IEEE 802.3bj: 100GBASE-CR4 Specifications

Minneapolis, MN
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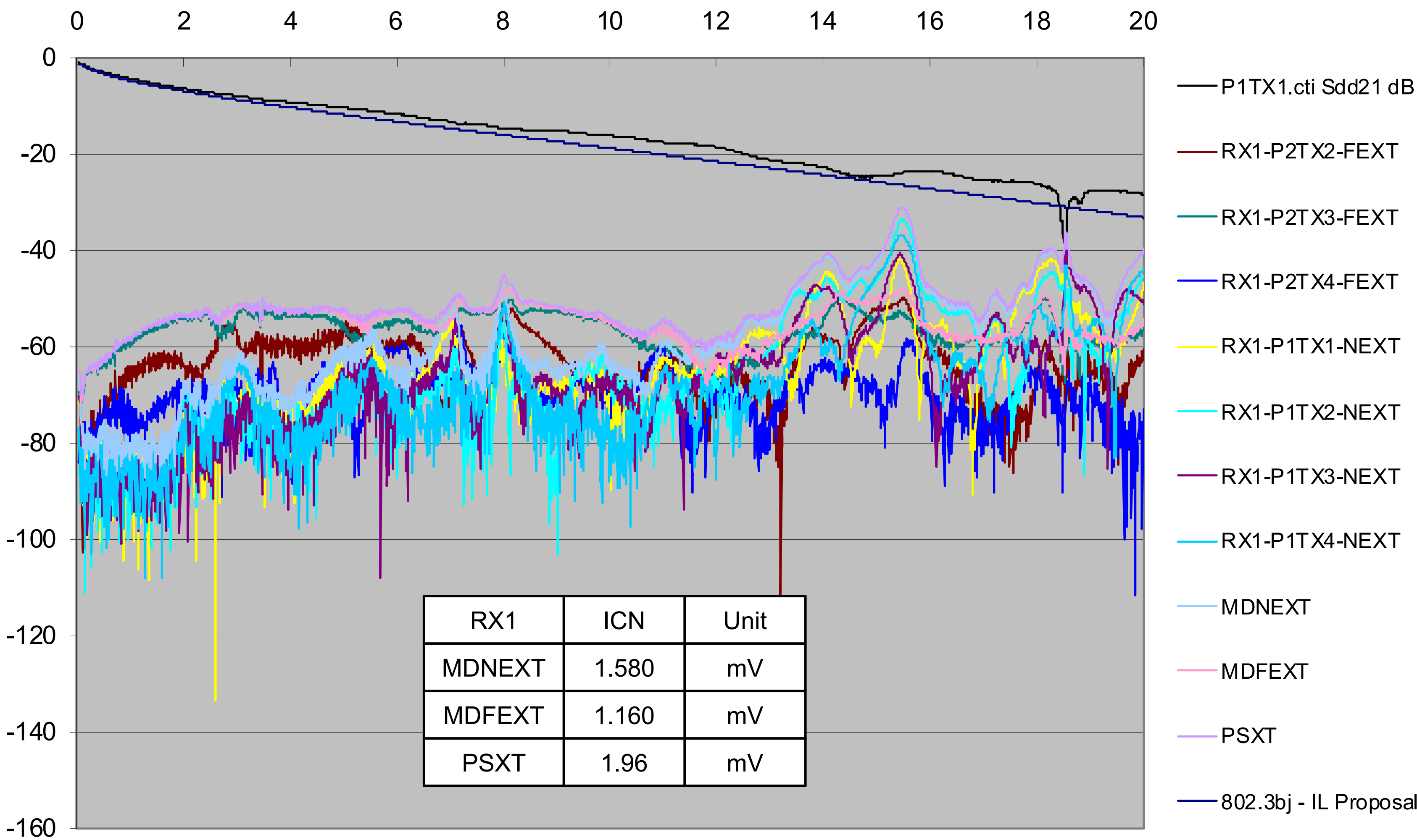
Purpose

- Specifications for the 100GBASE-CR4
  - Cable Assembly Characteristics
    - ✓ICN
  - 100GBASE-CR4 channel IL

Cable Assembly ICN – 5 m – 24 AWG

26 GBd – crosstalk disturbers
1200 mV P-P
Rise time (20%-80%) 9.6 ps
4 NEXT, 3 FEXT

Cable Assembly 5 m - RX1- MDNEXT-MDFEXT -PSXT



RX1	ICN	Unit
MDNEXT	1.580	mV
MDFEXT	1.160	mV
PSXT	1.96	mV

test fixtures included

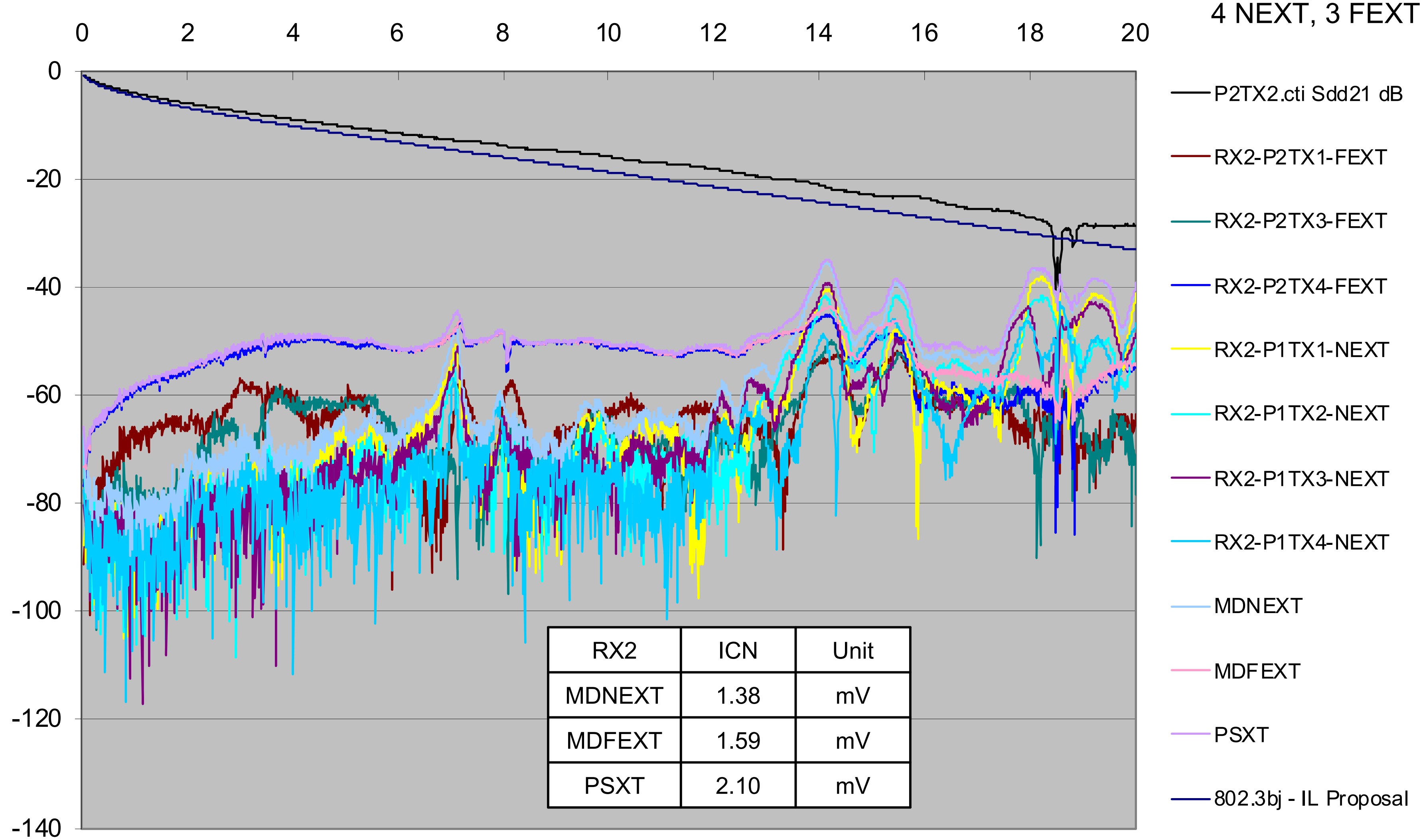
3 dB reference receiver bandwidth, set to 20 GHz.

