

OM3 reach based on the 100 m OM4 reach PMD baseline modeling

Jonathan King, Finisar

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Summary

71 m

Approach

- Use model parameters from petrilla_01_0313
 - VCSEL rise-time, RIN, TP1 DJ & RJ and DCD, fibre dispersion values (modal and CD), Rx bandwidth and sensitivity, target Q, baseline wander.....
- and an independently modified spreadsheet model derived from 10GEPBud3_1_16a.xls,
 - adjusted for bit rate etc
 - with jitter calculation similar to those described in king_01_0110
 - plus a first order approximation to include MPN induced jitter and a 0.17 UI allowance for other jitter introduced by optical Tx & Rx chains.

Values from petrilla_01_0113

Parameter	Unit	100G 100m
Signal rate	GBd	25.78125
Q (BER)		3.8905 (5.0E-5)
Center Wavelength, min	nm	840
Spectral Width, max	nm	0.60
OMA at max TDP, min	dBm	-3.0
Extinction ratio, min	dB	3.0
Tx output transition times, 20% -80%, max	ps	21
RIN ₁₂ OMA, max	dB/Hz	-128
RIN coefficient		0.7
MPN coefficient		0.3
Modal Noise Penalty	dB	0.129
Tx reflectance, max	dB	-12
Tx optical return loss tolerance, max	dB	12

Parameter	Unit	100G 100m
Signal rate	GBd	25.78125
Q (BER)		3.8905 (5.0E-5)
Wavelength, min	nm	840
Rx sensitivity (OMA), max	dBm	-11.2
Rx Bandwidth, min	MHz	18,047
RMS base line wander coefficient		0.025
Rx reflectance, max	dB	-12
Parameter	Unit	100G 100m
Signal rate	GBd	25.78125
Q (BER)		3.8905 (5.0E-5)
Reach	m	100
Fiber Attenuation	dB/km	3.5
Dispersion min Uo	nm	1316
Dispersion So	ps/nm ² km	0.10275
Fiber modal bandwidth	MHz·km	4400
Reflection Noise Factor		0
Signal power budget at max TDP	dB	8.20
Connector & splice loss allocation	dB	1.50
Fiber Insertion loss	dB	0.36

