Channel insertion loss for 1x64 and 1x128 split EPONs

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Task -1- Participants

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Abbreviations

- PLC = Planar Lightwave Circuit
- FBT = Fused Biconical Taper
- PSC = Passive Splitter Combiner
- WCS = Worst Case Scenario

1x64 / 1x128 port splitter analysis

- 1x64 port splitters available only in PLC from one company
- 1x128 do not exist on the market
- 1x64 / 1x128 port splitter loss was estimated by adding theoretical loss and excess loss approximated for lower port count devices
- PLC devices – more likely to be employed in high port count systems
  - better integration
  - easier processing
  - possibly lower end cost

PCS vendor data [1]

	port count	1:2	1:3	1:4	1:8	1:16	01:32	1:64	1:128
	Theoretical loss	3,01	4,77	6,02	9,03	12,04	15,05	18,06	21,07
Vendor1	SM M DW[1310,1550]		5.8	7.4					
	SM W DW[1310,1550]			7.2;0.8	10.8;1.5	14.4;2.0	18;2.5		
	SM M SW[1310/1550]		5,6	7,2					
	SM W SW[1310/1550]			6.8;0.6	10.2;0.9	13.6;0.8	17;1.5		
Vendor2	SM W DW[1310,1550] LGX	3.6;0.2	5.8;0.2	7.4;0.2	11.4;0.6	14.5;0.5	18.3;0.5		
	SM M DW[1310,1550]		6.1;0.4	7.7;0.4					
	SM M SW[1310/1550]		5.8;0.3	7.3;0.4					
	SM W DW[1310,1550] Tree	3.6;0.2	5.8;0.2	7.4;0.2	11.4;0.6	14.5;0.5			
	SM W SW[1310/1550] Tree	3.5;0.2	5.7;0.3	7.2;0.3	11.0;0.6	14.0;0.5			
	SM PLC WW[1260-1550]				11.5;1.2	14.7;1.7	18.3;2.2		
	SM PLC WW[1260-1650] LGX			8.0;1.0	11.5;1.2	14.7;1.7	18.3;2.2		
	SM PLC WW[1260-1550] Premium			7.5;1.0	10.7;1.0	14.2;1.5	17.0;2.0		
	SM PLC WW[1260-1550] Standard			7.5;1.0	11.0;1.0	14.2;1.5	17.8;2.0		
Vendor3	SM PLC DW[1310,1550] Standard				11.0;1.0	14.5;1.5	17.3;2.0		
	SM PLC DW[1310,1550] Premium				10.4;0.8	13.8;1.3	16.8;1.5		
Vendor4	SM PLC DW[1310,1550]			7.5;0.8	10.8;1.0	14.0;1.5	16.5;1.8		
	SM FBT DW[1310,1550]	3.6;0.8		7.2;1.0	10.7;1.3	14.0;1.6	17.6;1.9		
	SM FBT DW[1310,1550] Rugged			7.5;0.8	10.8;1.0	14.0;1.5	16.5;1.8		
Vendor5	SM FBT DW[1310,1550]	3.9;0.5		7.3;1.0	10.7;1.5	14.5;2.0			
	SM PLC DW[1310,1550] Rugged						16.2;1.6		
	SM FBT DW[1310,1550] Rugged						17.2;1.8		
Vendor6	SM FBT DW[1310,1550]			7.5;0.6	10.7;1.0	14.0;1.3	17.5;1.5		