measurement data in cooperation with Mark Bugg– Molex

Cable Assembly ICN – 5 m – 24 AWG

26 GBd – crosstalk disturbers
1200 mV P-P
Rise time (20%-80%) 9.6 ps
4 NEXT, 3 FEXT

Cable Assembly 5 m - RX2- MDNEXT-MDFEXT -PSXT



RX2	ICN	Unit
MDNEXT	1.38	mV
MDFEXT	1.59	mV
PSXT	2.10	mV

Test fixtures included

3 dB reference receiver bandwidth, set to 20 GHz.

measurement data in cooperation with Mark Bugg– Molex

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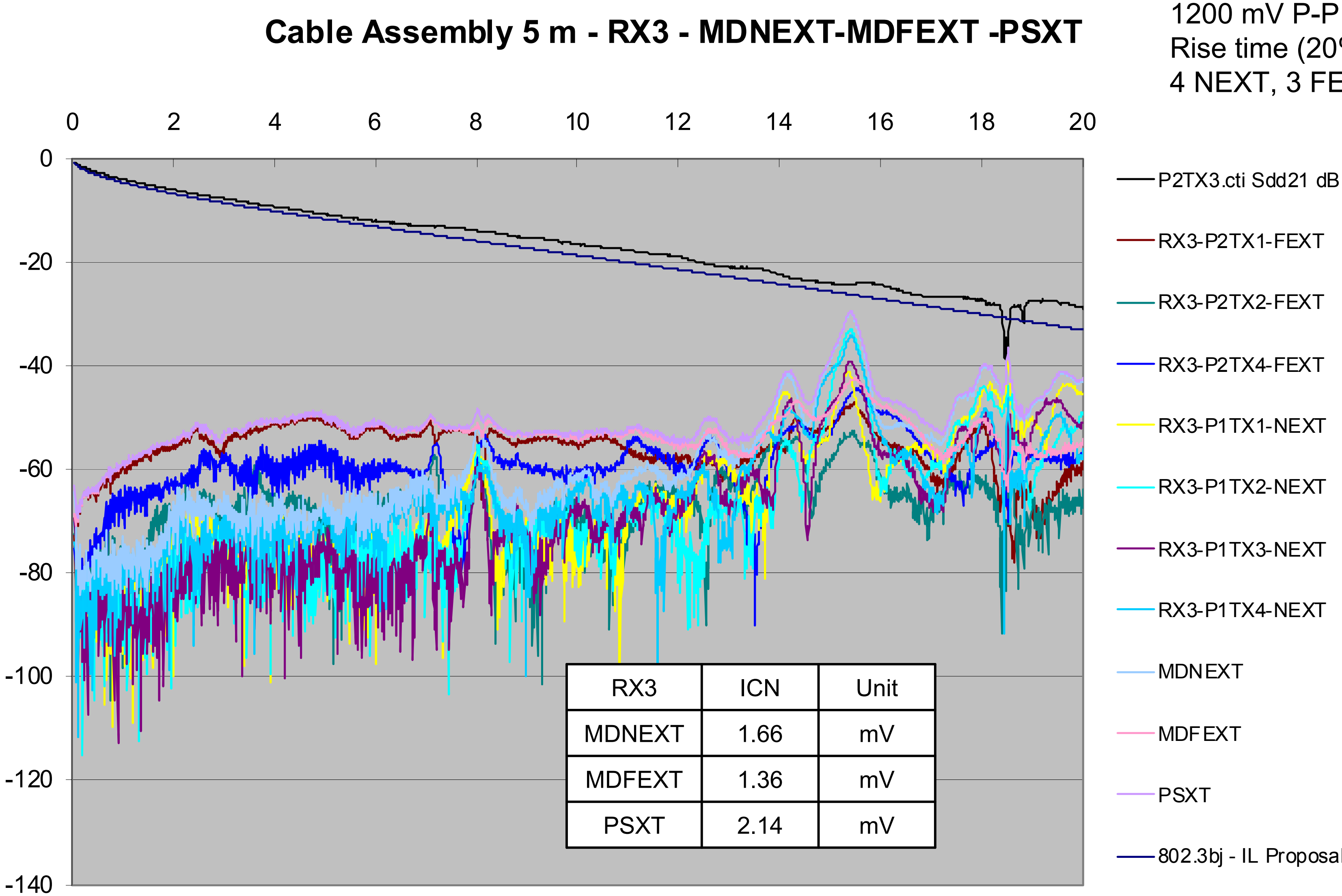
4 NEXT, 3 FEXT



RX3	ICN	Unit
MDNEXT	1.66	mV
MDFEXT	1.36	mV
PSXT	2.14	mV

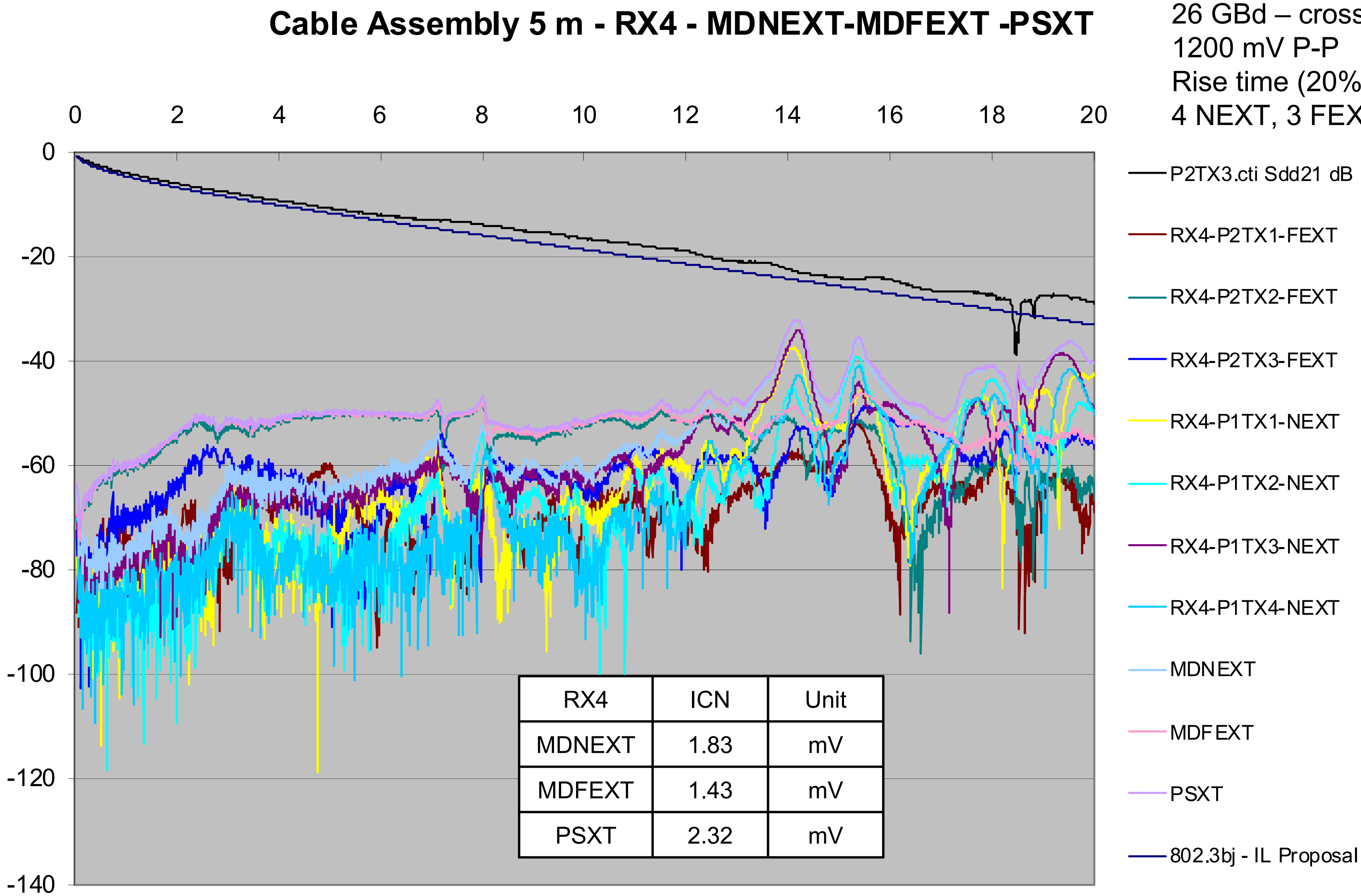
test fixtures included

3 dB reference receiver bandwidth, set to 20 GHz.

measurement data in cooperation with Mark Bugg– Molex

Cable Assembly ICN – 5 m – 24 AWG

26 GBd – crosstalk disturbers
1200 mV P-P
Rise time (20%-80%) 9.6 ps
4 NEXT, 3 FEXT



RX4	ICN	Unit
MDNEXT	1.83	mV
MDFEXT	1.43	mV
PSXT	2.32	mV

test fixtures included

3 dB reference receiver bandwidth, set to 20 GHz.

measurement data in cooperation with Mark Bugg– Molex

ICN - 100 Gbps Copper Cable Channels*

ICN Parameters

Parameter	Value	Units	Explanation
Ant	1200	mV	Near End Disturber Diff. Output Amplitude
fb	25.78125	GBd	Symbol Rate (Given)
fn	Calculate	GHz	This is the frequency step
fnt	24.64	hertz	Constant of Proportionality (0.2365) = Tnt*Fnt, Tnt = 9.6ps
fr	20	GHz	3dB Reference Receiver Bandwidth
Aft	1200	mV	Far End Disturber Diff. Output Amplitude
fft	24.64	hertz	Constant of Proportionality (0.2365) = Tnt*Fnt, Tnt = 9.6ps

ICN Cont.

