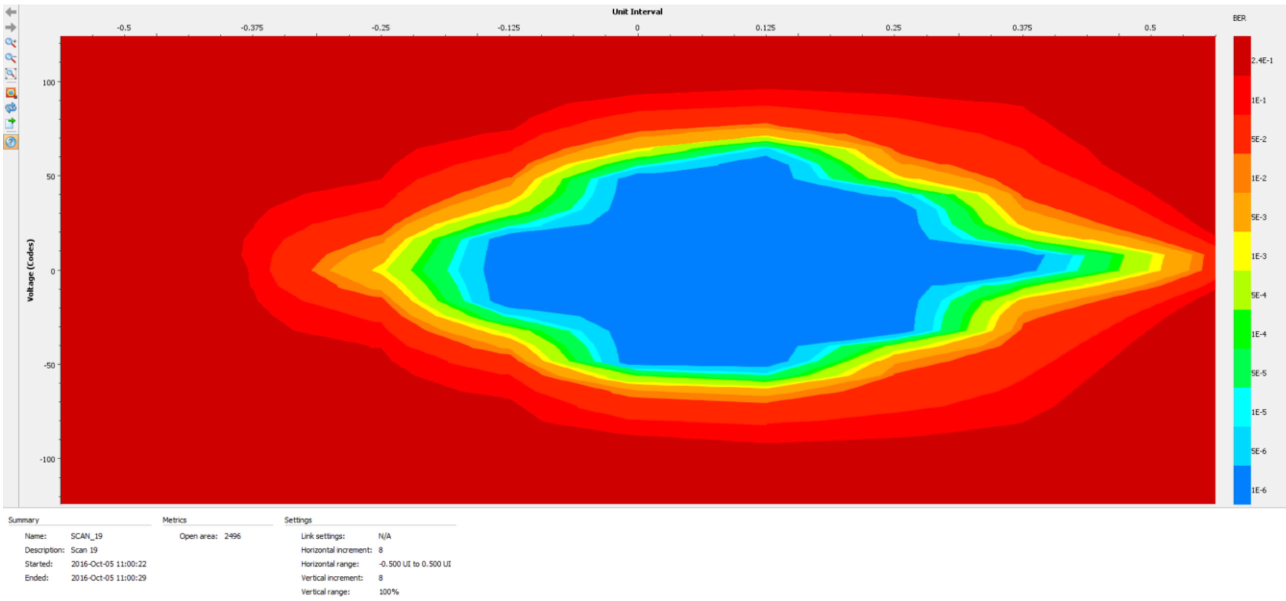


Figure 20: Eye-pattern for 0.5m SFP+ (link 2)

