

Process (nm)	Year	Pads/ASIC	# differential pairs	4 x F04 delay (ps) MIN	4 x F04 delay (ps) MAX	Fmin (GHz)	Fmax (GHz)
45	2010	4600	1150	63	90	11.11	15.87
32	2013	4800	1200	44.8	64	15.63	22.32
22.5	2016	6000	1500	31.5	45	22.22	31.75
15.9	2019	6200	1550	22.26	31.8	31.45	44.92

Process (nm)	Year	Radix	pairs/link	Min BW/link (Gb/s)	Max BW/link (Gb/s)	Min I+O BW (Tb/s)		10Gb Serdes	Watts
						Total	Total		
45			64	18	200.0	285.7	12.8	18.29	147.46
			96	12	133.3	190.5	12.8	18.29	147.46
			128	9	100.0	142.9	12.8	18.29	147.46
			160	7	77.8	111.1	12.444	17.78	143.36
			192	6	66.7	95.2	12.8	18.29	147.46
32			64	18	281.3	401.8	18	25.71	75.50
			96	12	187.5	267.9	18	25.71	75.50
			128	9	140.6	200.9	18	25.71	75.50
			160	7	109.4	156.3	17.5	25	73.40
			192	6	93.8	133.9	18	25.71	75.50
22.5			64	24	533.3	761.9	34.133	48.76	51.54
			96	16	355.6	507.9	34.133	48.76	51.54
			128	12	266.7	381.0	34.133	48.76	51.54
			160	10	222.2	317.5	35.556	50.79	53.69
			192	8	177.8	254.0	34.133	48.76	51.54
15.9			64	24	754.7	1078.2	48.302	69	26.39
			96	16	503.1	718.8	48.302	69	26.39
			128	12	377.4	539.1	48.302	69	26.39
			160	10	314.5	449.2	50.314	71.88	27.49
			192	8	251.6	359.4	48.302	69	26.39

Serdes Scaling

Process (nm)	Year	10Gbaudm W/Gbps	25Gbaud mW/Gbps	Basis - existing 2007 20% CAGR (Rambus-ISSCC) power reduction for 10Gb and 1.5x adder for 25 Gb (OIF)
65	2007	25.00	37.50	
45	2010	12.80	19.20	
32	2013	6.55	9.83	
22.5	2016	3.36	5.03	
15.9	2019	1.72	2.58	

25Gb Serdes Min I/O Watts	10 Gb Serdes @ 75 watt reduction	Reduction estimate 10Gb Serdes pairs/link	Actual ≈= 75 watt 10 Gb SERDES I+O even number per link	10 Gb Serdes I+O Bandwidth (Tb/s)	I+O Power w/ 10Gb SERDES (watts)	10 Gb SERDES Bwidth/Power product (Tbps/Watt)
552.96	0.51	9	8	5.12	65.54	0.08
552.96	0.51	6	6	5.76	73.73	0.08
552.96	0.51	4	4	5.12	65.54	0.08
537.6	0.52	3	2	3.2	40.96	0.08
552.96	0.51	3	2	3.84	49.15	0.08
283.116	0.99	17	16	10.24	67.11	0.15
283.116	0.99	11	10	9.6	62.91	0.15
283.116	0.99	8	8	10.24	67.11	0.15
275.251	1.02	7	6	9.6	62.91	0.15
283.116	0.99	5	4	7.68	50.33	0.15
193.274	1.46	34	34	21.76	73.01	0.30
193.274	1.46	23	22	21.12	70.87	0.30
193.274	1.46	17	16	20.48	68.72	0.30
201.327	1.40	13	12	19.2	64.42	0.30
193.274	1.46	11	10	19.2	64.42	0.30
98.956	2.84	68	68	43.52	74.77	0.58
98.956	2.84	45	44	42.24	72.57	0.58
98.956	2.84	34	34	43.52	74.77	0.58
103.079	2.73	27	26	41.6	71.47	0.58
98.956	2.84	22	22	42.24	72.57	0.58

25 Gb Serdes @ 75 watt reduction	Reduction estimate 25Gb Serdes pairs/link	Actual \approx 75 watt 25 Gb		25 Gb Serdes I+O Bandwidth (Tb/s)	I+O Power w/ 25Gb SERDES (watts)	25 Gb SERDES Bwidth/Power product (Tbps/Watt)
		SERDES pairs I+O even number per link	SERDES pairs I+O Bandwidth (Tb/s)			
0.14	2	2	2	3.20	61.44	0.05
0.14	1	0	0	0.00	0.00	N/A
0.14	1	0	0	0.00	0.00	N/A
0.14	0	0	0	0.00	0.00	N/A
0.14	0	0	0	0.00	0.00	N/A
0.26	4	4	4	6.40	62.91	0.10
0.26	3	2	2	4.80	47.19	0.10
0.26	2	2	2	6.40	62.91	0.10
0.27	1	2	2	8.00	78.64	0.10
0.26	1	0	0	0.00	0.00	N/A
0.39	9	10	10	16.00	80.53	0.20
0.39	6	6	6	14.40	72.48	0.20
0.39	4	4	4	12.80	64.42	0.20
0.37	3	4	4	16.00	80.53	0.20
0.39	3	2	2	9.60	48.32	0.20
0.76	24	18	18	28.80	74.22	0.39
0.76	16	12	12	28.80	74.22	0.39
0.76	12	8	8	25.60	65.97	0.39
0.73	10	6	6	24.00	61.85	0.39
0.76	8	6	6	28.80	74.22	0.39

NOTES

power limited for 10Gb and 25Gb
25 Gb SERDES doesn't make sense at 45 nm

pin limited for 10 Gb, power limited for 25 Gb
25 Gb SERDES doesn't make sense at 32 nm

pin limited for 10 Gb, power limited for 25 Gb
25 Gb SERDES doesn't make sense at 22.5 nm

pin limited for both 10 and 25 Gb SERDES
25 Gb SERDES doesn't make sense at 15.9nm