Model snapshot for OM4

IP1-IP4 Jitter, extensions by jpk, Sept 2010; MPN Jitter, IDP, variable names removed + easy-copy eye plots added June 2012															Rx sensy offset									
Spreadsheet by Del Hanson, David Cunningham, Piers Dawe, David Dohi, Agilent Technologies															Rev. 3.2/3 This file of 17-Oct-01									
Basics Input= Bold Ts(20-80) 21 ps Case: 850nm serial newMMF Attenuation= 3.5 dB/km Model/format rev 3.1.16a of 31-Oct-01															Fiber at 850 nm NomSens OMA -11.21 dBm Margin 1.51 dB at									
Lane Rate= 25781 MBd RIN(OMA) -128 dB/Hz Target and graph Target reach 0.10 km L_start= 0.002 km C_att= 1.00 Receive Refl Rx -12 dB Answer! 0.1 km															Noise Ltd equiv -11.21 Delta Nom to Noise Ltd Rx sensy (Y4-Y6) 0.00 dB At input OMA= -4.90 dBm Rx RN= 0.033									
Host J2 5.702 ps IP1 Qsq(J12) 50 Ix linear adder J.3 0.17 UI, of w. 30% DCD 6.555 ps J2 Jset 0.1470 UI Rx linear adder J.3 0.00 UI, of w. 50% DCD 0 ps T-h(10-90) 17 ps TP2 J9 0.2052 UI RN(1sd), from RIN 0.064 UA RJ(1 sigma) 0.0079 UI TJ 0.2199 UI RN(1sd), from Rx noise 0.017 UA 4.68 x RJ 0.0371 UI of which 45% DDWPS 0.049 1.918 ps CLK R 0.006 UI DJ=J3 0.11 UI															Power Budget P= 8.21 dB Other+Connections C 1.5 dB Pwr Bud.-Conn.Loss 6.714 dB C1= 480 ns.MHz Other Loss 0.0 dB Reflection Noise factor 0 no units Effective Rate 28651 MBd Effective Rec Eye 0.22 UI					Attenuation= 3.62 dB/km Rec_BW= ##### MHz Rx BW 18,047 MHz Disp. min. Uo= 1316 nm T_rx(10-90) 18.2 ps Test Source ER= 6.5 dB Disp. So= 0.1028 ps/nm^2.km IP4 Ey 8 ps Test El 1.98 dBo Disp. D1= -108.41 ps/(nm.km) Opening (=1x eye)				
Tx tdp ma: 3.5 dB RIN at MinER -137.6 dB/Hz Wavelength Uc 840 nm RIN_Coeff= 0.70 H+M Det.Jitter 10.82 ps inc. equiv 0.279 UI, total link H+M CD_DJ= 3.885 ps IP3 equiv 0.1 UI, total link Effect DJ= 0.20 (UI) ex DCD Det jit 0.28 UI															IP J2 J9 J12 J15 units IP1 0.147 0.205 0.220 UI IP2 0.466 0.812 0.908 UI IP3 0.466 0.812 0.908 UI IP4 0.513 0.800 1.052 UI					RMS Baseline wander SD 0.025 fraction of 1/2 eye V.E.C.P. 3.88 dB BWm= 4400 MHz*krH_BLW(no ISI) 0.02 dB P_BLW 0.02 dB				
Uw (see notes) 0.60 nm H+M CD_DJ= 3.885 ps IP3 equiv 0.1 UI, total link Min. Ext Ratio= 3.00 dB Effect DJ= 0.20 (UI) ex DCD Det jit 0.28 UI XOMA-min-IDP= -8.69 dB Det jit 0.28 UI															IP J2 J9 J12 J15 units IP1 0.147 0.205 0.220 UI IP2 0.466 0.812 0.908 UI IP3 0.466 0.812 0.908 UI IP4 0.513 0.800 1.052 UI					Pcross central (dB) Ptotal central (dB) P Pen central (dB) Margin central (dBm)				