- Extend ICN cable limits to 22.64 dB

Cable A

P1 RX1		P2 RX1	
IL @ 5.15625GHz	ICN	IL @ 5.15625GHz	ICN
19.21452	3.008266378	19.42877	2.91379
P1 RX2		P2 RX2	
IL @ 5.15625GHz	ICN	IL @ 5.15625GHz	ICN
17.93161	3.344124887	17.7239	3.06897
P1 RX3		P2 RX3	
IL @ 5.15625GHz	ICN	IL @ 5.15625GHz	ICN
18.21257	2.663265064	18.03871	2.41855
P1 RX4		P2 RX4	
IL @ 5.15625GHz	ICN	IL @ 5.15625GHz	ICN
19.72026	2.965518333	18.17616	2.83286

Cable B

P1 RX1		P2 RX1	
IL @ 12.89GHz	ICN	IL @ 12.89GHz	ICN
21.28884	1.966020262	20.83558	2.302287
P1 RX2		P2 RX2	
IL @ 12.89GHz	ICN	IL @ 12.89GHz	ICN
19.50886	2.09344203	20.5627	1.968806
P1 RX3		P2 RX3	
IL @ 12.89GHz	ICN	IL @ 12.89GHz	ICN
20.84237	2.139436402	20.81699	2.191258
P1 RX4		P2 RX4	
IL @ 12.89GHz	ICN	IL @ 12.89GHz	ICN
20.57817	2.319157151	21.0176	2.313332

- Cable A has max ICN of 3.34mV
- Cable B has max ICN of 2.32 mV
- ICN values are expected to be higher is shorter cables
- Future work should include analysis of low loss higher ICN channels

**Reference:*
100 Gbps Copper Cable Channels 14-Mar 12
Mark Bugg Molex
http://www.ieee802.org/3/bj/public/mar12/index.html

Cable Assembly ICN – 5 m – 24 AWG

RX1	ICN	Unit
MDNEXT	1.580	mV
MDFEXT	1.160	mV
PSXT	1.96	mV

RX2	ICN	Unit
MDNEXT	1.38	mV
MDFEXT	1.59	mV
PSXT	2.10	mV

RX3	ICN	Unit
MDNEXT	1.66	mV
MDFEXT	1.36	mV
PSXT	2.14	mV

RX4	ICN	Unit
MDNEXT	1.83	mV
MDFEXT	1.43	mV
PSXT	2.32	mV

Proposal: Maximum integrated crosstalk noise for maximum cable assembly insertion loss of 22.64 dB at 12.89 GHz.	Revise Equation 85A-6	3.5 to 3.2	mV

The total integrated crosstalk RMS noise voltage of the channel is recommended to meet the values determined using Equation (85A–6) illustrated in Figure 85A–2.

$$\sigma_{x,\,ch} \le \begin{Bmatrix} 10 & 3 \le IL \le 7.5 \\ 13.4 - 0.45IL & 7.5 < IL \le 24.44 \end{Bmatrix} \quad \text{(mV)} \qquad (85A\text{–}6)$$

where IL is the value of the channel insertion loss in dB at 5.15625 GHz.

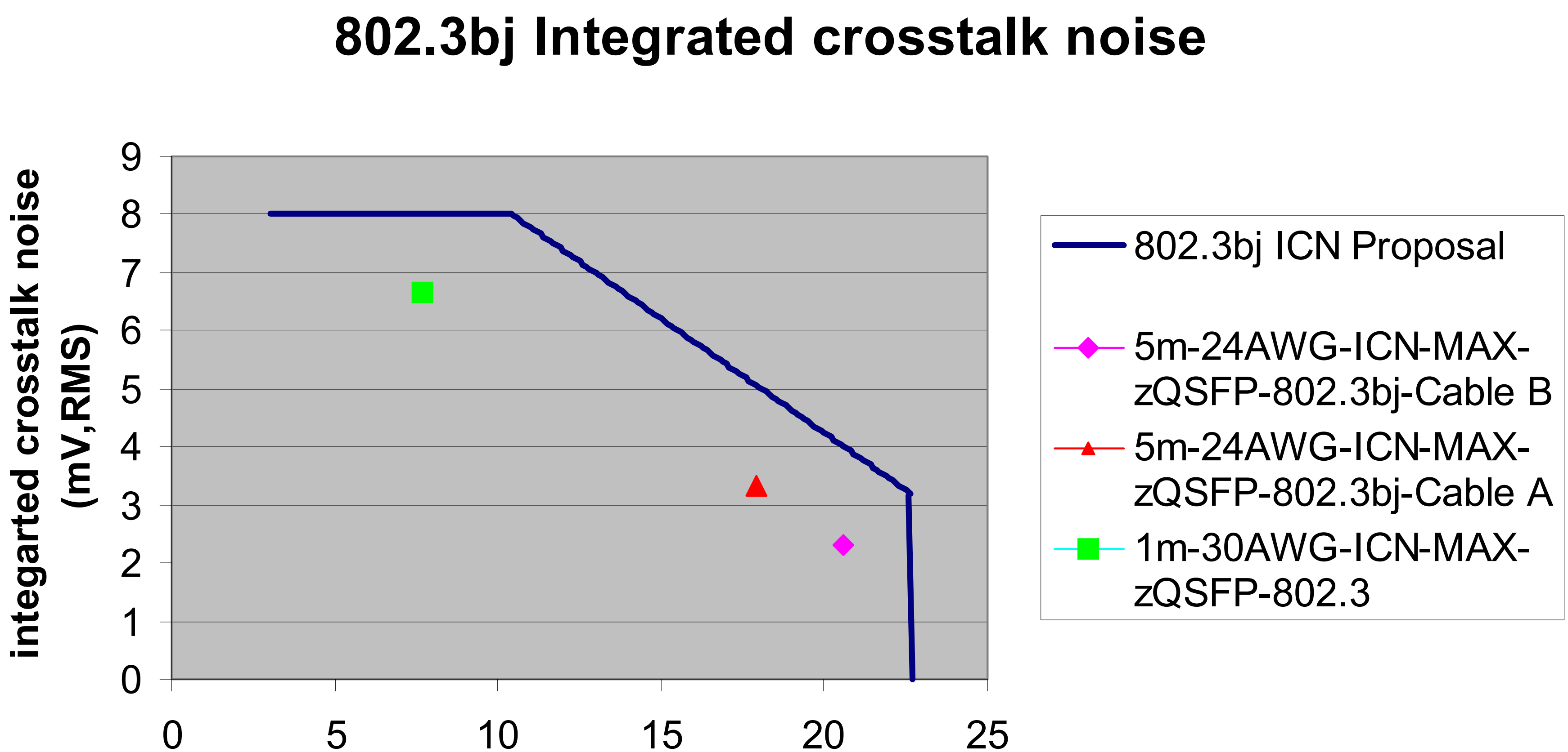
Cable Assembly ICN – 1 m – 30 AWG

Data Summary							
P1 Rx1		P1 Rx2		P1 Rx3		P1 Rx4	
IL at 12.89 GHz (dB)	ICN (mV)	IL at 12.89 GHz (dB)	ICN (mV)	IL at 12.89 GHz (dB)	ICN (mV)	IL at 12.89 GHz (dB)	ICN (mV)
8.97	6.27	8.69	5.42	8.69	6.48	9.13	5.63
P2 Rx1		P2 Rx2		P2 Rx3		P2 Rx4	
IL at 12.89 GHz (dB)	ICN (mV)	IL at 12.89 GHz (dB)	ICN (mV)	IL at 12.89 GHz (dB)	ICN (mV)	IL at 12.89 GHz (dB)	ICN (mV)
8.78	5.81	8.60	5.22	8.73	6.76	8.90	5.27

