10GE Link Model Extensions

John Petrilla: Avago Technologies

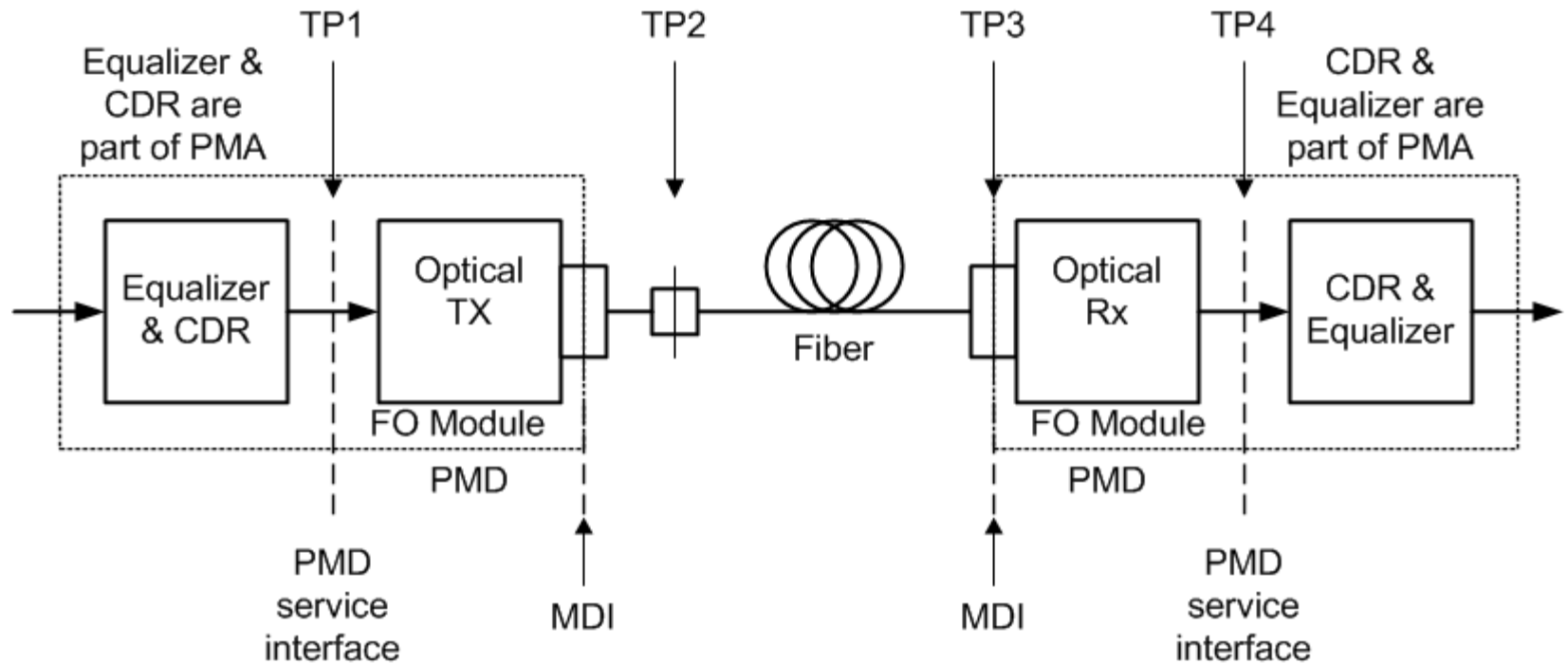September 2012

Link Model References

http://grouper.ieee.org/groups/802/3/hssg/public/nov06/dawe_01_1106.pdf

M.C. Nowell, D.G. Cunningham, D.C. Hanson and L.G Kazovsky, "Evaluation of Gb/s laser based fibre LAN links: Review of the Gigabit Ethernet model", *Optical and Quantum Electronics, 32(2), pp 169*-192, 2000

Fiber Optic Links

The 10GbE link model begins at TP2 and calculates power penalties at the decision point (between TP3 and TP4) in the Rx.