Worst ave. IxPwr -1.23 dBm MPN k(OMA) 0.3 Ix eye height 30.0% Refl Ix -12 dB ModalNoisePen 0.166 dB Tx mask top 0.2 UI X2= 0.4 UI Y1= 0.25															IP J2 J9 J12 J15 units IP1 0.147 0.205 0.220 UI IP2 0.466 0.812 0.908 UI IP3 0.466 0.812 0.908 UI IP4 0.513 0.800 1.052 UI					Pcross central (dB) Ptotal central (dB) P Pen central (dB) Margin central (dBm)				
L (km) Pat (dB) Ch IL (dB) DTL (ps/nm/ps) DZL (MHz) BWcd (MHz) ellBwm (ps) Ie (ps) Ic (ps) IP3 IP3 IP3 IP4 IP4 IP4 IP4 J=0, dB (dB) P Eye central (dB) P_DJ central (dB) P_DJ central (dB) Preflection central (dB) Beta SUmpn Pmpn Pprn (dB) Ptotal central (dB) Ptotal central (dB) P Pen central (dB) Margin central (dBm)															IP J2 J9 J12 J15 units IP1 0.147 0.205 0.220 UI IP2 0.466 0.812 0.908 UI IP3 0.466 0.812 0.908 UI IP4 0.513 0.800 1.052 UI					Pcross central (dB) Ptotal central (dB) P Pen central (dB) Margin central (dBm)				
0.002 0.01 1.51 -0.22 0.00 1E+06 ##### 32 37 0.466 0.812 0.908 0.459 0.678 0.871 0.981 2.57 0.27 0.22 0.77 0 -1E-02 0.00 0.00 0.10 3.05 3.88 3.0 3.7 -6.2															IP J2 J9 J12 J15 units IP1 0.147 0.205 0.220 UI IP2 0.466 0.812 0.908 UI IP3 0.466 0.812 0.908 UI IP4 0.513 0.800 1.052 UI					Pcross central (dB) Ptotal central (dB) P Pen central (dB) Margin central (dBm)				
0.002 0.01 1.51 -0.2 0.00 ##### 32 37 0.466 0.812 0.908 0.459 0.678 0.871 0.981 2.37 0.27 0.22 0.77 0 -0.01 0.00 0.00 0.37 0.11 3.4 4.3 3.4 3.3 -6.6															IP J2 J9 J12 J15 units IP1 0.147 0.205 0.220 UI IP2 0.466 0.812 0.908 UI IP3 0.466 0.812 0.908 UI IP4 0.513 0.800 1.052 UI					Pcross central (dB) Ptotal central (dB) P Pen central (dB) Margin central (dBm)				
0.012 0.04 1.54 -1.3 0.00 ##### 32 37 0.466 0.813 0.813 0.459 0.680 0.873 0.983 2.58 0.27 0.22 0.77 0 -0.07 0.00 0.00 0.37 0.11 3.5 4.3 3.4 3.2 -6.6															IP J2 J9 J12 J15 units IP1 0.147 0.205 0.220 UI IP2 0.466 0.812 0.908 UI IP3 0.466 0.812 0.908 UI IP4 0.513 0.800 1.052 UI					Pcross central (dB) Ptotal central (dB) P Pen central (dB) Margin central (dBm)				
0.022 0.08 1.58 -2.3 0.00 ##### 32 37 0.466 0.815 0.815 0.460 0.681 0.876 0.986 2.62 0.27 0.22 0.77 0 -0.13 0.00 0.00 0.37 0.11 3.6 4.4 3.5 3.2 -6.7															IP J2 J9 J12 J15 units IP1 0.147 0.205 0.220 UI IP2 0.466 0.812 0.908 UI IP3 0.466 0.812 0.908 UI IP4 0.513 0.800 1.052 UI					Pcross central (dB) Ptotal central (dB) P Pen central (dB) Margin central (dBm)				
0.031 0.11 1.61 -3.4 0.00 91,555 ##### 32 37 0.468 0.819 0.819 0.461 0.684 0.880 0.991 2.67 0.27 0.22 0.77 0 -0.18 0.01 0.00 0.37 0.11 3.7 4.5 3.5 3.1 -6.7															IP J2 J9 J12 J15 units IP1 0.147 0.205 0.220 UI IP2 0.466 0.812 0.908 UI IP3 0.466 0.812 0.908 UI IP4 0.513 0.800 1.052 UI					Pcross central (dB) Ptotal central (dB) P Pen central (dB) Margin central (dBm)				