Description	Symbol	Value	Unit
Symbol rate	f_b	25.78125	GBd
Near-end disturber peak differential output amplitude	A_{nt}	600	mV
Near-end disturber peak differential output amplitude	A_{ft}	600	mV
Near-end disturber 20% to 80% rise and fall time	T_{nt}	9.6	ps
Far-end disturber 20% to 80% rise and fall time	T_{ft}	9.6	ps

Molex zQSFP – Measurement data provided by Michael Rost – Molex

802.3bj Cable Assembly ICN - Proposal



The total integrated crosstalk RMS noise voltage shall meet the values determined by Equation (92–33) illustrated in Figure 92–12.

$$\sigma_{x,\,ca} \le \{TBD\} \quad \text{(mV)} \qquad (92\text{–}33)$$

Replace equation (92-33) TBD with

$$\sigma_{x,ca} \le \begin{cases} 8 & 4 \le IL \le 10.4 \\ 12.1-0.393*IL & 10.4 < IL \le 22.64 \end{cases} \quad \text{(mV)}$$

Channel Insertion loss

- **Derived from cable assembly, Tx and Rx PCB and test fixtures losses…**

85A.5 Channel insertion loss

This subclause provides information on channel insertion losses for intended topologies ranging from 0.5 m to 7 m in length. The maximum channel insertion loss associated with the 7 m topology is determined using Equation (85A–3). The channel insertion loss associated with the 0.5 m topology and a maximum host channel is determined by Equation (85A–4). The channel insertion loss budget at 5.15625 GHz is illustrated in Figure 85A–1.

The maximum channel insertion loss is determined using Equation (85A–3). The maximum channel insertion loss is 24.44 dB at 5.15625 GHz.

$$IL_{\text{Chmax}}(f) = IL_{\text{Camax}}(f) + 2IL_{\text{Host}}(f) - 2IL_{\text{MatedTF}}(f) \text{ (dB)} \quad (85A\text{–}3)$$

for 50 MHz $\leq f \leq$ 7500 MHz.

where

f	is the frequency in MHz
$IL_{\text{Ch}max}(f)$	is the maximum channel insertion loss between TP0 and TP5
$IL_{\text{Camax}}(f)$	is the maximum cable assembly insertion loss using Equation (85–19)
$IL_{\text{Host}}(f)$	is the maximum insertion loss from TP0 to TP2 or TP3 to TP5 using Equation (85–14)
$IL_{\text{MatedTF}}(f)$	is the maximum insertion loss of the mated test fixture using Equation (85–36)

The channel insertion loss between TP0 and TP5 representative of a 0.5 m cable assembly and a maximum host channel is determined using Equation (85A–4).

$$(IL_{\text{Ch0.5}m}(f) = 0.275IL_{\text{Camax}}(f) + 2IL_{\text{Host}}(f) - 2IL_{\text{MatedTF}}(f) \text{ (dB)} \quad (85A\text{–}4)$$

for 50 MHz $\leq f \leq$ 7500 MHz.

where

f	is the frequency in MHz

Host Tx and Rx PCB losses

- Transmitter and receiver differential printed circuit board trace loss

GHz	dB/in
1	0.1856
6.5	0.8971
7	0.9557
12.89	1.5924
14	1.702

Attenuation* (dB/in) at:	1 GHz	6.5 GHz	7 GHz	12.89 GHz	14 GHz
Meg6_LowSR – Wide	0.0951	0.4159	0.4433	0.7562	0.8127
Meg6_LowSR – Narrow	0.1466	0.5849	0.6205	1.0152	1.0847
Meg6_HighSR – Wide	0.1175	0.5960	0.6367	1.0891	1.1688
Meg6_HighSR – Narrow	0.1856	0.8971	0.9557	1.5924	1.7020
ImpFR4_LowSR – Wide	0.1202	0.6096	0.6541	1.1772	1.2734
ImpFR4_LowSR – Narrow	0.1717	0.7794	0.8323	1.4410	1.5512
ImpFR4_HighSR – Wide	0.1427	0.7904	0.8484	1.5158	1.6367
ImpFR4_HighSR – Narrow	0.2106	1.0930	1.1692	2.0283	2.1813

PROPOSED PARAMETERS; GRAPHS ON PREVIOUS SLIDE

*using Algebraic Model v2.02a – see backup slides for values entered in Model

Proposal for Defining Material Loss
26-Jan 12

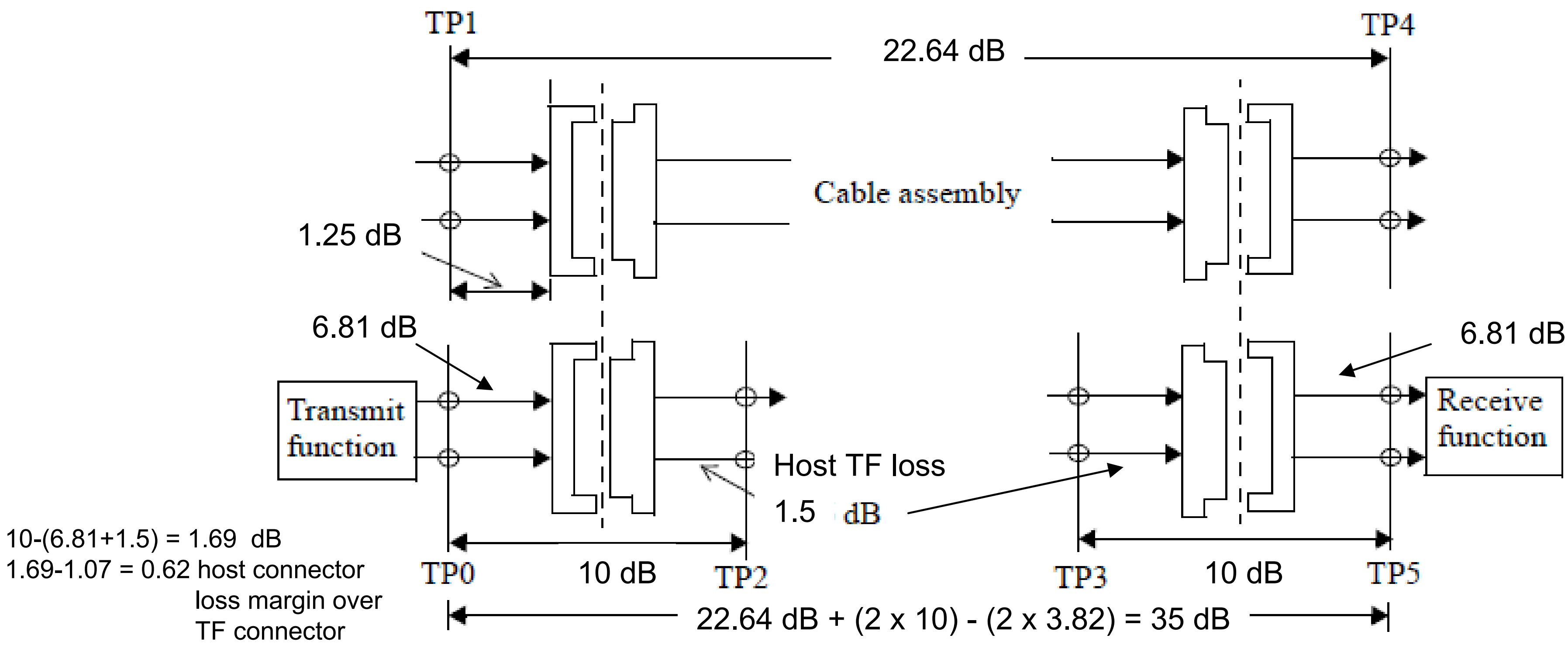
Elizabeth Kochuparambil
Joel Goergen

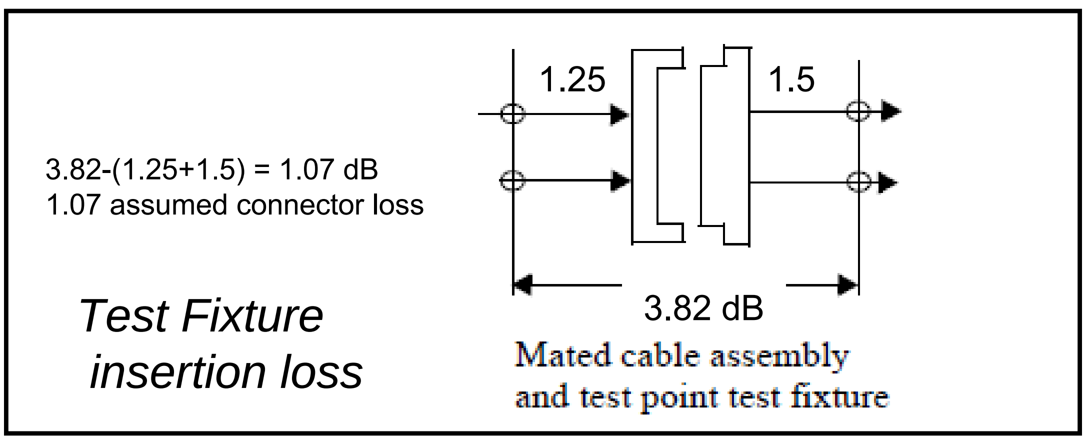
Cisco

http://www.ieee802.org/3/bj/public/jan12/kochuparambil_01a_0112.pdf

Channel insertion loss – 35 dB – 5 m cable assembly

Illustration of channel insertion loss budget at 12.89 GHz





Cable	3.4 dB/m	17 dB
Paddle card	0.5 dB	1 dB
Connector	1.07 dB	2.14 dB
CA-TF loss	1.25 dB	2.5 dB
Cable assembly		22.64 dB