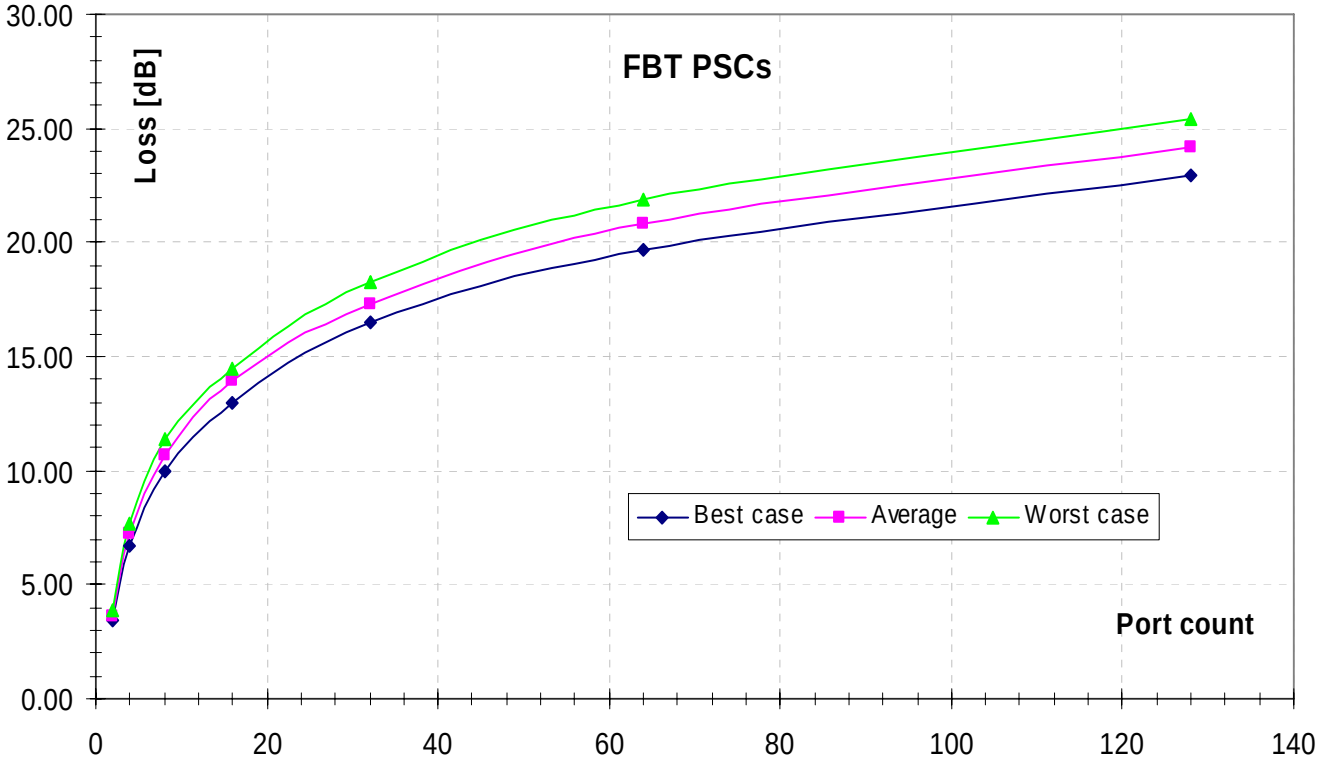
PCS vendor data [2]

	port count	1:2	1:3	1:4	1:8	1:16	01:32	1:64	1:128
	Theoretical loss	3,01	4,77	6,02	9,03	12,04	15,05	18,06	21,07
Vendor7	SM PDL DW[1310,1550] Initial	4,5		7,9	11,2	14,5			
	SM PDL DW[1310,1550] class A			7.3;0.5	10.5;0.8	13.8;1.0	17.1;1.3	20.5;2.0	
	SM PDL DW[1310,1550] class B			7.5;0.6	10.9;1.0	14.0;1.1	17.5;1.5	21.0;2.5	
	SM PDL DW[1310,1550] class C			8.0;0.8	11.4;1.2	14.5;1.4	18.5;1.7	22.0;3.0	
Vendor8	SM PDL DW[1310,1550]			7.0;0.7	10.3;1.0	13.8;1.6	16.9;1.9		
	SM FBT DW[1310,1550]	3.4;0.5							
Vendor9	SM PLC DW[1310,1550]			7.5;0.8	10.8;1.0	14.0;1.5	17.2;1.8		
Vendor10	SM PLC SW[1310/1550] class A			6.4;0.6	9.7;1.0	12.9;1.5			
	SM PLC SW[1310/1550] class B			6.6;1.0	9.9;1.5	13.3;2.1			
	SM PLC DW[1310,1550] class A			6.8;1.3	10.3;2.0	13.7;2.7			
	SM PLC DW[1310,1550] class B			7.1;1.7	10.7;2.7	14.4;3.7			
Vendor11	SM PLC DW[1310,1550]	3.9;0.5		7.4;0.9	10.8;1.0	14.1;1.3	17.3;1.6		
Vendor12	SM PLC DW[1310,1550]			7.0;0.5	10.3;0.5	13.4;0.8	16.8;0.9		
Vendor13	SM PLC DW[1310,1550]				11.6;2.0				
Vendor14	SM PLC DW[1310,1550] modules			7.4;0.8	10.3;1.0	14.0;1.3	17.4;1.5		
Vendor16	SM FBT DW[1310,1550] class A	3.6;0,8		6.7;0.8	10.0;1.2	13.0;2.4	17.0;3.2		
	SM FBT DW[1310,1550] class B	3.8;1.2		7.2;1.2	11.0;3.0	14.0;3.8	18.0;5.0		
	SM PLC DW[1310,1550]			7.3;0.75	10.6;1.0	14.0;1.5	17.3;2.3		
Vendor17	SM FBT DW[1310,1550] class A	3.6;1.0	5.8;1.0	7.2;1.5					
	SM FBT DW[1310,1550] module			6.7;1.2	10.0;1.8	13.3;2.4	16.6;3.0		
Vendor18	SM PLC DW(1310,1550]			6.64;0.36	10.27;1.01	13.58;1.01	16.62;1.01		
Vendor19	SM PLC DW(1310,1550]			7.0;0.8	11.5;1.0	14.5;1.5	17.5;2.0		
Vendor20	SM PLC DW(1310,1550]			7.5;0.6	11.0;0.8	14.0;1.2	18.0;1.7		