0.041 0.15 1.65 -4.5 0.00 69,778 ##### 33 38 0.471 0.828 0.828 0.463 0.689 0.887 1.000 2.75 0.27 0.22 0.77 0 -0.24 0.01 0.00 0.37 0.12 3.8 4.6 3.6 2.9 -6.8															IP J2 J9 J12 J15 units IP1 0.147 0.205 0.220 UI IP2 0.466 0.812 0.908 UI IP3 0.466 0.812 0.908 UI IP4 0.513 0.800 1.052 UI					Pcross central (dB) Ptotal central (dB) P Pen central (dB) Margin central (dBm)				
0.051 0.18 1.68 -5.5 0.00 56,369 86,275 33 38 0.476 0.843 0.843 0.467 0.697 0.898 1.013 2.85 0.27 0.22 0.77 0 -0.30 0.02 0.01 0.37 0.13 3.9 4.8 3.7 2.8 -6.8															IP J2 J9 J12 J15 units IP1 0.147 0.205 0.220 UI IP2 0.466 0.812 0.908 UI IP3 0.466 0.812 0.908 UI IP4 0.513 0.800 1.052 UI					Pcross central (dB) Ptotal central (dB) P Pen central (dB) Margin central (dBm)				
0.061 0.22 1.72 -6.6 0.00 47,284 72,368 34 39 0.484 0.866 0.866 0.472 0.708 0.915 1.033 2.97 0.27 0.22 0.77 0 -0.36 0.03 0.02 0.38 0.14 4.1 4.9 3.9 2.6 -6.9															IP J2 J9 J12 J15 units IP1 0.147 0.205 0.220 UI IP2 0.466 0.812 0.908 UI IP3 0.466 0.812 0.908 UI IP4 0.513 0.800 1.052 UI					Pcross central (dB) Ptotal central (dB) P Pen central (dB) Margin central (dBm)				
0.071 0.26 1.76 -7.7 0.00 40,720 62,323 35 39 0.496 0.899 0.899 0.479 0.724 0.939 1.061 3.11 0.28 0.22 0.78 0 -0.41 0.03 0.04 0.38 0.15 4.3 5.2 4.1 2.4 -6.9															IP J2 J9 J12 J15 units IP1 0.147 0.205 0.220 UI IP2 0.466 0.812 0.908 UI IP3 0.466 0.812 0.908 UI IP4 0.513 0.800 1.052 UI					Pcross central (dB) Ptotal central (dB) P Pen central (dB) Margin central (dBm)				
0.08 0.29 1.79 -8.7 0.00 35,757 54,726 36 40 0.511 0.943 0.943 0.488 0.744 0.969 1.097 3.27 0.28 0.22 0.78 0 -0.47 0.04 0.06 0.39 0.17 4.6 5.4 4.3 2.1 -7.0															IP J2 J9 J12 J15 units IP1 0.147 0.205 0.220 UI IP2 0.466 0.812 0.908 UI IP3 0.466 0.812 0.908 UI IP4 0.513 0.800 1.052 UI					Pcross central (dB) Ptotal central (dB) P Pen central (dB) Margin central (dBm)				
0.09 0.33 1.83 -9.8 0.00 31,872 48,780 37 41 0.530 0.997 0.997 0.500 0.770 1.008 1.143 3.45 0.28 0.22 0.79 0 -0.53 0.05 0.09 0.40 0.20 4.9 5.7 4.5 1.9 -7.1															IP J2 J9 J12 J15 units IP1 0.147 0.205 0.220 UI IP2 0.466 0.812 0.908 UI IP3 0.466 0.812 0.908 UI IP4 0.513 0.800 1.052 UI					Pcross central (dB) Ptotal central (dB) P Pen central (dB) Margin central (dBm)				
0.10 0.36 1.86 -10.8 0.00 28,748 44,000 38 42 0.553 1.062 1.062 0.513 0.800 1.052 1.196 3.65 0.28 0.22 0.80 0 -0.59 0.06 0.13 0.42 0.24 5.2 6.1 4.8 1.5 -7.2															IP J2 J9 J12 J15 units IP1 0.147 0.205 0.220 UI IP2 0.466 0.812 0.908 UI IP3 0.466 0.812 0.908 UI IP4 0.513 0.800 1.052 UI					Pcross central (dB) Ptotal central (dB) P Pen central (dB) Margin central (dBm)				