Slide 7-diminico_01a_0312

Tx and Rx PCB insertion loss

92A.3 Receiver characteristics at TP5

The receiver characteristics at TP5 are defined in 93.8.2.

92A.4 Transmitter and receiver differential printed circuit board trace loss

With the insertion loss TP0 to TP2 or TP3 to TP5 given in 92.8.3.4 and an assumed mated connector loss of 1.69 dB, the maximum insertion loss allocation for the transmitter and receiver differential controlled impedance printed circuit boards for each differential lane (i.e., the maximum value of the sum of the insertion losses from TP0 to the MDI host receptacle and from TP5 to the MDI host receptacle) are determined using Equation (92A–1). The maximum insertion loss allocation for the transmitter and receiver differential controlled impedance printed circuit boards is 13.62 dB at 12.9806 GHz. The maximum insertion loss for the transmitter or the receiver differential controlled impedance printed circuit board is one half of the maximum insertion loss $IL_{PCBmax}(f)$.

Editor's note (to be removed prior to final publication): **ILpcbmax(f) @ 12.890 GHz = 6.81 dB.**

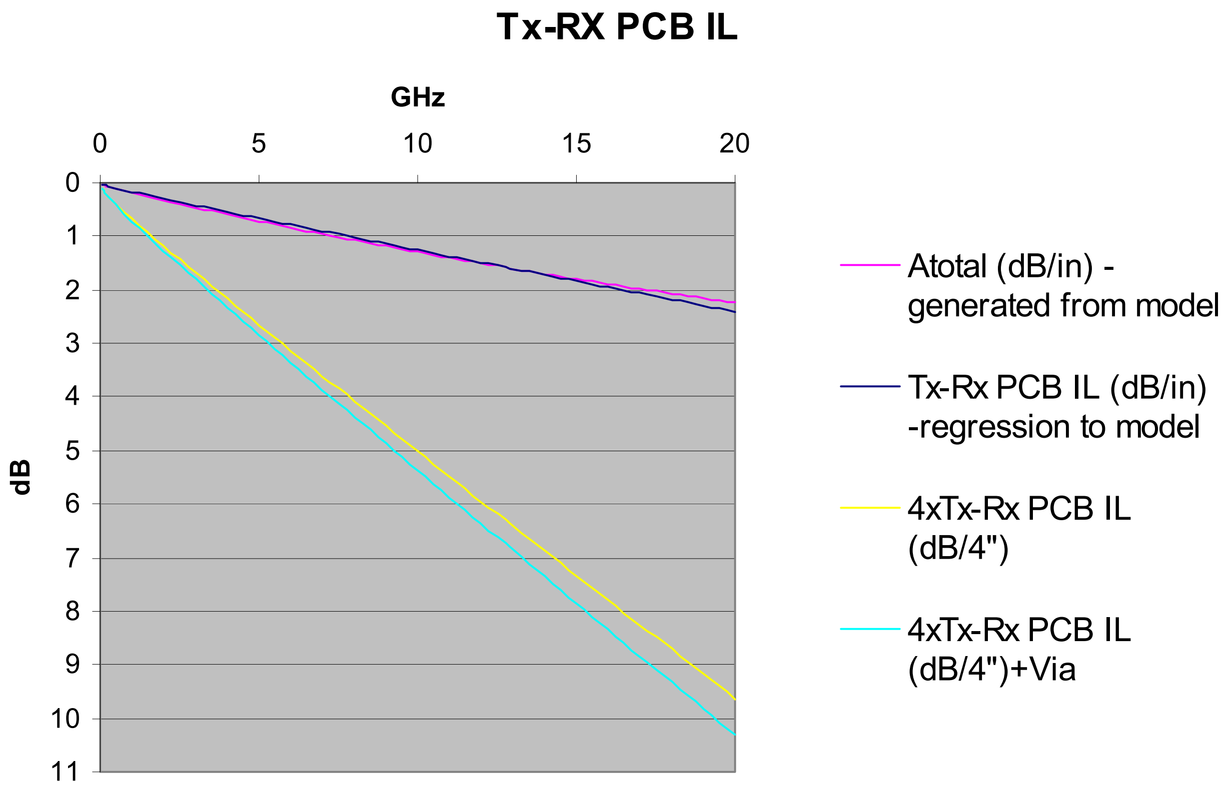
$$IL_{PCB}(f) \le IL_{PCBmax}(f) = TBD(f) \quad \text{(dB)} \qquad (92A–1)$$

for 10 MHz ≤ f ≤ 18750 MHz.

Replace equation (92A-1) TBD with > ILpcb(f)≤ILpcbmax(f) =0.0694+0.4284*SQRT(f)+0.9322*f = 13.62 @ 12.89 GHz

Change editors note: ILpcbmax(f) @ 12.890 GHz = 6.81 dB.
one half of the maximum insertion loss 0.5(ILpcbmax(f)) @ 12.890 GHz = 6.81 dB.

Tx and Rx PCB insertion loss



$$IL_{\mathrm{PCB}}(f) \le IL_{\mathrm{PCBmax}}(f) = TBD(f) \qquad \text{(dB)} \qquad (92A\text{–}1)$$

for 10 MHz $\le f \le$ 18750 MHz.

Replace equation (92A-1) TBD with > ILpcb(f)≤ILpcbmax(f) =0.0694+0.4284*SQRT(f)+0.9322*f = 13.62 @ 12.89 GHz

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one half of the maximum insertion loss 0.5(ILpcbmax(f)) @ 12.890 GHz = 6.81 dB.

Motions:

Motion #xx
Move to adopt the cable assembly total integrated crosstalk RMS noise voltage equation described on slide 10 of diminico_01a_0512.pdf.

- Moved by: Chris Di Minico
- Seconded by:
- Technical >=75%

Yes: No: Abstain:

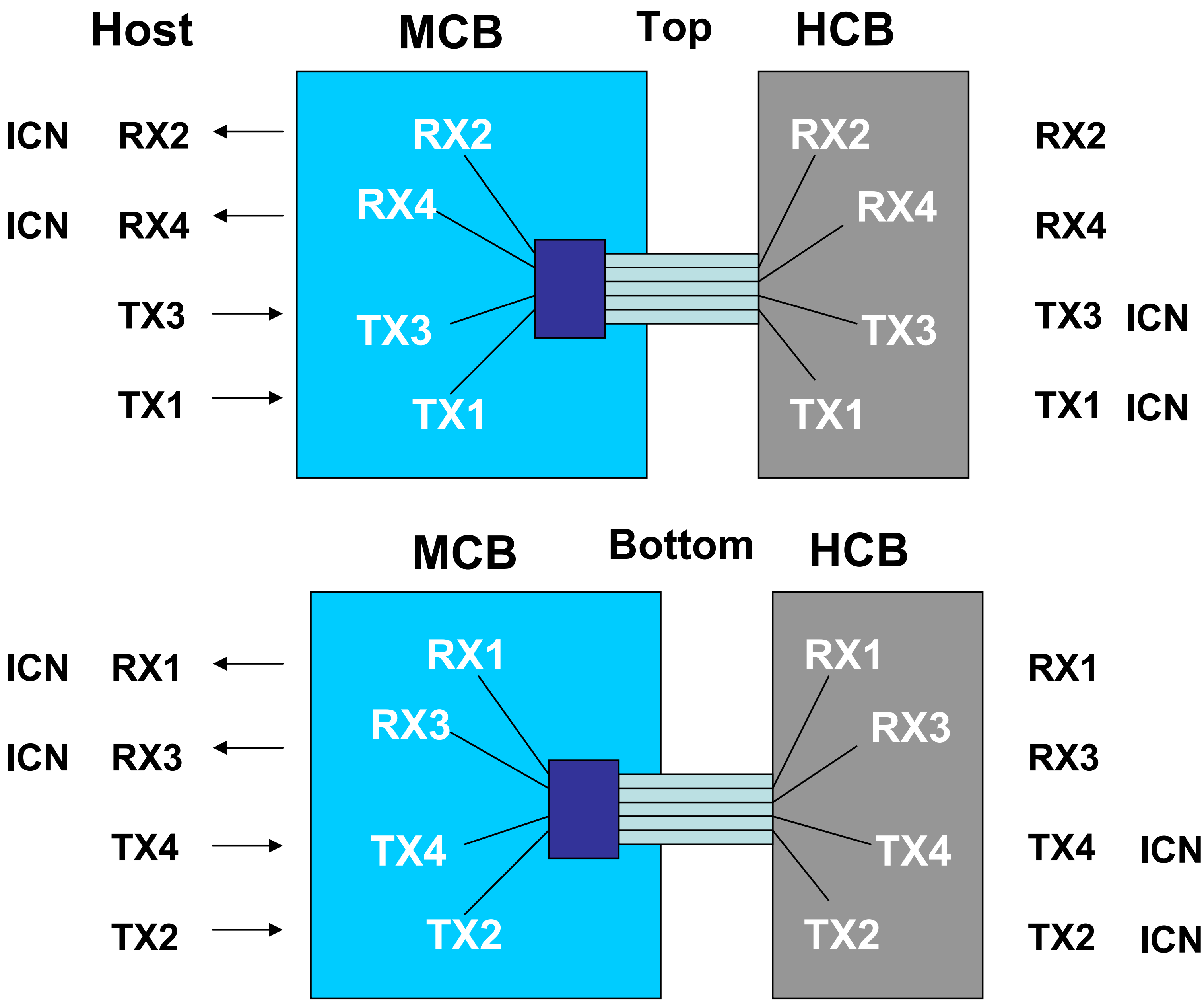
Motion #xx
Move to adopt transmitter and receiver differential printed circuit board trace loss equation described on slide 15 diminico_01a_0512.pdf.

- Moved by: Chris Di Minico
- Seconded by:
- Technical >=75%

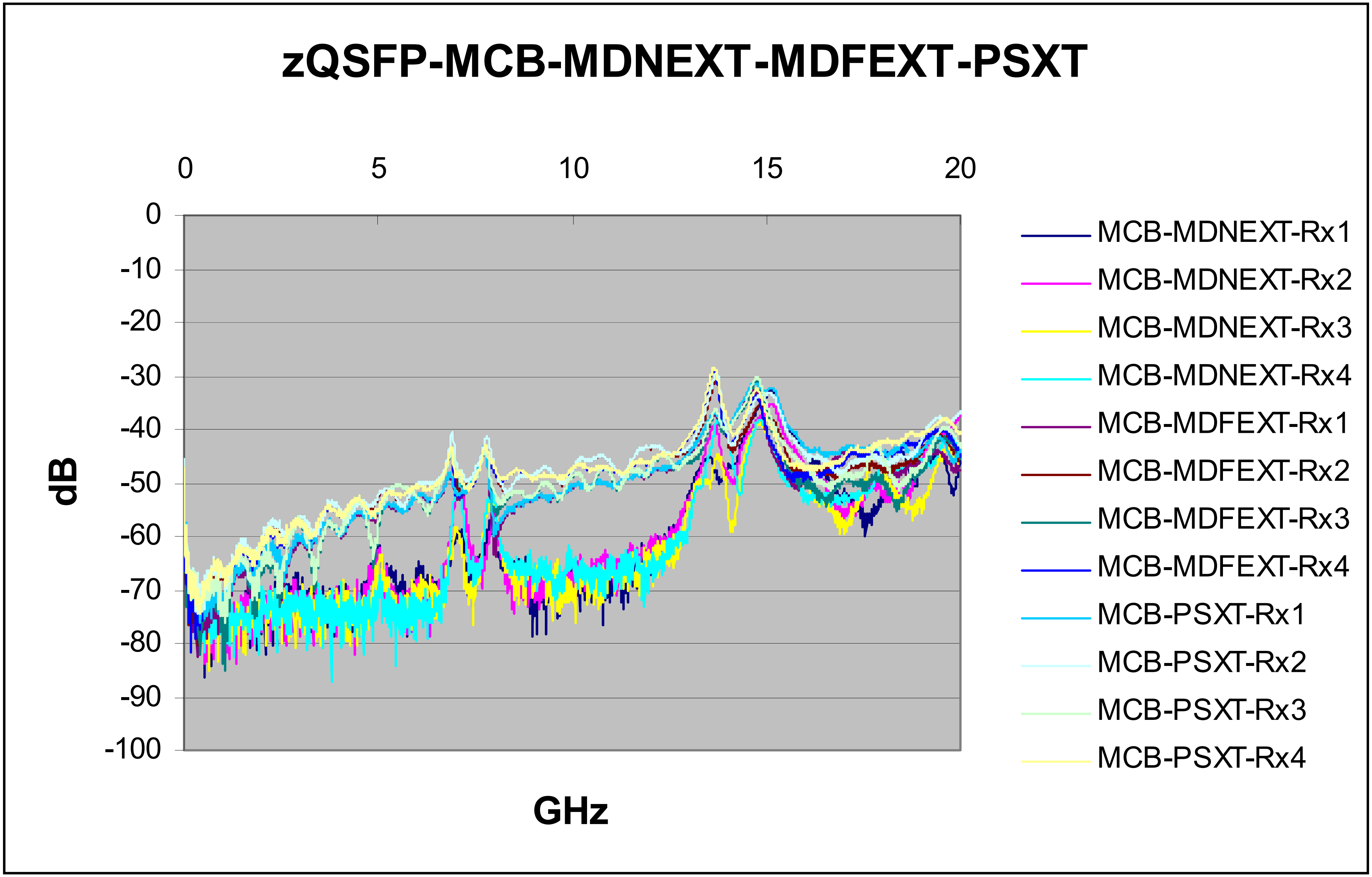
Yes: No: Abstain:

BACKUP

Test Fixture Crosstalk

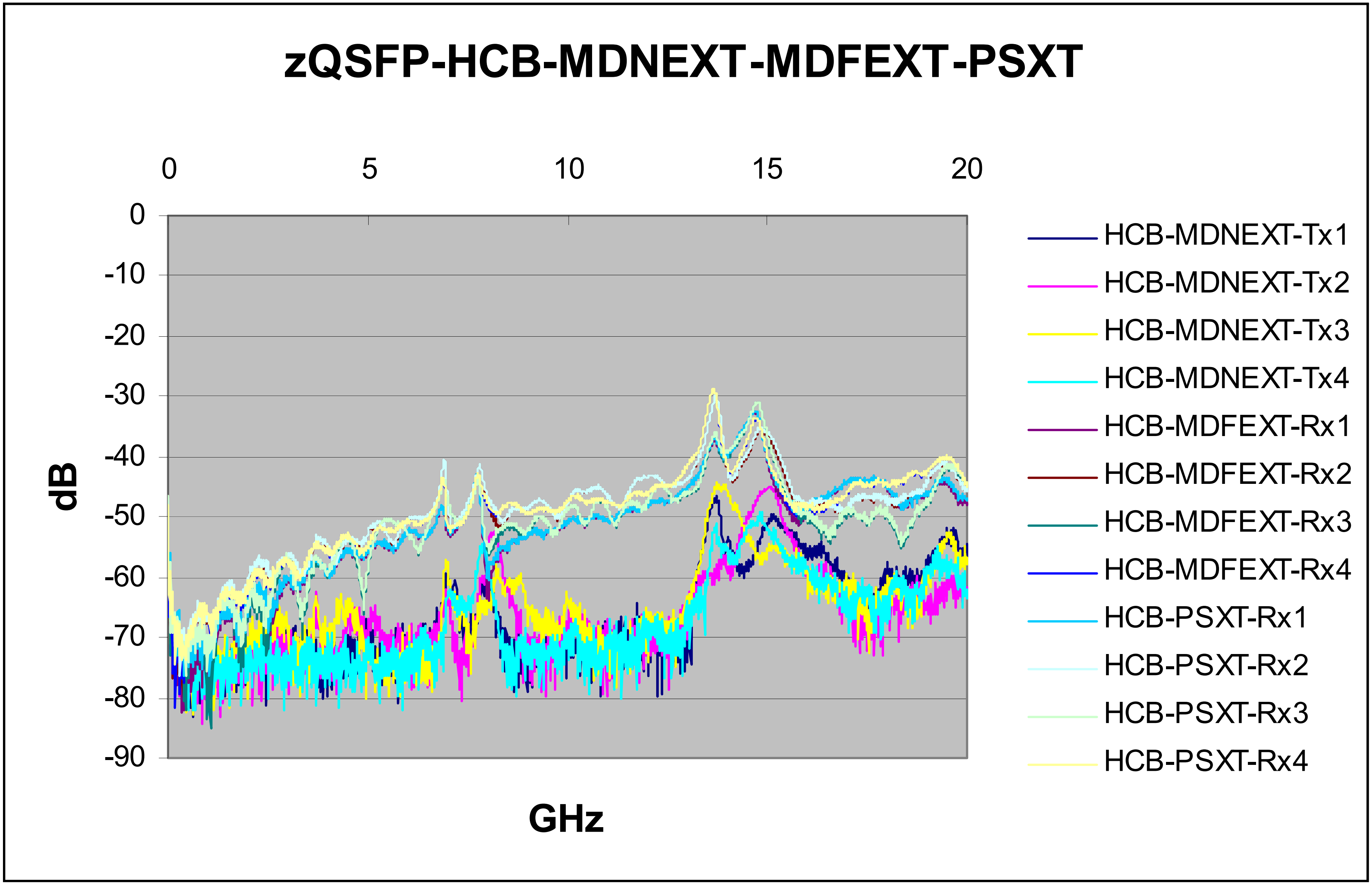


MCB side – Integrated Crosstalk Noise



Molex zQSFP – S4P measurement data provided by Michael Rost – Molex

HCB side – Integrated Crosstalk Noise



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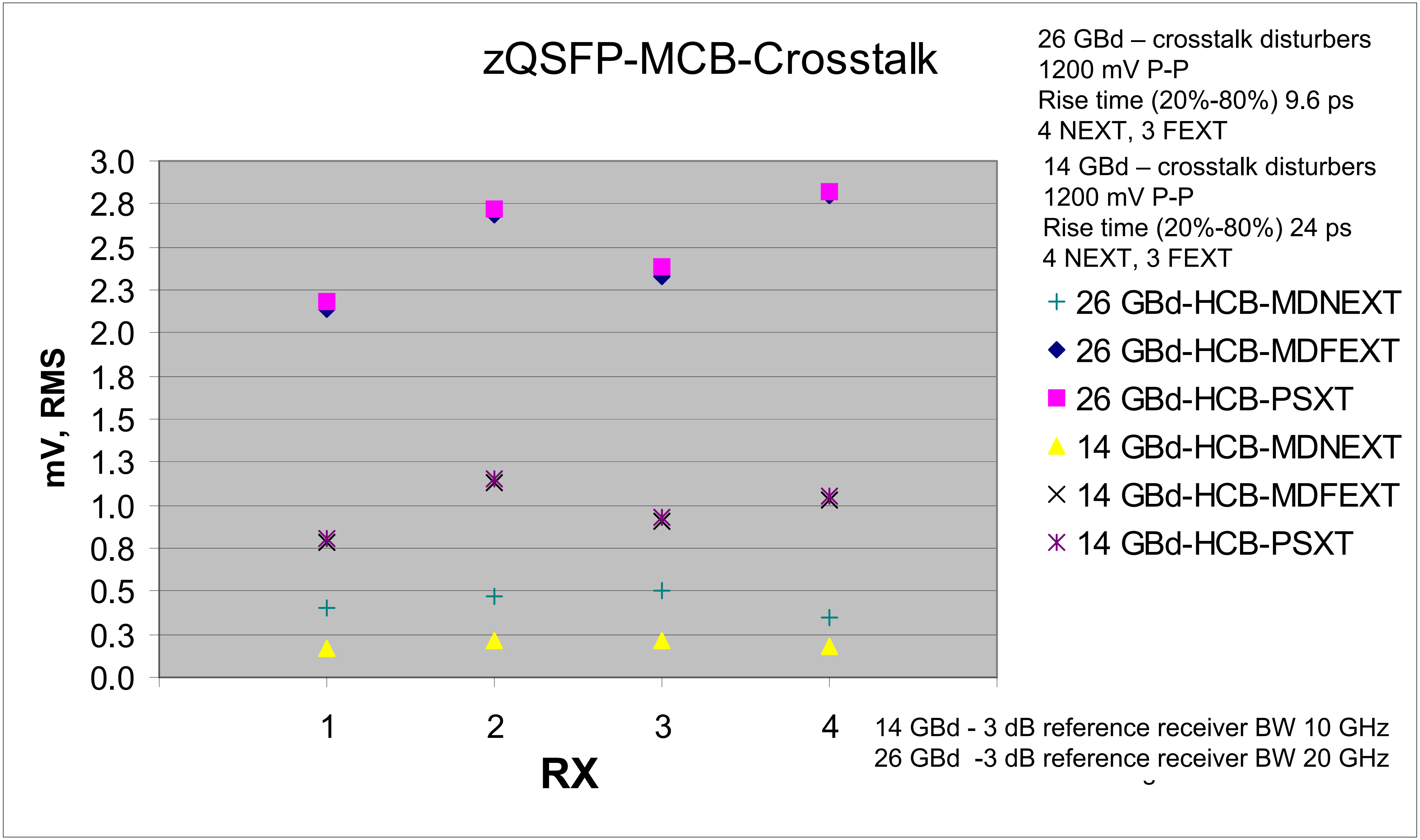

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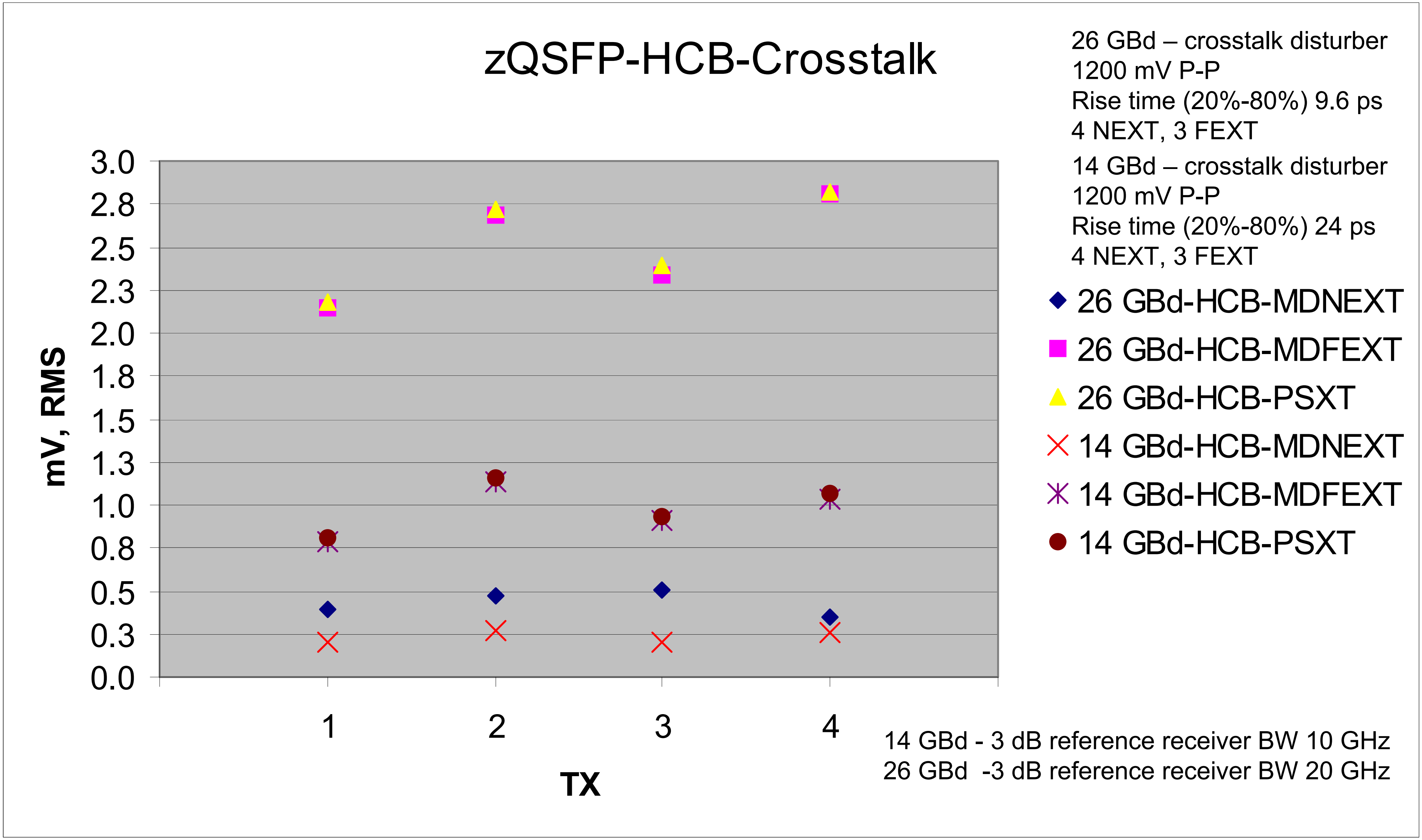