FBT PSCs

Port count	2	4	8	16	32	64	128
Min loss [dB]	3.40	6.70	10.00	13.00	16.50	19.67	22.92
Average loss [dB]	3.63	7.22	10.72	13.95	17.30	20.78	24.19
Max loss [dB]	3.90	7.70	11.40	14.50	18.30	21.84	25.40

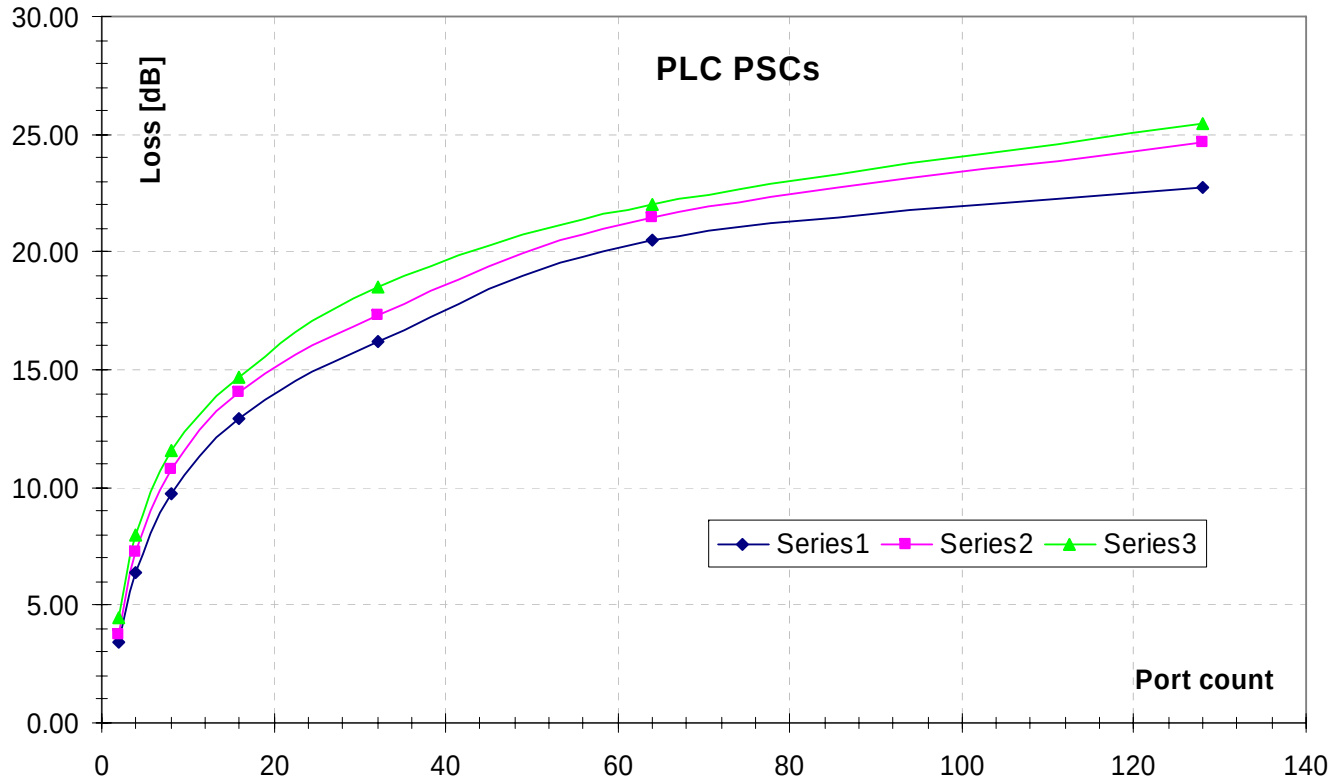
Estimated values



PLC PSCs

Port count	2	4	8	16	32	64	128
Min loss [dB]	3.40	6.40	9.70	12.90	16.20	20.50	22.77
Average loss [dB]	3.78	7.30	10.75	14.03	17.33	21.50	24.65
Max loss [dB]	4.50	8.00	11.60	14.70	18.50	22.00	25.43