- 100 m on OM4 for VECP ≤ 4.0 dB and TJ ≤ 0.8 UI jitter at 'TP4' at target BER

Model snapshot for OM3

[IP1-IP4 Jitter, extensions by jpk, Sept 2010; MPN Jitter, IDP, variable names removed + easy-copy eye plots added June 2012]															Rev. 3.2/3		this file		of 17-Oct-01										
Spreadsheet by Del Hanson, David Cunningham, Piers Dawe, David Dolfi Agilent Technologies															Attenuation= 3.5 dB/km		Model/format rev 3.1.16a		of 31-Oct-01										
Basics		Input= Bold		Ts(20-80) 21 ps		Case: 850nm serial		newMMF		Fiber at 850 nm		NomSens OMA -11.21 dBm		Margin 1.63 dB at															
Lane Rate= 25781 MBd		Q= 3.89		RIN(OMA) -128 dB/Hz		Target reach		L_start= 0.002 km		C_att= 1.00		Receive Ref Rx -12 dB		Answer! 0/0/1 k															
Host		J2 5.702 ps IP1		Qsq(J12) 50		Module		1x linear adder J.3 0.170 UI, of w/ 30 % DCD 6.594 ps		Delta Nom to Noise Ltd Rx sensy (Y4-Y6) 0.00 dB		At input OMA= -4.78 dBm																	
1-h(20-80) 11.2 ps IP1		J2 Jset 0.147 UI		J9 0.2052 UI		Rx linear adder J.3 0.000 UI, of w/ 50 % DCD 0 ps		RN(1sd), from RIN) 0.064 UA		RN(1sd), from Rx noise) 0.017 UA		Rx RN= 0.032																	
T-h(10-90) 17 ps TP2		RJ(1 sigma) 0.0079 UI		TJ 0.2199 UI		of which 45 % DDWPS 0.049 1.978 ps																							
4.68 x RJ 0.03/1 UI		CLK R. 0.006 UI		DJ=J.3 0.11 UI																									
Tx tdp ma: 3.5 dB		RIN at MinER -137.6 dB/Hz		RIN_Coeff= 0.70				Power Budget P= 8.21 dB		Attenuation= 3.62 dB/km		Rec_BW= ##### MHz		Rx BW 18,047 MHz															
Wavelength Uc 840 nm		H+M Det Jitter 10.86 ps inc equiv 0.28 UI, total link		H+M CD_DJ= 3.896 ps IP3 equiv 0.1 UI, total link				Other+Connections C 1.5 dB		Disp. min. Uo= 1316 nm		T_rx(10-90) 18.2 ns.MHz		Test Source ER=															
Tx pwr OMA= -3.00 dBm		Effect DJ= 0.20 (UI) ex DCD		Det jit 0.28 UI				Pwr.Bud.-Conn.Loss 6.714 dB		Disp. So= 0.1028 ps/nm^2/km		IP4 Eyr 8 ps		Test I 6.5 dB															
Min. Ext Ratio= 3.00 dB		Effect DJ= 0.20 (UI) ex DCD		Det jit 0.28 UI				C1= 480 ns.MHz		Disp. D1= -108.41 ps/(nm.km)		Opening (= 1x eye)		Test I 1.98 dB															
OMA-min-IDP= -8.69 dB		MPN k(OMA) 0.3		IP1 0.147 0.205 0.220 UI				Other Loss 0.0 dB		RMS Baseline wander SD 0.025 fraction of 1/2 eye																			
Worst' ave. 1xPwr -1.23 dBm		1x eye height 29.9%		IP2 0.467 0.813 0.909 UI				Reflection Noise factor 0 no units		BWm= 2000 MHz*km^P_BLW(no ISI) 0.02 dB																			
Ext. ratio penalty 4.78 dB		Reff 1x -12 dB		IP3 0.467 0.813 0.909 UI				Effective Rate 28660 MBd		(not in use) 10																			
