Gaussian noise loading for TP3 comprehensive Rx test

Comment #399

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Austin Tx, May 2005

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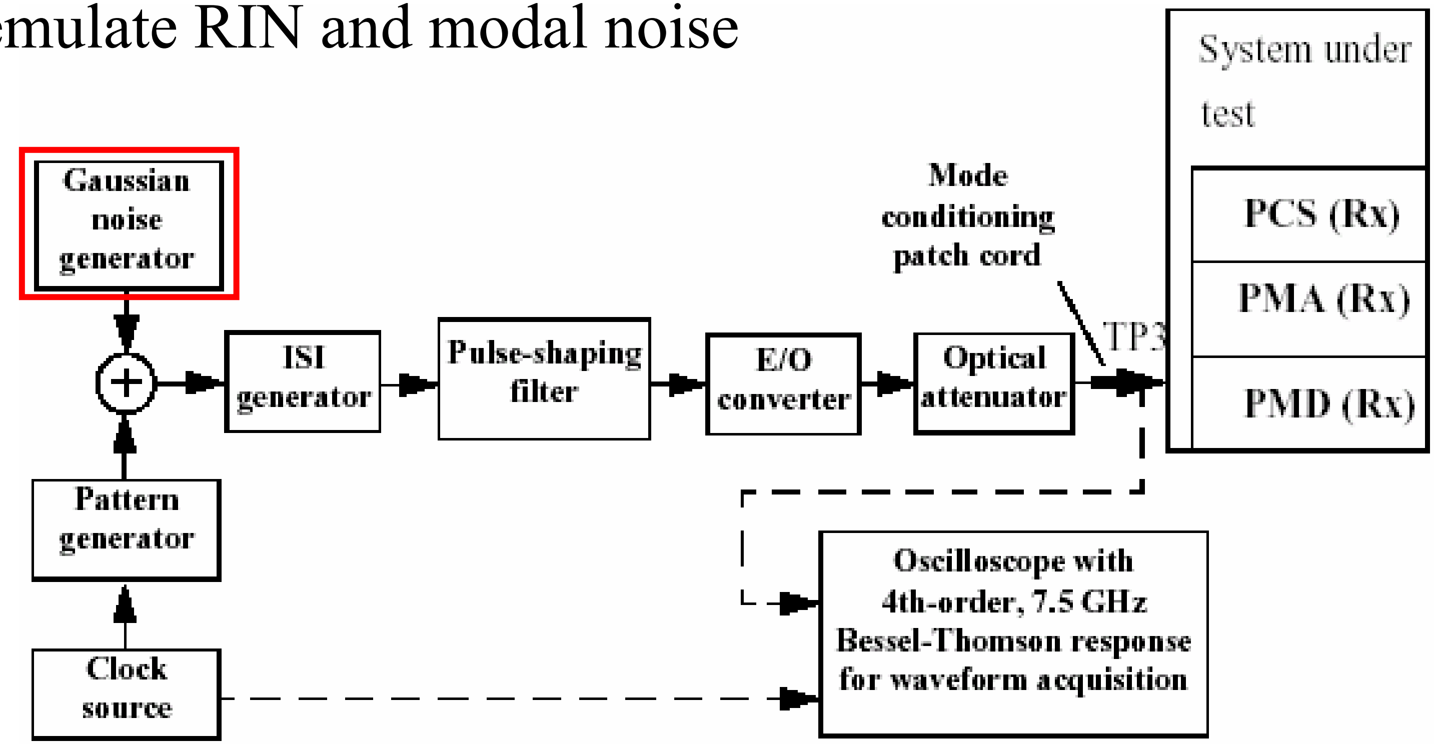
Purpose

- Current noise loading (Qsq = 11.5) in TP3 comprehensive stress test is excessive and does not correctly represent the noise magnitude for RIN and modal noise expected in compliant applications.
- The correct amount of noise must be determined.