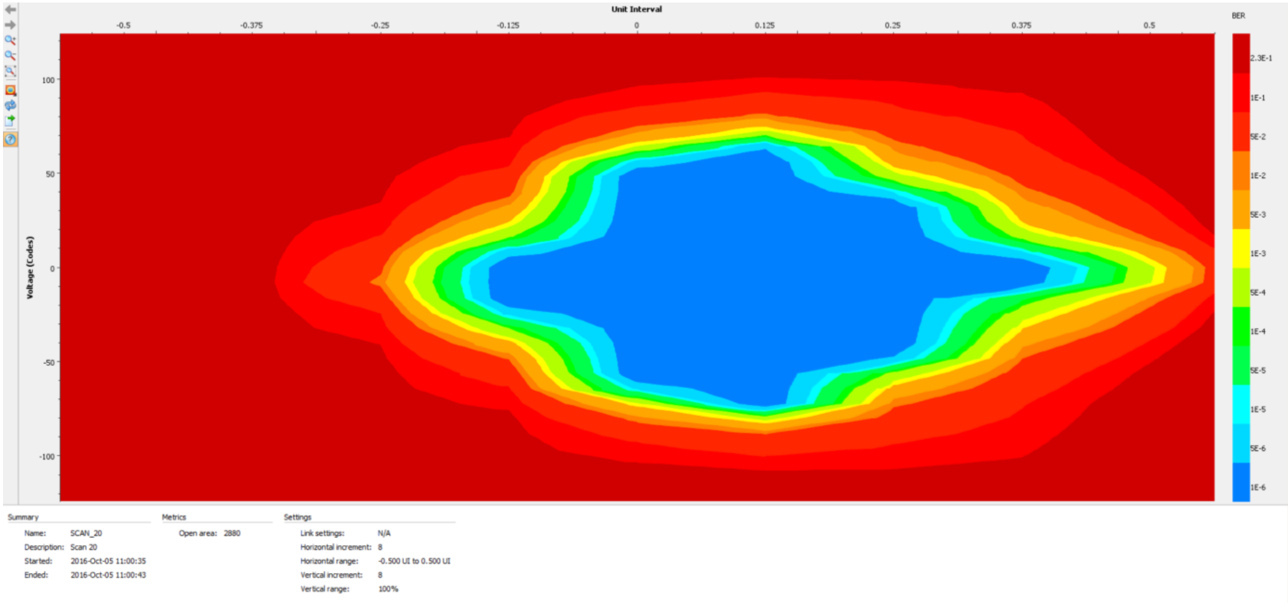
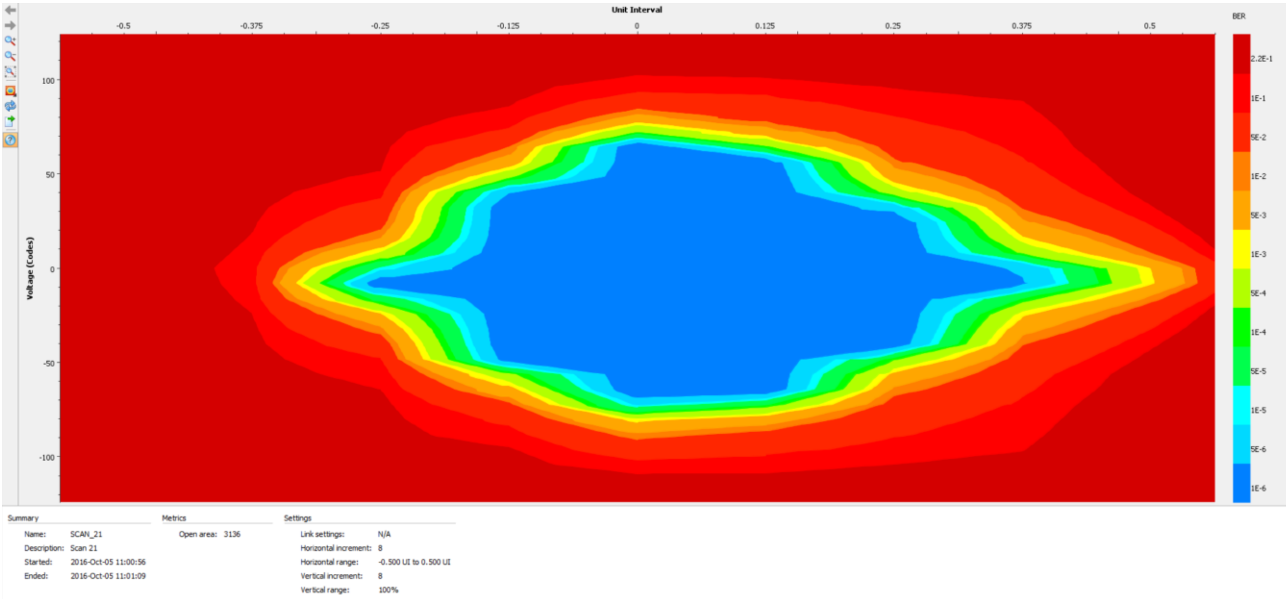


Figure 21: Eye-pattern for 0.5m SFP+ (link 3)



SFP+ Link Summary

Table 6 provides a summary of the eye-pattern opening area for the different tests performed.

Table 6: Eye opening summary

Link	Cable 1 (2.0m)	Cable 2 (0.5m)
0	2432	3008
1	2432	2496
2	1984	2880
3	1920	3136

Conclusion

The eye patterns show there is no issue at building up error-free links operating at bit rate of 12.5 Gbps through SFP+ or HDMI cable using the transceiver default settings

As expected, the attenuation is higher for the HDMI cables than for the SFP+ cables. For the HDMI tests, the attenuation introduced by the FMC adapter board must be taken into account and strongly degrades the performances. It is expected that the HDMI link attenuation will be smaller (increased eye pattern opening) if a direct connection is used between the target FPGA and the EXOSTIV probe.

The attenuation introduced by the cable seems to be marginal compared to the attenuation of the FMC module. The Samtec cable bandwidth was expected to be higher than the standard HDMI cable. There is a benefit to use the HDMI cable from Samtec indeed, but it is relatively small with the current setup.

HDMI tests performed with the VCU108 have shown much better results. It seems to indicate that the quality of the transmitter has more impact than the cable – as it is expected with this newest generation of FPGA technology.

For the SFP+ tests, the cable length directly impacts the eye opening. This impact is higher than for the HDMI tests. It appears that the FMC adapter module induced a bigger attenuation on the signal than the cable. Hence, it is expected that the data transmission quality will be improved if no such adapter is in the way.

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