40GBASE-ER4 optical budget proposals

Pete Anslow, Ciena

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Introduction

The Next Generation 40 Gb/s and 100 Gb/s Optical Ethernet Study Group SMF Ad Hoc has received three contributions proposing values for the 40GBASE-ER4 power budget:

anslow_01a_0812_smf.pdf

ulrichs_01_0912_smf.pdf

anderson_01_0912_smf.pdf

This contribution captures these proposals in one set of tables.

Table 87-9 changes

Table 87–9–40GBASE–LR4 and 40GBASE–ER4 illustrative link power budgets

Parameter	**40GBASE-LR4**	**40GBASE-ER4**		**anslow_01a_0812_smf**		**ulrichs_01_0912_smf**		**anderson_01_0912_smf**		**Unit**
Power budget (for max TDP)	9.3	(= B+C)		21.6		21.6		21.6		dB
Operating distance	10	(D)	40 [a]	30	40		40	30	40	km
Channel insertion loss [b]	6.7	(A)	(B)	16.5	19		19	16.5	18 |19	dB
Maximum discrete reflectance	-26			–26				–26		dB
Allocation for penalties [c] (for max TDP)	2.6	(C)		2.6		2.6		2.6		dB
Additional insertion loss allowed	0	(= B–A)	0	2.5	0		0	2.5	0	dB

[a] Links longer than (D) km are considered engineered links. Attenuation for such links needs to be less than the worst case for B1.1, B1.3, or B6_a single-mode cabled optical fiber.

[b] The channel insertion loss is calculated using the maximum distance specified in Table 87–6 and cabled optical fiber attenuation of 0.47 dB/km at 1264.5 nm plus an allocation for connection and splice loss given in 87.11.2.1.

[c] Link penalties are used for link budget calculations. They are not requirements and are not meant to be tested.

Table 87-7 changes

Table 87–7–40GBASE–LR4 and 40GBASE–ER4 transmit characteristics

Parameter	**40GBASE-LR**	**40GBASE-ER4**	**anslow_01a_0812_smf**	**ulrichs_01_0912_smf**	**anderson_01_0912_smf**	**Unit**
Signaling rate, each lane (range)	10.3125 ± 100 ppm			As LR4	As LR4	GBd
Lane wavelengths (range)	1264.5 to 1277.5 1284.5 to 1297.5 1304.5 to 1317.5 1324.5 to 1337.5			As LR4	As LR4	nm
Side-mode suppression ratio (SMSR), (min)	30		30	30	30	dB
Total average launch power (max)	8.3	(=F+6)		10.5	10.5	dBm
Average launch power, each lane (max)	2.3	(F ≤ f(G,L))		4.5	4.5	dBm
Average launch power, each lane [a] (min)	–7	(=H–3)	–1.7	–2.2	–2.7	dBm
Optical Modulation Amplitude (OMA), each lane (max)	3.5	(G)		5.5	5	dBm
Optical Modulation Amplitude (OMA), each lane (min) [b]	–4	(H=J+TDPmin)	1.3	0.8	0.3	dBm
Difference in launch power between any two lanes (OMA) (max)	6.5	(I)		4.7	4.7	dB
Launch power in OMA minus TDP, each lane (min)	–4.8	(J)	0.5	0	–0.5	dBm
Transmitter and dispersion penalty (TDP), each lane (max)	2.6	(K)	2.6	2.6	2.6	dB
Average launch power of OFF transmitter, each lane (max)	–30		–30	–30	–30	dBm
Extinction ratio (min)	3.5	(L)		5.5	5.5	dB
$RIN_{20}OMA$ (max)	–128		–128		–128	dB/Hz
Optical return loss tolerance (max)	20		20	20	20	dB
Transmitter reflectance [c] (max)	–12		–12	–12	–12	dB
Transmitter eye mask definition {X1, X2, X3, Y1, Y2, Y3}	{0.25, 0.4, 0.45, 0.25, 0.28, 0.4}			As LR4	As LR4	

Table 87-7 footnotes

[a] Average launch power, each lane (min) is informative and not the principal indicator of signal strength. A transmitter with launch power below this value cannot be compliant; however, a value above this does not ensure compliance.