Architecture

- Gaussian noise generator at source end is intended to emulate RIN and modal noise



- Output of E/O corresponds to TP2 if ISI generator is removed

RIN

- RIN is a TP2 property and is measured at TP2
  - Without fiber
- Since the TP3 tester will emulate RIN essentially the way it occurs in practice, it’s measurement and specs should be the same as for TP2
  - Without ISI generator(s)
- Measure with power meter or scope methods
  - BT4 filter, NBW = 7.85 GHz
- -128 dB/Hz
  - SNR form, Qsq = 28.3 (per Eq 68-4)

Modal noise (MN)

- MN penalty studied in pepeljugoski_1_1104
  - Shows ~0.5 dB max
- TP3 tester will use white noise source (before ISI generators) to emulate MN (common HW & approach as for RIN)
  - Increase penalty by 0.5 dB
- Question – what white noise density or Qsq at source will create 0.5 dB additional penalty?

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Spreadsheet tool

- Paul Voois & Norm Swenson developed a tool that predicts penalty due to white noise at TP2
  - Theory in voois_1_0504.pdf
  - Spreadsheet tool in voois_2_0504.xls
- Developed for RIN, but can apply generally to any white noise source including MN emulation
  - Shows RIN penalty = 0.3 dB
  - Combined penalty with MN should be 0.8 dB

Theory of tool

- Spreadsheet extended from 10GBASE-LR
  - Includes interaction of source noise with ISI
  - All-Gaussian impulse response (Tx, fiber)
- Adds ZFE-DFE
  - For LRM, predicted penalty ~0.1 dB higher than MMSE-DFE

Use of tool for noise

- Adjust MBW to 865 MHz-km to achieve 4.6 dB Pisi (ZFE_PIE-D) at 300 meters
  - To match Ewen work (300 meters, dual launch, 2 connectors at source, etc.)
  - 4.6 dB includes 0.1 dB for ZFE approximation
  - 865 MHz-km indicates equivalent BW improvement due to selective launch
- Adjust density to -124.2 dB/Hz to achieve 0.8 dB combined penalty
  - SNR form, Qsq = 18.3 (per Eq 68-4)

Red – for standard, Table 68-4

Spreadsheet view

Spreadsheet by Del Hanson, David Cunningham, Piers Dawe, David Dolfi Agilent Technologies
Modified for 10G FDDI MMF by Paul Voois ClariPhy Communications

Basics Input=	**Bold**	
Q=	**7.04**	
Base Rate=	**10312.5**	MBd
Transmitter		
Wavelength Uc	**1260**	nm
Uw (see notes)	**2.40**	nm
Tx pwr OMA=	**-4.50**	dBm
Min. Ext Ratio=	4.00	dB
"Worst"ave.TxPwr	**-3.85**	dBm
Ext. ratio penalty	3.66	dBo
Tx mask X1=	**0.3**	UI
X2=	**0.4**	UI
Y1=	**0.25**	
Num Tx Levels	**2**	
Multilevel Pen	0.00	dB
ultilevel RIN Pen	0.00	dB
Sym Period Tb	97.0	ps

Ts(20-80)	**47.1**	ps
Ts(10-90)	71	ps
RIN(OMA)	**-124.2**	dB/Hz
RIN at MinER	-131.5	dB/Hz
RIN_Coef=	**0.70**	
Det.Jitter	**6.0**	ps inc. DCD
DCD_DJ=	**6**	ps TP3
Effect. DJ=	0.00	(UI) ex DCD
MPN k(OMA)	**0**	
Tx eye height	49.9%	
Refl Tx	**-12**	dB
ModalNoisePen	**0**	dB
Tx mask top	0.2	UI
RIN Const A0	**0.9393**	no units
RIN Const Exp	**-1.3656**	no units
RIN Const A1	**-0.5044**	no units
RIN Const A2	**0.5360**	no units

Case: 1310nm serial	**MMF**	
Target Target reach	**0.30**	km
and L_start=	**0.1**	km
graph L_inc=	**0.02**	km
Power Budget P=	9.45	dB
Connections C	**1.5**	dB
Pwr.Bud.-Conn.Loss	7.946	dB
C1=	**480**	ns.MHz
Reflection Noise factor	**0.6**	no units
Effective Rate	10993	MBd
Tb_eff=	91	ps
Effective Rec Eye	0.21	UI
Pisi Constant A1	**0.396**	no units
Pisi Constant A2	**1.029**	no units