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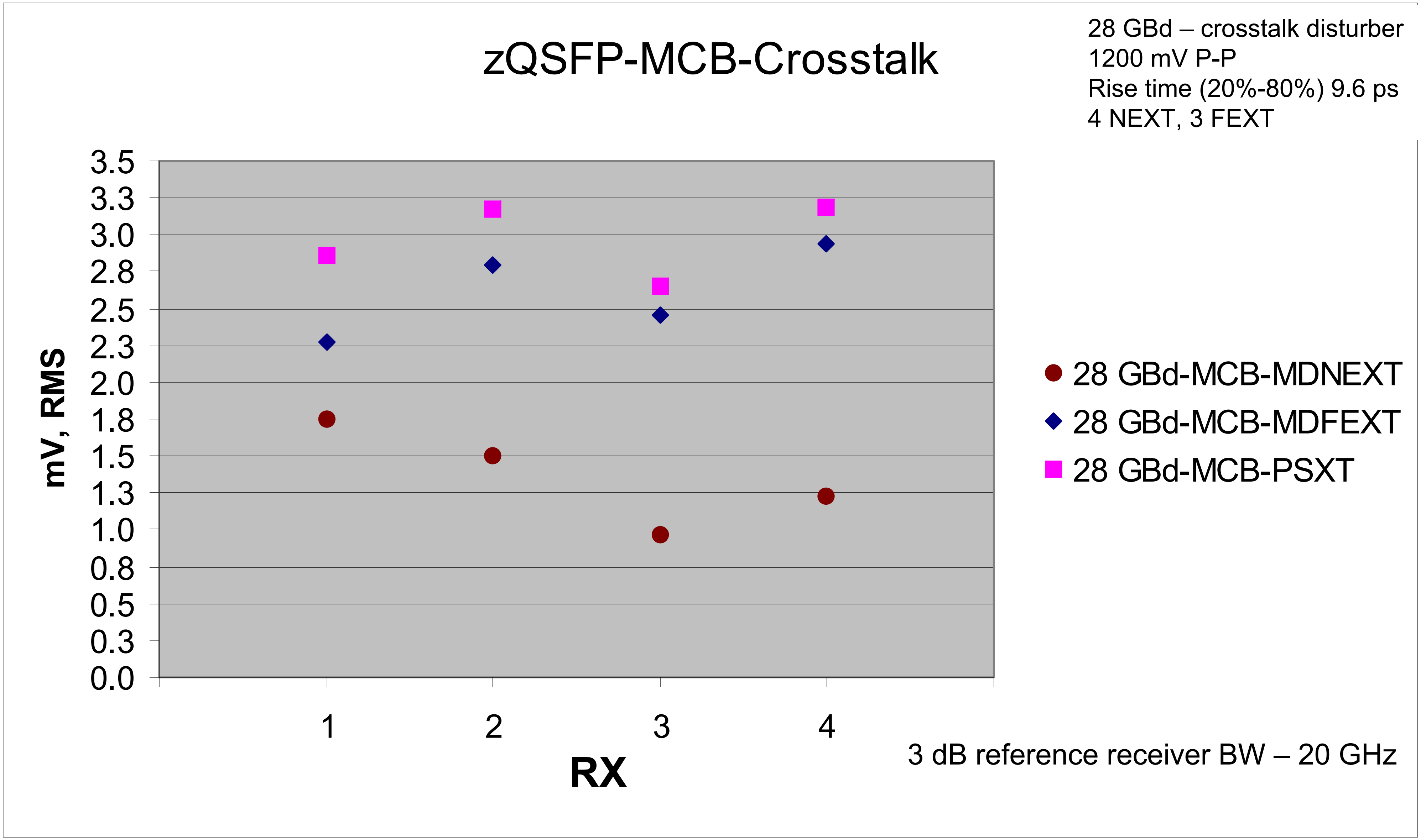

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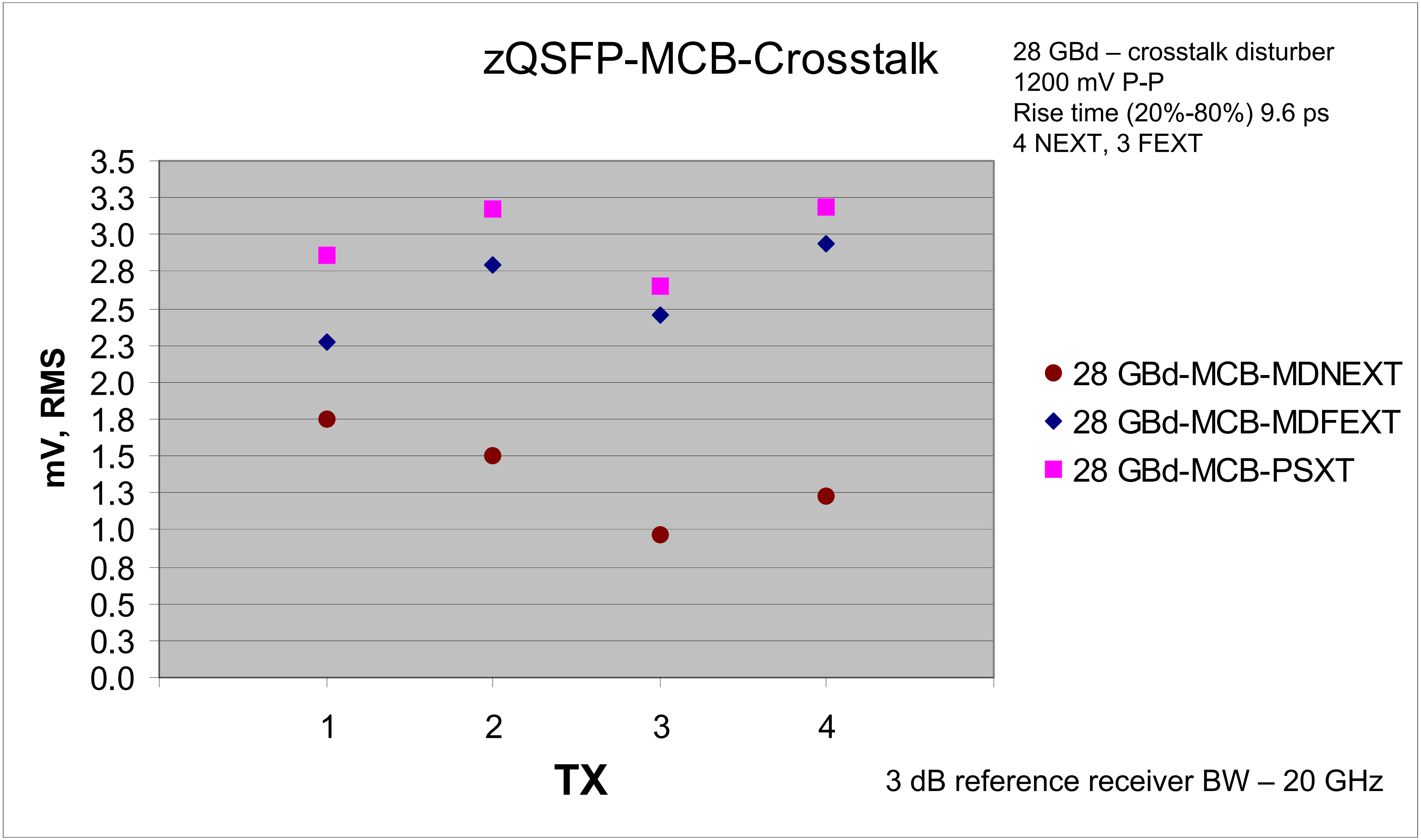

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