[b] Even if the TDP < 0.8dB, the OMA (min) must exceed this value.

[c] Transmitter reflectance is defined looking into the transmitter.

Table 87-8 changes

Table 87–7–40GBASE–LR4 and 40GBASE–ER4 receive characteristics

Parameter	40GBASE-LR4	40GBASE-ER4	anslow_01a_0812_smf	ulrichs_01_0912_smf	anderson_01_0912_smf	Unit
Signaling rate, each lane (range)	10.3125 ± 100 ppm			As LR4	As LR4	GBd
Lane wavelengths (range)	1264.5 to 1277.5 1284.5 to 1297.5 1304.5 to 1317.5 1324.5 to 1337.5			As LR4	As LR4	nm
Damage threshold [a] (min)	3.3	(>F–N+1)	3.8	3.8	3.8	dBm
Average receive power, each lane (max)	2.3	(=F–N)		–1.5	–1.5	dBm
Average receive power, each lane [b] (min)	–13.7	(=H–3–B)	–20.7	–21.2	–20.7 | –21.7	dBm
Receive power, each lane (OMA) (max)	3.5	(=G–N)		–1	–1	dBm
Difference in receive power between any two lanes (OMA) (max)	7.5	(=I+Δ)	Δ = 2.3	7	7	dB
Receiver reflectance (max)	–26		–26	–26	–26	dB
Receiver sensitivity (OMA), each lane [c] (max)	–11.5	(=J–B)	–18.5	–19	–18.5 | –19.5	dBm
Receiver 3 dB electrical upper cutoff frequency, each lane (max)	12.3		12.3	12.3	12.3	GHz
Stressed receiver sensitivity (OMA), each lane [d] (max)	–9.6	(=J–B+M)	–16.3	–16.8	–16.3 | –17.3	dBm
Conditions of stressed receiver sensitivity test:						
Vertical eye closure penalty, [e] each lane	1.9	(M)	2.2	2.2	2.2	dB
Stressed eye J2 Jitter, [e] each lane	0.3		0.3	0.3	0.3	UI
Stressed eye J9 Jitter, [e] each lane	0.47		0.47	0.47	0.47	UI

Table 87-8 footnotes

[a] The receiver shall be able to tolerate, without damage, continuous exposure to an optical input signal having this average power level

[b] Average receive power, each lane (min) is informative and not the principal indicator of signal strength. A received power below this value cannot be compliant; however, a value above this does not ensure compliance.

[c] Receiver sensitivity (OMA), each lane (max) is informative.

[d] Measured with conformance test signal at TP3 (see 87.8.11) for BER = 10^{-12}.

[e] Vertical eye closure penalty, stressed eye J2 Jitter, and stressed eye J9 Jitter are test conditions for measuring stressed receiver sensitivity. They are not characteristics of the receiver.

Table 87-14 changes

Table 87–14–Fiber optic cabling (channel) characteristics ~~for 40GBASE–LR4~~

Parameter	**40GBASE-LR4**	**40GBASE-ER4**		**anslow_01a_0812_smf**		**ulrichs_01_0912_smf**		**anderson_01_0912_smf**		**Unit**
Operating distance (max)	10	(=D)	40	30	40		40	30	40	km
Channel insertion loss [a, b] (max)	6.7	(=B)		19		19		18 | 19		dB
Channel insertion loss (min)	0	(N)				7		6		dB
Positive dispersion [b] (max)	33.5		134	100.5	134			100.5	134	ps/nm
Negative dispersion [b] (min)	–59.5		–238	–178.5	–238			–178.5	–238	ps/nm
DGD_max [c]	10			12				12		ps
Optical return loss (min)	21			21				21		dB

[a] These channel insertion loss values include cable, connectors, and splices.

[b] Over the wavelength range 1264.5 nm to 1337.5 nm.

[c] Differential Group Delay (DGD) is the time difference at reception between the fractions of a pulse that were transmitted in the two principal states of polarization of an optical signal. DGD_max is the maximum differential group delay that the system must tolerate.

Conclusion

Based on the contributions received to date, the power budget for 40GBASE-ER4 baseline seems to be converging.

Thanks!