1x mask X1= 0.3 UI		ModalNoisePen 0.166 dB		IP4 0.483 0.731 0.949 UI				Ib_eff= 35 ps		Eff. BWm= ##### MHz*km		P_BLW 0.02 dB		Rx sens															
X2= 0.4 UI		Tx mask top 0.2 UI						Effective Rec Eye 0.22 UI																					
Y1= 0.25																													
L (km)	Pat (dB)	Ch IL (dB)	DTL ps/nm	DZL ps/nm	BWcd (MHz)	entBWm (MHz)	Ie (ps)	Ic (ps)	Ic J2	Ic J9	Ic J12	Ic J5	Ic J9	Ic J15	Psi central J=0 dB	P Eye central (dB)	P_DJ central (dB)	P_DJ central (dB)	Preflection central (dB)	Beta	SDmpn	Pmpn (dB)	Prn (dB)	Pcross central (dB)	Ptotal central (dB)	<Ptotal central (dB)	P Pen central (dB)	Margin (dB)	OMA central (dBm)
0.002	0.01	1.51	-0.22	0.00	1E+06	#####	32	37	0.467	0.813	0.909	0.460	0.679	0.872	2.57	0.27	0.22	0.77	0	-1E-02	0.00	0.00	0.37	0.11	3.06	3.88	3.1	3.7	-6.4
0.002	0.01	1.51	-0.2	0.00	#####	#####	32	37	0.467	0.813	0.909	0.460	0.679	0.872	2.57	0.27	0.22	0.77	0	-0.01	0.00	0.00	0.37	0.11	3.4	4.3	3.4	3.3	-6.7
0.009	0.03	1.53	-1.0	0.00	#####	#####	32	37	0.467	0.814	0.814	0.460	0.680	0.874	2.59	0.27	0.22	0.77	0	-0.05	0.00	0.00	0.37	0.11	3.5	4.3	3.5	3.2	-6.8
0.016	0.06	1.56	-1.7	0.00	#####	#####	32	37	0.467	0.816	0.816	0.461	0.681	0.875	2.63	0.27	0.22	0.77	0	-0.09	0.00	0.00	0.37	0.11	3.6	4.4	3.5	3.2	-6.8
0.023	0.08	1.58	-2.5	0.00	#####	88,106	33	37	0.468	0.819	0.819	0.461	0.683	0.878	2.69	0.27	0.22	0.77	0	-0.13	0.00	0.00	0.37	0.11	3.6	4.5	3.6	3.1	-6.8
0.03	0.11	1.61	-3.2	0.00	97,123	67,568	33	38	0.470	0.823	0.823	0.462	0.686	0.881	2.77	0.27	0.22	0.77	0	-0.17	0.01	0.00	0.37	0.12	3.8	4.6	3.6	3.0	-6.8
0.037	0.13	1.63	-4.0	0.00	78,763	54,795	34	38	0.472	0.830	0.830	0.464	0.689	0.886	2.88	0.27	0.22	0.78	0	-0.21	0.01	0.00	0.37	0.12	3.9	4.7	3.8	2.8	-6.9
0.043	0.16	1.66	-4.7	0.00	66,241	46,083	34	39	0.476	0.840	0.840	0.466	0.693	0.893	3.01	0.28	0.22	0.78	0	-0.25	0.01	0.01	0.38	0.13	4.1	4.9	3.9	2.6	-6.9
0.05	0.18	1.68	-5.5	0.00	57,154	39,761	35	40	0.480	0.853	0.853	0.469	0.700	0.902	3.16	0.28	0.22	0.78	0	-0.29	0.02	0.01	0.38	0.15	4.3	5.1	4.1	2.4	-6.9
0.057	0.21	1.71	-6.2	0.00	50,259	34,965	36	40	0.487	0.871	0.871	0.472	0.708	0.915	3.33	0.28	0.22	0.79	0	-0.33	0.02	0.02	0.40	0.16	4.5	5.3	4.3	2.2	-7.0
0.064	0.23	1.73	-6.9	0.00	44,849	31,201	37	41	0.495	0.894	0.894	0.477	0.718	0.930	3.53	0.28	0.22	0.80	0	-0.38	0.03	0.03	0.41	0.18	4.8	5.6	4.5	1.9	-7.1
0.071	0.26	1.76	-7.7	0.00	40,491	28,169	38	42	0.505	0.923	0.923	0.483	0.731	0.949	3.75	0.28	0.23	0.81	0	-0.42	0.03	0.04	0.43	0.21	5.1	5.9	4.8	1.6	-7.1

- 71 m with same input and optical parameter values for VECP ≤ 4.0 dB and TJ ≤ 0.8 UI jitter at 'TP4' at target BER

Conclusion

- Independent calculation based on 100 m PMD parameters values in petrilla_01_0113 indicates
 - 100 m on OM4
 - 71 m on OM3