Link Model Notes

ExampleMMF LinkModel 120914 prep'd for 802.3bm use as an example of an MMF link model based on 10GEPBud3_1_16a

This version adds extensions to 10GEPBud3_1_16a that provide for inclusion of TP1 jitter allocations and estimates of jitter and eye width at TP4.

The tab Base includes entries in cells A39:H52 to provide for calculation of TP4 jitter. These calculations are based on row 28 being aligned with the target reach and for link margin, cell W28, = 0.

Base tab cell G7 has been redefined as the combined DJ at TP3, Rx contributed DJ, RJ at TP1 & target TP4 eye width. The 'DJ at TP3' value is now entered (in units of UI instead of ps) in cell F44.

Base(c) tab is slaved to the Base tab except it maintains the original definition of cell G7, DJ at TP3.

 The difference in the link penalties between the tabs Base and Base(c) yields the power required for the target TP4 eye, Peye.

To account for Peye in the calculation of Stressed Rx Sens OMA, the value in tab Base(c) cell W3 is zeroed out.

To match the definition of VECP in Clause 52, calculations were added to Base(c) tab cells W12 & W13 to account for included noise.

The equations in AQ18:27 and AQ29:38 were corrected.
See"10GbE Notes" tab for 10GEPBud3_1_16a notes.
Tab 850S2000 is included unchanged from 10GEPBud3_1_16a for reference.

Link Model Extensions – Base Tab

	A	B	C	D	E	F	G	H	I
39	TP4 Eye Width Extension: J Petrilla Avago Technologies								
40	Reach	Peye			TP1 RJ, UI =	0.110	4.27	ps for BER=E-12	
41	m	dB			TP1 RJrms, UI =	0.0079	0.31	ps	
42	120	1.21			TP1 RJ(@BER), UI =	0.064	2.48	ps	
43					TP1 DJ, UI =	0.110	4.27	ps	
44	BER =	1.4E-05			TP3 DJ wo ISI, UI =	0.160	6.21	ps	
45	Qjit@BER				TP3.5 DJisi, UI =	0.039	1.51	ps	
46	4.027				DJ at TP4, UI =	0.224	8.69	ps	
47	Qjit@BER=E-12				RJ(link noise), UI =	0.553	21.4	ps	
48	6.937				Cum RJ(TP4), UI =	0.556	21.6	ps	
49	Q(@Jn)	k(DJ)			TP4 TJ(@BER), UI =	0.780	30.3	ps	
50	2.576	0.85			TP4 J2, UI =	0.546	21.2	ps	
51	6.109	1.0			TP4 J9, UI =	1.068	41.4	ps	
52					TP4 Eye Width, UI =	0.220	8.5	ps	

Caution: Calculations are based on the target reach aligned with row 28.

• Inputs are normally indicated by **bold** fonts.

• Cell A42 provides the target reach.

• Cell B42 provides the power required to support the TP4 values in cells F49:52 when the link margin, cell W28, equals 0

▪ Cell G47 links TP4 jitter calculations to the penalty calculations via cell G7.

▪ Based on the premise that what isn't DJ & eye width (cell G7) is RJ, cell G47 yields RJ based on the additional assumption that the noise related power penalties in aggregate yield RJ.

▪ For the case where the link margin (cell W28) equals 0, the eye closure due to power penalties is matched with eye closure due to jitter.

▪ The model requires inputs for all DJ and RJ at TP1 (cells F40 and F43:46).

▪ Cells A46, A48, A50 and A51 are Q values for the target BER and J2 and J9 jitter.

▪ Cells B50 and B51 are discounting factors for DJ in J2 and J9 calculations.

▪ There are two common use cases.
 - Use cell G7 to force one of the TP4 attributes, e.g. TP4 TJ to a desired value and check the link margin, cell W28.
 - Use one of the Tx, cable plane or Rx attributes, to force cell link margin, cell W28 to 0, and check the TP4 attributes.