Estimated values



Assumptions for loss budget estimation

- Channel insertion loss:
  - includes: splitter, splices, connectors, fibre cable
  - does not include: non-linear effects
- Minimum channel insertion loss based on table 60-1 from IEEE 802.3 - 2005
- 1x64 / 1x128 splitter loss was estimated
- No assumptions on TX / RX for ONU / OLT
- Power margin is not included in the final loss budget estimation -> Task 4
- Presented values are based on average expected splitter loss – best available splitters loss lower by approx. 1dB for 1x128 devices (added cost & selection required)

1x64 / 1x128 split @ 10 / 20 km [average]

1x64	10km			20km		
PLC PSCs	fibre loss [dB]	spliced [dB]	connectorized [dB]	fibre loss [dB]	spliced [dB]	connectorized [dB]
1x64	5	26.90	27.30	10	31.90	32.30
1x32 + 1x2	5	26.51	27.31	10	31.51	32.31
1x16 + 1x4	5	26.73	27.53	10	31.73	32.53
1x8 + 1x8	5	26.90	27.70	10	31.90	32.70
1x16 + 1x2 + 1x2	5	26.99	28.19	10	31.99	33.19
1x8 + 1x4 + 1x2	5	27.23	28.43	10	32.23	33.43
1x4 + 1x4 + 1x4	5	27.30	28.50	10	32.30	33.50

1x128	10km			20km		
PLC PSCs	fibre loss [dB]	spliced [dB]	connectorized [dB]	fibre loss [dB]	spliced [dB]	connectorized [dB]
1x128	5	30.05	30.45	10	35.05	35.45
1x64 + 1x2	5	30.68	31.48	10	35.68	36.48
1x32 + 1x4	5	30.03	30.83	10	35.03	35.83
1x16 + 1x8	5	30.18	30.98	10	35.18	35.98
1x32 + 1x2 + 1x2	5	30.29	31.49	10	35.29	36.49
1x16 + 1x4 + 1x2	5	30.51	31.71	10	35.51	36.71
1x8 + 1x8 + 1x2	5	30.68	31.88	10	35.68	36.88

1x64 / 1x128 split @ 10 / 20 km [WCS]

1x64	10km			20km		
PLC PSCs	fibre loss [dB]	spliced [dB]	connectorized [dB]	fibre loss [dB]	spliced [dB]	connectorized [dB]
1x64	5	27.40	27.80	10	32.40	32.80
1x32 + 1x2	5	28.40	29.20	10	33.40	34.20
1x16 + 1x4	5	28.10	28.90	10	33.10	33.90
1x8 + 1x8	5	28.60	29.40	10	33.60	34.40
1x16 + 1x2 + 1x2	5	29.10	30.30	10	34.10	35.30
1x8 + 1x4 + 1x2	5	29.50	30.70	10	34.50	35.70
1x4 + 1x4 + 1x4	5	29.40	30.60	10	34.40	35.60

1x128	10km			20km		
PLC PSCs	fibre loss [dB]	spliced [dB]	connectorized [dB]	fibre loss [dB]	spliced [dB]	connectorized [dB]
1x128	5	30.83	31.23	10	35.83	36.23
1x64 + 1x2	5	31.90	32.70	10	36.90	37.70
1x32 + 1x4	5	31.90	32.70	10	36.90	37.70
1x16 + 1x8	5	31.70	32.50	10	36.70	37.50
1x32 + 1x2 + 1x2	5	32.90	34.10	10	37.90	39.10
1x16 + 1x4 + 1x2	5	32.60	33.80	10	37.60	38.80
1x8 + 1x8 + 1x2	5	33.10	34.30	10	38.10	39.30

Conclusions

- Estimated channel insertion loss:

Scenario \ PSC	Spliced [average]	Spliced [WCS]	Connectors [average]	Connectors [WCS]
1x64 @ 10 km	**26.94 dB**	**28.64 dB**	**27.85 dB**	**29.56 dB**
1x64 @ 20 km	**31.94 dB**	**33.64 dB**	**32.85 dB**	**34.56 dB**
1x128 @ 10 km	**30.35 dB**	**31.12 dB**	**31.26 dB**	**33.05 dB**
1x128 @ 20 km	**35.35 dB**	**37.13 dB**	**36.26 dB**	**38.05 dB**

- [average] = average among average values of all examined PSC combinations for a particular total split
- [WCS] = average among worst case values of all examined PSC combinations for a particular total split

- **The presented channel insertion loss does not include optical margins for component / fiber ageing, repair, or dispersion penalties.**