Rev. NA	This file	
Attenuation=	**1.5**	dB/km
Fiber at	1310	nm
C_att=	1.01	
Attenuation=	1.57	dB/km
at	1260	nm
Disp. min. Uo=	**1365**	nm
Disp. So=	**0.093**	ps/nm^2*km
Disp. D1=	-11.05	ps/(nm.km)
(not in use)	**10**	
BWm=	**865**	MHz*km
Eff. BWm=	8.7E+02	MHz*km

NA		
Model/format rev	0.3	
NomSens OMA	**-13.00**	dBm
Pmfb NRZ	-0.946	dB
MFB Sens NRZ	-13.95	dBm
MFB Sens	-13.95	dBm
Receiver Refl Rx	**-12**	dB
Rec_BW=	**7,725**	MHz
NEB Factor	1.032	no units
NEB	7972	MHz
c_rx	**329**	ns.MHz
T_rx(10-90)	42.6	ps
TP4 Eye	19	ps
Opening		(=Tx eye)
RMS Baseline wander SD	**0.025**	fraction of
P_BLW(no ISI)	0.07	dB
P_BLW	0.07	dB

L (km)	Patt (dB)	Ch IL (dB)	D1.L ps/nm	D2.L ps/nm	BWcd (MHz)	effBWm (MHz)	Te (ps)	Tc (ps)	Norm Tc no units	Pisi central J=0, dB	P Eye corners (dB)	P_DJ central (dB)	P_DJ corners (dB)	Preflection central (dB)	Beta	SDmpn	Pmpn (dB)	Prin (dB)	Pcross central (dB)	Ptotal central (dB)
0.002	0.00	1.50	-0.02	0.00	4E+06	4.3E+05	72	83	0.86	1.10								0.28		1.4
0.10	**0.16**	**1.66**	**-1.1**	**0.02**	**70,475**	**8,650**	**91**	**100**	1.03	1.51								0.30		**2.0**
0.12	0.19	1.69	-1.3	0.02	58,729	7,208	98	107	1.10	1.69								0.31		2.2
0.14	0.22	1.72	-1.5	0.02	50,339	6,179	106	114	1.18	1.90								0.33		2.4
0.16	0.25	1.75	-1.8	0.02	44,047	5,406	115	122	1.26	2.13								0.35		2.7
0.18	0.28	1.78	-2.0	0.03	39,153	4,806	123	131	1.35	2.40								0.38		3.1
0.20	**0.31**	**1.81**	**-2.2**	**0.03**	**35,237**	**4,325**	**133**	**139**	1.44	2.70								0.41		**3.4**
0.22	0.35	1.85	-2.4	0.03	32,034	3,932	142	149	1.53	3.02								0.45		3.8
0.24	0.38	1.88	-2.7	0.04	29,365	3,604	152	158	1.63	3.37								0.51		4.3
0.26	0.41	1.91	-2.9	0.04	27,106	3,327	162	167	1.73	3.76								0.58		4.7
0.28	0.44	1.94	-3.1	0.04	25,170	3,089	172	177	1.83	4.16								0.67		5.3
0.30	**0.47**	**1.97**	**-3.3**	**0.05**	**23,492**	**2,883**	**182**	**187**	1.93	4.60								0.80		**5.9**
0.32	0.50	2.00	-3.5	0.05	22,023	2,703	193	197	2.03	5.07								0.97		6.5

Informative stress test

- Informative Rx test OMA (-7.5 dBm) currently 1 dB lower than comprehensive test (-6.5 dBm)
  - Accounts for overall noise penalty of 1 dB, since noises are not part of informative test
- This presentation shows that overall link noise penalty = 0.8 dB
  - Adjust informative test OMA value to -6.5 – 0.8 = -7.3 dBm

Calculation of white noise BW (NBW) of BT4

$$y(f, f_{Tx}) := \frac{2.114 i \cdot f}{f_{Tx}}$$

$$Tx_{filt}(f, f_{Tx}) := \frac{105}{105 + 105 \cdot y(f, f_{Tx}) + 45 \cdot y(f, f_{Tx})^2 + 10 \cdot y(f, f_{Tx})^3 + y(f, f_{Tx})^4}$$

$$\int_0^{\infty} \left(\left|Tx_{filt}(f, 7.5)\right|\right)^2 df = 7.847 \quad \text{(GHz)}$$