Link Model Tx Section – Base Tab

	A	B	C	D	E	F	G	H
1	Spreadsheet by Del Hanson, David Cunningham, Piers Dawe, David Dolfi Agilent Technologies							
2	Basics	Input=	Bold			Ts(20-80)	21.0	ps
3		Q=	4.1865			Ts(10-90)	31.9	ps
4		Base Rate=	25781.3	MBd		RIN(OMA)	-130.0	dB/Hz
5		Transmitter				RIN at MinER	-137.3	dB/Hz
6		Wavelength Uc	840	nm		RIN_Coef=	0.70	
7		RMS Width, Uw	0.60	nm		DJ+ & TP4eye	17.4	ps inc. DCD
8		Tx pwr OMA=	-3.00	dBm		DCD_DJ=	1.94	ps TP3
9		Min. Ext Ratio=	4.00	dB		Effect. DJ=	0.42	(UI) ex DCD
10		"Worst"ave.TxPwr	-2.35	dBm		MPN k(OMA)	0.3	
11		Ext. ratio penalty	3.66	dBo		Tx eye height	22.8%	
12	Tx mask	X1=	0.3	UI		Refl Tx	-12	dB
13		X2=	0.4	UI		ModalNoisePen	0.15	dB
14		Y1=	0.25			Tx mask top	0.2	UI

•Inputs are normally indicated by **bold** fonts.

•With the exception of the use of cell G7, there are no changes within this section.

•Note the entry for Q, cell C3, is set for a BER = 1.4E-5. See calculation in cell B44.

Link Model Case & Cable Plant Section – Base Tab

	I	J	K	L	M	N	O	P	Q
1						Rev.	3.2/3		This file
2	Case:		850nm serial	newMMF			Attenuation=	3.5	dB/km
3	*Target*		Target reach	0.120	km	*Fiber*	at	850	nm
4	*and*		L_start=	0.07	km		C_att=	1.00	
5	*graph*		L_inc=	0.005	km		Attenuation=	3.62	dB/km
6			Power Budget P=	7.55	dB		at	840	nm
7			Connections etc	1.50	dB		Disp. min. Uo=	1316	nm
8			Pwr.Bud.-Conn.Loss	6.05	dB		Disp. So=	0.1028	ps/nm^2*km
9			C1=	480	ns.MHz		Disp. D1=	-108.41	ps/(nm.km)
10			Reflection Noise factor	0	no units				
11			Effective Rate	27138	MBd		(not in use)	10	
12			Tb_eff=	37	ps		BWm=	4400	MHz*km
13			Effective Rec Eye	0.21	UI		Eff. BWm=	4.4E+03	MHz*km

- Caution: Calculations in A40:H52 are based on the target reach aligned with row 28.

- The calculation, Target Reach = L start + 10 x L increment was inserted in cell L3.

- Inputs are normally indicated by **bold** fonts.

- There are no other changes in this section.

Link Model Rx Section – Base Tab

	R	S	T	U	V	W	X
1		10GEPBud3_1_16a.xls			of		17-Oct-01
2			Model/format rev	3.1.16a	of		31-Oct-01
3		NomSens OMA	**-10.55**	dBm	Margin	0.00	dB at
4	*Receiver*	Refl Rx	**-12**	dB	*Answer!*		0.12 km
5		Rec_BW=	**17,918**	MHz	Test Rx BW	**19,336**	MHz
6		c_rx	**329**	ns.MHz			
7		T_rx(10-90)	18.4	ps	Test Source ER=		
8		TP4 Eye	8	ps	*Test Tx*	**6.5**	dB
9		Opening		(=Tx eye)	TestERpen.	1.98	dBo
10		RMS Baseline wander SD	**0.013**	fraction of 1/2 eye			
11					V.E.C.P.	4.54	dBo
12		P_BLW(no ISI)	0.01	dB			Stressed
13		P_BLW	0.01	dB			Rx sens

· Inputs are normally indicated by **bold** fonts.

·There are no changes to this section.